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COOPERATIVE AGREEMENT AID-492-CA-1707
PROJECT NO. 498-0265

ANNUAL PROGRESS REPORT
September 30, 1985

COOPERATIVE AGREEMENT AID-492-CA-1707
Project No. 498-0265

Annual Progress Report
September 30, 1985

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COOPERATIVE AGREEMENT AID 492-CA-1707
Project Number 498-0265

ANNUAL PROGRESS REPORT
September 30, 1985

Project Title: Extension of Small-Scale Agricultural Equipment
The International Rice Research Institute

One of the main problems of farmers in the world, including the small farmers of Asia, is the high costs of production. As countries increase the production of crops, the world market prices continue to be relatively stable but the input costs continue to rise. As a result, farmers are looking for ways to reduce their costs of production. Agricultural machinery can often reduce these costs.

Although there is an abundance of labor in many countries, labor shortages still exist at critical times of production such as when preparing land for planting or at harvest time. Because such labor is also costly, farmers are looking for small simple machines to reduce costs, and enable them to complete critical tasks on a timely basis.

There was considerable change in the Agricultural Engineering Department during 1985. The Economics Section of the Department was transferred to the Agricultural Economics Department effective January 1, 1986. This move involved one senior staff member, Mr. Bart Duff, Associate Economist, and six junior staff.

On April 1, 1985, Mr. Makoto Ariyoshi, Agricultural Engineer, retired. Because of budget limitations, the position was eliminated.

The official date of termination for the Industrial Extension project (Cooperative Agreement AID 492-CA-1707) was September 30, 1985. The Philippine phase, and the India phase were continued for one more year to enable the local USAID missions to establish budgets for continuation of the projects. The Headquarters, the Indonesia, and the Thailand components were terminated.

Table 1 shows the organization chart for the Agricultural Engineering Department from April 1 to September 30, 1985. Effective October 1, 1985, the chart was the same except for the elimination of the Thailand and Indonesian Industrial component. The activities in Burma and Egypt were terminated on December 31, 1985.

In general the project has made considerable progress in providing assistance to national programs. In Indonesia and Thailand the Industrial Extension activity is now a part of the national program. The manufacturers are assisted in fabrication of the prototype machines and are provided blueprints. Organized field days and demonstrations are bringing the new machines to the attention of farmers.

Headquarter Activities

1. Staffing

The staffing of the Agricultural Engineering Department as of September 30, 1985 was as follows:

Dr. C. W. Bockhop, Head of Department and Project Leader of Industrial Extension; and with major responsibility for Evaluation and Testing, Industrial Liaison and Training.

Dr. Amir U. Khan, Agricultural Engineer, with major responsibility for Design and Development.

Dr. Yong Woon Jeon, Associate Agricultural Engineer, with major responsibility in Grain Drying Research and Crop Utilization. Funds for his support and for a research project on Grain Drying are provided by the International Development Research Center.

Support staff included two assistant engineers, three senior research assistants, 11 research assistants, 3 shop supervisors, 4 secretaries, and 29 technicians, shop personnel and laborers.

The Department had one Visiting Scientist. Dr. M. A. Choudhary, Senior Researcher, Massey University, Palmerston North, New Zealand was appointed for six months starting November 5, 1985 with special assignment of development of planters and seeders for upland conditions.

Outreach Staff

Dr. Robert Stickney, Agricultural Engineer, Adviser to the Industrial Extension Program in the Philippines, stationed in Manila working with the Agricultural Engineering Division, Ministry of Agriculture and Forestry.

Mr. Fred Nichols, Agricultural Engineer, Adviser to the Industrial Extension program in India stationed in Coimbatore,

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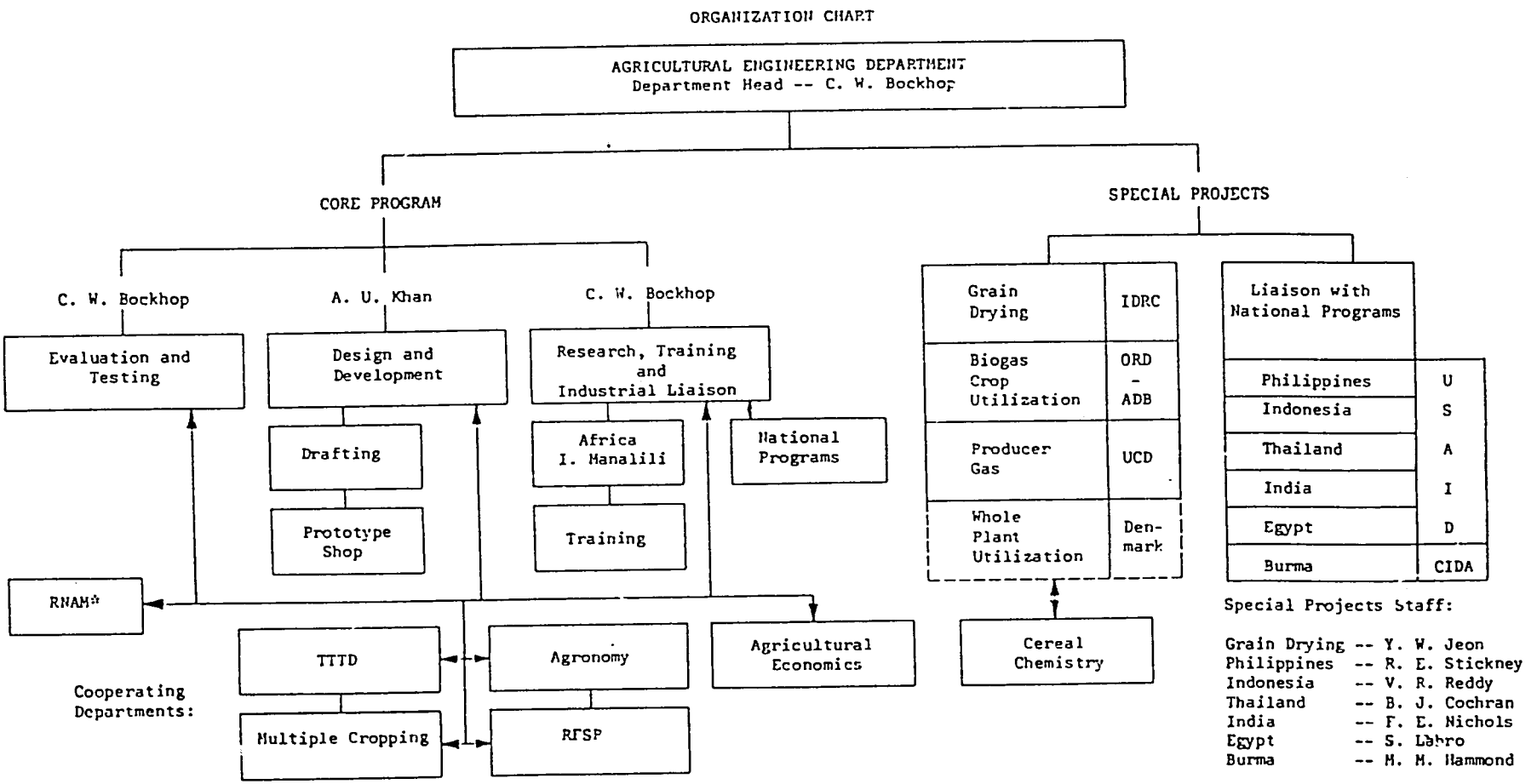
TABLE 1



*Regional Network for Agricultural Machinery

Tamil Nadu State. The program is administered by the Central Institute of Agricultural Engineering in Bhopal.

Mr. V. R. Reddy, Agricutural Engineer, Adviser to the Industrial Extension Program in Indonesia stationed in Jakarta. This program terminated on September 30, 1985.

Dr. B. J. Cochran, Agricultural Engineer, Adviser to the Industrial Extension program in Thailand stationed in Bangkok. This program terminated on September 30, 1985.

Although not part of the program supported by this project, the following were assigned to IRRI Industrial Extension Programs in other countries:

Mr. S. Labro, Assistant Engineer, Agricultural Engineering Department, IRRI, was assigned at the Egypt Rice Project stationed in Sakha, Egypt. This project, part of a University of California at Davis contract with USAID, terminated on December 1, 1985.

Mr. Malcolm M. Hammond, Agricultural Engineer, was assigned to a project located in Yezin, Burma. The project terminated on December 31, 1985.

2. Training

The following scholars were supported by IRRI while pursuing requirements leading to the Master of Science degree:

Miss Leonides Halos, Research Assistant in the department, was awarded the degree of Master of Engineering by the Asian Institute of Technology, Bangkok, Thailand. The thesis title is, "Performance Analysis of an IRRI Natural Convection Dryer". Adviser: Y. W. Jeon.

Mr. Wenceslaus George Kilasara completed research for a thesis as partial requirement for a Master of Science Degree in Agricultural Engineering from the Faculty of Agriculture, Sokoine University of Agriculture, Morogoro, Tanzania. The title of his thesis is "Construction and Evaluation of a Modified Multi-crop Thresher, Model IRRI-PAK". Adviser: C. W. Bockhop.

Mr. Francis Mwombeki completed research for a thesis as partial requirement for a Master of Science Degree in Agricultural Engineering from the Faculty of Agriculture, Sokoine University of Agriculture, Morogoro, Tanzania. The title of his thesis is "Auger Metering Studies for Fine Prilled Urea". Adviser: A. U. Khan.

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Mr. Luhong Zhang, China, continued his studies toward a Master of Science degree at UPLB. His thesis title is "The Force Analysis of Corn Kernel Detachment". He is expected to graduate in 1986.

Mr. Thanya Kiatiwat, Thailand, continued his studies toward a Master of Science Degree at the University of the Philippines at Los Banos. The title of his thesis is "Determination of Optimum Design Parameters of the IRRI-Designed Axial Flow Pump". He is expected to graduate in 1986.

Mr. Trinh Ngoc Vinh, Vietnam, began his studies toward the Master of Science Degree at the University of the Philippines at Los Banos in November, 1985.

Mr. Than Shein, Burma, began his studies toward the Master of Science degree at the University of the Philippines in Los Banos in July, 1985.

The Agricultural Engineering Department conducted two courses during 1984-85, each of three weeks duration. A copy of the course schedule for the course May 27 to June 14 is included in Appendix A. Attendance for the two courses is shown in Table 1.

3. Machinery Development

The objectives for Machinery Development for 1985 were:

1. to complete the design, development, and testing of fertilizer application machines.

2. to design and develop machines for the direct seeding of rice

3. to develop seeders and planters for upland conditions

4. to develop machines for the incorporation of organic materials into the soil

The work on fertilizers is nearly completed and several experimental machines for direct seeding of rice have been developed.

A unique planter for upland conditions has been developed by a Visiting Scientist from Massey University and will be tested during 1986. Several machines to incorporate organic material are being tested.

Table 1. Attendance at Agricultural Engineering Course

Country	Nov. 19 - Dec. 7 '84	May 27 - June 14 '85
Bangladesh		1
China		2
India		1 (a)
Indonesia	1 (a)	2 (a)
Iran		1
Philippines	4 (a)	5 (a)
Sri Lanka	5	3
Thailand	2 (a)	2 (a)
Vietnam		1
	12	18

(a) Received support from USAID Cooperative Agreement 492-CA-1707. All others were supported from other sources.

A detailed summary of machinery development is included in Appendix B.

4. Crop Drying

The department is engaged in research on crop drying, biogas, and biomass utilization research. A detailed summary of the crop drying research is included as Appendix B.

5. Conference, September 2-7, 1985

The conference on "Small Farm Equipment for Developing Countries: Past Experiences and Future Priorities" was convened at the International Rice Research Institute to discuss the experiences of those who have been developing machines for the small farmer and review and evaluate the results of past efforts. Ninety research workers from 24 countries gathered at IRRI in Los Banos September 2-7, 1985. After the formal presentation of papers, committees met to develop recommendations for future work. These recommendations are a part of the proceedings; and we hope that they will provide guidance for those who will be developing programs of mechanization for the small farm.

The conference was made possible by a grant from the United States Agency for International Development.

6. Other Activities

In addition to administration of the Agricultural Engineering Department and the supervision of the Industrial Extension Outreach Program, C. W. Bockhop served as a member of the Technical Advisory Committee of the Regional Network for Agricultural Machinery (RNAM), an agency funded by UNDP.

Dr. B. J. Cochran, Dr. V. R. Reddy, Mr. F. E. Nichols, Dr. R. E. Stickney, and Dr. C. W. Bockhop attended the Annual Meeting of the American Society of Agricultural Engineers at Michigan State University, East Lansing, Michigan, June 23-26, 1985.

Dr. C. W. Bockhop was coordinator for the IRRI training program, "Orientation cum Training Program on Improving the Income and Employment Potential of Rice Farming Systems". A ten-day training program was held October 1-11, 1985.

Dr. C. W. Bockhop participated in the Grains Post Harvest Workshop in Kuala Lumpur, Malaysia, October 8-10, 1985.

OUTREACH PROGRAMS

Philippines

The MAF-IRRI Industrial Extension project is extended to September 30, 1986.

The project has made good progress in the short time it has been in existence but needs furthr extension before the activities will become an integral part of the national program.

A report for 1984-85 follows.

MAF-IRRI INDUSTRIAL EXTENSION PROGRAM FOR SMALL FARM EQUIPMENT

Agricultural Engineering Division, Bureau of Plant Industry
Ministry of Agriculture and Food
Philippines

ANNUAL REPORT: October 1, 1984 through September 30, 1985

and

PROPOSED WORK PLAN: October 1, 1985 through September 30, 1986

I. INTRODUCTION

The objectives, priorities, organizational structure, and activities of the MAF-IRRI Program are summarized in Annex A. These aspects of the Program have not changed significantly since the previous annual report in which detailed descriptions were provided.

II. PRINCIPAL ACCOMPLISHMENTS: OCTOBER 1, 1984 - SEPTEMBER 30, 1985

1. Institutionalization

- Four new MAF engineers attended the IRRI three-week training course on agricultural engineering, and five others received "on-the-job" practical training for three months at BPI, IRRI, and in the field.

- Collaboration with MAF regional offices (both extension and research) has increased, as summarized in Annex B.

- Efforts have been continued to establish closer collaboration with related programs, such as the Farming Systems and Rainfed Resources programs, Philippine-Australian Development Projects (Zamboanga del Sur and Northern Samar), and the Agricultural Mechanization Development Program (UPLB).

- Communication linkages with farmers and manufacturers have improved by utilizing existing agricultural programs on television (e.g., Ating Alamin) and local radio, and also continuing with written materials (leaflets, newspaper and journal articles), some in local dialects.

2. Participatory Efforts of IRRI, MAF, Manufacturers, and Farmers

- In our opinion, the Program's most important achievement is the development of synergistic efforts which combine: (a) the high-level science and technology of IRRI; (b) the regional R&D and extension capabilities of MAF; and (c) the practical "know-how" and innovations of exceptional manufacturers and farmers. This participatory approach has resulted in substantial advances,

including: (a) a more economical procedure for preparing rice seedlings for the transplanter (Annexes D and H); (b) a simple modification of the axial-flow thresher so it may also serve as a corn sheller (Annexes C and H); (c) a 50% reduction in the cost of the axial-flow pump (Annex G); and (d) experimental prototypes of a paddy dryer and a hydro-tiller (Section 4 below) which involved the participation of both users and manufacturers. We believe that successful development of appropriate agricultural equipment for small farmers requires collaborative efforts of the public and private sectors; - e.g., research, extension, industry, and consumers (farmers).

3. Equipment Promotion

- 1984 production statistics (Table 1) for cooperating manufacturers indicate that the depressed economic situation in the Philippines has resulted in a decreased demand for certain types of equipment.

- Thresher/sheller : Ten cooperating manufacturers have been assisted to produce the MAF-IRRI thresher/sheller modification of the popular IRRI-type axial-flow thresher. MAF purchased 50 thresher/shellers for areas where corn production is hampered by the shortage of shellers. The MAF-IRRI Program was awarded a Presidential Medal for the development of the thresher/sheller (Annex C).

- Transplanter : As a result of an intensified extension effort, sales of manually-operated transplanters increased slightly. Acceptance of the transplanter is slow due to both technical and economic factors, as well as the increasing trend of farmers to adopt direct seeding. (See Annex D.)

- One-meter Reaper : Sales fell drastically due to technical and socio-economic factors described in Annex E. We are working to overcome the technical problems, but will restrict reaper promotion until the country's economic situation has improved.

- Seed and Fertilizer Applicator (SFA) : Sales have increased very slowly, primarily due to the depressed economy and the fact that planting equipment generally is the last type of agricultural technology to be accepted by farmers in developing countries.

- Tapak-Tapak Pump : This foot-operated pump for small rainfed farms was introduced during late 1984, and initial farmer acceptance has been encouraging. The pump and associated extension program are described in Annex F.

- Chipping Machine : The design of this machine has been improved and three cooperating manufacturers are now fabricating units. MAF purchased 60 units for areas where sweet potato production is limited by the lack of chipping and drying facilities. Intensive durability tests are now needed.

4. Equipment Being Developed

- Sipa Pump : Since sales of the IRRI axial-flow pump were low due to its high cost, we developed a lower cost version which combines the best features of the IRRI design with innovations developed by farmers and manufacturers in Bicol. The technical features of the pump are described in Annex G. Initial extension efforts indicate that the pump will be accepted by farmers for rainfed and partially irrigated rice fields and perhaps fishponds.

- Manually-operated Corn Sheller : Small upland farmers in Zamboanga del Sur have shown interest in a low-cost (approx. ₱200) corn sheller (Fig. 1) promoted by the Philippine-Australian Development Program and now produced by local shops. We will explore farmer acceptance in other regions.

- Rotary Dryer : This low cost dryer which utilizes rice hull as fuel is designed for areas (e.g., Bicol and Mindanao) where traditional sundrying of rice is often delayed due to clouds and rain, thereby resulting in serious deterioration of grain quality and, consequently, farm-gate price. A full-size prototype is now being tested in collaboration with a rice mill in Bicol (Fig. 2).

- Manually-operated Weeders : In collaboration with IRRI and MAF, we will evaluate push-type paddy weeders (Fig. 3), - now popular in only a few provinces (e.g., Laguna, Leyte, and Nueva Vizcaya) as a labor-intensive technology for reducing inputs of costly herbicides and fertilizers (by improving incorporation). Weeders developed by UPLB, IRRI, and local manufacturers will be evaluated.

- Hydro-Tiller : Sled-type ("floating") power tillers developed by several innovative manufacturers in the Philippines over the past 10 years have gained considerable acceptance in Western Visayas and Mindanao. We have modified the design to overcome common problems of uneven tillage and poor maneuverability and control. The prototype (Fig. 4) is now being tested to determine technical and economic performance, e.g., reductions in cost and improved timeliness of land preparation, with possible increase in cropping intensity.

III. PRINCIPAL PROBLEMS

1. Depressed socio-economic conditions have severely reduced the demand for agricultural equipment in many areas. This problem is aggravated by high interest rates (40% or more) and social unrest. Since the MAF-IRRI Program has no control over these factors, our only alternative is to readjust our extension areas and give more attention to low-cost equipment.

2. Shortage of qualified staff is an increasingly severe problem. MAF regulations prevent BPI Engineering from hiring needed staff, and our Program has lost three of its most qualified engineers during the recent year, - one to NFAC and two to the Middle East. The present staff is unable to carry out the design, drafting, and prototype fabrication requirements of the Program's work plan. Moreover, it appears that the new MAF staffing pattern will eliminate the positions of most of our regional engineers. In addition, we have not yet found a suitable engineer to be trained as the Program's coordinator, as described on page 8 of Annex H.

3. Reduced MAF budget has severely limited the activities of MAF-IRRI engineers, especially with respect to per diem and fuel for travel relating to extension activities in the provinces. This problem has been brought to the attention of the Program's Advisory Committee, as well as BPI and ARO (Annex B), but a suitable solution has not yet been found.

4. Inadequate collaboration by IRRI Engineering has limited the effectiveness of the MAF-IRRI Program. Although the two IRRI engineers assigned to Industrial Extension have close collaboration with the Program, the remainder of the Engineering Department has generally failed to respond to the Program's request for engineering, drafting, and shop assistance. Steps for improving collaboration have been discussed with IRRI's Director General and Engineering Department Head.

IV. PROPOSED WORK PLAN : OCTOBER 1, 1985 - SEPTEMBER 30, 1986

As indicated in Annex H, the MAF-IRRI Program has readjusted its objectives to favor lower cost equipment suitable for small farmers in rainfed areas, both upland and lowland. Highest priority will be given to pumps and implements that will increase cropping intensity. In addition, the main objective will be to continue to strengthen the institutional structure of the Program. However, these efforts will only be successful if the above-mentioned problems concerning staff, budget, and collaboration are resolved. We are requesting the Program's Advisory Committee to help us overcome these problems.

See Annex H for additional details on future plans.

Table 1

PRODUCTION STATISTICS FOR MAF-IRRI COOPERATING MANUFACTURERS

PHILIPPINES 1975-1984

EQUIPMENT	YEAR										TOTALS
	1975	1976	1977	1978	1979	1980	1981	1982	1983	1984	
1. Hand Tractor (various designs)	2178	2586	856	795	1337	978	1107	2310	2268	1985	16400
2. Axial Flow Thresher (TH7 & 8)	275	552	494	689	1850	1059	1417	1689	1162	1571	10758
3. Portable Thresher (TH6)	-	-	827 1/	1746	2290	1218	1275	1113	1129	515	10113
4. Batch Dryer (BD1, BD2, and variations)	33	93	64	34	47	82	118	47	26	95	639
5. Axial Flow Pump (PU4)	-	-	-	-	13 2/	55	66	38	86	63	321
6. Transplanter (TR1, 4, and 5)	-	-	-	-	-	17 3/	82	73	31	80	283
7. 1.0 m Reaper (RE2)	-	-	-	-	-	-	-	37 4/	363	40	440
8. Seed and Fertilizer Applicator (SFA)	-	-	-	-	-	-	-	50 5/	67	74	191
9. Tapak-Tapak Pump	-	-	-	-	-	-	-	-	-	213 6/	213
TOTALS	2486	3231	2241	3264	5537	3409	4065	5357	5132	4636	39358
No. of manufacturers reporting	14	19	17	20	21	31	33	55	75	79	

1/ Portable thresher was released during later part of 1976.

2/ Axial flow pump was released during 1979.

3/ Transplanter was first released during later part of 1979; modified version released in 1983.

4/ 1.0 m reaper was introduced in early 1982.

5/ Seed and fertilizer applicator was introduced in 1983; data include existing designs.

6/ Tapak-Tapak pump was introduced in late 1983.

NOTE: These statistics should not be interpreted as being representative of the total production of agricultural equipment in the Philippines because: a) data have been obtained only from MAF-IRRI cooperating manufacturers; and b) the number of cooperators has increased markedly over the past four years.

Fig. 1. Manually-operated corn sheller promoted by the Philippine-Australian Development Program in Zamboanga del Sur.

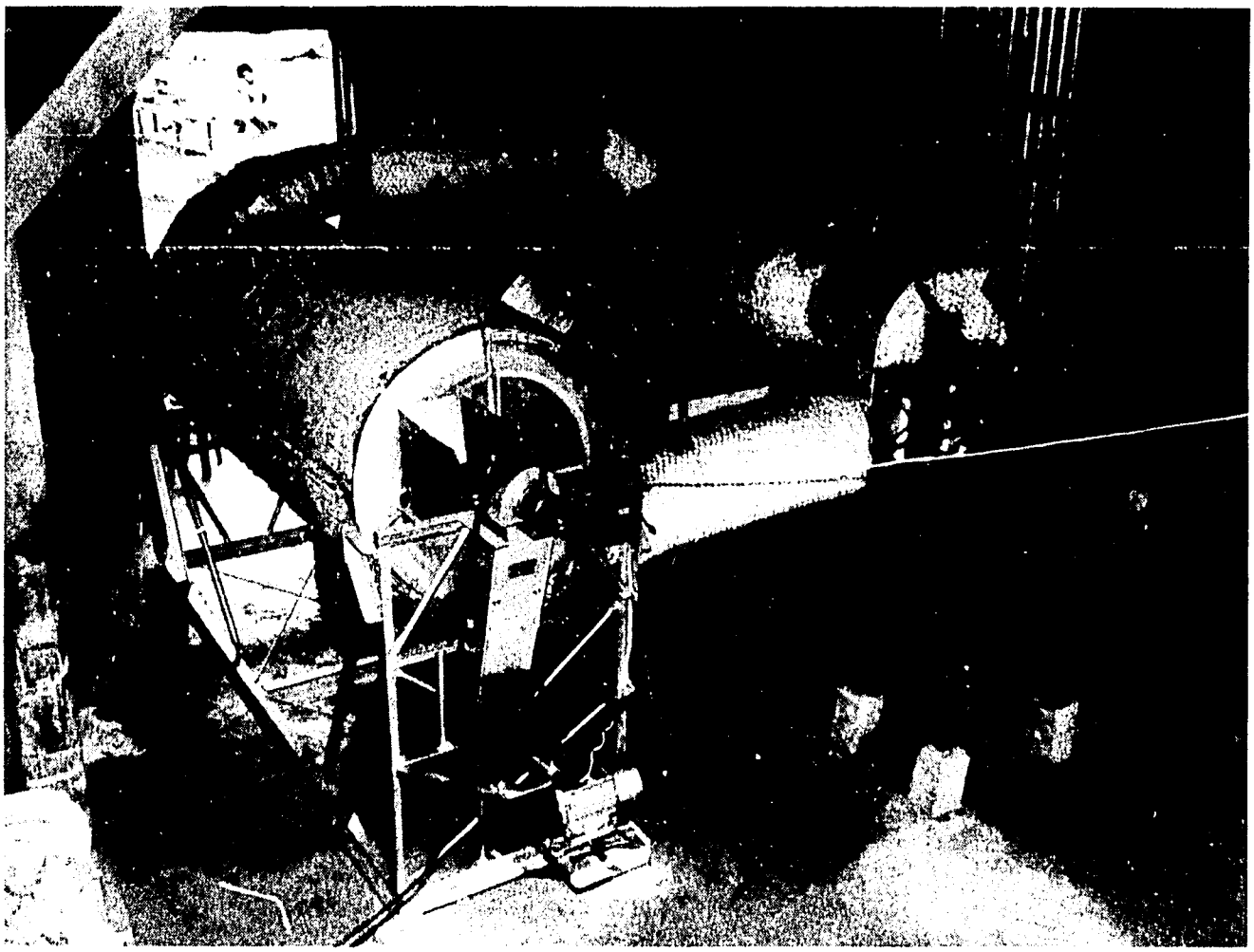

Figure 2. MAF-IRRI rotary dryer for partial drying of paddy, using rice hull as fuel.

Figure 3. IRRI push-type paddy weeder

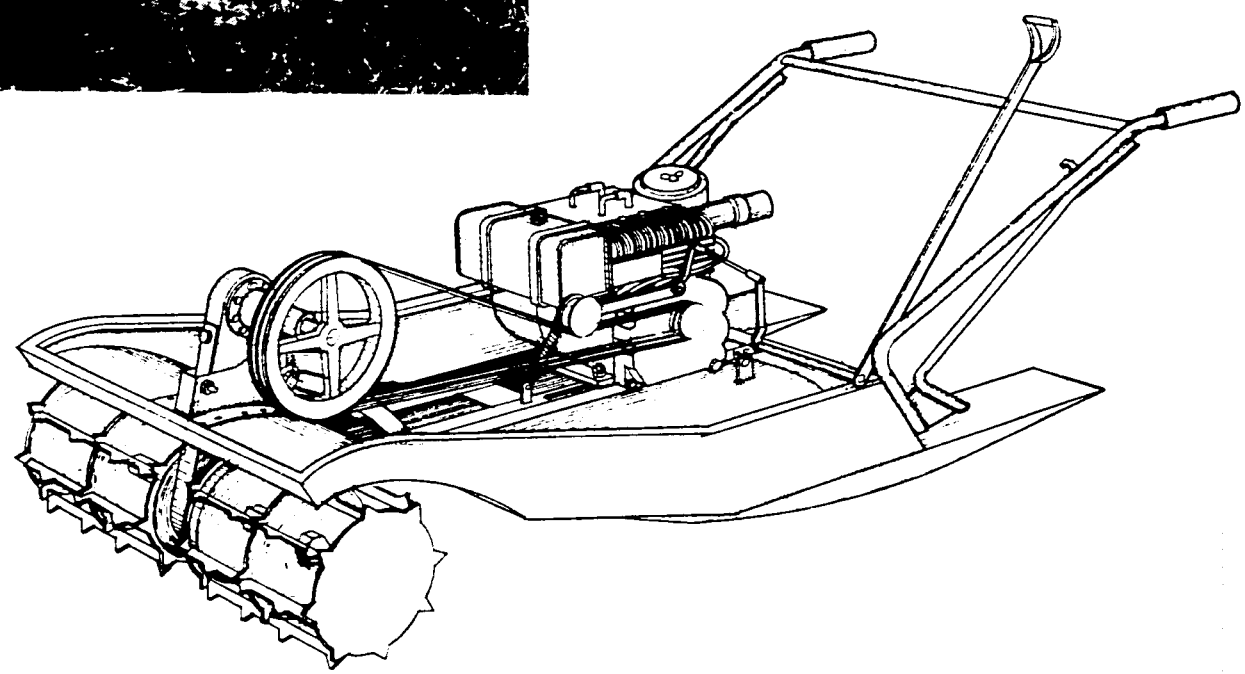

Figure 4. MAF-IRRI hydro-tiller (experimental prototype now under testing).

MAF-IRRI INDUSTRIAL EXTENSION PROGRAM FOR SMALL FARM EQUIPMENT

ANNEXES

for

ANNUAL REPORT
(1984-1985)

Annex A	-	Extension of Small-Farm Equipment in the Philippines.
Annex B	-	Summary of Regional Activities of the MAF-IRRI Program.
Annex C	-	Announcement on the MAF-IRRI Program's presidential medal award for developing the thresher/sheller.
Annex D	-	Rice Seedling Transplanters: Philippines.
Annex E	-	CAAMS-IRRI Mechanical Reaper: Experiences in the Philippines.
Annex F	-	Human-Powered Pump for Low-Lift Irrigation.
Annex G	-	MAF-IRRI "Sipa" Pump leaflet
Annex H	-	Draft Proposal for MAF-IRRI Program for Small Farm Equipment.

ANNEX A

EXTENSION OF SMALL-FARM EQUIPMENT IN THE PHILIPPINES

by

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For presentation at the CHINESE ACADEMY OF AGRICULTURAL MECHANIZATION SCIENCES

Beijing, Peoples Republic of China
October, 1984

SUMMARY:

The Philippine Ministry of Agriculture and the International Rice Research Institute have undertaken an extension program on agricultural equipment suitable for small farmers and capable of being fabricated by small-scale manufacturers. This report describes the program's focus, activities, and achievements during the period 1981-84.

• AGRICULTURAL ENGINEERING DEPARTMENT •
THE INTERNATIONAL RICE RESEARCH INSTITUTE
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1. INTRODUCTION

In September, 1981, the Ministry of Agriculture (MA) of the Philippines and the International Rice Research Institute (IRRI) initiated a collaborative effort to promote the development and extension of agricultural equipment that would be appropriate for small farms and may be fabricated within the country. The MA-IRRI Industrial Extension Program for Small Farm Equipment has grown out of a small-scale informal extension effort initiated by IRRI over 15 years ago, and its objective is to institutionalize the Program within the Ministry and related organizations as described in Section 3. The central office of the MA-IRRI Program is located in Manila at the Agricultural Engineering Division of the Bureau of Plant Industry (BPI) of the Ministry of Agriculture.

Interested manufacturers may become cooperators in the MA-IRRI Program by signing a memorandum of agreement covering two major points. First, the MA-IRRI Program agrees to provide cooperators with designs of agricultural equipment, together with training and technical assistance. Second, the cooperators agree to: (a) refrain from starting commercial production of equipment based on MA-IRRI designs until they have manufactured a prototype unit which successfully passes an acceptance test by MA-IRRI engineers; and (b) provide data annually to MA-IRRI on the types and numbers of agricultural equipment manufactured by the cooperator during the year.

As of May, 1984, a total of 197 manufacturers have registered as cooperators in the MA-IRRI Program. These cooperators are located in many areas of the Philippines (see Figure 1) and range in size from small blacksmith and metalcraft shops to large-scale industries (see Table 1). Special attention is given to manufacturers located in agricultural areas, thereby ensuring availability of parts and service, creating rural employment, and stimulating innovations and adaptations to local conditions and farmer preferences.

2. EXTENSION ACTIVITIES

Field Demonstrations/Evaluations/Trials

A major activity was to conduct field demonstrations and evaluations of small-farm equipment in the principal rice and corn areas of the Philippines. The MA-IRRI Regional Project Engineers* who live in the areas were vital to the coordination of these demonstrations, particularly with respect to ensuring that the attendees included outstanding farmers, leaders of cooperatives, local manufacturers, agricultural extension technicians, and rural bank officials.

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*These engineers are regular employees of the Ministry's regional offices and experimental farms, and they devote only part of their time to the MA-IRRI Program.

The main results of these demonstrations and evaluations were:

1. The MA-IRRI staff learned from farmers regarding which equipment would be most appropriate and beneficial in specific areas;

2. By observing the enthusiasm of farmers for particular equipment, local manufacturers became interested in fabricating units;

3. MA-IRRI engineers became better acquainted with the manufacturers of the area, thereby recruiting new cooperators and initiating on-going technical assistance to those interested in fabricating equipment promoted by the Program.

Intensive tests of the performance and durability of the reaper, hand tractor, thresher, and transplanter were carried out in Mindanao on a 370 ha farm where rice is grown continuously throughout the year. The advantage of this farm was that equipment could be utilized intensively on up to 2.5 ha per day, 6 days per week, throughout the year. The test results served as the basis for modifying the original designs to improve performance and durability.

Equipment Promoted by the Program

In addition to the abovementioned evaluations, the Program organized two workshops in which farmers, agricultural technicians, and equipment specialists were asked to determine what types of small-farm equipment should be defined as top priorities. The results have guided the Program's selection of equipment for extension and R&D efforts.

At present, the MA-IRRI Program is promoting the following types of equipment which are shown in Figure 2:

1. *Lightweight hand tractor*. This hand tractor is designed specifically for small rice farms because it is lighter and less expensive than existing designs in the Philippines. By reducing the engine power from 10 hp to 5 hp, the initial and operating costs are substantially lower to farmers, with little sacrifice of field capacity. Moreover, the smaller engine also reduces the dollar cost of importing engines.

2. *One-meter reaper*. This reaper unit attaches to the lightweight hand tractor. The principal advantages over existing reapers are: low cost; light weight; local production; availability of parts; and simplicity of operation and repair.

3. *Axial-flow thresher/sheller*. Although the axial-flow thresher is the most popular design in Central Luzon and Panay Island, it is still relatively unknown in several of the major rice producing areas in the Philippines. Three sizes of the axial-flow thresher are being promoted, according to differences in farm size, transport, and cultural practices. MA-IRRI has successfuly modified the thresher so that it may also be used as a corn sheller.

4. *Axial-flow pump*. This pump is easily fabricated in small shops and is more efficient (300% higher efficiency at one meter lift) than the centrifugal pump which is now most popular among Filipino farmers. Consequently, it leads to substantial savings with respect to fuel.

5. *Seed and fertilizer applicator (SFA)*. In a single operation, this animal-drawn implement forms a furrow and applies fertilizer, seed, and a soil covering. It is the newest addition to the Program and is expected to be especially popular among corn farmers. The SFA may also be used for planting mungbean, soybean, sorghum, and rice.

6. *Rootcrop chipping machine*. This machine is designed for cutting cassava tubers and other rootcrops into chips to improve drying and storage. It can be powered by foot pedal or a small engine or motor.

7. *Rice seedling transplanter*. Recent improvements of this manually-operated device have increased its capacity and simplified fabrication and operation. Moreover, the procedures for growing and handling seedlings have been greatly simplified in response to feedback from farmers.

8. *Foot-powered pump*. The advantages of this device are its low cost, ease of fabrication and repair, and efficient operation for low-lift irrigation (such as for vegetables planted in rice fields during the dry season).

The Program and collaborating institutions are actively developing other equipment which may be suitable for extension in the future. These include paddy dryers, zero-tillage planters, and weeder/cultivators.

Training Courses

All cooperating manufacturers were invited to attend a two-day intensive training course on fabricating the reaper and hand tractor. This course was given twice during 1982 at BPI in Manila and was attended by a total of 43 cooperators plus 11 engineers who are participating in the MA-IRRI Program. The course was designed to help the trainees understand: (a) the blueprints for the reaper and the hand tractor; (b) the main steps of fabrication and assembly; (c) operation, maintenance, and repair; and (d) the economics of fabrication and utilization of the reaper and hand tractor.

Based on this experience, it may be concluded that manufacturers will devote their time and money to attend training courses if the topic is of sufficient interest to them. In the present case, many of the attendees were from small-scale firms located in provinces far from the site of the two training courses. The attendees paid for their transportation and lodging expenses, while the Program covered the cost of providing each attendee with blueprints and instruction materials.

Twelve qualified cooperators have attended the IRRI Agricultural Engineering training course which is offered twice per year. Since this course is designed for college graduates in engineering, it is not appropriate for the majority of the cooperating manufacturers.

Technical Assistance and Prototype Testing

MA-IRRI Project Engineers make periodic visits to cooperating manufacturers in their area. The purpose of the visit is to provide whatever technical assistance might be needed by the cooperator in fabricating equipment promoted by the Program. In cases where the engineer is not capable of providing the needed technical assistance, he contacts the MA-IRRI central office for information and/or for the help of an engineer who is familiar with the specific problem.

Regarding technical assistance now being provided to cooperators, the most common activities are:

1. To help manufacturers in understanding the blueprints and in finding suppliers of special components (e.g., reaper blades).
2. To loan prototype models of equipment to those manufacturers who have difficulty reading blueprints.
3. To perform the prorotype test of the first unit fabricated by a manufacturer, utilizing a special test procedure and form. The purpose of the test is to determine that the unit has been fabricated and assembled correctly and that it functions properly in the field. It is also an opportunity to advise the manufacturers regarding critical adjustments, operating procedures, maintenance, and repair. After passing the prorotype test, the manufacturer is authorized by MA-IRRI to proceed with commercial production of the particular equipment.
4. To assist manufacturers with field demonstrations for farmers (often at meetings of farmer organizations) and, in a few instances, with applications for loans.
5. To maintain two-way communication with manufacturers on both problems and improvements that arise with respect to the design, fabrication, or operation of equipment promoted by the Program. Communication was improved in 1984 by initiating annual meetings of cooperators in three major areas: Mindanao, Luzon, and Panay.

3. INSTITUTIONAL RELATIONSHIPS

A primary purpose of the Program is the establishment of institutional relationships and technical competency which will lead to a national capability for developing, manufacturing, and marketing agricultural equipment appropriate for small farms. At the end of the 5-year period of this Program an institutional structure similar to that shown in Figure 3 should be functioning in an effective and sustained manner.

Although Figure 3 presents a highly simplified picture of the institutional relations affecting the Program, it helps us to describe several of the principal factors. The main component is the FARMERS*, who in this case

*The components of Figure 3 are typed in capital letters for emphasis.

are primarily rice and corn farmers with small land holdings (less than 3 ha). The objective is to enable FARMERS to purchase appropriate agricultural equipment from local MANUFACTURERS. Both the FARMERS and the MANUFACTURERS are influenced by EXTENSION & CREDIT INSTITUTIONS which promote certain types of equipment by various means, such as field days, training courses, accreditation, and loans. There is a wide variety of EXTENSION & CREDIT INSTITUTIONS in the Philippines, including the Bureau of Agricultural Extension, Regional Development Projects, National Food and Agriculture Council, National Food Authority, National Irrigation Administration, Ministry of Agrarian Reform, Farm Systems Development Corporation, Area Marketing Cooperatives, Samahang Nayon cooperatives, Small Business Advisory Centers, National Cottage Industry Development Authority, KKK Livelihood Projects, and banking institutions.

The principal role of the MA-IRRI PROGRAM is to provide the EXTENSION & CREDIT INSTITUTIONS and the MANUFACTURERS with the information on: the types of small farm equipment which should be given highest priority; comparative advantages and disadvantages of different equipment; appropriate equipment designs and fabrication procedures; proper utilization of equipment by farmers; testing, maintenance, and repair of equipment. The MA-IRRI Program also has direct contact with MANUFACTURERS through promotional and technical assistance visits, training courses, field days, and feedback sessions to learn from manufacturers about specific problems or innovations relating to equipment design, fabrication, or performance. It is also essential for the MA-IRRI PROGRAM to have direct communication with FARMERS regarding their views on deficiencies of existing equipment and on priorities for new equipment. This communication is accomplished through workshops, field days, and informal surveys, including farm visits and meetings with leaders of farmer cooperatives.

The success of the MA-IRRI PROGRAM depends largely upon its ability to find appropriate designs of equipment which will be acceptable to both FARMERS and MANUFACTUERS. Initially, the MA-IRRI PROGRAM has relied primarily on selecting (and adapting) appropriate equipment designs from the pool of designs developed by IRRI. However, IRRI and the MA-IRRI PROGRAM are not capable of developing the quantity or variety of equipment needed to sustain a dynamic extension program in the future. One of the objectives of the MA-IRRI PROGRAM is to help promote the growth of a national capability for the development of appropriate equipment for small farms. The main groups involved are the Agricultural Machinery Development Program (AMDP) at the University of the Philippines at Los Baños, R&D INSTITUTIONS (agricultural engineering departments at universities such as UPLB, CLSU, VISCA, ISU, and Xavier; government agencies such as NAPHIRE, PCARRD, and ARO; and regional organizations such as SEARCA and RNAM), and the INVENTORS & INNOVATORS, who may be independent (e.g., students, farmers, or professional inventors) or employees of manufacturing firms or R&D INSTITUTIONS. The MA-IRRI PROGRAM is promoting the R&D INSTITUTIONS and INVENTORS & INNOVATORS through workshops, field days and fairs, and contests, - and it is also encouraging national and international organizations to provide funds to these institutions for R&D on appropriate equipment.

The MA-IRRI PROGRAM is guided by an ADVISORY COMMITTEE whose members are the Assistant Secretary of the Ministry of Agriculture, the head of the IRRI

Agricultural Engineering Department, the director of the Bureau of Plant Industry, the director of the Agricultural Machinery Development Program (University of the Philippines at Los Baños), the director of the Agricultural Machinery Testing Center (AMTEC), and representatives of the Central Bank, the Ministry of Trade and Industry, and the Agricultural Machinery Manufacturers' and Distributors' Association. This Committee meets quarterly to review progress and plans, recommend corrective actions, and ensure that their institutions provide necessary collaboration.

The Government of the Philippines is now considering a proposal for the creation of a PERMANENT INTERAGENCY COMMITTEE FOR AGRICULTURAL MECHANIZATION (PICAM) which would coordinate studies of policies and plans relating to agricultural machinery. If the proposal is approved, the ADVISORY COMMITTEE will assist in defining collaborative relationships between the MA-IRRI PROGRAM and PICAM. The National Economic & Development Authority (NEDA) has recently given increased attention to agricultural machinery, joining together with the Ministry of Agriculture and IRRI to sponsor a workshop on agricultural mechanization in 1983. However, neither NEDA nor PICAM has been able to initiate substantive activities on mechanization.

4. SUGGESTIONS ON POLICIES AND ACTIONS

On the basis of the experience of the MA-IRRI Industrial Extension Program for Small Farm Equipment, there appears to be a need for policies and actions which would help to:

1. Provide a clear understanding of what types of agricultural equipment would be most beneficial and acceptable to small farmers. (Without this understanding, R&D and extension efforts may be misdirected.)
2. Promote the development of appropriate designs of the agricultural equipment identified in point #1. (At present, extension efforts are severely limited by the shortage of appropriate designs.)
3. Establish a more effective means for providing loans to manufacturers and buyers of small farm equipment. (Example: loans to manufacturers for self-financing of installment sales of equipment to farmers.)
4. Prevent large government purchases of imported agricultural equipment which either are available from local manufacturers (e.g., hand tractors, dryers) or are inappropriate (e.g., combine harvesters.)
5. Obtain adequate funds for supporting activities on policies, R&D, extension, and evaluations relating to small-farm equipment. (For example, funds might be obtained from existing government duties on imported agricultural equipment.)

It is recognized that these efforts will be of limited value unless economic conditions and government policies lead to higher net income for the small farmers, thereby making it possible for them to buy agricultural equipment.

Table 1. Profile of Cooperating Manufacturers according to Capital Assets and Labor[a]

Ranges		Cooperators (%)
CAPITAL ASSETS[b]		
Cottage Industry :	Below ₱100,001	43
Small Industry :	₱100,001 to ₱1,000,000	43
Medium Industry :	₱1,000,001 to ₱4,000,000	10
Large Industry :	Above ₱4,000,000	4
LABOR (Number of employees)		
Below 6		29
6 to 15		44
16 to 50		21
above 50		6

[a]Data as of March 1, 1983.

[b]Approximate conversion rate: ₱10 per US dollar.

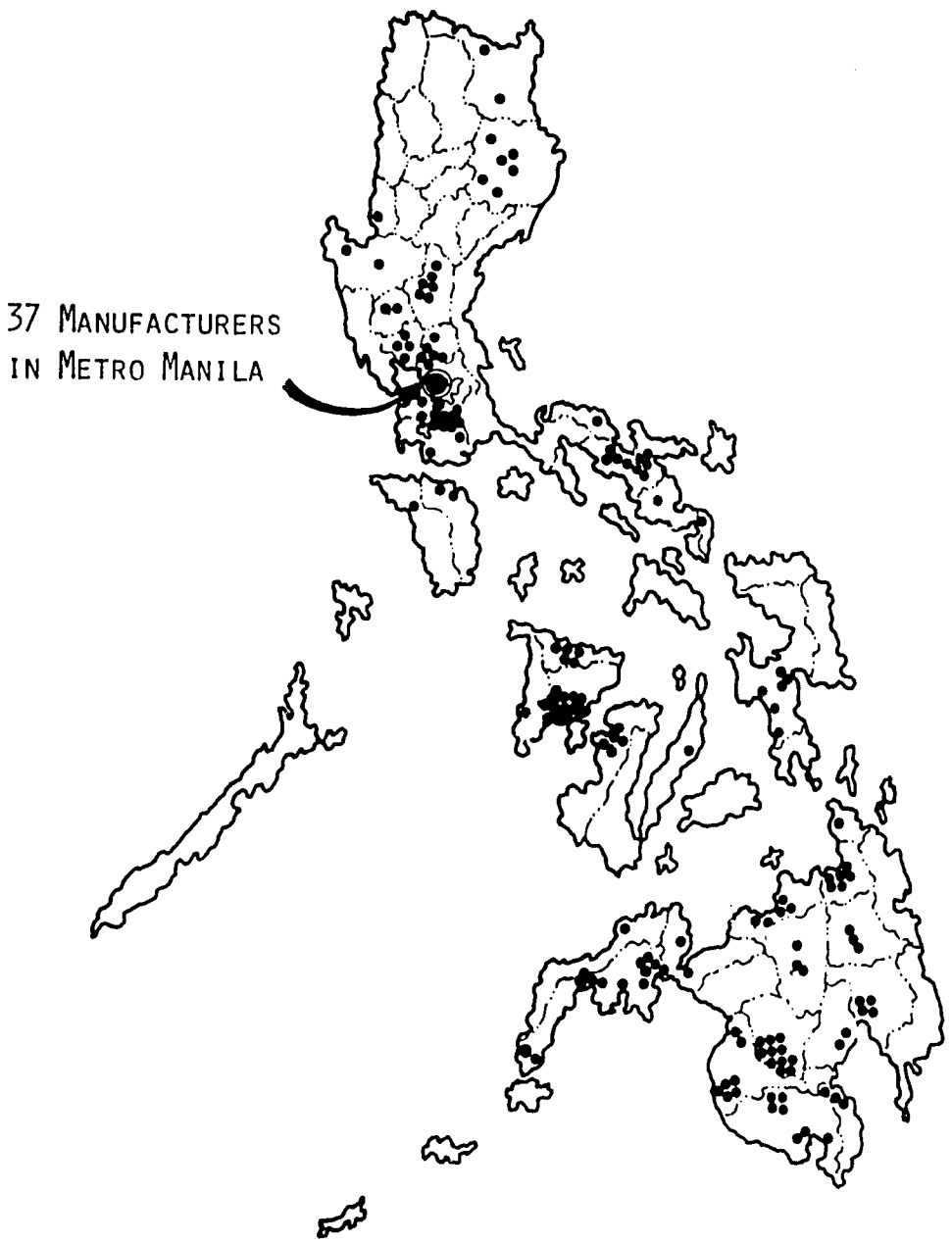
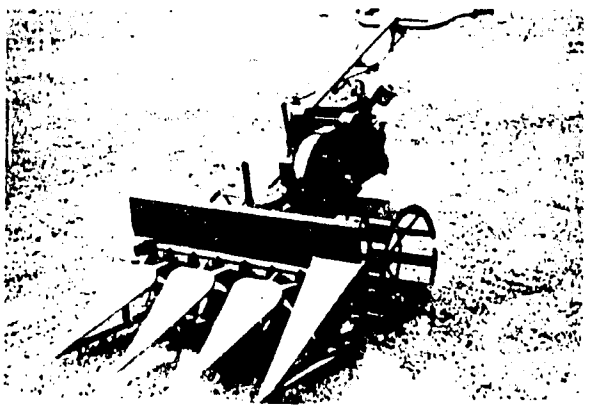


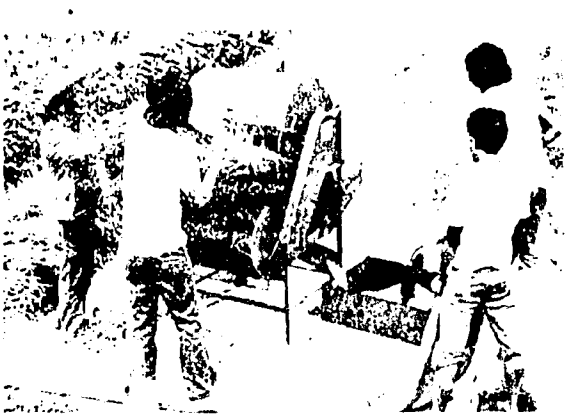
Figure 1. Geographical Location of Cooperating Manufacturers of the MA-IRRI Industrial Extension Program for Small Farm Equipment.

22

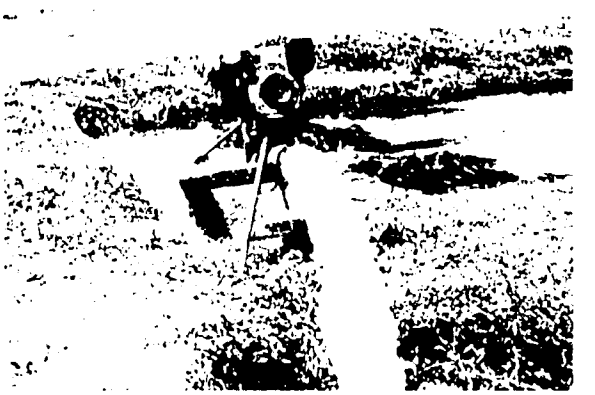
Lightweight Hanc Tractor



One-meter Reaper



Axial-flow Thresher



Axial-flow Pump

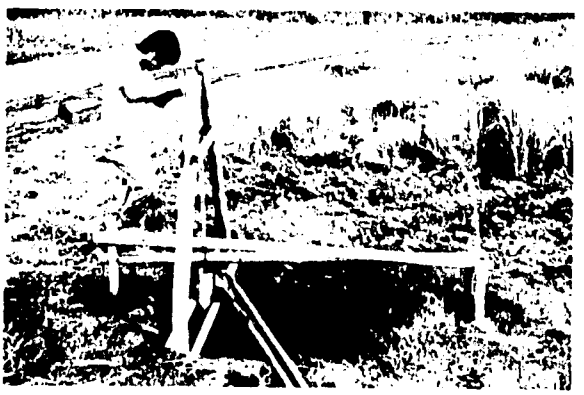
Seed and Fertilizer Applicator

Figure 2. Equipment being promoted by the MA-IRRI Industrial Extension Program.

(continued on following page)

Rootcrop
Chipping Machine

Rice Seedling Transplanter



Foot-powered Pump

Continuation of Figure 2

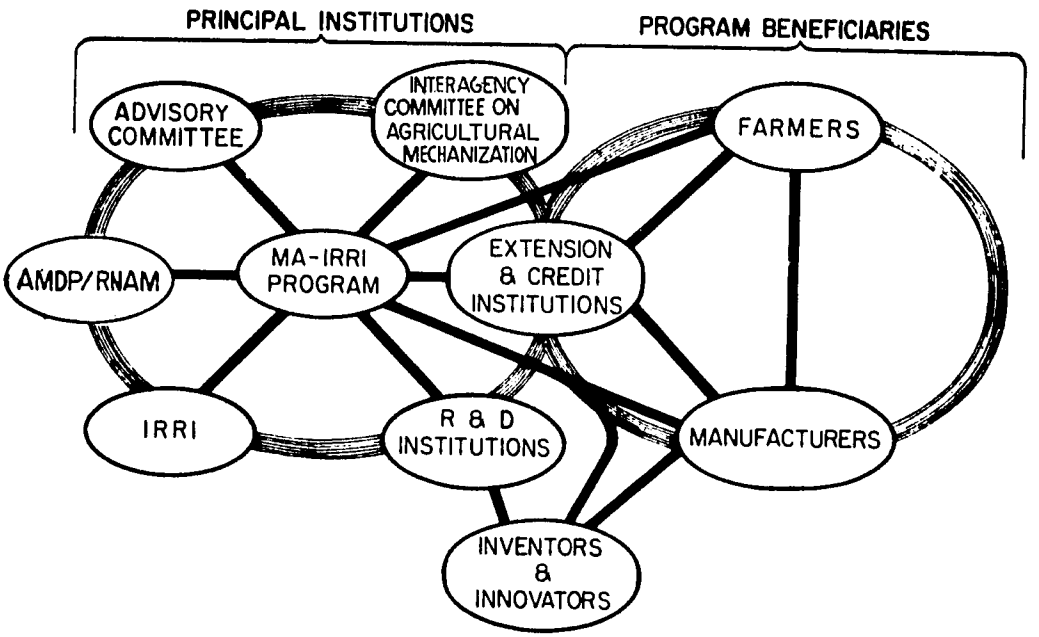


Figure 3. Institutional Relationships of the MA-IRRI Program.

ANNEX B

MAF-IRRI INDUSTRIAL EXTENSION PROGRAM FOR SMALL FARM EQUIPMENT

Summary of Regional Activities

B. C. Gonzalo and R. E. Stickney
March 1985

1. Regional Project Engineers have been appointed in each Region (see list below) to serve as coordinators of Program activities. All but the newest engineers have received training at IRRI and BPI. Some are located at Experiment Stations, while others are in the Regional Offices.

Region	Engineer	Location
1	Clemente Abrina	Regional Office San Fernando, La Union
2	Rodolfo Bayucan	Ilagan Experiment Station Ilagan, Isabela
3	Leonardo Gappi	Regional Office San Fernando, Pampanga
4	Carlito Fernandez	BPI Central Office San Andres, Malate, Manila
5	Reynaldo Rivera	Bicol Experiment Station Pili, Camarines Sur
6	Ruperto Deysolong	Visayas Experiment Station Jaro, Iloilo City
7	Bonifacio Cabahug	Regional Office Cebu City
8	Carlos Macabenta	Gandara Experiment Station Gandara, Samar
9	Florencio Vivas	Ipil Experiment Station Ipil, Zamboanga del Sur
10	Rolando Ansale	Regional Office Cagayan de Oro City
11	Angel Platon	Davao Experiment Station Bago Oshiro, Davao City
12	Arturo Neyra	Mindanao Experiment Station Midsayap, North Cotabato

2. Principal Responsibilities of Regional Engineers are:

- Determine equipment practices and needs of farmers in the Region
- Field test equipment prototypes developed by the Program

- Demonstrate the Program's equipment to farmers to determine potential acceptability and/or necessary modifications
- Provide technical assistance to local manufacturers of equipment promoted by the Program
- Train farmers on the operation and maintenance of equipment

3. Equipment now being promoted in the regions are summarized in Table 1. Promotion of the 1.0 m reaper has been temporarily suspended. The rootcrop chipping machine will be promoted later this year, and the rolling injection planter (RIP) is being evaluated in Region VI. Efforts to develop a suitable dryer and lower-cost axial-flow pump are continuing.

4. Principal Problems that are limiting the effectiveness of Regional Engineers:

   a. Insufficient funds for fuel and per diem (100%)
   b. Unavailability of suitable vehicle and driver (75%)

Table 1: STATUS OF EQUIPMENT PROMOTED BY THE MAF-IRRI PROGRAM

EQUIPMENT	REGION											
	1	2	3	4	5	6	7	8	9	10	11	12
Seed and Fertilizer Applicator (SFA)	-	D,M,S	D,M,S	D,M,S	D,S	D,M,S	D,M,S	D,S	-	D,S	D,M,S	D,M
Transplanter	D	D,M,S	D,M,S	D,M,S	D,M,S	D,M,S	-	D	D	-	D,M,S	D,M,S
Tapak-Tapak Pump	D,M,S	-	D,S	D,M,S	D,S	D,M,S	D,M,S	D,S	D	D	D	D
Thresher/Sheller	-	D,S	D,M,S	D,M,S	-	D,M,S	-	-	D,M	D	D	D,M,S

Note: D = Equipment has been demonstrated to farmers in the region

M = Equipment is being manufactured in the region

S = Equipment has been sold in the region

ANNEX C

MAF-IRRI THRESHER/SHELLER

by

TERESITA C. SILVA

In response to the need for corn shellers, the MAF-IRRI Industrial Extension Program for Small Farm Equipment – a cooperative effort of BPI/MAF and IRRI – has undertaken the development of a corn sheller which is appropriate for our farmers and can be locally manufactured.

Incidentally, this thresher/sheller that came out innovating the ordinary axial-flow palay thresher to work as sheller for corn won the presidential merit medal for first prize in the creative research category of the 1985 Inventors' contest of the 19th Annual National Inventors Week held at PHILTRADE Manila.

Since thousands of units of the axial-flow palay thresher* (See figure 1) now exist in many areas of the country, the *Program* decided to modify this thresher so that it can also be used as a corn sheller. The first step was to experiment by shelling corn with a conventional axial-flow thresher without any modifications. The thresher is a TH6 model which is not equipped with an oscillating screen-type cleaning mechanism. Although the shelling capacity and shelling efficiency were satisfactory (See Table 1), several problems were encountered:

1. The cobs were broken into pieces of varying size (see Table 2), some of which were small enough to pass through the concave with the kernels, thereby making it difficult to separate kernels from cobs.
2. About 4% of the shelled kernels did not pass through the concave (see "separation loss" in Table 1) and therefore exited through the discharge outlet, mixed with cobs. This degree of separation loss must be reduced because farmers will object to the effort required to recover the kernels from the cobs.
3. The concave bars were damaged during corn shelling because the impact loading is higher than for threshing palay.
4. Corn kernels escaped from every opening of the machine, with high velocity due to impacts associated with the shelling process.

Minister Blas F. Ople presenting the award to Engr. Quirino P. de Sagun and Dr. Robert E. Stickney, BPI Agricultural Engineer and IRRI co-leader, respectively, during the award ceremonies on February 28, 1985 at PHILTRADE.

Based on these results, the *Program* came up with the following conceptual design: In order to avoid the problem of some kernels being discharged with the cobs, it was proposed that all of the kernels and cobs should be directed to an oscillating screen-type cleaner (common on TH7 and TH8 axial-flow threshers) where the kernels would be separated from the cobs. This channeling of kernels and cobs to the cleaner may be achieved by various simple modifications to the thresher, such as those illustrated in Figure 2. Number (1) provides a passage for the cobs and kernels through the concave just before the discharge section. This could be accomplished either by means of small door in the concave or by removing several of the concave bars. Number (2) involves an additional baffle or an extension of the existing baffle ("grain cut-off") between the threshing and discharge sections, thereby blocking the passage of kernels

*The axial-flow thresher was developed by the Agricultural Engineering Department of the International Rice Research Institute (Philippine Patent No. UM 1379 and UM 2292).

and cobs into the discharge section and forcing these materials to pass through the concave. The baffle could either be removable or slide to desired positions. Concepts (1) and (2) could be combined. Number (3) provides a hole in the discharge section to permit kernels and cobs to pass to the oscillating screen rather than through the discharge outlet. This passage hole would have a simple door which would be closed when threshing palay. Number (4) provides a baffle to block the discharge outlet and an opening or duct which directs the kernels and cobs through the sidewall of the discharge section to the oscillating screen. The baffle would be removable for palay threshing and the opening in the sidewall would be closed with a door or sliding plate. These four modifications could be combined in a variety of manners depending upon the particular configurations and dimensions of existing threshers.

The *Program* built three thresher/shellers based on different modifications of concept Number (4). Two of these are illustrated in Figures 2. The baffle in the discharge outlet is shown in Figure 3, and it may easily be removed to thresh palay in the normal manner. The triangular duct shown in Figure 3 directs the kernels and cobs sidewards and then downwards to the oscillating screen. A sliding metal plate closes the passage in the sidewall of the discharge outlet when palay is to be threshed.

The concave has been strengthened so that it will withstand the impacts of corn shelling. This is accomplished either by using heavier materials in fabricating the concave or by adding additional supporting (reinforcing) bars on the concave. The screen in the oscillating cleaner has been modified so that it may be removed in order to install one with larger holes suitable for corn kernels. Several designs of hoppers have been installed to facilitate feeding of corn into the machine, although some operators find that the existing tray for feeding palay is also adequate for corn. Rubber, fabric, and/or metal pieces have been added to minimize the escape of corn kernels from various openings in the machine.

One of these thresher/shellers has been tested by National Food Authority and Agricultural Machinery Testing and Evaluation Center. The results of these tests demonstrate that the capacity of the machine ranges from 3.6 to 4.9 tons/hour of shelled kernels with a shelling efficiency of 99+% and a purity of over 99%. These performance characteristics compare very favorably with the best corn shellers now available in the Philippines. The principal advantage of the thresher/sheller is that it is suitable for both threshing palay and shelling corn.

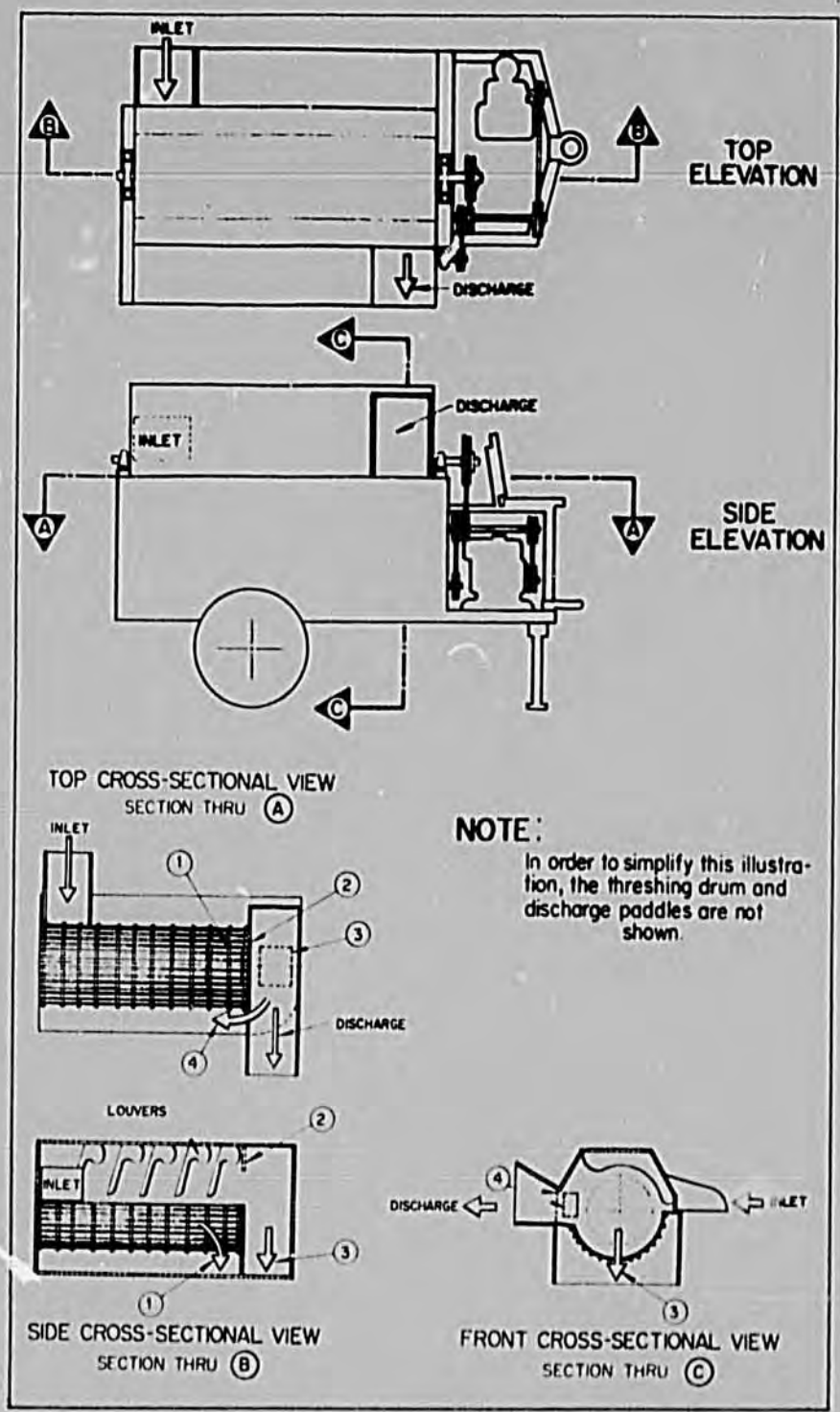


Figure 1 Illustration of possible means of modifying axial-flow threshers to also serve as corn shellers.

In summary, the thresher/sheller innovation enables farmers to have a two-purpose machine at a cost that is only slightly higher (about P1,000) than the cost of the palay thresher. The modification may be made to existing thresher/shellers as well as to newly fabricated units. Small shops are capable of making the modification because it is a simple task requiring only commonly-available tools and materials (principally sheet metal and metal bars).

Once a machine has been modified, it may then be easily changed from thresher to sheller (or from sheller to thresher) in less than 15 minutes with common hand tools (e.g., wrench and screw driver). Perhaps the most important fact is that the performance of the thresher/sheller is comparable to available single-purpose corn shellers.

Since the configuration and dimensions of axial-flow threshers vary from one manufacturer to another, the *Program* has not developed detailed engineering drawings showing the proposed thresher/sheller modification for a specific machine. It was found more advantageous to describe the general concept to manufacturers and assist them to make the most convenient form of modification of their particular machine. This assistance has been provided by the staff of the MAF-IRRI Industrial Extension Program for Small Farm Equipment. Detailed information can be obtained from the MAF-IRRI Program Office located in Manila at the Agricultural Engineering Division of the Bureau of Plant Industry (BPI) of the Ministry of Agriculture and Food (MAF).

Table 1. Performance of TH6 thresher for shelling corn.

	TRIAL NUMBER						
	T1	T2	T3	T4	T5	T6	Average
Unshelled Loss, %	0.73	0.46	1.62	1.77	3.33	1.31	1.54
Separation Loss, %	3.62	3.67	3.1	4.9	5.2	3.8	4.05
Kernel Breakage, %	1.41	1.25	1.11	1.25	1.16	1.13	1.22
Shelling Efficiency, %	99.27	99.54	98.38	98.23	96.66	98.69	98.46
Capacity, Cav/hr.	50.23	-	44.1	-	47.12	-	47.15

Table 2. Distribution of sizes of broken cobs passing through concave and discharge of TH6 thresher used for shelling corn (in terms of percent by weight).

TRIAL NO.		COB SIZE				Cobs passing concave (%)
		0.25 mm	25-50 mm	50-75 mm	75-100 mm	
T1	Discharge	16.6	34.0	6.6	1.67	-
	concave	23.0	16.8	1.2	0	41.1
T2	Discharge	16.9	34.0	8.2	0.98	-
	concave	22.4	16.1	1.23	0	39.7
T3	Discharge	8.0	42.0	11.7	2.1	-
	concave	18.6	14.1	3.4	0	36.1
T4	Discharge	7.3	37.4	22	0	-
	concave	15.1	17.2	0.9	0	33.0
T5	Discharge	5.9	38.7	14.2	7.7	-
	concave	13.5	18.1	1.8	0	33.4
T6	Discharge	7.2	35.7	19.6	0.98	-
	concave	14.7	18.0	1.9	0	34.6

Figure 2 Two prototypes of MAF-IRRI thresher/sheller

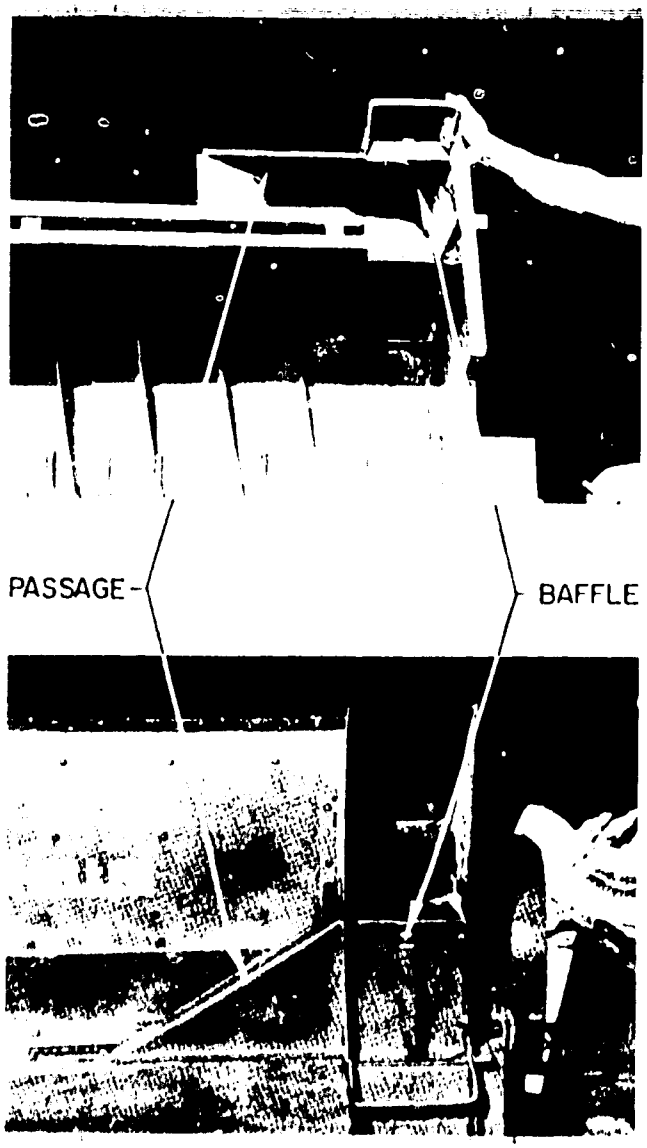
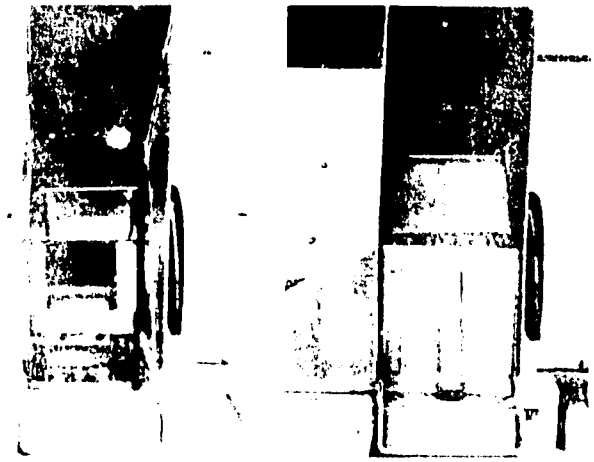
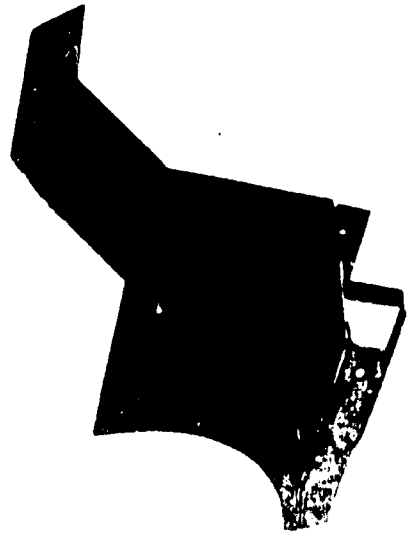


Figure 3 Photographs of the baffle and passage in the discharge outlet of the thresher/sheller



Discharge outlet without baffle, as for palay threshing

Discharge outlet with baffle installed, as for corn shelling



Baffle (Removed)

Figure 3 (Continuation)

Paper presented at the Conference on "Small Farm Equipment for Developing Countries: Past Experiences and Future Priorities", The International Rice Research Institute, September 2-7, 1985.

ANNEX D

RICE SEEDLING TRANSPLANTERS: PHILIPPINES

G. Salazar, L. Ebron, H. Icatlo, B. Duff & R.E. Stickney

The International Rice Research Institute

INTRODUCTION

Hand transplanting of seedlings in puddled soils is the most common method of planting rice in developing countries in Asia. It has the advantages of requiring less precision in land preparation than direct seeding, creating conditions for better water and weed control, and above all, saving up to 20 days of the occupancy of the field by the crop. Transplanting is a labor intensive operation, requiring 10-20 labor-days per hectare (1). This high labor input often results in labor shortages during the planting season. In areas practicing double-cropping, land preparation and transplanting of the second crop and harvesting of the first crop take place simultaneously, making it difficult to complete these operations quickly using traditional methods. Consequently, farmers in the Philippines are changing from transplanting to direct seeding at an increasing rate.

For several decades engineers from rice producing countries, notably Japan, China, and India, endeavored to mechanize the transplanting of rice seedlings. Japan began to mechanize in the late sixties when a special method of seedling preparation was adopted (2). In this method the seedlings are grown in a wooden or plastic tray having a perforated bottom on which a layer of specially prepared soil is placed. The soil holds the seedlings together. When removed from the tray with the aid of a scraper, the seedlings appear like a mat and are therefore known as mat-type seedlings.

Use of mat-type seedlings facilitates mechanized rice transplanting because a simpler picking mechanism can be used to pull seedlings. The soil also helps protect the roots from damage by the mechanical fingers. In Japan, where farm labor is expensive, seedling preparation is a fully mechanized process. This was not possible with the traditional method of seedling preparation.

In China, several machines have been developed to use traditional seedlings. The Chinese have tried to mechanize the pulling of seedlings from the nursery bed, but thus far without success.

UD

Japan and China are the leading exporters of rice transplanting machines. The Japanese machines are mostly power-driven with sizes ranging from 2 to 4 rows for the walking type and 6 to 8 rows for the riding type. The Chinese produce both manually-operated and power-driven machines. Powered machines have more rows than the Japanese but closer spacing between rows (3). A disadvantage of these machines is the frequent reloading of seedlings, which requires two seedling tenders to ride on the machine in addition to the driver. Machines of other countries are generally patterned after the Japanese and Chinese designs.

The price of imported power-driven transplanters is beyond the reach of small farmers in developing countries. Their complex design and the skill required to operate and maintain them do not suit the ordinary farmer. Recognizing these problems, the IRRI Agricultural Engineering Department designed and developed a manually-operated transplanter for transplanting mat-type seedlings. This paper summarizes IRRI's experiences with the transplanter, including recent extension efforts in the Philippines with the MAF-IRRI Industrial Extension Program.

In the next section, we summarize the development of the first model (TR1) and the initial method of seedling preparation. Then we describe the introduction of this machine and the problems encountered, followed by efforts to overcome these problems. This culminated in the development of the TR4 6-row model and further simplification of the seedling preparation.

We then describe the experiences in introducing the machine in a pilot area in the Philippines. This led to a new extension approach for popularizing the machine. Technical and socio-economic studies, before and after the pilot extension effort, evaluated the machine's performance and acceptance. In the final section, we summarize the lessons acquired from these experiences and present suggestions for further efforts.

DEVELOPMENT OF THE IRRI TR1 5-ROW TRANSPLANTER

A feasibility study conducted at IRRI in 1977 (4) indicated it may be too costly for small rice farmers to use powered transplanters. As a result, the IRRI Engineering Department began development of a manual transplanter. The initial work concentrated on redesigning a Chinese 5-row machine (Fig. 1) with 20 cm row spacing, attempting to make

it less expensive and easier to operate by simplifying the picking and planting mechanism. The original machine required four motions of the transplanting arm (Fig. 2); to open the picker fingers, pick the seedlings from the tray, push the seedlings into the soil, and then release the planted seedlings. This operation was complicated and tiring to the operator. The redesign unit (Fig. 3) uses only two motions. The downward stroke picks a group of seedlings (3 to 7) from the tray and inserts them into the soil. The upward stroke releases the seedlings. The redesign replaced the earlier pincer-type pickers with a blade type (Fig. 4a) and finally with a fork-type picker (Fig. 4b).

With each downward movement of the handle, a simple pawl lever indexing assembly (Fig. 5) moves the tray laterally to insure seedlings are in position to be grasped in the next cycle. After seedlings are inserted in the soil, the handle is retracted toward the operator. Near the end of the retraction stroke, a cam deflects the picker to prevent it from touching the seedlings (Fig. 6). At the end of the retraction stroke, the operator slides the machine a desired distance to the next planting position. The machine is provided with side markers to guide the operator for the next pass. These changes from the original design produced a relatively lightweight (25 kg), low cost machine.

As the machine was being developed, a new seedling preparation method evolved. Seedlings are prepared in a modified wet bed on 1 m wide seedbeds. Bottomless wooden frames with 5 compartments (the same size as the seedling tray division) are arranged so that 10 frames can be accommodated on a 1 m wide x 5.5 m long bed (Fig. 7). Each compartment is filled with mud and levelled to a uniform thickness of about 1.5 cm. About 180 ml. of pre-germinated seeds are uniformly spread in each compartment and pressed lightly. The seeding rate is 40-50 kg/ha. After 15-20 days, the wooden frames are carefully removed. A sharp-edged blade is pushed carefully under the seedlings until the seedling mat is completely severed from the seedbed. This process cuts roots that have penetrated the seedbed but does not unduly damage the seedlings.

INTRODUCTION OF THE TR1 5-ROW TRANSPLANTER

After extensive laboratory and field testing at IRRI, the Industrial Extension Section began a trial introduction of the TR1. In 1978, the machine was extensively demonstrated at several Philippine locations to determine farmers' interest. Blue-prints were distributed to interested manufacturers. In all cases, except for a

corporate farm of the Philippine Packing Corporation (PPC) in Musuan, Bukidnon, the transplanter failed to generate sustained interest.

Beginning in 1981, the PPC rice farm used the transplanter for several cropping seasons. They adopted their own method of seedling preparation, a modified "dapog" method in which 1.0 - 1.5 cm of dry, screened soil mixed with fertilizer is used as the seedling mat soil. The soil is placed on top of a layer of used urea plastic bags. Wooden frames are placed only around the outer edge of seedbed, thereby eliminating the more expensive compartment frames used in the original method. An ordinary sickle can be used for cutting the seedling mat (Fig. 8) which can be rolled for ease of transport.

In 1982, the MAF-IRRI Extension Program evaluated these experiences to estimate the potential market for this machine. The principal results were (5):

1. For experienced transplanter operators at PPC, the average field capacity was approximately 0.2 ha/day (7-1/2 hours of operation), slightly lower than IRRI's estimate of 0.25 ha per day.

2. The middle row of the transplanted seedlings fell directly in the operator's footprints, increasing the percentage of floating hills.

3. Tension springs in the cam and in the picker holder lost their resilience after only two weeks of operation.

4. It was difficult to move the unit from one paddy to another, especially when the adjoining field was already transplanted.

5. Some operators, especially inexperienced ones, complained of the effort required to pull (slide) the machine.

6. Seedling preparation needed further simplification.

7. Manufacturers complained that the machine was difficult to fabricate and had too many parts.

DEVELOPMENT OF THE TR4 6-ROW TRANSPLANTER

Improvement of the TR4 transplanter began in late 1982, culminating in the IRRI 6-row transplanter (Fig. 9), having the following features:

1. **Increased field capacity**

Changing from a 5-row to a 6-row version increased capacity to 0.3-0.4 ha per day, and reduced the percentage of floating hills since the operator's

footprints then fall between the 3rd and 4th rows of the transplanted seedlings. The tray length was also increased, reducing the loading frequency.

2. **Better operator comfort**

The pulling force was considerably reduced:

- Two long narrow skids are used instead of a single wide skid. This substantially reduced drag and weight.
- Total weight was reduced to 20 kgs.
- Rubber grips on the handle help prevent blisters on operators' hands.

3. **Easier fabrication**

The redesign uses fewer parts, and the seedling tray is now straight instead of curved. A bicycle free-wheel sprocket assembly (readily available in rural areas) serves as a tray indexing assembly. Furthermore, the whole transplanter mechanism can be bolted to the skids as one unit.

4. **Less troublesome operation**

The tension springs in both the cam and picker assemblies were eliminated by the new <u>inertia control</u> mechanism. The new mechanism requires only a slight jerk at the beginning of the downward stroke so that

the picker lever will move forward against a stop to position the picker properly (Fig. 10). On the return stroke, the picker will not hit the seedlings because the picker lever will move slightly backward against the opposite stop.

5. **Versatility**

To change the number of seedlings per hill, the free-wheel sprocket assembly can be changed to one having a different number of teeth, thereby varying the tray displacement per stroke (Table 1). When the number of rows remain to be planted on the last pass are fewer than the number of tray divisions, one of the skids is placed between the transplanted rows and the seedling mats located above the transplanted rows are removed (Fig. 11). This was not possible with the previous design having a wide single skid.

To facilitate adoption of the new transplanter, two simplified methods of growing seedlings were developed. In the modified "Dapog" method, minor changes were made in the seedling preparation method used by the PPC Rice Farm. Mud soil taken from the sides of the seedbed is placed on top of

a surface covered with plastic sheet or banana leaves to form a layer 1.0 to 1.5 cm thick. This method requires a wooden frame around the seedbed.

The modified wet-bed method is a minor modification of the traditional "LapLap" method widely practiced in Bicol (Fig. 12). No wooden frames are needed. A special sharp-edge knife is used in cutting the roots to obtain mats with a soil layer of 0.5-0.7 cm thickness.

These two methods have different advantages and disadvantages (Table 2).

INTRODUCTION OF THE TR4 6-ROW TRANSPLANTER

Machine performance depends critically upon the quality of seedling preparation and, to a lesser degree, on the quality of land preparation. These are the main reasons the IRRI mechanical transplanter requires more time and effort to promote than do other agricultural machines like threshers, reapers and power tillers.

In 1983, a much simplified seedling preparation technique was suggested by from farmers during a demonstration of the transplanter in Libmanan, Camarines Sur. Farmers in that area developed the unique "Laplap" modified wet-bed method described above. Farmers prefer the

small mats provided by the "Laplap" method because these avoid the pulling-and-bundling operations of the conventional wet-bed method. When transplanting by hand, the mat is held in one hand and the other hand is used to pick and transplant the seedlings. Libmanan farmers claim this method incorporates the best features of the "dapog" and standard wet-bed methods (Table 3):

a) both young and old seedlings can be transplanted,

b) area of seedbed is smaller than required for standard wet bed nursery, and

c) slicing seedling mats requires less time than pulling and bundling. Farmers also devised a simple seedling transporter (Fig. 14) for easier handling of seedling mats.

To prove that the transplanter can be operated continuously for eight hours by one person, we arranged for an experienced operator from the PPC Rice Farm to demonstrate this to farmers in Libmanan.

After the demonstration, several farmers were eager to buy the 6-row transplanter, provided their operators would be trained. Nine transplanters were needed for the training. Six units were ordered from three welding shops in Libmanan. The local manufacturers received technical assistance and materials not readily available in the area.

A two-week training program was held May 28 to June 8, 1984 (Appendix A). Trainees learned seedbed and seedling preparation, operation, maintenance and adjustment of the machine, and trouble shooting. Units used during training were subsequently sold at special prices to farmers.

Since many farmers prefer 15 cm row spacing, an 8-row model (TR5) (Fig. 15) with 15 cm row spacing was fabricated in the IRRI prototype shop. It was sent to Libmanan as a guide to manufacturers. One manufacturer had built and sold 10 units of this model as of September 1984.

These experiences in Libmanan guided transplanter promotion in other areas in the Philippines. In the province of Iloilo, for example, we collaborate with the KABSAKA Program, a rainfed cropping system project of the Ministry of Agriculture. The objective is to promote MAF-IRRI equipment, including the transplanter. We provided one-week training at IRRI for six KABSAKA specialists and cooperating manufacturers. The lone transplanter manufacturer in Iloilo has sold more than 20 units.

TECHNICAL AND ECONOMIC STUDY

As the machine was being introduced in Libmanan a bench-mark survey was conducted with the following objectives:

- To determine existing transplanting practices and problems.
- To describe the characteristics of the labor used for transplanting.
- To compare the cost of present practices with the use of mechanical transplanters.

Manual transplanting practices and problems

Both random and one-way straight line planting are practiced. Row spacings range from 15 cm to 18 cm. Most farmers prefer the closer spacing. Bad weather before, during, or shortly after transplanting is a serious problem. Transplanting is often delayed by storms, and farmers must continue to feed idle laborers until work resumes.

Lack of labor is also a major problem expressed by Libmanan farmers. Those who can not advance a portion of the payment to workers find it very difficult to secure workers.

Other problems are listed in Table 4.

Characteristics of labor for transplanting

As seen in Table 5, transplanting appears to be a light farm job as reflected by the age and sex of transplanters. Women represented 63% of available labor. Labor is local: 80% of the workers reside in the village where they work. Two-thirds of the workers are regularly hired to do transplanting.

Economic analysis of the mechanical transplanter

The breakeven point analysis (Fig. 16 and Appendix B) estimates that the mechanical transplanter is more profitable than hand transplanting when annual use is greater than 4.4 ha or 6.2 ha if machine cost is increased from ₱2,500 to ₱3,500. This suggests purchase of a machine is justified for a 2.2 ha. farm planted twice each year. Farmers who intended to buy the machine stated they were not as concerned with reducing cost as in easing the problem of labor procurement.

Nine months after the transplanter was introduced, owners of mechanical transplanters were interviewed to examine the extent of adoption and use, to determine how owner-users and non-user farmers evaluate the transplanter's performance, and to assess changes in the pre-planting activities such as seedbed and seedling preparation and land preparation.

The 15 owners surveyed owned a total of 20 transplanters. Twelve were 6-row and 8 were 8-row models. Most units were located in a waterlogged and flood prone area. Two farmers owned 4 units in Ibid where soil and drainage conditions are excellent. The follow-up surveys showed that:

1. Machine use was low on the waterlogged farms. In three cases, however, the machines were taken to location where soil and water control conditions were more suitable and performance was significantly improved.

2. Some owners, after preparing seedlings to suit the machine, were unable to use the machine because of heavy rains and flooding which scattered the seeds and made seedlings unfit for machine use.

3. Use was more successful in Ibid, a village with good soil and drainage conditions. The two owners used the transplanters on their entire farms (22 ha) and rented them to neighboring farmers. These farmers owned water pumps to supplement gravity irrigation. Both have taught their neighbors the proper seedling preparation for effective use of the machines. Both intend to procure more units and train operators for custom transplanting.

4. There were no significant changes in seedling preparation methods, except that the width of the seedbed was reduced to one meter.

SUMMARY AND RECOMMENDATIONS

1. Training operators in seedbed and seedling preparation, operation, maintenance and adjustments of the machine, and trouble shooting are essential to successful extension of the mechanical transplanter.

2. The required seedling preparation can be carried by small farmers. Most farmers quickly learned how to prepare good seedlings at a density suitable for the IRRI transplanter. Libmanan farmers showed ingenuity in their method of slicing the seedling mat to the required thickness using a special knife, as well as in methods they employ to transport seedlings. This indigenous technology was adopted by the researchers.

3. Most Japanese literature on seedling preparation for mechanical transplanter does not recommend use of heavy clay for the mat soil. Our experience shows that with 1.0 cm thick of seedling mat, and with 1-3 cm standing water in the field, the machine performed well with the clay mat soil prevalent in Libmanan.

4. Since fabrication of the transplanter requires precision, manufacturers must be given technical assistance in building jigs and fixtures.

5. The machine fits areas where random or one way straight planting are the usual practices. The field capacity will be much lower if a uniform distance between hills is required in both directions.

6. The machine works well in moderately-levelled fields and with water up to a depth of 5 cm.

7. The main limitation is that the transplanter is not suitable for water logged areas since the skids sink, thereby affecting the stand of seedlings. Such areas should be drained 3-7 days before transplanting.

8. Carefully planned demonstrations are essential to avoid negative reactions of farmers. It is very hard to change farmers initial impressions.

9. The transplanter design should be adapted to farmers' needs and preferences. The TR5 8-row model was designed to meet the requirement of a 15-cm row spacing. In a similar fashion, the poor land preparation employed in Isabela, Northern Luzon, requires attachment of an optional wooden leveller across the two skids to level mud in the path of the machine.

10. Promotion of the mechanical transplanter will be simplified and more effective if coordinated with well-organized farmer associations, such as the Irrigators' Association in Libmanan.

To accelerate popularization of the mechanical transplanter, these actions are recommended:

1. A simple instruction manual on seedling preparation and transplanter operation and maintenance should be given to each owner. This publication should contain an abundance of illustrations and little narrative (which should be written in local dialect). Such a manual will considerably reduce the extension work needed to promote the transplanter.

2. In labor short areas, the possibilities should be explored to assist helping landless workers to acquire transplanters. In this way, the productivity of manual labor will be increased by as much as 3 to 5 times, avoiding delays in transplanting. This will also raise the income of landless workers while discouraging the spread of direct seeding practices which drastically displace labor.

3. Many poorly-drained areas in the Philippines require a transplanter which can plant 30-40 day old seedlings in fields with up to 15-20 cm standing water.

4. For areas lacking labor and with hand tractors available, a transplanter attachment for lightweight hand tractors may be appropriate.

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3. Manalili, I. Rice Seedling Transplanter, Agricultural Engineering Training Program Handout, IRRI, Philippines.

4. IRRI. 1977. Semi-annual Report No. 25, Rice Machinery Development and Industrial Extension.

5. Salazar, G.C. and R.E. Stickney. 1984. Improved rice seedling transplanter and simplified method of growing seedlings. Paper presented at the Conference of MA-IRRI Cooperator-Manufacturers, MRRTC, Nueva Ecija, Philippines.

Table 1. Examples of tray travel adjustment, TR4/TR5 IRRI Rice Transplanter.

Tray travel per stroke (cm)	Free wheel sprocket teeth	Free wheel description recommended		Seeding density of seedling mat	
		Brand	Origin	Grams/ m^2	Classi-fication
0.9	16	SY	Japan	800-1000	Higher
1.0	16	Rocket	Taiwan	800-1000	Higher
1.0	16	Sport Compe	Taiwan	800-1000	Higher
1.2	20	SY	Japan	500-700	Lower
1.3	20	Rocket	Taiwan	500-700	Lower
1.3	20	Sport Compe	Taiwan	500-700	Lower

Table 2. Comparison of the modified "dapog" method and the modified wet bed method of seedling preparation.

Type of seedling preparation	Advantages	Disadvantages
1. Modified "dapog"	1. Seedling mats are easier to handle	1. Seedbeds are more difficult to prepare.
	2. Thickness of mat is more uniform	2. Requires wood frames.
	3. No cutting of seedling roots	3. Suitable only for 13-16 day-old seedlings.
	4. Less time required in cutting seedling mats.	4. Requires stronger forces for picking seedlings.
		5. Not suitable for hand transplanting.
		6. Requires frequent watering for the first few days after sowing.
2. Modified wet-bed method	1. Easier seedbed preparation.	1. Requires more care in handling of seedling mat.
	2. Does not require wood frames.	2. Thickness of mat is less uniform.
	3. Suitable for 13-25 day-old seedlings.	3. Requires cutting of seedling roots.
	4. Lower forces for picking seedlings.	4. Requires special knife.
	5. Suitable also for hand transplanting.	5. More time required in cutting seedling mats.

Table 3. Comparison of different types of seedling preparation for hand transplanting.

	Seedbed area (m^2/ha)	Age of seedlings at transplating (days)	Pulling and bundling (mandays/ha)	Mat cutting (manday/ha)
"Dapog"	10-15	10-13	-	0.2
"Laplap"	40-50	10-25	-	1.0
Wet-bed	400-500	25-35	4-5	-

Table 4. Problems during transplanting, 198 farmers, Libmanan and Cabusao, 1984.

Item	Farm size (ha)				All
	1.0 or less	1.1 to 2.0	2.1 to 3.0	Over 3.0	
Number reporting	19	28	24	27	98
Problems:					
Bad weather	11	13	10	22	56
Lack of labor	10	10	12	19	51
High cost of hand transplanting	10	12	6	17	45
Poor quality of work	3	5	7	11	26
Supervision required	1	4	4	9	19

Table 5. Characteristics of labor for transplanting, 100 farmers, Libmanan and Cabusao, Camarines Sur, 1984.

Item	Farm size (ha)				All
	1.0 or less	1.1 to 2.0	2.1 to 3.0	Over 3.0	
	Percent				
Age distribution					
Below 12	5	2	3	5	4
12 - 20	27	22	24	24	24
21 - 30	35	38	30	35	35
Over 30	33	38	43	3	37
Sex					
Male	42	37	34	35	37
Female	58	63	66	65	63
Origin					
Within village	82	81	78	70	78
Outside village	18	19	22	30	22
Status					
Regular	74	67	53	72	66
Casual	26	33	47	28	34
Method of contact					
Individual	40	25	21	14	24
Group	60	75	79	86	76
Manner of recruitment					
Workers ask for work	2	8	10	7	7
Farmers look for workers	98	92	90	93	93

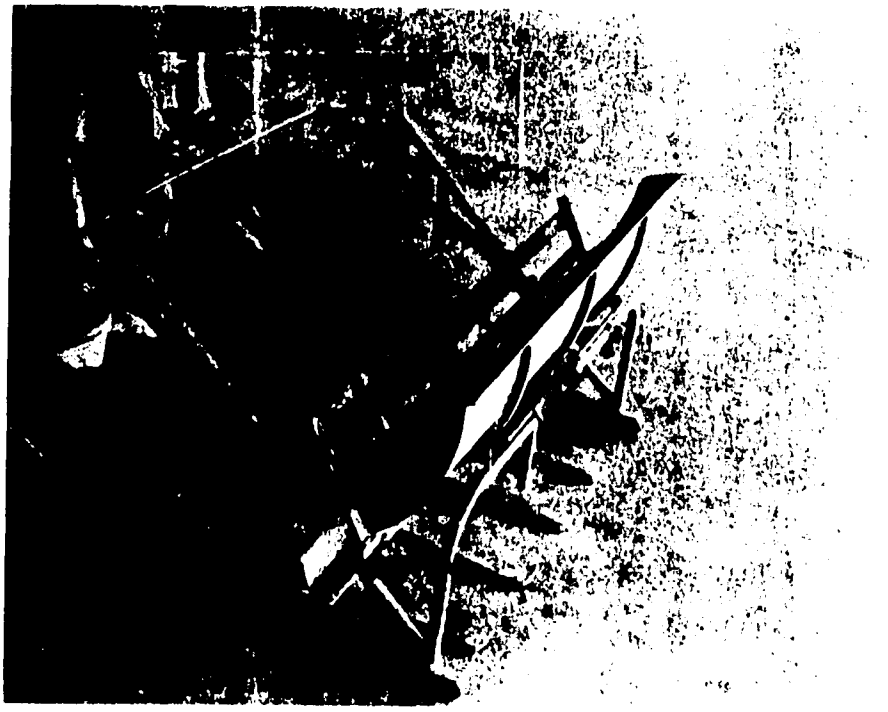

Fig. 1. Commercial model of Chinese type transplanter manufactured in the Philippines.

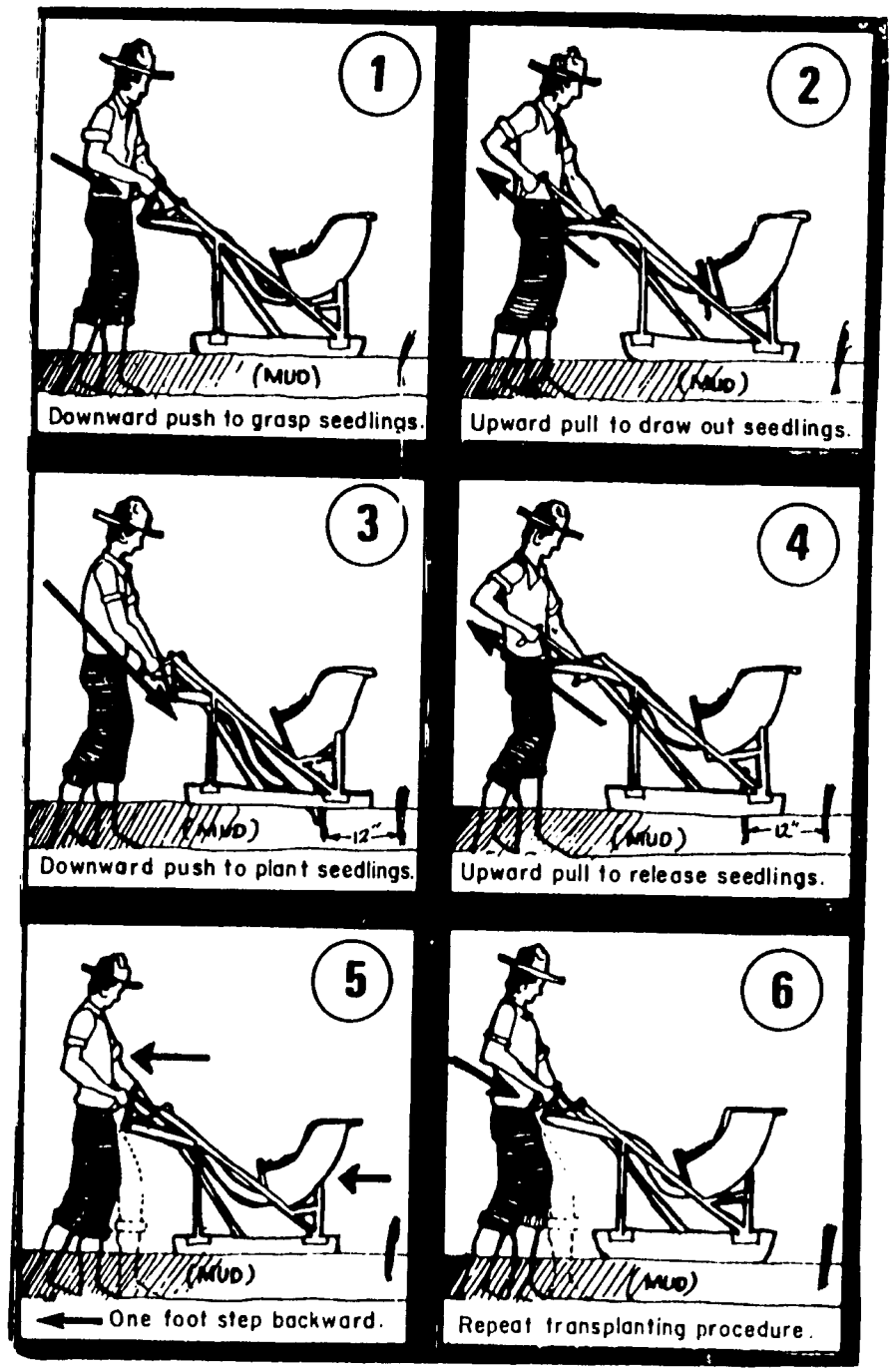

Fig. 2. Operating procedure for Chinese type manual rice transplanter.

Fig. 3. IRRI TR1 5-Row Rice Transplanter.

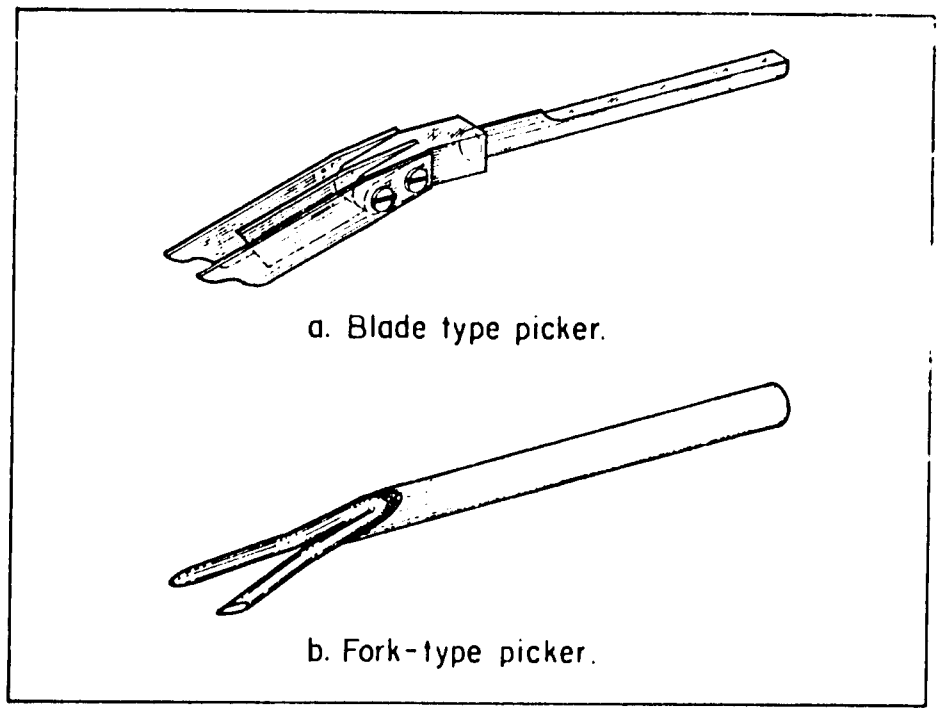

Fig. 4. Type of rice seedling picker.

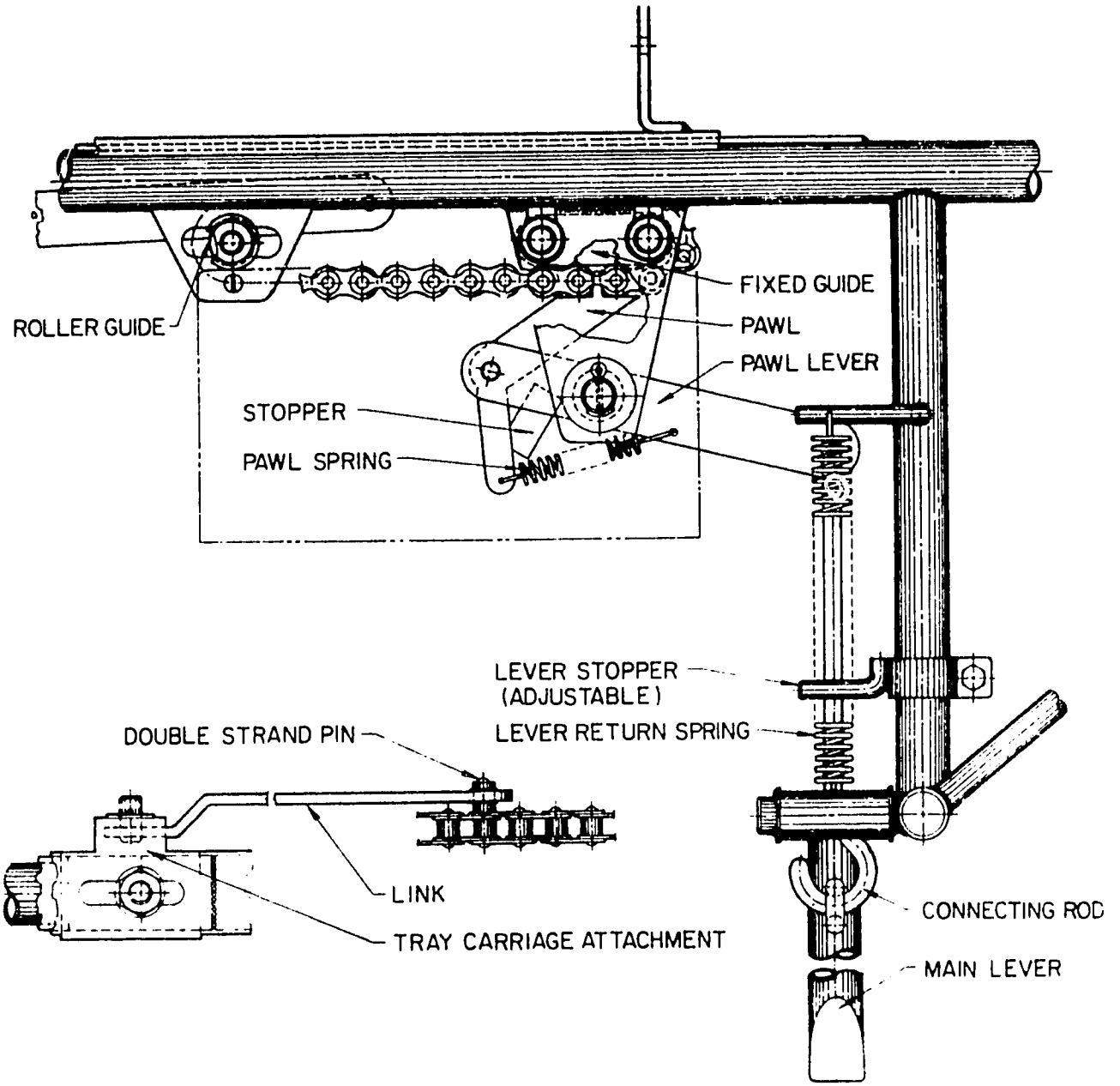

Fig. 5. Pawl lever tray drive mechanism.

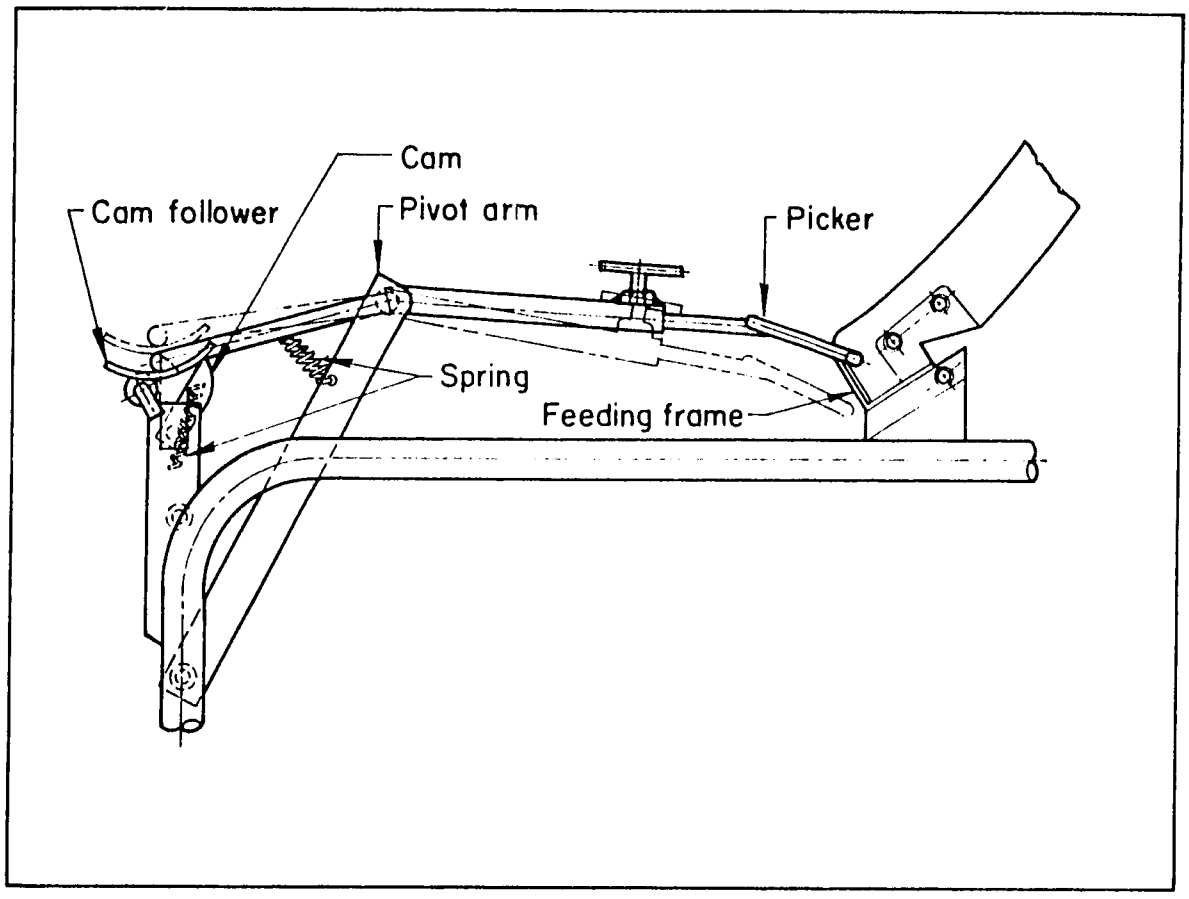

Fig. 6. Cam and Picker assembly of IRRI TR1 5-Row Rice Transplanter.

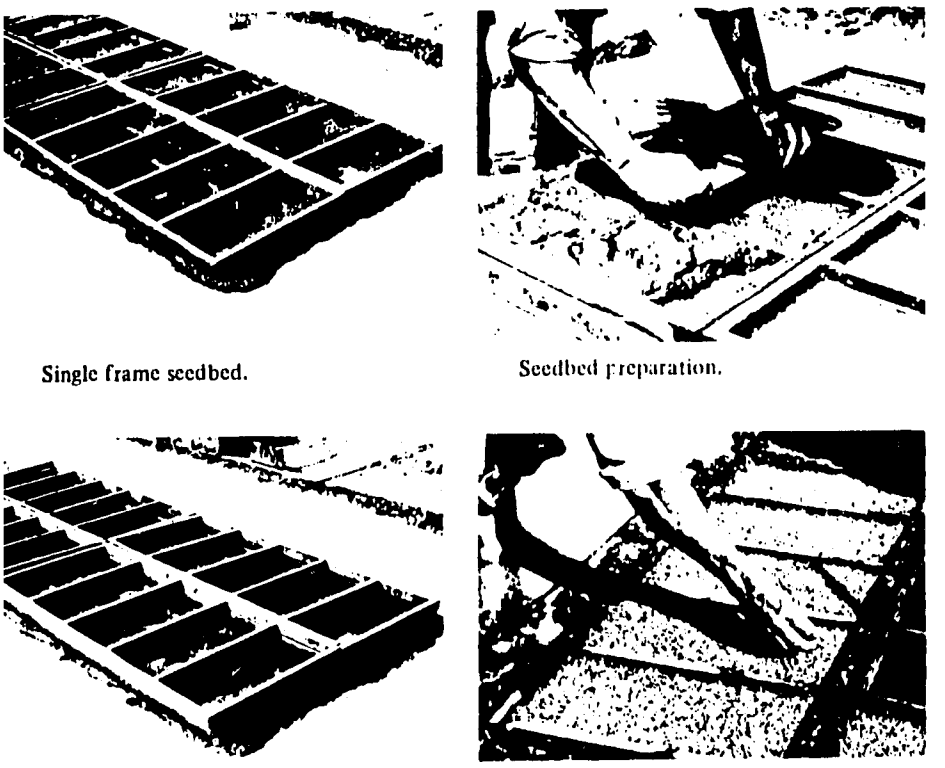

Fig. 7. Original method of seedling preparation for IRRI transplanter.

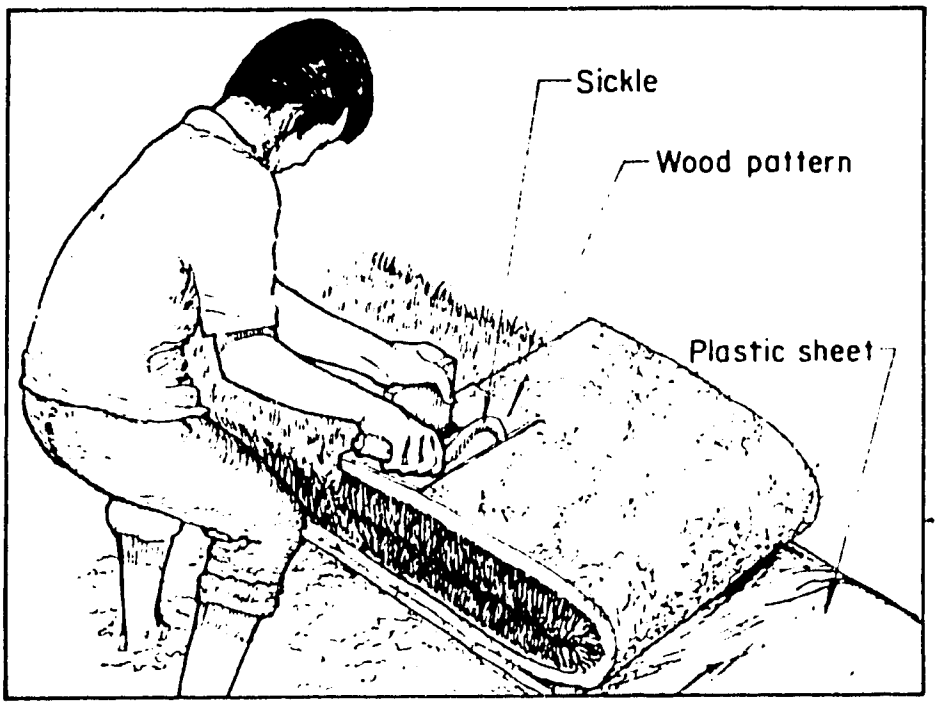

Fig. 8. PPC method of seedling preparation.

Fig.9. IRRI TR4-6 Row Rice Transplanter.

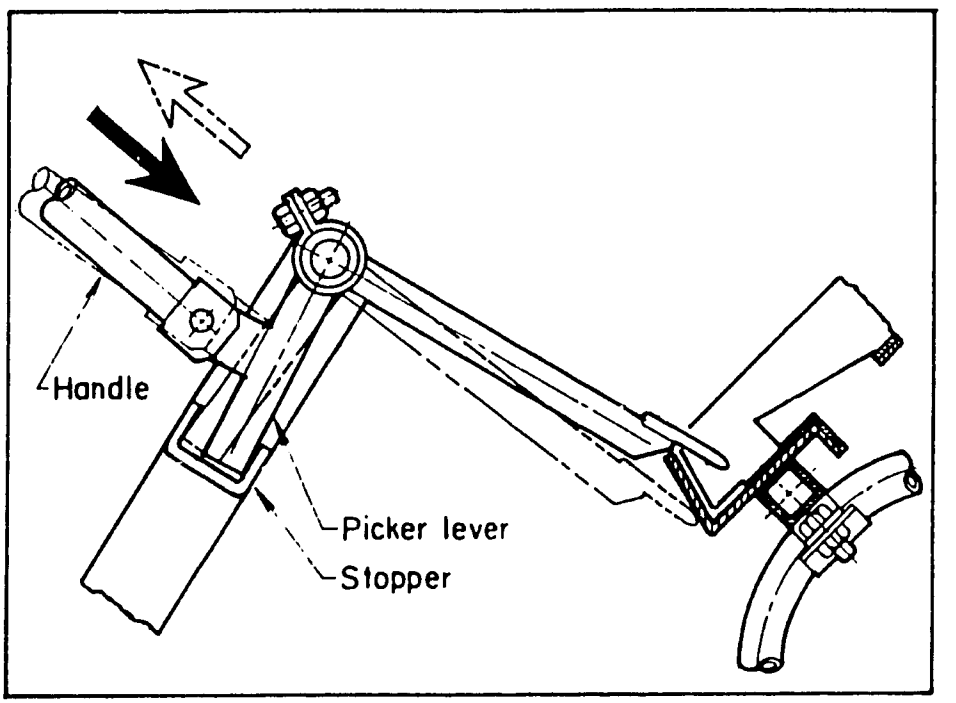

Fig. 10. Inertia control picking mechanism.

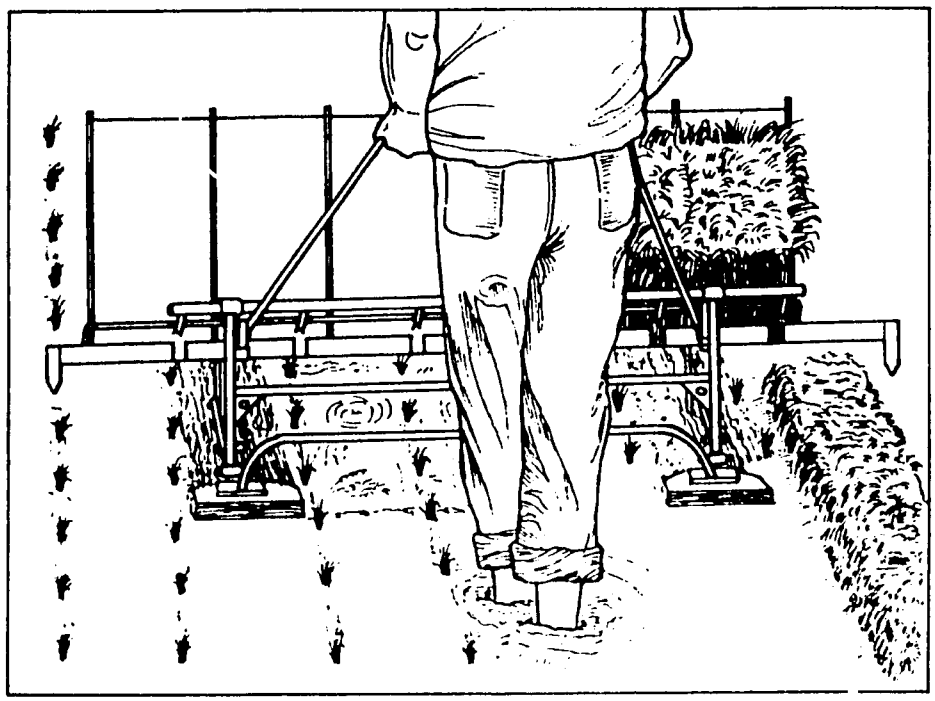

Fig.11. Planting when the remaining rows is less than 6.

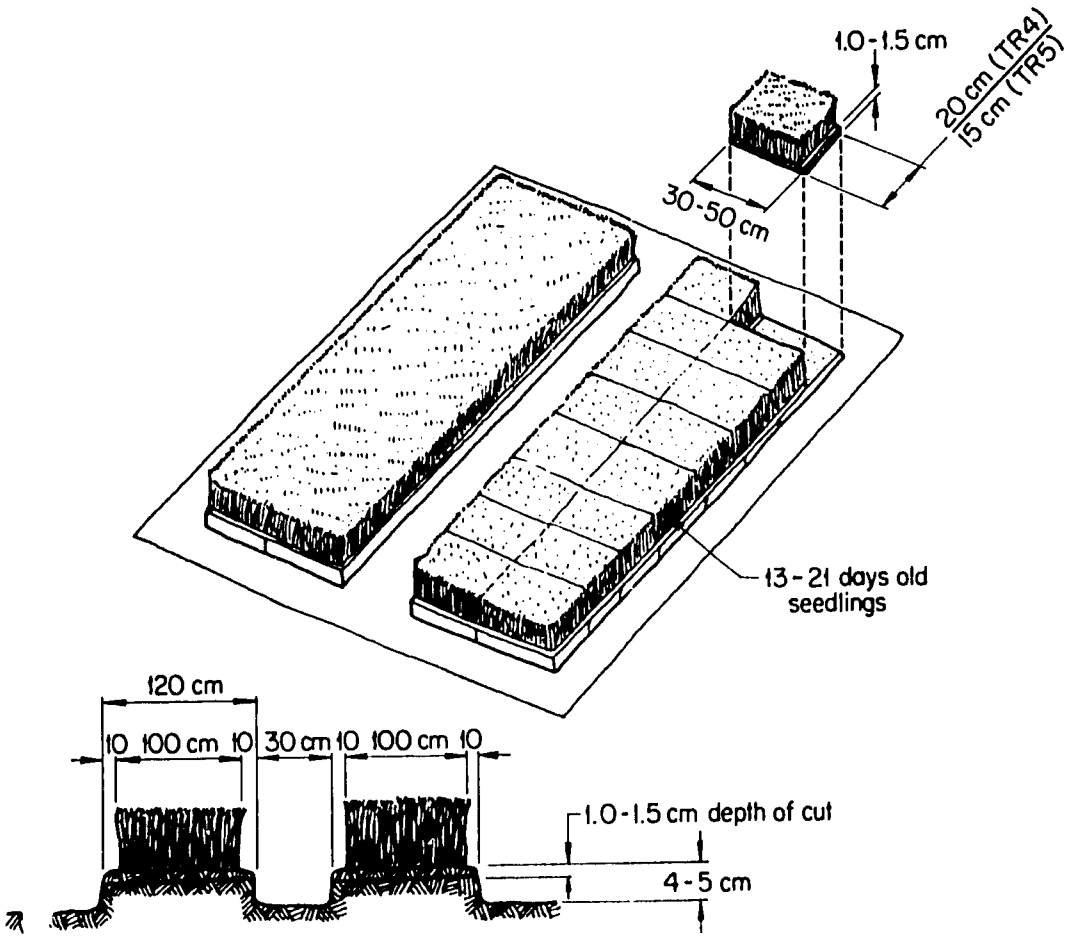

Fig.12. Modified wet-bed method of seedling preparation.

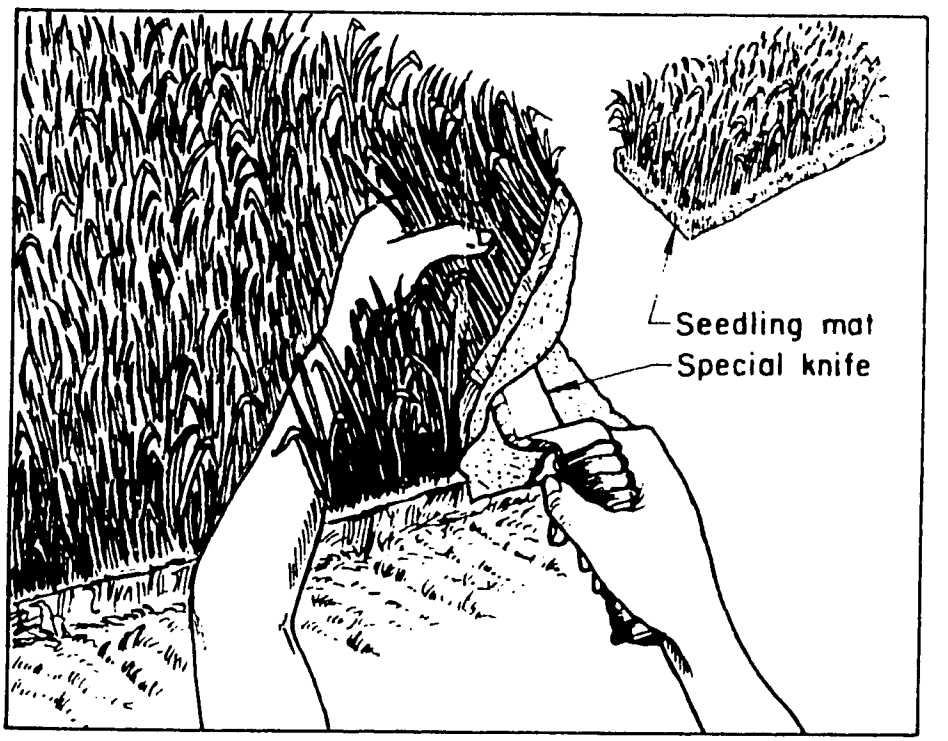

Fig.13."Laplap" method of seedling preparation.

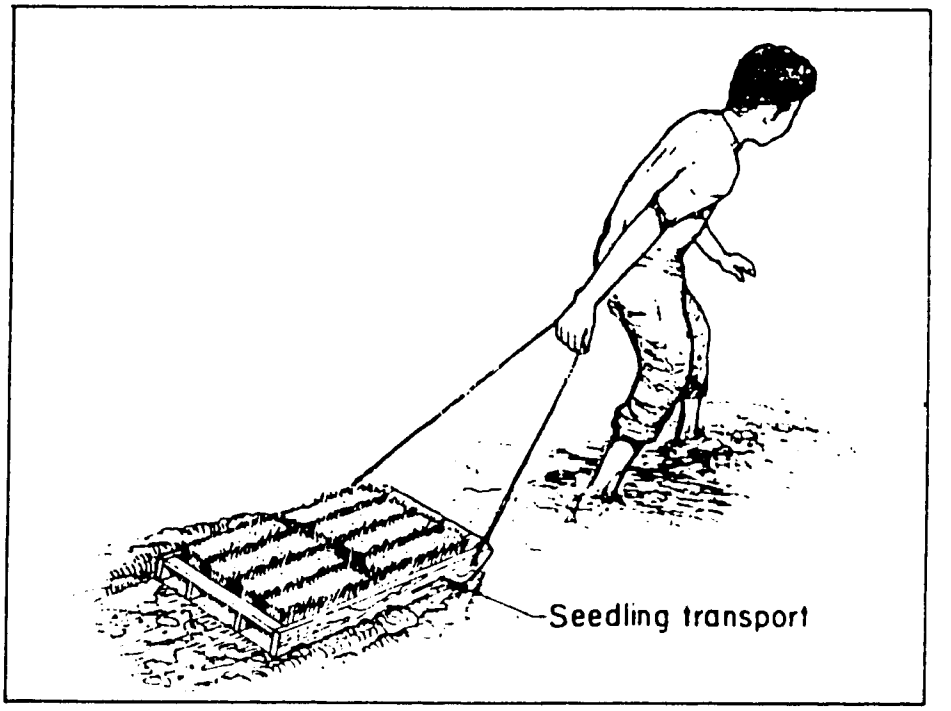

Fig. 14. Transporting seedlings in Bicol Region.

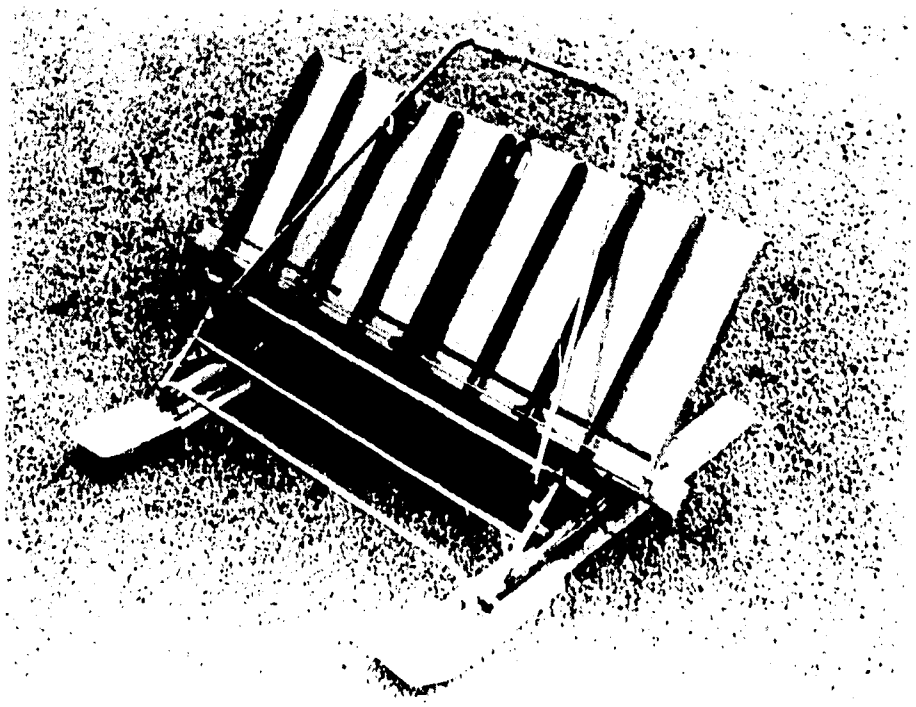

Fig. 15. IRRI TR5 8-Row Rice Transplanter.

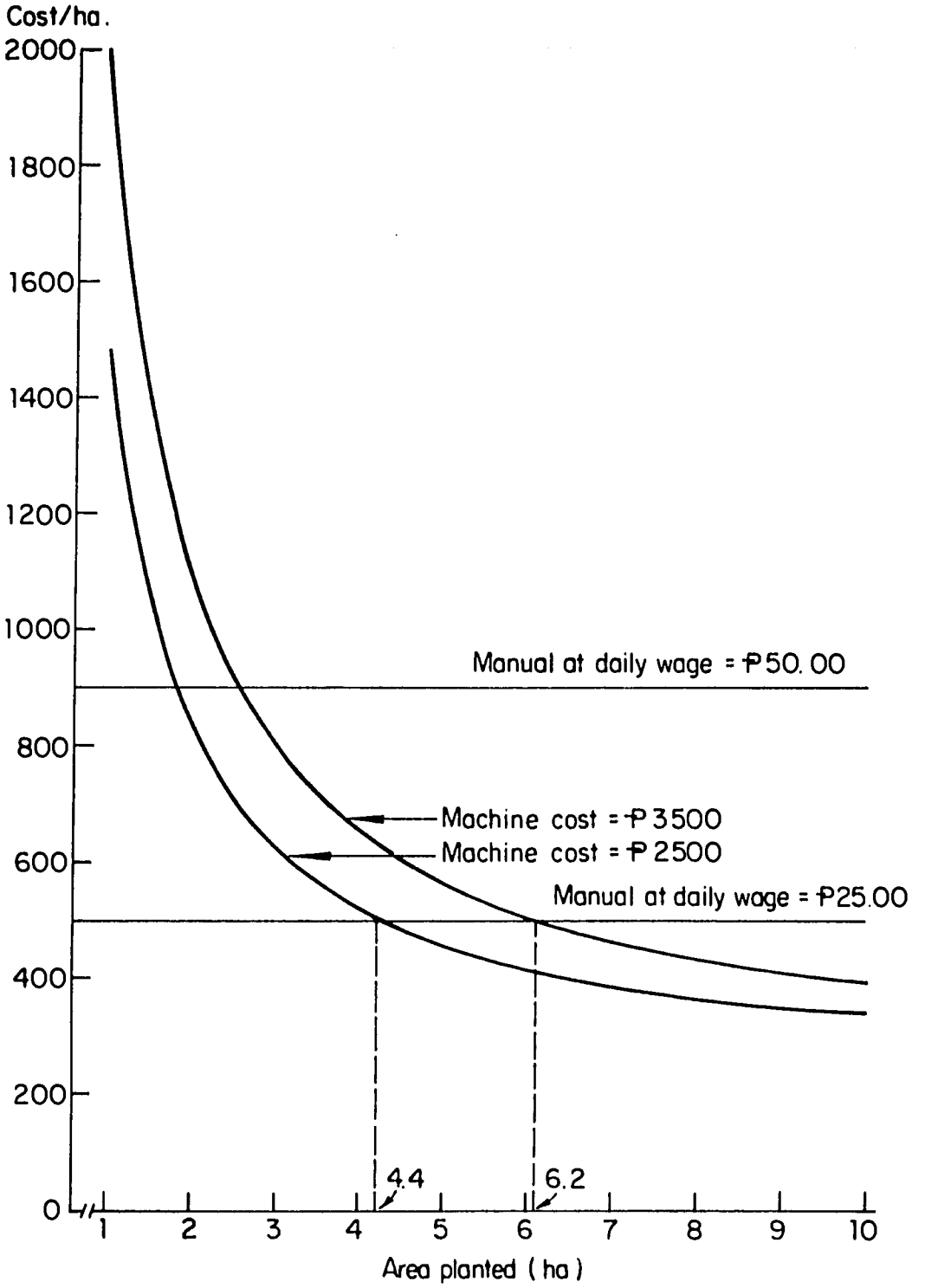

Fig. 16. Comparative average costs for manual and mechanical methods of transplanting.

IRRI TRANSPLANTER OPERATOR TRAINING COURSE
Libmanan, Camarines Sur

1st day

0800 - 0815	Welcome Address
0815 - 0845	Opening Remarks
0845 - 0915	Brief description of progress of the MA-IRRI Program
0915 - 1000	Introduction of the Board of Directors, trainees trainors, and manufacturers
1000 - 1015	Coffee break
1015 - 1100	Development of mechanical transplanter in IRRI
1100 - 1200	Economic consideration in the use of mechanical transplanter
1200 - 1300	Lunch and short program
1300 - 1330	Brief description of the training program
1330 - 1400	Seedlings for mechanical transplanter
1500 - 1515	Coffee break
1515 - 1545	Transplanter construction and operation
1545 - 1700	Sequence of movements in mechanical transplanter operation

2nd day

0800 - 1000	Field practice -- seedbed preparation and sowing
1000 - 1015	Coffee break
1015 - 1100	Seedling mat cutting and transport
1100 - 1200	Transplanter field operation without seedlings
1200 - 1300	Lunch
1300 - 1620	Transplanter field operation with seedlings (three-20 min. intermittent operation per trainee)

3rd day

0800 - 1000	Seedbed preparation and sowing (1 meter wide x 20 meter long seedbed/trainee)
1000 - 1015	Coffee break
1015 - 1200	Seedling mat cutting and transport
1200 - 1300	Lunch
1300 - 1630	Transplanter field operation (two - 1/2 hour intermittent operation/trainee)

4th day

0745 - 1700	Transplanter field operation (two - 1 hour intermittent operation/trainee)

Appendix A - 2

5th day

0700 - 1700	Transplanter field operation (two - 1 1/2 hour intermittent operation/trainee)

6th - 11th day

0745 - 1700	Transplanter field operation (two - 2 hour continuous operation/trainee)

12th day

0800 - 1200	Field day (a contest was held to determine the 3 best operators. They were judged on the quality of planting, speed, straightness of row and uniformity of spacing)
1200 - 1300	Lunch
1300 - 1500	Disassembly, assembly and adjustment of the machine
1500 - 1700	Graduation

APPENDIX B

Break-even point analysis for the 6-row transplanter

I. BASIC INFORMATION

A. Machine use

Machine cost	P2500
Machine life	3 years
Repairs and maintenance	5% of machine cost
Interest on investment	25%
Salvage value	nil
Machine capacity	0.33 ha/day
Labor requirement	two men alternating
Operator's wage	P25/day
Food provided to operators	P9.60/person/day

B. Manual method:

Labor	P400/ha
Food provided to workers (P6.25/worker/day x 16 workers-days/ha)	P100/ha
Total cost	P500/ha

Note: Current exchange rate is approximately 18 pesos per US dollar.

II. COST ITEMS

Annual fixed costs

$$\text{Depreciation} = \frac{\text{Initial cost} - \text{salvage value}}{\text{Machine life}}$$

$$\frac{₱2500 - 0}{3} = ₱833.3$$

Repairs and maintenance = Machine cost x 0.05 = ₱125.00

$$\text{Interest on investment} = \frac{\text{Machine cost} + \text{salvage value}}{2} \times (\text{interest rate})$$

$$\frac{₱2500 + 0}{2} \times (0.25) = ₱312.50$$

Total fixed costs = ₱1270.83

Variable costs

Labor = ₱25/person/day x 3 days x 2 persons = ₱150.00

Food provision = ₱9.60/person/day x 3 days x 2 persons = ₱ 57.60

Total variable costs = ₱207.60

III. BREAK-EVEN POINT:

$$= \frac{\text{Annual fixed cost}}{\text{Variable cost for manual method} - \text{Variable cost for machine use}}$$

$$\frac{₱1270.83}{₱500.00 - ₱207.60}$$

4.40 ha/year

Presented at the Conference on Small Farm Equipment for Developing Countries: Past Experiences and Future Priorities", The International Rice Research Institute, September 2-7, 1985.

ANNEX E

CAAMS-IRRI MECHANICAL REAPER: EXPERIENCES IN THE PHILIPPINES

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F.S. Juarez, B. Duff and C.W. Bockhop
The International Rice Research Institute

and

C.P. Fernandez
Bureau of Plant Industry, Ministry of Agriculture

In the developing countries of South and Southeast Asia, nearly all paddy fields of small farmers are reaped manually by groups of laborers using knives or sickles (5, 15, 18). Reaping (cutting only, not hauling or threshing) requires a high labor input (10-16 labor days per hectare) and, because it is the most strenuous activity of rice production, the labor wage rate (in cash or in kind) is often substantially higher than for other activities. Consequently, reaping is a major expense in rice production. Moreover, in areas having labor shortages during the peak harvest period, reaping is often delayed past the optimum date, reducing grain yield and quality (6). This problem is particularly serious in areas where typhoons hamper harvest.

History indicates that reaping changes from a manual operation to a mechanized operation when the cost of labor increases to the point that machine use is more economical (2). Japan exemplifies this change, and similar trends are occurring in Malaysia, Taiwan, and Korea. On the other hand, mechanical reapers used in middle and high income countries are too costly to be economically viable in developing countries having low income levels. Furthermore, these reapers generally prove to be too large for small farms, too heavy for water-logged fields, insufficiently durable for intensive use, difficult to maintain, and costly to repair.

Numerous efforts to develop a simple, low-cost reaper appropriate for small farms in developing countries have not been particularly successful. However, a reaper developed in the People's Republic of China (1, 9) may prove to be a breakthrough, and it has recently been modified by several institutions (10, 12, 17) to adapt it to different conditions in developing countries.

The International Rice Research Institute (IRRI) has worked with the Chinese reaper, and this paper summarizes our experiences in adapting and promoting the reaper in the Philippines. We describe the collaboration of the Chinese Academy of Agricultural Mechanization Sciences (CAAMS) and IRRI to modify the original Chinese reaper design so it better suits agricultural and industrial conditions of developing countries in South and Southeast Asia. This collaboration represents a unique illustration of the potential benefits of technology transfer and cooperation between countries and international organizations.

We then briefly summarize the promotion of the CAAMS-IRRI reaper in the Philippines by the Ministry of Agriculture and Food (MAF) and IRRI. This effective collaboration includes the direct involvement of local manufacturers.

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We also report results of technical and socioeconomic surveys to evaluate the extension, performance, and impact of the reaper in the Philippines.

Finally, we pull together the lessons learned from this experience, including suggestions for future work in the Philippines and other developing countries.

DEVELOPMENT OF THE CAAMS-IRRI REAPER

Development of the vertical-conveyor reaper in China began in the early 1960s (1, 9). The advantages of this design compared with the conventional horizontal or inclined conveyor designs are light weight, simple construction, and ease of front-mounting on small two-wheel and four-wheel tractors to improve maneuverability in small fields. Improvements were made during the 1960s and 1970s, and the design illustrated in Figure 1 was manufactured in China beginning in the late 1970s. The principal innovations are (Figure 2):

1. Lugged V-belts and star wheels gather the crop and feed it to the cutting mechanism. The star wheels also hold the crop during cutting and then help feed the cut crop into the conveyor. The V-belt and star wheels are driven (rotated) by direct contact with the moving lugs of the conveyor belt.

2. A conveyor consists of two flat belts with lugs suitable for transporting the cut crop laterally across the reaper to the side where it is gently released to fall into a uniform windrow on the ground. The cut crop is held against the conveyor belt by pressure springs.

During a visit to China in the late 1970s, an IRRI engineer observed the Chinese reaper and was enthusiastic about its potential applications in developing countries. This led to the agreement between CAAMS and IRRI to collaborate in modifying the Chinese reaper design for small rice farms in South and Southeast Asia. In 1980 three Chinese engineers worked with IRRI engineers in the Philippines to develop a simplified reaper which was lighter, less expensive, and easier to fabricate with shop tools, materials, and components (bearings, belts, etc.) generally available to small-scale manufacturers in the Philippines and other developing countries. The design eliminated the lugged V-belts and simplified the power take-off, conveyor drive, and cutter mechanism (10, 17). The reaper unit was designed as an attachment for hand tractors which are also used for plowing, transport, and other operations. Two models were developed, the 1.0 meter wide unit fits the IRRI PT5 hand tractor, and the 1.6 meter wide unit matches larger conventional hand tractors.

EXTENSION OF THE CAAMS-IRRI REAPER IN THE PHILIPPINES

MAF-IRRI program

MAF-IRRI collaboration began in 1981 to develop and extend agricultural equipment appropriate for small farms and produced by local industry in the Philippines (14).

Over 200 manufacturers have become cooperators in the MAF-IRRI Program by signing a memorandum of agreement. These cooperators, located throughout the Philippines (see Figure 3), range from small blacksmith and metalcraft shops to large-scale industries. Special attention is given to manufacturers located in agricultural areas, thereby ensuring availability of parts and service, while also creating rural employment and stimulating innovations and adaptations to local conditions and farmer preferences. The MAF-IRRI Program provides them with agricultural equipment designs, together with training and technical assistance. In turn, the cooperators agree to provide annual production statistics and to sell units only after testing and authorization by MAF-IRRI.

The MAF-IRRI Program organized workshops for farmers, agricultural technicians, and R & D engineers to help identify priorities for small farm equipment in the Philippines (11). Identified as a high priority was a mechanical reaper suitable for small rice farms in areas having labor shortages at harvest time. Consequently, the MAF-IRRI Program began promoting the CAAMS-IRRI reaper to cooperating manufacturers in 1982. The 1.0 m reaper was chosen over the 1.6 m model because of lower cost and better maneuverability in small fields. A copy of the promotional leaflet for the 1.0 m reaper is included in Annex A, and it provides the technical specifications. Because of its light weight and low cost, this reaper could minimize problems encountered previously with imported reapers which Philippine rice farmers did not accept. We expected this reaper to compete with similar machines recently imported from Japan.

Selection of target areas

The first task was to identify Philippine areas where the reaper might be appropriate; i.e., areas where labor shortages lead to significant delays of harvesting. Mindanao and the Cagayan Valley (principally Isabela) were selected as the priority areas for reaper extension. The MAF-IRRI Program decided to not promote the reaper in labor-surplus areas (e.g., Bicol and Central Luzon) even though some farmers in these areas complain of labor shortages during peak harvest times.

Field demonstrations/evaluations/trials

The second step was to conduct field demonstrations and evaluations of the reaper in the major rice-producing areas of Mindanao

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and the Cagayan Valley. The MAF-IRRI Regional Project Engineers located in these areas are regular employees of the Ministry's regional offices and experimental stations, and devote part of their time to the MAF-IRRI Program. They were vital to the coordination of these demonstrations, particularly in insuring that the attendees included outstanding farmers, leaders of cooperatives, local manufacturers, agricultural extension technicians, and rural bank officials.

The major results of these demonstrations were:

1. During evaluation sessions held immediately after the field demonstrations, most farmers stated that the reaper would be appropriate and beneficial in their areas;

2. Observing the enthusiasm of farmers for the reaper, many manufacturers became interested in fabricating it;

3. The MAF-IRRI engineers became better acquainted with the manufacturers of the area, thereby recruiting new cooperators and bringing technical assistance to those interested in fabricating the reaper.

An intensive test of the performance and durability of the reaper and hand tractor was carried out in Mindanao on a 370-ha farm where rice is grown continuously during the year. Reapers could be used regularly on up to 2.5 ha per day, 6 days per week, throughout the year. The test results served as the basis for modifying the reaper and hand tractor to improve operation and durability.

Training courses

A two-day intensive training course on fabricating the reaper and hand tractor was given twice during 1982 in Manila for cooperating manufacturers and MAF-IRRI engineers. The course was designed to help trainees to understand: a) the blueprints for the reaper and hand tractor; b) the main steps of fabrication and assembly; c) operation, maintenance, and repair; and d) the economics of fabrication and reaper use.

All 68 cooperators in the MAF-IRRI Program were invited to attend the first course (February 1982). Twenty-four (35%) attended. Ten attendees had successfully fabricated at least one reaper and hand tractor by the end of the first survey (May 1983).

For the second course (August 1982), of 110 cooperators, the 86 who had not attended the first course were invited. Nineteen (22%) attended, and 6 successfully fabricated at least one unit by survey time. Eleven cooperators who did not attend either training course have also fabricated at least one reaper and hand tractor.

Many attendees were from small-scale firms located in Mindanao and other areas far from Manila, the training site. The attendees paid for

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their transportation and lodging expenses, while the MAF-IRRI Program provided them with blueprints and instruction materials.

Technical assistance and prototype testing

MAF-IRRI engineers periodically visit cooperating manufacturers to provide technical assistance in fabricating the reaper or other equipment promoted by the Program (e.g., threshers and pumps). If an engineer cannot provide the requested assistance, he contacts the MAF-IRRI central office for information or for help from an engineer familiar with the problem.

The most common forms of technical assistance given are:

1. To help manufacturers understand the blueprints and to locate suppliers of special components (e.g., reaper blades).

2. To loan equipment (e.g., reaper) to manufacturers who have difficulty reading blueprints.

3. To perform the prototype test of the first unit fabricated by a manufacturer. This test determines if the unit has been fabricated and assembled correctly and if it functions properly in the field. It is also an opportunity to advise manufacturers on critical adjustments and operating procedures. After passing the prototype test, the manufacturer is authorized by the Program to proceed with production.

4. To assist manufacturers with field demonstrations for farmers (often at meetings of farmer organizations) and, in a few instances, with applications for loans.

5. To maintain two-way communication with manufacturers on both problems and improvements in design, fabrication, or operation of equipment promoted by the Prog am.

TECHNICAL AND SOCIOECONOMIC EVALUATIONS OF THE CAAMS-IRRI REAPER

Reaper production statistics

Table 1 provides the number of CAAMS-IRRI reapers produced by MAF-IRRI cooperating manufacturers 1982-1984. Production rose sharply in early 1983, but fell off during the second half of 1983 because of decreasing sales. Reasons for the disappointing sales are discussed in the following sections.

1983 survey

One year after reaper introduction, the program surveyed cooperating manufacturers to: a) evaluate the impact of extension efforts, b) detect problems encountered by manufacturers and owners/operators, and c) determine what actions should be taken to overcome these problems. The main conclusions (7) are:

1. Reaper introduction to manufacturers was rapid, with 27 firms successfully fabricating at least one unit within the first 15 months.

2. Fabrication of the reaper and hand tractor is sufficiently simple to be done by small manufacturing firms having limited capital, personnel, and equipment (Table 2).

3. Many firms were willing to devote their own money and time to attend the reaper training course, including small firms in agricultural areas far from Manila.

4. Although the training course helpped introduce the reaper to firms, it was not indispensable in all cases because 41% of the initial reaper manufacturers did not attend the course. However, many of these untrained reaper manufacturers have purchased reapers to copy or hired experienced reaper fabricators (Table 3).

5. Since the majority of the reaper manufacturers were unable to fabricate a machine from engineering drawings alone, the program loaned reapers to them to copy.

6. Manufacturers identified aspects of the reaper design, fabrication, and operation which should be improved (Table 4). Several manufacturers have made improvements (7).

7. Reaper sales were extremely low, primarily because of the depressed economic conditions of rice farmers in the Philippines. Furthermore, farmers were understandably reluctant to buy a new machine of unproven performance and durability, or which may cause problems with hired farm workers.

8. This early survey provided only preliminary information on sales and no direct information on buyers (farm size, location, cropping intensity, etc.) or on use (e.g., used only on owners' farms; contract work on other farms; costs and returns; use rate (hectares/year); and labor displacement). Fernandez et al (7) recommended that a second survey be conducted in 1984 to obtain data on buyers and use, including a study of the positive and negative impacts of the machine on those who own reapers, those who hire reapers, and those laborers who are displaced by reapers.

1984 Surveys

IRRI economists and engineers collaborated in 1984 to study the status and potential impact of the reaper in the Philippines (13, 16). The first step was to visit reaper manufacturers and dealers. This verified that sales of CAAMS-IRRI reapers had declined markedly in late 1983 and throughout 1984. The principal reasons given for the decline in sales (13) were:

1. Technical Problems. The major technical problem was that cutter knives often become dull after reaping only 5-20 ha. This was especially serious because knives are costly imported items and are difficult to sharpen or replace without the help of an experienced mechanic. Main causes of dulling are: a) insufficient rigidity of the cutting mechanism due to deviations from the specified materials or dimensions; b) improper assembly and adjustment of the cutter, producing faulty knife alignment and clearance; and c) failure of reaper owners to check and adjust knife clearances at appropriate intervals. Of the remedies undertaken by MAF-IRRI, the most difficult task will be to train manufacturers, repair shops, and owners to adjust and sharpen the knives at appropriate intervals. Other technical problems are easier to correct, such as improving the useful life of the starwheels, pitman arm, flat conveyor belts, and V-belt (13).

2. Performance Limitations. The reaper is not acceptable in fields which cannot be drained before harvesting because the cut crop will be laid in the water and the grain will become wet, thereby increasing the difficulty of threshing and drying and, consequently, reducing grain quality. The reaper's performance is also unacceptable in fields having excessive weeds or deep, soft mud.

3. Socioeconomic Problems. Since many farm laborers earn a substantial part of their total annual income from manual reaping, some farmers and manufacturers decided against using mechanical reapers which displace labor. We were told of laborers protesting against the reaper either by threatening to boycott the farm (i.e., refuse to provide labor for transplanting, weeding, and other farm operations) or by sabotaging the reaper (e.g., putting metal bars in the rice field to damage the cutter).

We did not survey owners of CAAMS-IRRI reapers because they were spread over a wide area and the reapers had not been used to a significant degree as most owners were part-time farmers with above average incomes. We were unable to find reaper owners who were using their machines intensively on a contract-hire basis as is common with the axial-flow thresher.

The best alternative was to survey owners of the Kubota AR120 reaper which were most conveniently concentrated in the province of

Bataan (16). The AR120 reaper is based on the CAAMS-IRRI design but has a 1.2-meter cutting width and involves a much higher level of technology, such as lightweight materials and diecast components, a transmission with forward and reverse gears, and a drive shaft with a clutch for transmitting power from the engine to the reaper assembly. The AR120 is designed only for reaping and cannot be used for plowing or other operations.

Bataan has features favoring reaper acceptance: a) farm labor is more scarce than in most Philippine areas because of employment opportunities at the Bataan industrial complex (export processing zone), the nearby US Navy base, and construction projects such as the country's first nuclear power plant; b) many Bataan workers have overseas employment and use their savings to finance businesses in Bataan, such as purchasing reapers to be hired out on a contract basis; c) since much of the rice area in Bataan is irrigated, farmers wish to reduce the time required for harvesting so that the next crop may be planted with minimum delay; and d) the Kubota dealer in Bataan is highly respected by farmers, and he initially offered the reaper on a trial basis, providing reliable service, parts, and repair.

During 1982-84 the dealer sold more than 100 AR120 reapers. The 1984 survey (16) included 15 owners of AR120 reapers, 41 farmers who have hired these reapers, 37 farmers who hired manual labor rather than mechanical reapers, and 58 laborers who earn part of their income by manual reaping.

Results show owners used their reapers on an average of 45 ha per year, with only 6% of total use on their own farms. Therefore, reapers were primarily used (94%) to earn income from contract hiring to reap paddy of other farmers. Reaper owners usually charged farmers an average of US$22 per hectare (₱309/ha, converted at ₱14/dollar, the exchange rate in late 1983 and early 1984), with the owners providing the machine, fuel, operator, and helpers. This fee was slightly lower (12%) than the average cost of manual reaping.

The main reasons surveyed farmers preferred the mechanical reaper over manual labor are the difficulty in hiring labor and the speed of the reaper (Table 5).

Most reaper owners were very satisfied with the AR120, and a few purchased two or three units. Their main complaint was that the reaper blades became dull easily and had to be sharpened or replaced. Kubota provided instructions and training on blade sharpening. New blades (US$165 per set) were purchased by 82% of the owners after an average of 49 hectares of use.

As shown in Table 6, owners found the reaper's performance unsatisfactory when fields had deep mud or were small, flooded, weedy or densely seeded, or when crops were lodged or wet. In severe lodging, flooding, or deep mud, the mechanical reaper cannot be used and farmers must resort to manual reaping.

The surveyed owners preferred the AR120 to the CAAMS-IRRI reaper because it was easier to operate and to transport, provides more space

between windrows, and is more reliable due to higher quality and excellent service from the Kubota dealer. The price of the AR120 is substantially higher than that of the locally-produced reaper,- US$2,400 versus US$1,400 in mid-1983 (10 pesos/dollar)-and its replacement parts are more expensive. However, owners felt this difference was more than offset by the superior operation and durability of the AR120. The price difference would have been even greater if exchange rates and tariff structures had not been so favorable for imported equipment during this period. This illustrates how government policies can discourage local production by subsidizing imports (4). Fortunately, the Philippine Government has recently taken steps to correct this problem.

In late 1982 and early 1983, owners found the reaper to be a highly profitable investment, some informally reporting reaper earnings were sufficient to pay off investments in less than one year. However, the situation has since changed markedly with devaluation of the currency (from 8.50 pesos per dollar in 1982 to 18.50 pesos per dollar in August 1985), restrictions on importations, and sharp increases in interest rates to 40% or more.

Economic analysis indicates the AR120 is not a profitable investment under present conditions (16). To provide a simplified illustration of this point, we have computed the breakeven curve for a range of values for interest rates and initial costs of the reaper (Fig. 4). The computation is based on the following assumptions: the contract rate is P400/ha for either mechanical or manual reaping; for mechanical reaping, 25% of the contract rate goes to labor and P50/ha to fuel and oil; annual costs for taxes, insurance, repair and maintenance are estimated to be 7% of the initial cost of the reaper; the reaper is used on 45 ha/ year and has an estimated life of 5 years. As seen in Fig. 4, the AR120 reaper was profitable (i.e., well below the breakeven curve) in late 1982/early 1983 when interest rates were 20-30% and the average price for the reaper was approximately P18,000. In 1985, interest rates have increased to 40% or more and the AR120 price is at least P29,000, thereby causing the reaper to be unprofitable, as indicated in Fig. 4. This result is consistent with sharply falling AR120 sales. The devaluation and import restrictions should favor sales of locally-produced CAAMS-IRRI reapers, but these effects have been overpowered by high interest rates, inflation, and low wages for labor used for manual reaping.

Since labor displacement was a principal consideration in the survey of Te et al (16), farmers were asked to estimate the amount of labor required for manual and mechanical reaping. The average values were 17 labor days/ha for manual reaping and 2 days/ha for mechanical, indicating a labor displacement of 15 days/ha. This indirect estimate is substantially higher (15 versus 10 labor days/ha) than direct measurements obtained in an earlier study in Mindanao (8). However, in both cases labor displacement is sufficient to markedly reduce employment.

The Bataan survey of farm laborers indicates that manual reaping provides an average of 22% of total annual household income, and this

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income component has declined by 47% since the introduction of the mechanical reaper in 1982. Their average household income is US$760/year (₱10,600 then), with 29% of the sample falling below US$360/year. They earn an average of 72% of their total income by working as hired laborers on rice farms. Sixty-nine percent are landless, while the remainder have small farms (average size of 0.9 ha). Only 14% of these laborers work more than 200 days per year, indicating substantial underemployment. In 46% of the surveyed laborer households, some alternative employment helped compensate for the decline in manual reaping opportunities; however, only 40% reported sufficient new income to counterbalance the loss in income from reaping. Reaper impact has been most severe for the lower income households (i.e., below US$360/year) who are less capable of finding equivalent income opportunities.

A detailed study of one community of farm workers in Bataan indicates that the number of seasonal migratory laborers from other provinces has declined markedly since the introduction of the AR120 reaper and that community members tend to migrate readily to other areas (rural or urban) to find employment opportunities (3).

SUMMARY AND CONCLUSIONS

These experiences of the CAAMS-IRRI and Kubota AR120 reapers in the Philippines show how technical and socioeconomic factors combine to influence the degree of acceptance of new technology. In this case, the reaper was a radically new technology compared with the labor-intensive manual reaping. Although history generally indicates that extreme changes of this nature are, at best, slowly accepted, we initially expected that the CAAMS-IRRI reaper might prove to be an exception because: (a) farmers were extraordinarily enthusiastic about the reaper at field demonstrations; (b) manufacturers were eager to attend the training courses, and many were able to fabricate units shortly thereafter; (c) preliminary economic analyses indicated that the machine was highly profitable in areas where there are labor shortages at harvest time; (d) results of an intensive field test on a continuously-cropped farm in Mindanao indicated that the reaper's performance and durability were satisfactory, although the machine required careful maintenance and repair. However, after a brief period of encouraging sales during late 1982 and early 1983, farmer acceptance fell off due to a combination of factors:

1. Limited utility. Farmers recognize that mechanical reapers are not as versatile or dependable as manual reaping. The reaper cannot be used in fields having lodged crops, excessive water, or mud, frequently present in typhoon-prone areas. The reaper's utility is further reduced by mechanical problems (e.g., dull cutter knives or broken drive mechanism) which occur without warning and result in

harvesting delays while repairs are being made. Philippine rice farmers generally have small farms, limited savings, and uncertain agroclimatic conditions; they cannot risk adopting radically new technology with limited utility and dependability unless there are overpowering economic benefits.

2. Undesirable labor effects. Although most farmers express complaints about the cost, scarcity, and inconvenience of hiring laborers for manual reaping, many decided against adopting the mechanical reaper because of their moral concern for displaced laborers or their fear of forceful reactions by laborers, such as sabotage or boycotts. At present, this concern is a real issue in the Philippines because of the economic recession, rising underemployment, and increasing reprisals by armed groups of dissidents.

3. Unfavorable economic conditions. Although preliminary analyses in 1981 suggested that the reaper would be economically viable in the Philippines (10), conditions changed markedly during 1981-85 due to inflation, devaluation, rising interest rates, and a decline in the real cost of labor. Considering these changes, Te et al (16) concluded that the reaper is no longer a profitable investment in most Philippine areas.

Although our engineers and cooperating manufacturers can devise improvements to reduce the technical problems limiting the reaper, we do not expect that this will significantly increase its acceptability under present Philippine socioeconomic conditions. A few areas like Bataan may be exceptions. Because of widespread underemployment in the country, the Philippine government should further its recent efforts to avoid policies (e.g., import and credit subsidies; overvaluation of local currency) which subsidize machinery at the expense of labor (4).

This study illustrates how strongly the acceptance of technology depends upon socioeconomic conditions. Initially during the development of the reaper, some persons were concerned that the machine's performance was so extraordinary that acceptance would be rapid and widespread, thereby causing serious unemployment of landless laborers. We now see that the reaper is not so extraordinary that it will be widely accepted in areas where farm labor is cheap (roughly US$1.50/day) and underemployed. On the other hand, we believe that the CAAMS-IRRI reaper will gain increasing acceptance in the Philippines when the economy recovers and labor costs begin to rise. This trend has been consistent throughout the history of agricultural mechanization (2).

IRRI and RNAM have disseminated information on the CAAMS-IRRI reaper to developing countries, in some cases with prototypes for evaluation under local conditions. Although the reaper has not been significantly accepted in areas of small rice farms, it has had substantial sales in several wheat areas of Pakistan and India (Punjab). The case of Pakistan, described in the following paper by Butt and

Rahman, illustrates the importance of adapting the basic design to The particular needs and conditions of the area. In China, the reaper has also been more readily accepted for wheat than for rice (1, 9). Rice areas present a more difficult challenge to the reaper because fields are smaller, more subject to flooding, and the crop is more apt to be lodged.

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Table 1. Production of CAAMS-IRRI reapers in the Philippines: 1982-1984.[a]

Year	Number of reapers produced	Number of reaper manufacturers
1982	68	18
1983	363	27
1984	40	12

[a] Based on annual surveys of cooperating manufacturers of the MAF-IRRI Industrial Extension Program for Small Farm Equipment.

Table 2. Classification of cooperating firms according to assets, labor, reaper training, and reaper manufacturing[a], data expressed as percentages.

Range	All cooperators (124)[c]	Trained cooperators[b] (30)[c]	Reaper Manufacturers[b]	
			Trained (16)[c]	Untrained (11)[c]
CAPITAL ASSETS[d]				
< $10,000	44	40	31	45
$10,001 to $100,000	44	37	38	27
$100,001 to $400,000	10	13	25	9
> $40,000	2	10	6	18
LABOR (Number of employees)				
< 5	29	20	31	36
6 to 15	45	53	31	18
16 to 50	21	13	19	36
> 50	6	13	19	9

[a] Data as of March 1, 1983.

[b] "Trained" cooperators are those who attended the reaper training course. "Untrained" reaper manufacturers are those who have fabricated at least one reaper without attending the training course.

[c] Number of firms in sample.

[d] Approximate conversion rate: ₱10 per US dollar in early 1983.

Table 3. Principal methods used by reaper manufacturers in fabricating their first prototype units.[a]

Methods	Number of manufacturers	Percentage
Followed blueprints provided by MAF-IRRI	11	41
Utilized reaper loaned by MAF-IRRI[b,c]	8	30
Utilized reaper purchased by firm[c]	6	22
Hired services of experienced reaper fabricator[c]	2	7
Total	27	100

[a] Data of Fernandez, Manaligod, and Stickney, 1984.

[b] MAF-IRRI loaned reapers only to manufacturers in the target areas: Mindanao and Cagayan Valley.

[c] These reaper manufacturers also utilized blueprints provided by MAF-IRRI.

Table 4. Manufacturers' suggestions on improvements of the CAAMS-IRRI reaper.[a]

Suggestions	Frequency[b]
Increase width of cutter bar to 25 mm. (1 inch)	7
Provide clutch to disengage reaper from hand tractor PTO	5
Modify reaper skid to reduce bumping and facilitate turning	4
Improve maneuverability of machine	3
Change hand tractor clutch lever to motorcycle type	3
Increase diameter of vertical shaft of reaper	3
Modify transmission or pulley ratios to reduce forward speed of machine	2
Eliminate need for twisted V-belt between PTO and reaper	2
Reduce problem of straw wrapping around starwheel shaft	2

[a] Based on responses of 27 reaper manufacturers, some of whom have made more than one suggestion. (Reference 7)

[b] Frequency represents the number of manufacturers who have either suggested the particular improvement or actually incorporated the improvement in their unit.

Table 5. Principal reasons for farmers' decisions to hire mechanical reapers instead of manual labor. (Survey of 41 farmers in Bataan, 1984 dry season.)

Reason	Percentage
Difficult to hire laborers for manual reaping	28
Mechanical reaping requires shorter time	27
Mechanical reaping is less expensive	12
Paddy cut by mechanical reaper dries more rapidly	10
Other reasons and unclear responses	23
Total	100

Source: A. Te, F. Juarez, C. Bantilan, and B. Duff, IRRI, 1985.

Table 6. Responses of reaper owners regarding adverse effects of field conditions, crop conditions, and season on suitability of AR120 reaper. (Survey of 15 owners in Bataan, 1984).

Conditions	Frequency of response
Adverse field conditions:	
- deep mud	12
- weedy field	12
- small field	8
- high levees	1
Adverse crop conditions:	
- lodged crop	13
- short height of crop	10
- wet crop	9
- densely-planted	8
- direct seeded	8
- unfavorable variety	1
Adverse conditions for wet season crop versus dry season crop	
- flooded fields	4
- lodged crop	3
- deep mud	3
- wet crop	2

Source: A. Te, F. Juarez, C. Bantilan, and B. Duff, IRRI, 1985.

Fig. 1. Mechanical reaper developed in the People's Republic of China.

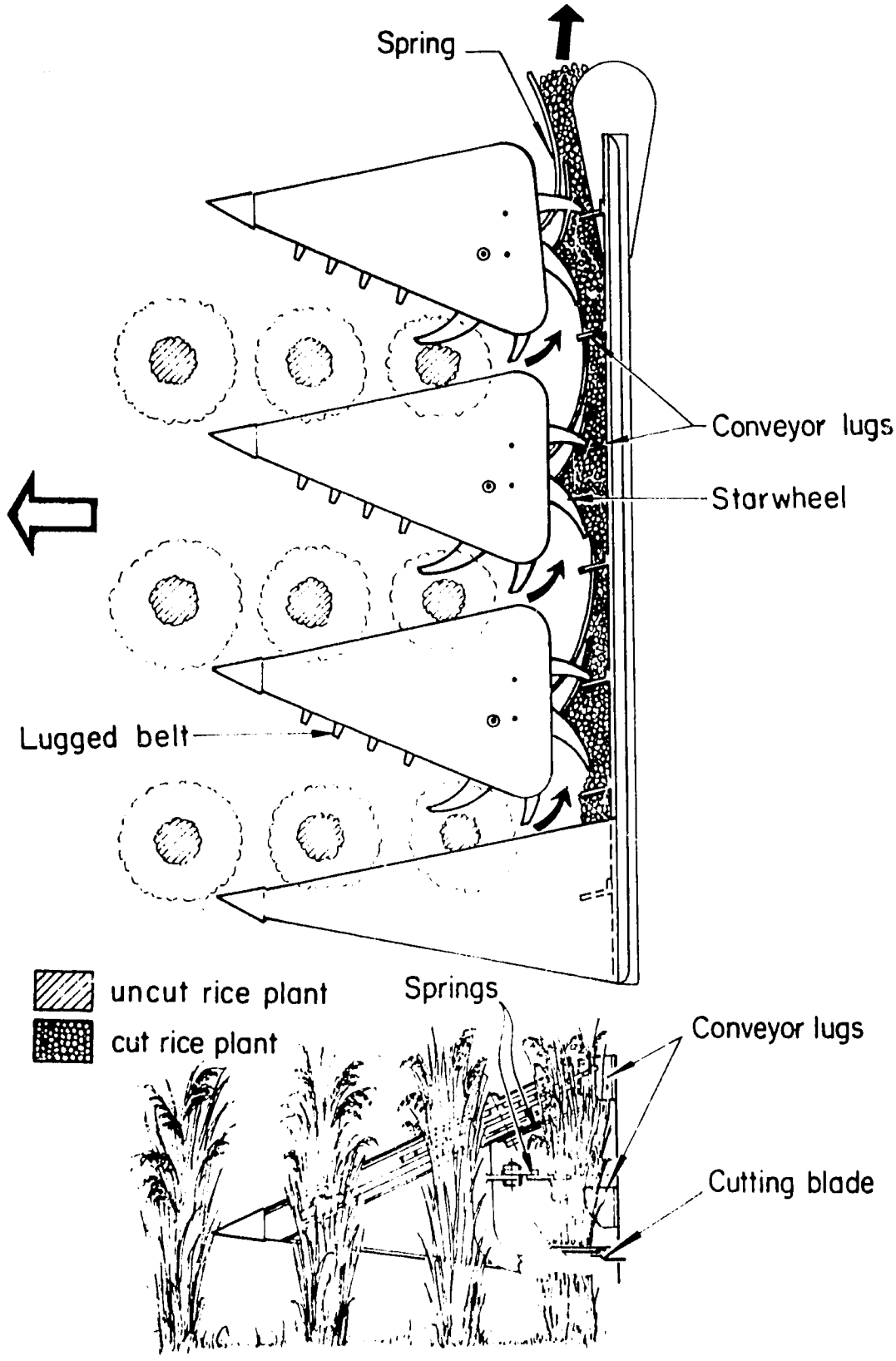


Fig. 2. Schematic illustration of principal components of Chinese reaper.

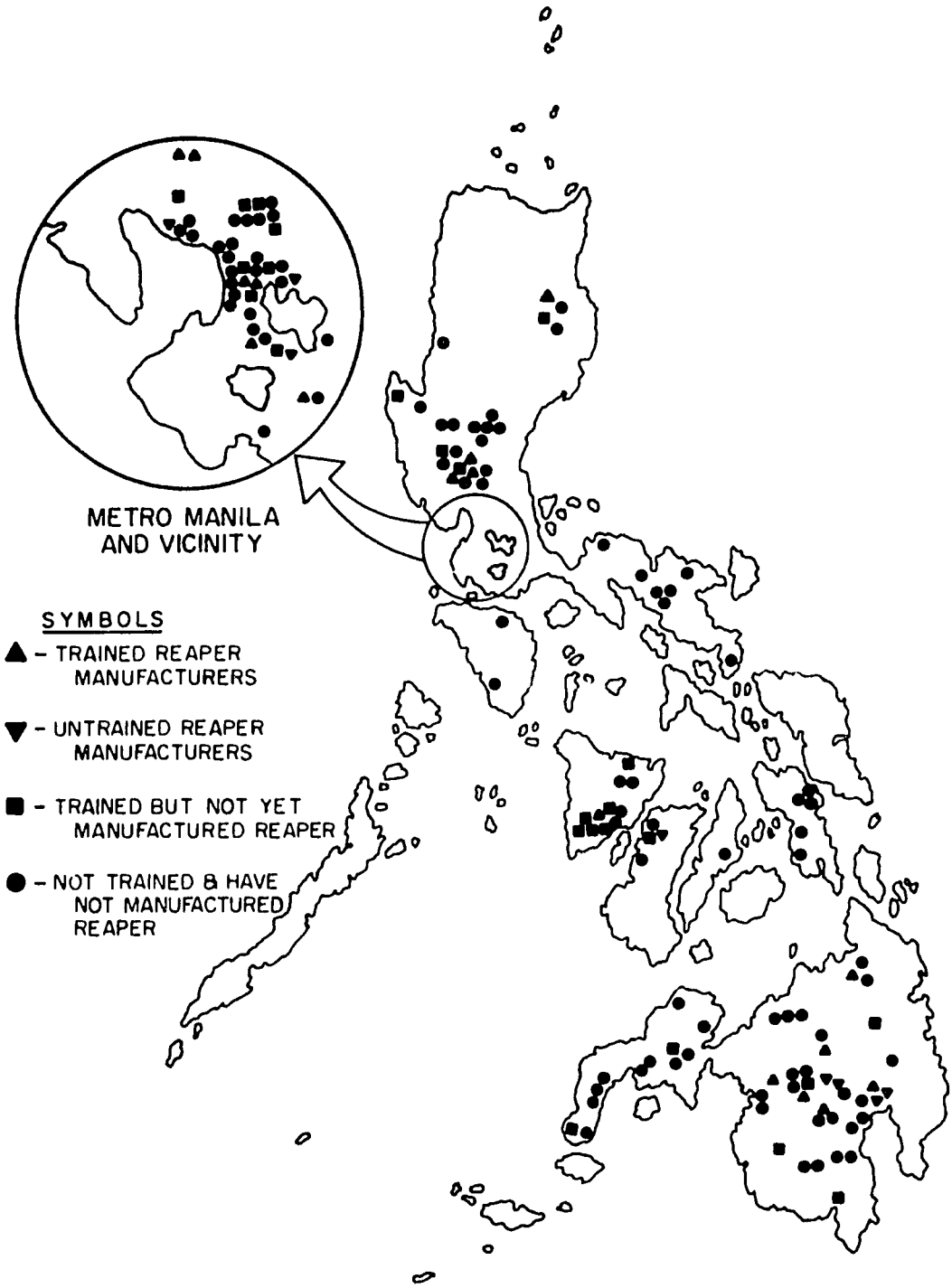


Figure 3. Geographical Location of Cooperating Manufacturers of the MAF-IRRI Industrial Extension Program for Small Farm Equipment. (Note: these data are for 143 manufacturers as of May, 1983.)

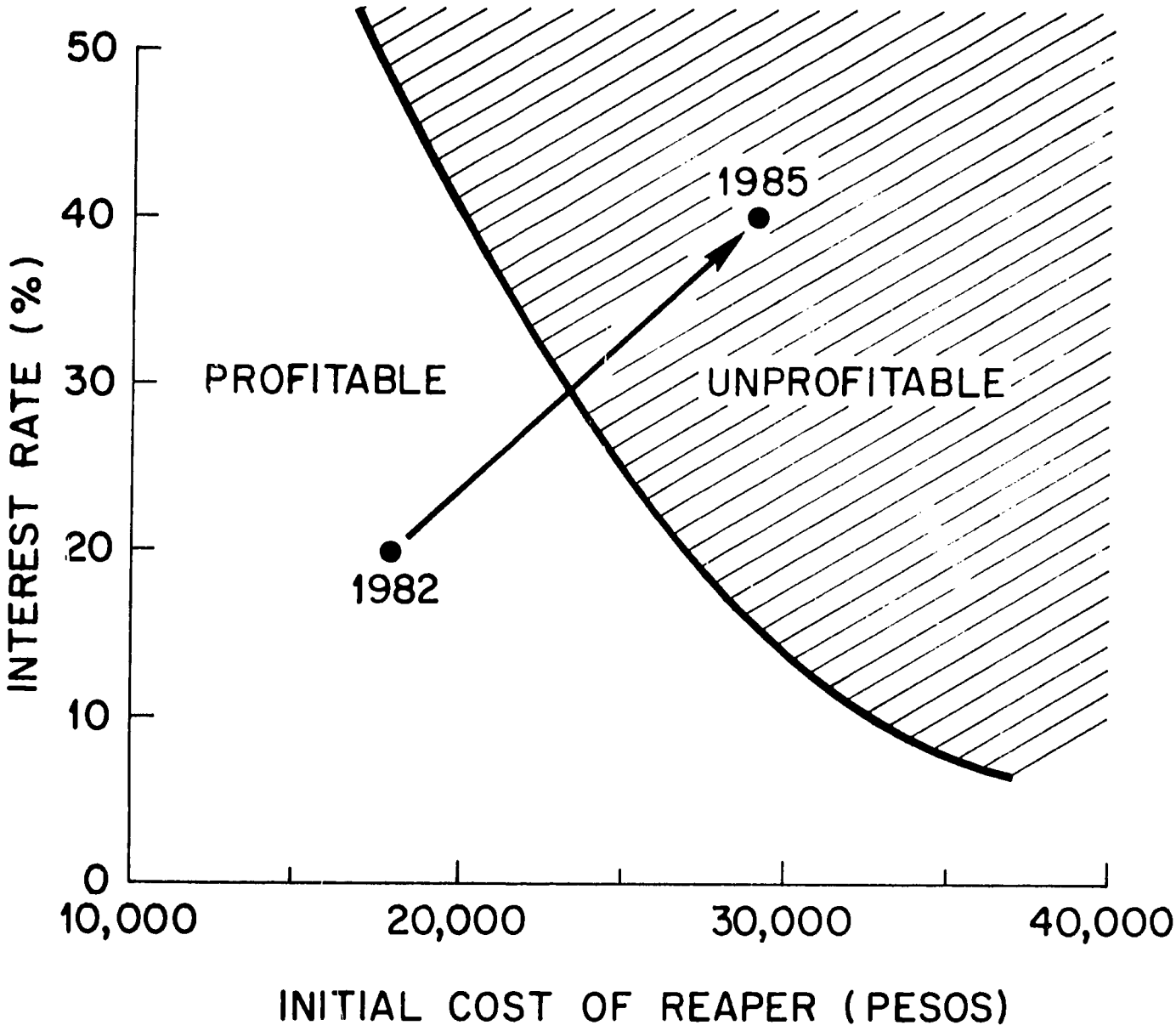


Fig. 4. Approximate illustration of change of profitability of AR120 reaper in the Philippines, 1982-1985.

CAAMS*-IRRI 1.0m reaper

Harvests paddy of different varieties

FEATURES:

HIGH CAPACITY . . . . . 2.4 hectare per day

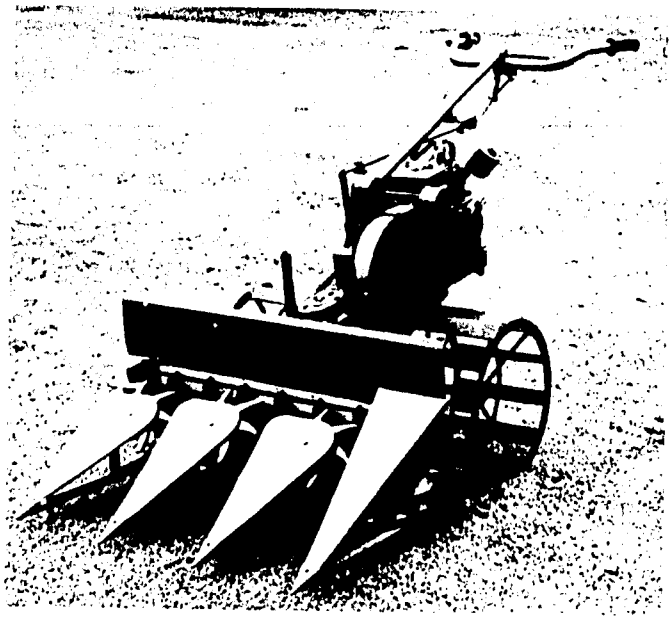
LOW HORSEPOWER REQUIREMENT . . . . . 3-hp engine

LOW LABOR REQUIREMENT . . . . . One to three men to operate, prepare plots and gather crop.

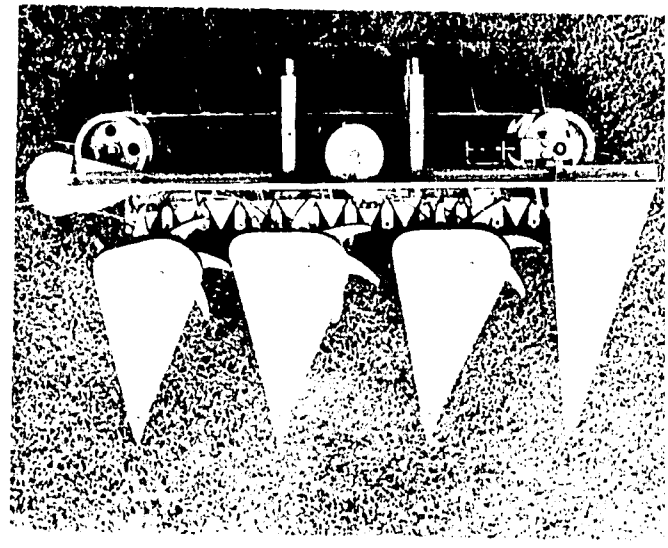
EASE OF OPERATION . . . . . Simplicity of design-reduces operation and maintenance problem.

HIGHLY MOBILE . . . . . Can be operated and carried with ease

* CHINESE ACADEMY OF AGRICULTURAL MECHANIZATION AND SCIENCES



Compact design



Reaper is adaptable to other hand tractor unit

Machine specifications:

POWER	3 hp gasoline engine
WEIGHT OF REAPER-TILLER UNIT	135 kg
WEIGHT OF REAPER ALONE	48 kg
TOTAL LENGTH OF REAPER PLUS 3 HP TILLER	218 cm
TOTAL WIDTH	117 cm
TOTAL HEIGHT OF 3 HP TILLER, MINIMUM	90 cm
FIELD CAPACITY	2.4 hectare per day
FIELD LOSSES	Less than 1%
MINIMUM CUT	7 cm
FORWARD SPEED	2.5 to 4.5 kph
KNIFE AVERAGE SPEED	1.3 x forward speed
CONSTRUCTION	All steel except the non-metallic starwheels
ADJUSTMENT	Throttle (synchronized with cutting speed), flat belt tension, windrow deflector.
FUEL CONSUMPTION	Approximately 1 liter per hr

For further information write: Agricultural Machinery Development Program
International Rice Research Institute
P.O. Box 933, Manila, Philippines
Cable: RICEFOUND, MANILA

ANNEX F

PAPER NO. 85-5054

HUMAN-POWERED PUMP FOR LOW-LIFT IRRIGATION

by

R. E. Stickney, V. Piamonte, Q. de Sagun, and I. Ventura

MAF-IRRI Industrial Extension Program for
Small-Farm Equipment
Philippines

For presentation at the 1985 Summer Meeting
AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

Michigan State University, East Lansing
June 23-26, 1985

SUMMARY:

A foot-operated pump developed by RDRS/Bangladesh has been adapted to the Philippines for irrigation of vegetables and other crops grown in rice fields during the dry season. This report describes the features of the pump and the initial extension efforts.

American Society of Agricultural Engineers

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INTRODUCTION

Water is a major constraint to food production in developing countries, particularly among the majority of the poorest farmers who have to rely on rainfall due to the lack of all-year irrigation systems. Consequently, there are continuing efforts to develop low-cost irrigation technologies which would enable farmers to grow additional crops during the dry season, while also providing supplemental irrigation in the wet season at times when rainfall is insufficient.

As a result of an intensive effort to find a suitable irrigation technology for small farms in northern Bangladesh, the Rangpur Dinajpur Rehabilitation Service (RDRS)* developed the twin treadle pump ("T-T pump") shown in Fig. 1. The outstanding features of the pump are its low cost (US $10) and ease of fabrication, operation, and repair. Over 20,000 units of the T-T pump were manufactured and installed in northern Bangladesh during 1981-84. (RDRS, 1984.)

This paper describes the adaptation and initial promotion of the T-T pump in the Philippines by the MAF-IRRI Industrial Extension Program for Small Farm Equipment.** In the Philippines the pump has been given the name "Tapak-Tapak" ("step-step") pump because it is powered by the

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*Address: RDRS/Lutheran World Federation, G.P.O. Box 618, Ramna, Dhaka-2, Bangladesh.

**The MAF-IRRI Program is a collaborative effort of the Ministry of Agriculture and Food (MAF) of the Philippines and the International Rice Research Institute (IRRI). See Stickney, Gonzalo, and Bockhop, 1983.

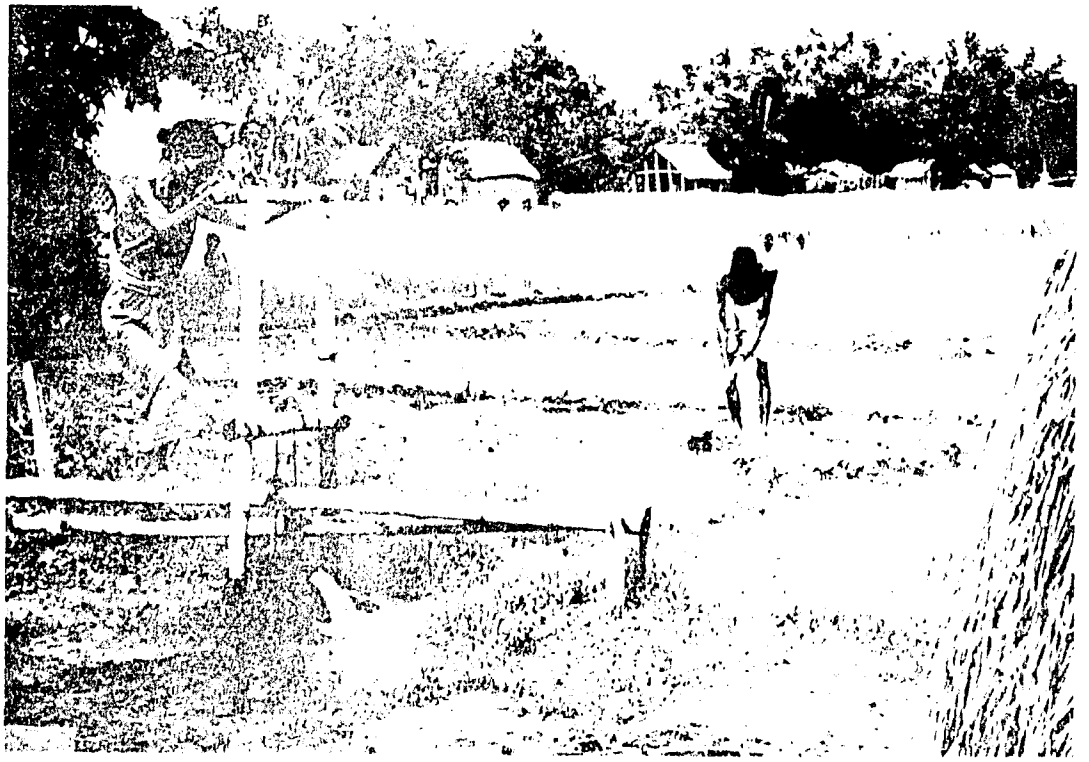
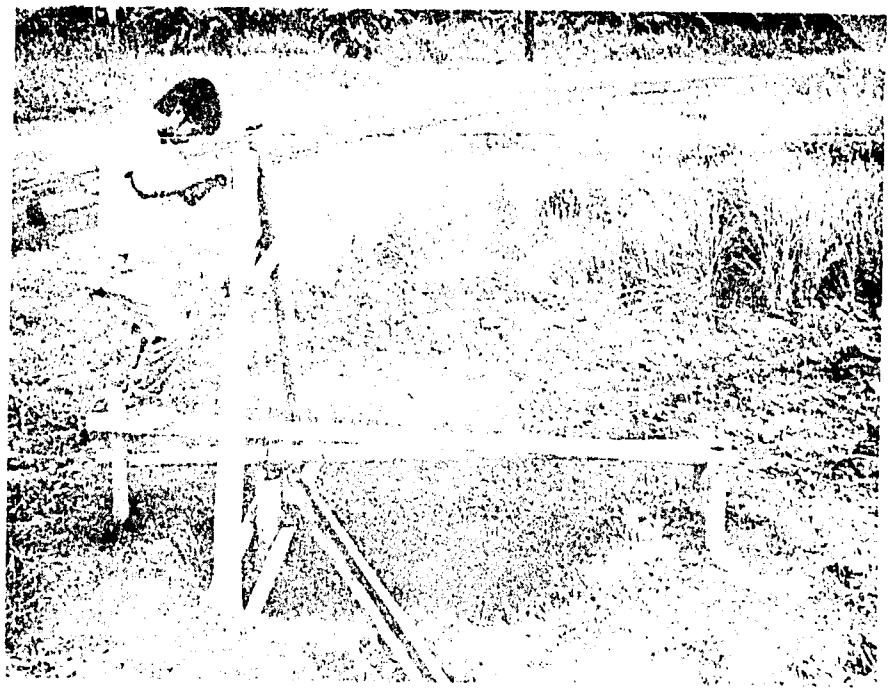


Figure 1. Installations of T-T pumps on shallow tubewells in Bangladesh. (Photo of RDRS/Bangladesh).



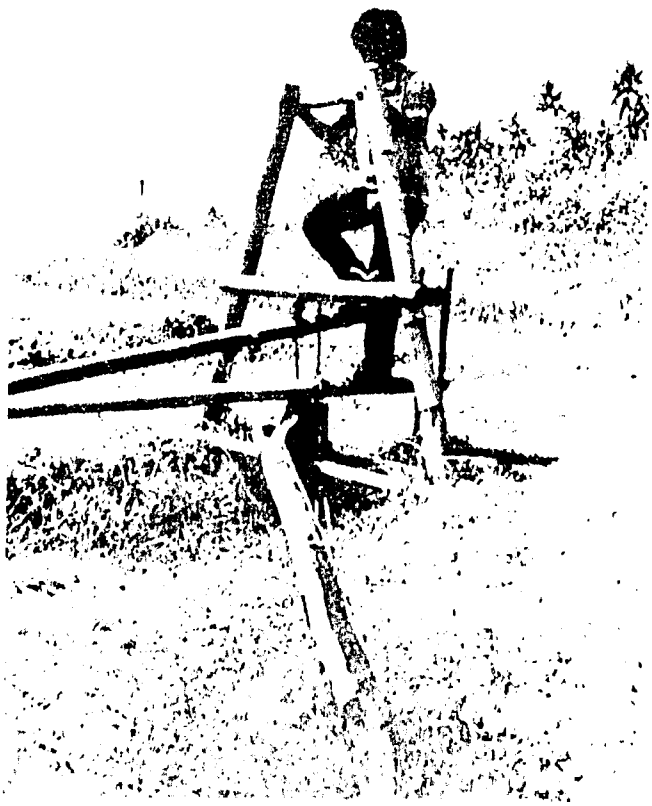


Figure 2. Installations of T-T pumps in the Philippines.

stepping action of the operator's feet. (Figure 2.) The principal features of the pump are:

EASY TO OPERATE: Uses the body weight and leg muscles, and therefore is less tiring than conventional pumps which use arm and back muscles.

LOW COST: About US $20 for the (pump alone (excluding the metal or bamboo framework and the cost of digging or drilling the well).

SIMPLE CONSTRUCTION: Can be fabricated from locally available materials using common shop tools, thereby reducing cost and simplifying maintenance and repair.

ADAPTABLE: Can be portable or stationary; suitable for shallow tubewells, open-pit wells, canals, lakes, and rivers; no priming required for depths as great as 4 meters.

HIGH CAPACITY: Due to the effective use of the body weight and the twin pump cylinders, the capacity is higher than for most manual pumps. Approximate capacities are:

3 liters/second (48 gallons/minute) for a 2-meter lift.

2 liters/second (32 gallons/minute) for a 4-meter lift.

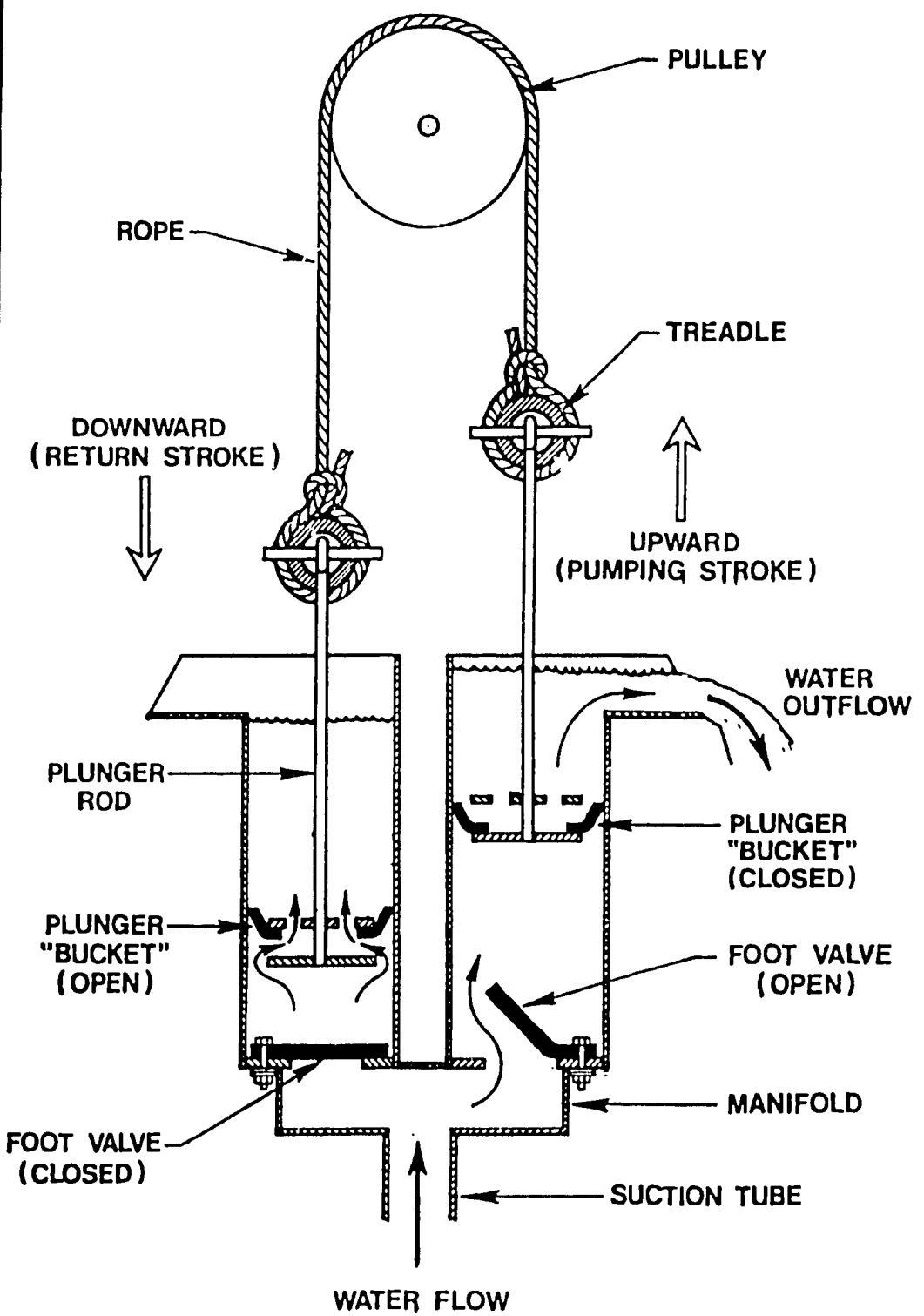


FIG. 3. SCHEMATIC OF T-T PUMP COMPONENTS AND OPERATION.

DESCRIPTION OF PUMP

The components and operation of the pump may be explained by referring to the schematic sketch in Fig. 3. The suction tube at the bottom of the pump is connected to the water source, which may be a tube well or an open-water source, such as an open-pit well, stream, or pond. The pump "sucks" water up the suction tube and into a manifold that is connected to the two pump cylinders. Each cylinder is equipped with a footvalve that prevents the back-flow of water from the cylinder to the suction tube during the return stroke of the pump. The footvalve is a simple rubber flap made from a used innertube of a truck tire.

The main reason for having two cylinders is that pumping will be smoother than the highly pulsating flow of a single-cylinder pump. Since frictional and inertial losses are reduced by smoothing out the pulsating flow, the work required to pump a given amount of water is lower for a two-cylinder pump than for an equivalent single-cylinder unit.

The pump plunger consists of two round disks fastened to a rod, plus a molded rubber cup or "bucket". The upper disk has holes that allow water to pass through the plunger during the downward return-stroke when, as illustrated in Fig. 3, the bucket moves off the lower disk and provides a water passage. On the upward pumping stroke, the bucket is pressed against both the lower disk and the cylinder wall, thereby providing a seal that prevents water from passing by the piston and creates a partial vacuum that sucks water into the cylinder from the manifold and suction tube. In this way, the bucket serves both as a flow valve and as the conventional seal against the cylinder wall.

The plunger assembly is easy to fabricate with simple tools, and it utilizes the buckets of standard domestic water handpumps which are widely used in developing countries. In the Philippines, buckets for 100mm (4 inch) pumps are readily available throughout the country at approximately US $0.25 per piece.

The plunger rods are connected to the treadles (generally bamboo poles) by means of a hinged joint (see Fig. 4). The two treadles are connected together by a rope which passes over a pulley (Fig. 3). This simple arrangement has an important function: when one treadle is forced downwards, the rope pulls the other treadle upwards, causing the attached plunger to move upwards and thereby pump water from the cylinder. Since a larger force is required to move a plunger upwards (pumping stroke) than downwards (return stroke), the rope is always under tension and therefore acts as if it were a rigid linkage between the two plungers. (Note: several existing designs of two-cylinder pumps

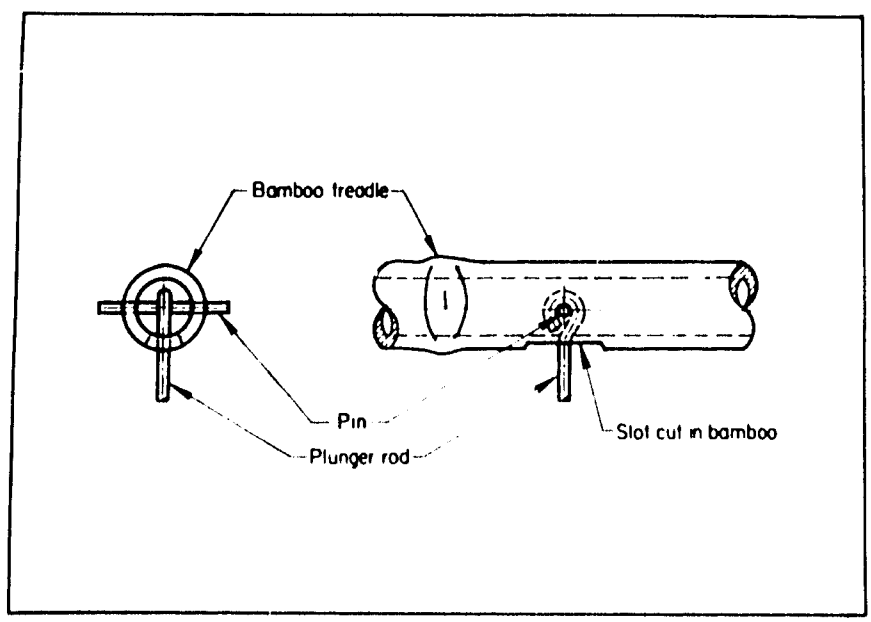


Figure 4. Hinged connection of plunger rod to bamboo treadle.

have rigid linkages which are more expensive and more difficult to fabricate than the rope and pulley arrangement.)

By placing the pivot point of the treadles at a considerable distance (about 1 meter) from the pump cylinders, the motion of the plunger will not deviate significantly from the centerline of the cylinder, thereby avoiding problems of poor sealing and rapid wear of the bucket. The length of the treadle is sufficient to enable the operator to vary the position of his feet to achieve comfortable and efficient operation. A hand rail is provided to allow the operator to balance himself (Figs. 1 and 2).

FABRICATION

Pump cylinders are generally made from standard sizes of pipe or tubes, or from cast iron. Since these pipes, tubes, and castings are rather expensive and/or of limited availability in rural areas of developing countries, RDRS decided to fabricate the pump cylinders from readily available sheet metal (gage 16), using a conventional sheet metal roller. The seam of the round cylinder is welded by means of an oxy-acetylene torch. The seam is then hammered to smoothen the weld, and the cylinder is re-rolled to ensure that it will be sufficiently round. Our experience shows that this technique can easily be utilized by small shops to produce satisfactory cylinders at very low cost using available tools and materials. The second advantage of the technique is that it enables manufacturers to produce cylinders having the most appropriate diameter with regard to local conditions in terms of lift, body weight, and available size of plunger buckets.

The manifold, suction tube, and plunger components are all fabricated from metal sheet, plate, and bars which are commonly available throughout the Philippines. Fabrication requires cutting and welding equipment that are available in most small-scale metalcraft shops. A lathe machine is not necessary but does facilitate cutting the round disks for the plunger and the cylinder bottom plates.

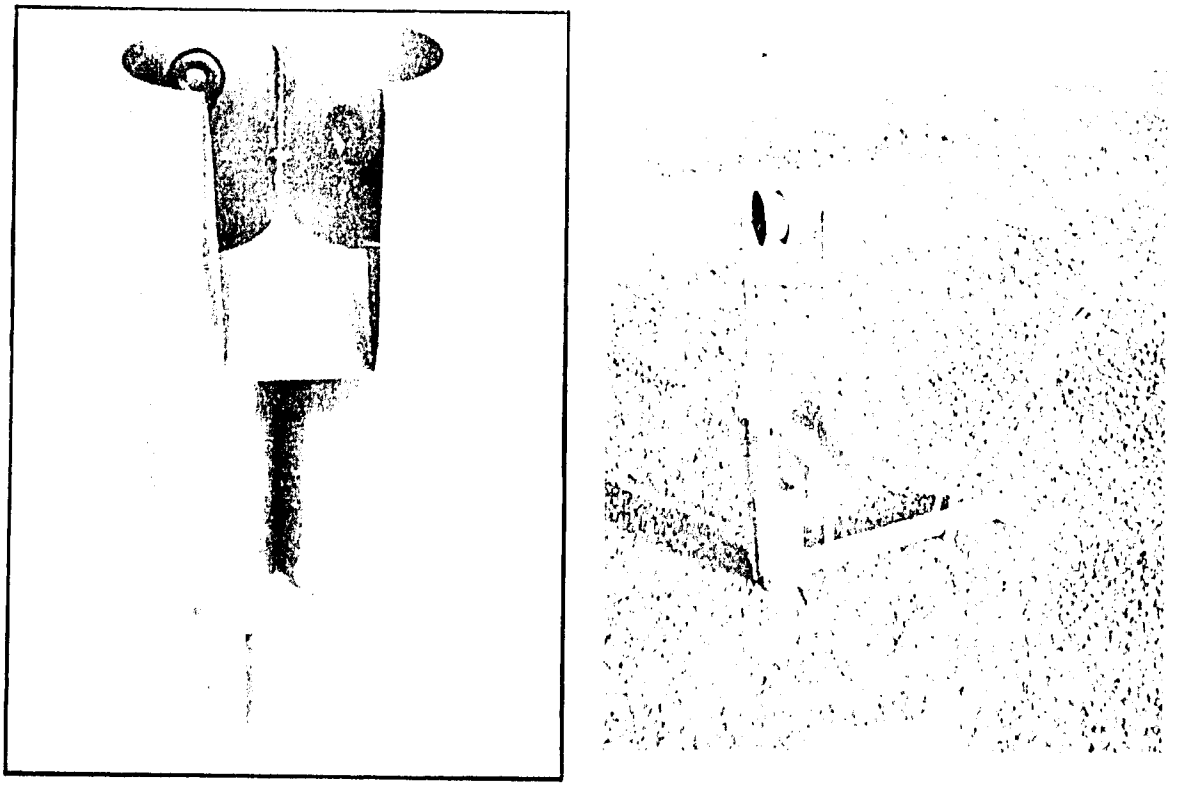
The pulley (see Fig. 3) is made from hardwood, and most of our manufacturers obtain these pulleys by contracting the services of a nearby carpentry shop having a woodworking lathe. The pump framework may be fabricated either from wood or metal bars, depending upon local preference, cost, and availability.

RDRS published a simple manual for interested manufacturers to help them learn to fabricate the pump. They found that the manual is more appropriate than engineering drawings because metalcraft workers in north Bangladesh seldom know how to read and interpret technical drawings. In the Philippines we have found that simplified engineering drawings are generally understood by metalcraft workers, and we have therefore prepared such drawings and provided sets to interested cooperating manufacturers of the MAF-IRRI Program. These drawings include full-size patterns for most of the pump components. Copies of the drawings may be obtained from the International Rice Research Institute, P.O. Box 933, Manila, Philippines.

The MAF-IRRI Program provides technical assistance to cooperating manufacturers who intend to fabricate the tapak-tapak pump. This assistance includes loaning a pump to the manufacturers because this simplifies understanding the engineering drawing, thereby facilitating fabrication of the first unit.

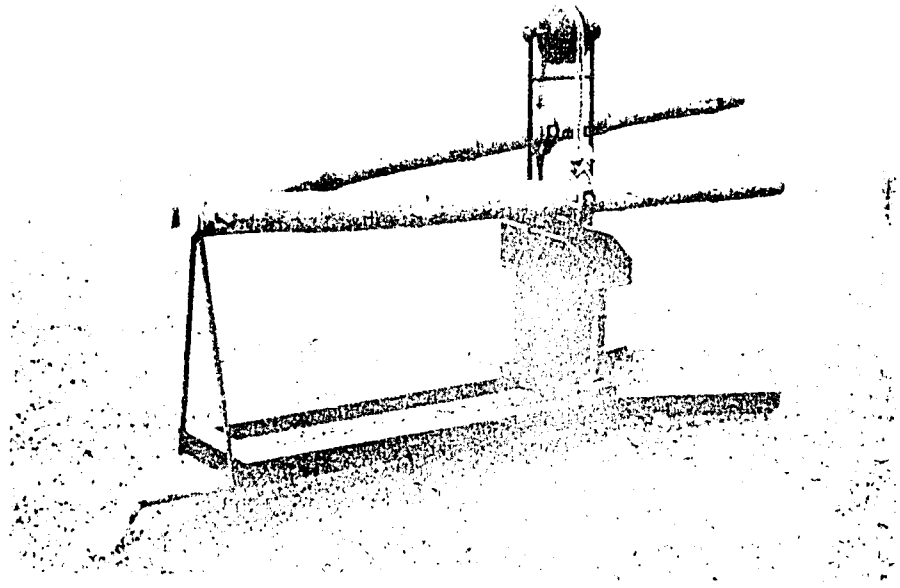
DESIGN VARIATIONS

The basic pump design has been modified to suit different types of water sources, irrigation applications, and farmer preferences with respect to materials and operation. In north Bangladesh, the most popular design is the tubewell pump similar to that shown in Fig. 5a but often without a spout. We have found that farmers in the Philippines generally prefer to have a spout on the pump to facilitate filling buckets which are then carried to the field to apply water to individual vegetable plants. Since shallow tubewells are less common than open wells in many areas of the Philippines, our initial experience is that the open well design shown in Fig. 5b appears to be the most appropriate



a. Tubewell model b. Open-well model

Figure 5. Tubewell and open-well models of the T-T pump.



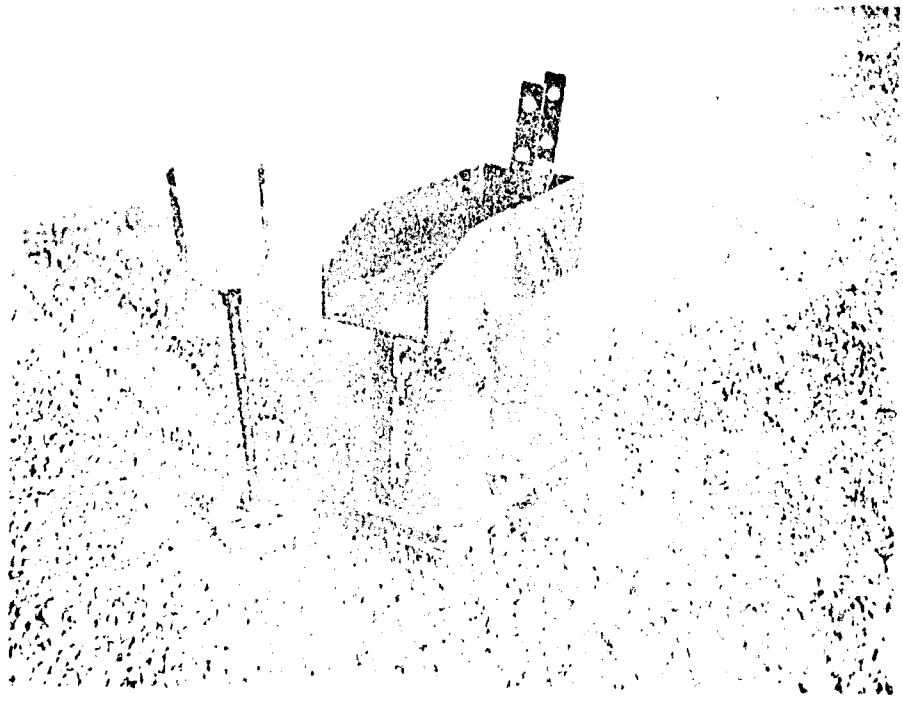


Figure 6. Cast iron version of the T-T pump.

configuration. This design is also advantageous with respect to portability, since the pivot for the treadles is an integral part of the pump assembly. On the other hand, this design is more expensive to produce than the simple tubewell design, - a factor which limits sales, but not to the same degree as in Bangladesh.

One of the cooperating manufacturers of the MAF-IRRI Program has a foundry and was producing cast iron handpumps for domestic use. After seeing the tapak-tapak pump, he decided to produce a cast iron version by mounting two of his standard cast iron cylinders on a common manifold and with a common spout as shown in Fig. 6. The advantage of this pump is that it uses many parts which are already available for domestic water handpumps, thereby taking advantage of the use of mass-produced components. The pump is expected to be more durable than the one fabricated from sheet metal, but its weight is a detriment for applications requiring a portable pump. At present, the cost is equal to or only slightly higher than that of the sheet metal pump.

INSTALLATION

The pump framework and installation may be varied according to type of water source, availability of materials, and application. In north Bangladesh, most of the pumps are permanent installations on tubewells utilizing bamboo as the suction tube and the strainer (screen). Bamboo is also used for the treadles and handrail, as shown in Fig. 1.

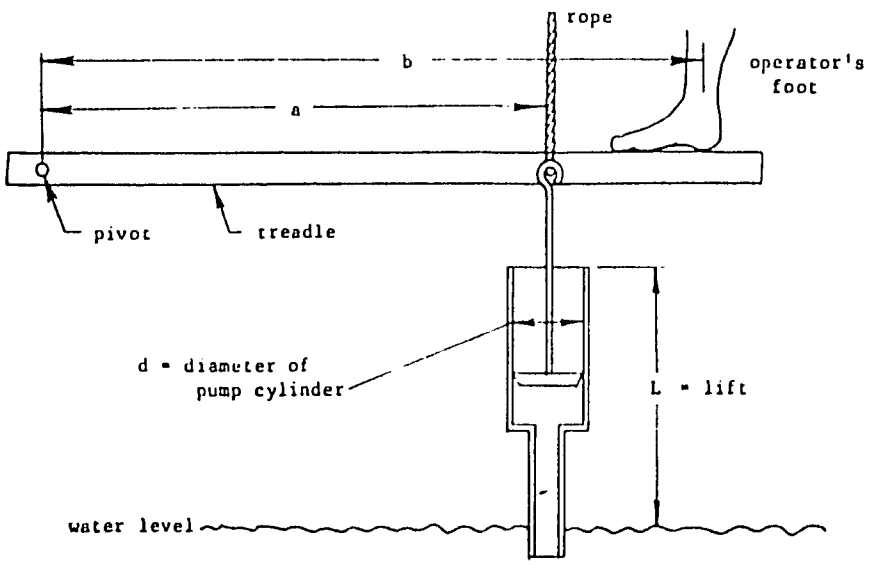
In the Philippines, the open-well pump is connected to a PVC suction pipe by means of a strip or band of rubber cut from a used tire

TABLE 1. Dependence of force exerted by pump operator on lift and pump diameter.

$$\text{Force exerted by operator} = \frac{a}{b} \times \text{Force required by pump}$$

$$= \frac{a}{b} \times \rho \times \frac{1}{4} \Pi d^2 \times L$$

where a, b, d, and L are defined in the sketch and ρ is the density of water (1000 kg/m^3).



Lift (L) (meters)	Force (F) exerted by operator,* kilograms (pounds)			
	d = 76 mm (3 in)	d = 102 mm (4 in)	d = 127 mm (5 in)	d = 152 mm (6 in)
1	3.63 (8)	6.53 (14)	10.1 (22)	14.5 (32)
2	7.25 (16)	13.1 (29)	20.3 (45)	29.0 (64)
3	10.9 (24)	19.6 (43)	30.4 (67)	43.5 (96)
4	14.5 (32)	26.1 (58)	40.5 (89)	58.0 (128)
5	18.1 (40)	32.7 (72)	50.7 (112)	72.6 (160)
6	21.8 (48)	39.2 (87)	60.8 (134)	87.1 (192)
7	25.4 (56)	45.7 (101)	70.9 (156)	101 (222)
8	29.0 (64)	52.2 (116)	81.0 (178)	116 (255)
9	32.6 (72)	58.8 (130)	91.2 (201)	131 (288)
10	36.3 (80)	65.3 (144)	101 (222)	145 (319)

A

B

*Notes:

1. It is assumed that $\frac{a}{b} = 0.8$.
2. Since the calculation neglects friction and other non-ideal aspects of pump operation, the computed forces are the minimum (ideal) values rather than the actual values.
3. The region between the dashed lines, A and B, is the comfortable operating range where the force exerted by the pump operator is between 15 and 45 kg (33 and 100 lbs.).

innertube. This provides a portable unit which may be easily moved from one well to another.

APPLICATIONS

Since the T-T pump is a suction-type pump, it is suitable only for low-lift applications (i.e., cases where the source of water is no more than approximately 7 meters below the pump). Although a suction-type pump has a theoretical maximum lift of approximately 11 meters, practical pumps are generally limited to lifts of no more than 7 meters. In fact, irrigation applications requiring considerable volumes of water are often viable only for lifts of no more than 5 meters because the force required to pump water increases with lift. This point is illustrated in Table 1 where the theoretical pumping force is tabulated for a range of values of lift and pump cylinder diameter.

In Bangladesh, suction-type pumps are applicable in widespread areas where the water table is close to the soil surface even during the dry season. The principal applications of T-T pumps have been to enable farmers to irrigate wheat during the dry season, while some farmers are also using the pump for small plots of paddy.

In the Philippines, our initial objective was to promote the pump to small farmers who grow vegetables in their rice fields during the dry season. At present, these crops are irrigated either by lifting buckets of water from open wells or by engine-driven centrifugal pumps on shallow tubewells. The T-T pump offers an intermediate level of technology which reduces the labor of bucket lifting and avoids the high initial and operating costs of engine-driven centrifugal pumps.

A preliminary evaluation was made by surveying 24 farmers who purchased pumps during the first extension effort. Over half of the pumps had not yet been utilized either because the owners encountered difficulties in installing the pumps and/or because the units were purchased late in the dry season. We plan to reduce these problems during the next dry season by providing more technical assistance on installation and ensuring that pump promotion and commercialization will be initiated earlier in the season. Our experience indicates that pumps should be available for sale at the time and place of promotional field demonstrations, thereby taking advantage of the farmers' interest and presence.

Many of the first persons to buy pumps were extension workers of the Ministry of Agriculture who quickly recognized the pump's potential usefulness on their own farms. We expect that their pumps will help promote future acceptance by neighboring farmers.

Many small farmers who attended our demonstrations wanted to buy a pump but did not have sufficient cash available at that time. Others preferred to wait for a season in order to see if the first persons to purchase pumps were satisfied with the unit's performance and durability.

Although most of the pumps are being used to fill buckets for hand-watering of vegetables, several are used to fill or drain fishponds or azolla ponds. Only two are installed for providing water for furrow

irrigation. One of these cases demonstrates that family labor is sufficient to irrigate a 1/3 ha field containing corn, bush sitao, mungbean, onion, and native fodder crop. This case and three others are now being evaluated in detail by IRRI economists to estimate the economic benefits and costs of T-T pumps for several different small-farm applications.

Acknowledgment

We are grateful to RDRS/Bangladesh for generously sharing the T-T pump technology.

REFERENCES

Stickney, R. E., B. C. Gonzalo and C. W. Bockhop. 1984. Philippine agricultural engineering extension of small farm equipment. Paper presented at the American Society of Agricultural Engineers, University of Tennessee, Knoxville, June 24-27.

RDRS, 1984. Annual Report, Rangpur Dinajpur Rehabilitation Service/Lutheran World Federation, Dhaka, Bangladesh.

MAF-IRRI "SIPA" PUMP

Ideal for low-lift applications where water needs to be raised only 1 to 2 meters, such as irrigation and drainage of rice fields and fishponds.

ADVANTAGES

LOW COST: About ₱1000 (US$50) excluding the engine, which is generally borrowed from another farm machine such as a handtractor or thresher.

EASY TO OPERATE: Portable; easily installed; self-priming.

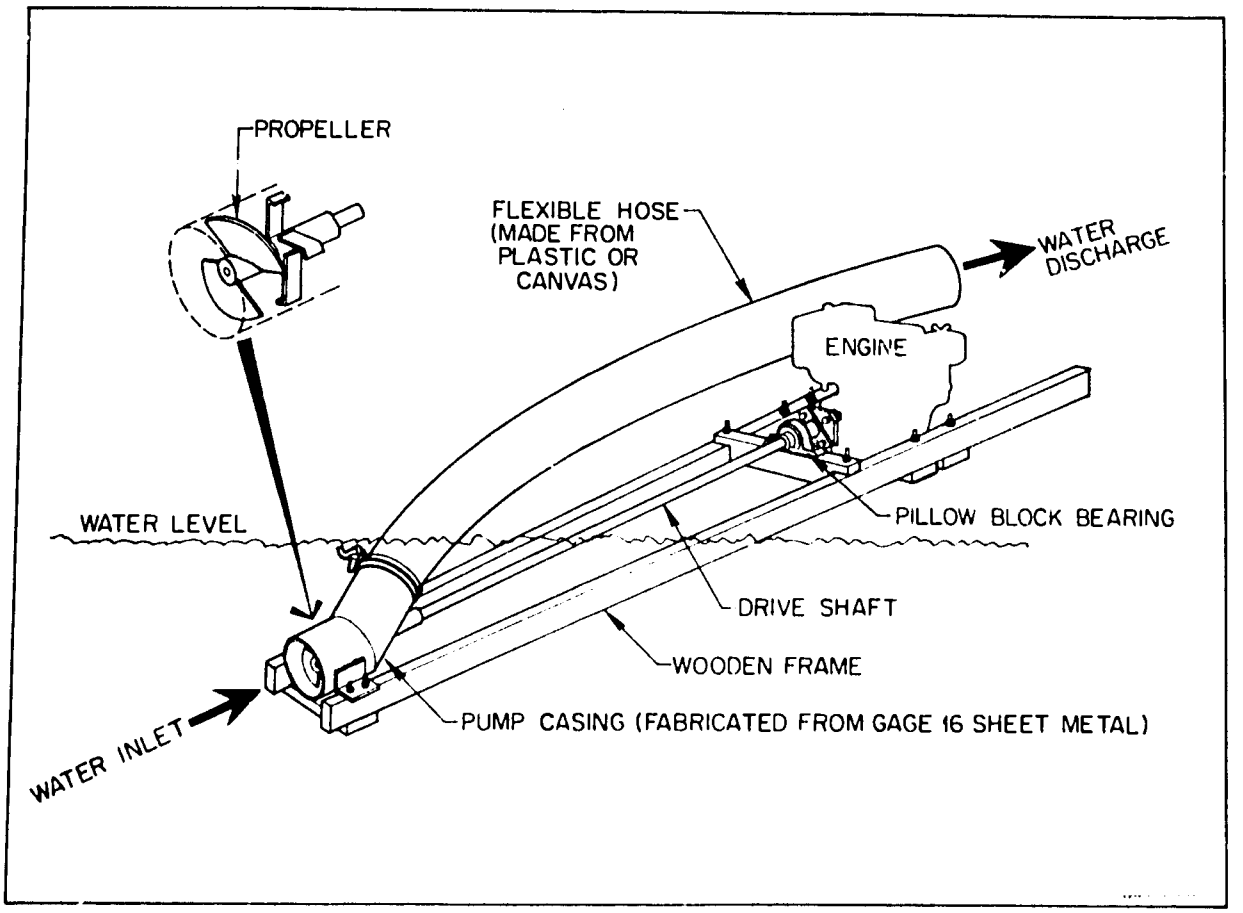
SIMPLE CONSTRUCTION: Fabricated from locally-available materials using common shop tools, thereby reducing cost and simplifying maintenance and repair.

ADAPTABLE: Suitable for irrigation, drainage, or aeration; flexible discharge hose allows water to be directed to desired point; can be adapted for brackish water.

HIGH CAPACITY: A 15 cm (6 "inch") diameter pump powered by a 7 hp engine has an output of approximately 40 liters per second (145 m^3/hr or 635 gallons/min) for a lift of 1.5 m. This capacity is 2 or 3 times higher than that of either a centrifugal pump or an axial-flow pump using a boat propeller, for the same lift and engine power. The difference is due to the specially designed propeller which provides highest efficiency for low-lift pumping.

- /over/ -

MAF-IRRI "SIPA" PUMP



Technical information and blueprints may be obtained from:

MAF-IRRI INDUSTRIAL EXTENSION PROGRAM
FOR SMALL FARM EQUIPMENT

Agricultural Engineering Division
Bureau of Plant Industry
San Andres Street, Malate
Metro Manila
Philippines

Telephone: 50-08-01
59-81-14

ANNEX H

(Prepared in February 1985)

PROPOSAL

for

MAF-IRRI PROGRAM FOR SMALL FARM EQUIPMENT

Summary

A continuation of the MAF-IRRI Program for Small Farm Equipment is proposed for two years, 1 October 1985 through 30 September 1987. The objective is to establish MAF's capability for the development and extension of agricultural equipment suitable for: (a) improving the income of disadvantaged farmers (e.g., those with small rainfed farms); and/or (b) increasing production of priority crops, such as yellow corn, sweet potato, soybean, and rice. The effectiveness of the present collaborative effort of MAF and IRRI is described, and it is proposed that the same relationship be maintained for the proposed continuation. The estimated total budget is US $457,200 for the two-year period.

1. INTRODUCTION

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 the US Agency for International Development (USAID) for the purpose of assisting national institutions in developing countries to strengthen their capabilities for the development and extension of locally-made agricultural equipment suitable for small farms.

Annex A provides a detailed description of the MAF-IRRI Program's activities and accomplishments up to September 1984. The principal achievements are:

a. A central office for the Program has been established at the Bureau of Plant Industry (BPI), where 8 engineers are participating on a part-time basis. The Program also has part-time participation of engineers located in each of the twelve agricultural regions. These engineers have received training at IRRI, BPI, and in the field, and are now responsible for demonstration and promotion of MAF-IRRI equipment in their regions, together with providing technical assistance to cooperating manufacturers.

b. Over 250 cooperating manufacturers have joined the Program. These manufacturers are located in all of the major agricultural areas of the country, as well as in the principal cities.

c. The Program is actively promoting nine types of small-scale agricultural equipment, and it is currently developing three other promising types of equipment. Cooperating manufacturers have responded by requesting over 500 sets of technical drawings for these equipment, and over 100 prototype units have been loaned by the Program to manufacturers to facilitate fabrication of their first units.

Since the USAID grant terminates September 30, 1985, USAID/Manila was requested to carry out an evaluation of the Program in 1984. The main recommendation of the evaluation team was that the Program should be continued for at least two more years in order to "enable BPI to gain needed additional institutional capability and to maintain its recently acquired momentum". The purpose of the present proposal is to suggest the objectives, institutional collaboration, and budget for the continuation.

2. OBJECTIVES

The purpose of the proposed project is to establish MAF's capability for the development and extension of locally-manufactured agricultural equipment which will benefit farmers who are among the principal target groups of current government programs, such as:

a. Farmers whose economic status is below average because of the lack of irrigation (i.e., areas which are totally rainfed or have irrigation only during part of the year), poor soils and/or water control (e.g., eroded or flooded areas), and/or inadequate infrastructure (e.g., inadequate roads, equipment sales and repair services, postharvest facilities and marketing systems).

b. Farmers who are potential producers of priority crops, such as yellow corn, sweet potato, soybeans, and rice.

At first, the MAF-IRRI Program promoted existing IRRI-designed equipment that generally are most appropriate for irrigated rice farms. However, during the last two years the Program has begun to direct its efforts towards rainfed areas and upland crops. The Tapak-tapak pump, sweet potato chipping machine, thresher/sheller, and seed and fertilizer applicator are concrete examples of this effort (see Annex A for details).

It is proposed that the Program be continued for an additional two years (October 1, 1985 through September 30, 1987) with the following specific objectives:

a. Develop and promote equipment suitable for farmers lacking irrigation during part or all of the year. Examples: (1) pumps; (2) minimum tillage and planting devices to conserve residual moisture and/or reduce the time and risk of crop establishment, such as the rolling injection planter promoted by the Program and now undergoing on-farm trials by KABSAKA and several RIARS; (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 machine, threshers, shellers, and dryers) that will reduce losses due to deterioration and will increase the prices received by farmers for their products.

c. Develop and promote equipment that will help farmers to increase the production of priority crops such as 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 RIARS 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).

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

3. PROPOSED MAF-IRRI COLLABORATION

The experience of the past four 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 scientific and technological knowledge and facilities, including inputs from economists, farming systems specialists, irrigation engineers, soil and plant scientists, and other disciplines available at IRRI.

The principal responsibility of the IRRI Liaison Engineer is to ensure that these comparative advantages of MAF and IRRI are utilized in an effective manner to achieve the main objective of the Program, - which is to increase the availability of agricultural equipment suitable for small farmers. This role may be illustrated by the following cases:

1. Transplanter. IRRI first introduced the transplanter in the Philippines in 1980, but it was not accepted by farmers because of the costly seedling production method, plus several technical problems with the machine (e.g., missing hills and difficulty to pull). The Liaison Engineer coordinated a collaborative effort of IRRI and the MAF-IRRI Program to carry out an intensive on-farm effort to evaluate and improve the transplanter. A cooperating farm in Bukidnon came up with a greatly simplified method for seedling production and handling, as well as suggesting mechanical improvements of the transplanter which were then developed by an IRRI engineer who also added his own innovations. Feedback from farmers in Camarines Sur provided another appropriate method for seedling production. The transplanter is now being promoted by the Program in four regions, - and many farmers have indicated their acceptance by buying units. MAF engineers have been trained at IRRI and in the field (e.g., Camarines Sur) on seedling preparation and on fabrication, assembly, adjustment, and operation of the transplanter. Consequently, the MAF engineers are now capable of assuming most of the responsibilities of the transplanter extension project. We believe that the MAF-IRRI collaboration was the essential factor in improving the transplanter to the level that it is now acceptable to farmers. Consequently, IRRI has also benefitted from the collaboration and is passing the benefit on to other countries.

2. Tapak-tapak pump. The Liaison Engineer and the BPI Engineering Chief organized a workshop to be held in Nueva Ecija for the purpose of bringing together farmers, manufacturers, and technicians to determine priorities for equipment R&D. They invited the current head of IRRI's Agricultural Economics Division to present a paper proposing equipment priorities on the basis of results of an on-going IRRI study of the principal constraints to increasing

rice production in the Philippines. One of his proposed priorities was low-cost irrigation pumps, and the Liaison Engineer began to search for appropriate designs. The most promising design that he found was the twin treadle ("Tapak-tapak") pump developed by the Rangpur Dinajpur Rehabilitation Service (RDRS) in North Bangladesh. He was able to visit the pump project in Bangladesh and arrange for an experienced RDRS engineer to stop over in the Philippines to give a 7-day training course to MAF-IRRI engineers. The resulting "Tapak-tapak pump" has been tested and modified by these engineers, and it is now being promoted with good acceptance by farmers. It is particularly appropriate in rainfed areas where farmers grow vegetables during the dry season after harvesting the wet-season rice crop.

3. Thresher/sheller. Government officials informed us that the national program for increasing production of yellow corn was being hindered by insufficient availability of corn shellers. Consequently, the Liaison Engineer suggested that the MAF-IRRI Program try to modify the IRRI-designed axial-flow paddy thresher so that it could also be used to shell corn. The axial-flow thresher is popular in many areas of the Philippines where it is fabricated by local manufacturers, many of whom are cooperating members in the MAF-IRRI Program. The modification was developed by MAF engineers and the Liaison Engineer, with the collaboration of a cooperating manufacturer who is an experienced fabricator of axial-flow threshers. The resulting modification is outstanding due to its low cost (about ₱1000 additional cost), high capacity (up to 5 tons/hour), and grain purity (99+%). The design has been disseminated to the Program's cooperating manufacturers, and over six have fabricated prototypes, with two already initiating commercial production.

These three 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. In the first case, the MAF-IRRI Program served as the channel for communicating essential information from farmers to IRRI regarding needed improvements of the transplanter. These improvements required the technical

capability of IRRI, and subsequent trials and training required the collaboration of both MAF and IRRI. In the second case, the MAF-IRRI staff was capable of carrying out most of the engineering and extension of the Tapak-tapak pump, while IRRI's role was to stimulate the Program's initial efforts to find a suitable low-cost pump and then, through the Liaison Engineer, enable the transfer of technology from RDRS/Bangladesh. In the third case, the MAF-IRRI staff and Liaison Engineer identified and developed the thresher/sheller modification, without additional assistance from IRRI, but the original thresher was an IRRI design.

The Philippines is fortunate to have the unique opportunity for MAF and IRRI to collaborate in the development and extension of small farm equipment, and it is proposed that the current relationship be continued in order to provide small farmers with additional equipment, such as the types indicated in Section 2.

4. PROPOSED IMPLEMENTATION AND FUNDING

At present, the MAF-IRRI Program is supported in part by the funds of a grant to IRRI from USAID/Washington. These funds have not only supported the IRRI Liaison Engineer and his staff (secretary and driver) at BPI, but have also been used for purchases and operating expenses that cannot be covered by BPI either because of the lack of funds (especially near the year's end) or because MAF regulations do not allow funds to be used for certain purposes (e.g., new equipment, additional personnel, incentives) or cannot be obtained on short notice (e.g., travel advances and materials purchases). An innovative "learning-by-doing" development project like the MAF-IRRI Program could not function effectively without a flexible budget which can respond immediately to sudden needs, such as materials or parts to repair or modify prototype equipment or urgent requests from regional offices for equipment demonstrations or technical assistance. In order to sustain the Program after the proposed two-year period, BPI will need to increase both the amount and the flexibility of the budget provided to the Program.

Since the present arrangement has proven to be effective, it is proposed that approximately the same amount of funds be channeled through IRRI for the MAF-IRRI Program (see "Proposed Budget for IRRI Liaison Office at BPI/Manila"). These funds would be managed in the same manner as at present, which is consistent with USAID regulations, but with joint approval of expenditures by both the IRRI Liaison Engineer and the BPI Engineering Chief.

A detailed accounting of expenditures would be provided to MAF on a quarterly basis, and any changes from the proposed budget would be submitted in advance for MAF approval.

BPI will continue to provide partial support to the Program from its regular budget. The current level of this support is estimated to be ₱300,000 which corresponds to approximately 25% of the total annual budget of BPI's Agricultural Engineering Division for 1984. This includes the transfer of BPI funds to MAF Regional Offices for travel and miscellaneous expenses of regional engineers while participating in activities of the Program. Due to inflation plus reductions in the BPI budget, it is no longer possible for BPI to transfer the necessary funds (₱2,000 per month for each of the 12 regions). Consequently, the proposed budget includes an appropriate amount for this purpose. (See "Proposed Supplementary Budget for BPI".) By the end of the proposed two-year continuation project, BPI's regular budget should be increased to cover these expenses.

The proposed budget also includes funds for purchasing tools and equipment needed to improve the BPI shop so that it will be more suitable for fabricating equipment prototypes.

The Program's progress is currently hindered by the lack of a BPI engineer capable of coordinating the diverse activities (e.g., equipment development and promotion, training, technical assistance to manufacturers, activities of regional engineers) under the direction of the BPI Engineering Chief with the assistance of the IRRI Liaison Engineer. The latter two persons have had to assume these duties but the situation needs to be improved because the BPI Engineering Chief cannot devote full-time to the Program and the IRRI Liaison Engineer should not coordinate the daily activities of BPI and MAF employees. The coordinator should be an experienced BPI/MAF engineer who has a demonstrated ability with respect to the practical development and extension of small farm equipment, as well as effective management of technical activities and personnel. Although engineers of this calibre are scarce, several potential candidates have been tentatively identified. The person should be appointed and trained during the two-year period so as to have a capable coordinator available to sustain the Program after the proposed project is completed. The Advisory Committee has been informed of the need, but no definite action has been taken.

IRRI has partially supported the Program from its regular budget by providing personnel and facilities for training of MAF engineers at IRRI, as well as collaboration on equipment development, testing, and promotion (e.g., transplanter, reaper, and rolling injection planter). This support is estimated to amount to approximately US $79,000 per year (10% of the total annual budget of IRRI Engineering, including senior staff engineers). It is proposed that IRRI continue to provide this level of support to the Program, - even after the two-year period of the proposed extension.

The Program is guided by an Advisory Committee having the following members: MAF Assistant Secretary, Head of IRRI Engineering, Dean of UPLB Engineering, Director of the Agricultural Machinery Testing Center (AMTEC), President of the Agricultural Machinery Manufacturers and Distributors Association (AMMDA), and representatives from the Central Bank and Ministry of Industry and Trade. It is proposed that the same Committee continue to guide the Program, but with the addition of a representative of ARO.

OUTREACH PROGRAMS

Indonesia

The project in Indonesia was terminated on September 30, 1985.

A report of the IRRI representative follows.

IRRI-DITPROD
MENUJU SWADAYA DAN SWASEMBADA
PROYEK PENGEMBANGAN ALAT-ALAT PERTANIAN

TERMINAL REPORT

IRRI INDUSTRIAL EXTENSION PROJECT IN INDONESIA

FROM SEPT. 1980 TO SEPT. 1985

BY

V.R. REDDY

CONSULTANT IRRI

P.O. BOX 18/KBYPM

JAKARTA-INDONESIA.

September 1985

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Best Available Document

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Back ground information :

IRRI machinery programme has had subcontract arrangement with * DITPROD since 1974. Later in the year 1977 on the request of USAID mission Jakarta, a three month study tour was undertaken by IRRI consultant in the same year to submit a report on the state of art of farm equipment in Indonesia and indicate the possibility of starting an industrial extension project in Indonesia.

Subsequently USAID Jakarta mission has funded the above industrial extension project (IRRI-DITPROD) since March 1978 until August 1980. After conducting the evaluation of this industrial extension project, a regional project (consisting of Phillippines, Thailand, & India for similar industrial extension projects through IRRI) was funded by USAID Washington since September 1980 until September 1985.

During the early years (including the subcontract period from 1974 to 1978) IRRI has supplied the technical drawings and the samples of IRRI developed small farm equipment to DITPROD and provided small funding to encourage the local manufacturers to produce the proto-types. About six workshops were identified in Java, who have been supported both financially & technically to produce the above proto-types.

These early attempts while did not prove particularly fruitful in the sense of sustaining the continuous growth of the above units & other similar units in Java but did provide the initial experience to develop a strategy for the project in the later years since 1980.

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* DITPROD - Directorate of Food Crop Production in Jakarta.

Prototype manufacturing & testing for the local production:

As per the above strategy, one of the first tasks that was undertaken was to select the technical staff from the counterpart agency DITPROD, and provide adequate workshop and office facilities for the project work in Jakarta.

As per the IRRI - DITPROD organisation chart (Appendix # 1), the development and testing group's main activities are :

1. Building proto-types & production aids like jigs, fixture, guages. etc...
2. Translation of drawings into Indonesian
3. Standardisation of material components and drawings, etc..
4. Durability & performance testing of locally built IRRI type equipment in the field conditions & suggest improvements.
5. Help in testing and training of operators in the selected provinces.

The majour emphasis, however, was to build several versions of prototypes with locally available materials and test them through every modification, until finally a satisfactory model emerges. This rigorous undertaking not only helped this project in modifying the original IRRI designs to suit the local conditions but also provided thorough training to the staff involved in the project. This was comparatively a slow process, but we believe this approach has helped in laying firm foundation for the institutionalisation of the project.

Field extension work :

a. West Sumatera

Our first choice was West Sumatera province as a pilot project area to test out our ideas and learn our lessons in actually carrying out the field extension work.

Initially few sets of demonstration equipment (consisting of hand tractors, paddy/threshers TH 6 model, axial-flow pumps, weeders, transplanters and one vertical bin dryer) which was fabricated in Jakarta was sent to DIPERTA (Agricultural department) in West Sumatera.

In addition to serving as samples for their fabrication in the department's workshop and train the provincial staff, this above equipment was used for demonstrating in the farmers' fields to create interest among the local farmers.

Simultaneously we were able to identify and motivate few local small workshops to take up the manufacture of IRRI designed farm equipment and all the technical assistance required was rendered.

Two provincial staff members and one cooperative fabricator were sent to Jakarta and Los Banos for advanced training in fabrication and operation of the equipment.

For the successful diffusion of the technology in this province, we soon discovered it was not enough to conduct few demonstrations by DIPERTA and encourage small workshops to fabricate them. We found following measures needed to be taken in order to create the sustained demand from the farmers.

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1. To identify few leader farmers in the potential areas and hand over them a well tested equipment for atleast one full season with periodical monitoring by the DIPERTA staff, has proved very effective.
2. To encourage and assist small fabricators in their early stages not only to fabricate the equipment but also to hire the equipment to the nearby farmers which will act not only as demonstration and create his own market but also to learn from its usage which parts need further improvement and thus help him in producing reliable equipment which we found is crucial in the early stages of product introduction to the market.
3. To coordinate through the local banks to provide the credit to the needy farmers (without insisting on difficult conditions such as land certificates etc, but to hypothecate the equipment itself to the bank, as we were able to get this policy decision from* B.I. in West Sumatera) and also to the small fabricators for their additional working capital and expansion.

These few important measures carried out effectively in the initial stages have contributed to a great extent in West Sumatera achieving self-sustaining growth in the production and sales of paddy threshers, weeders and now small hand tractors. It may be seen from the appendix # 2 list of IRRI cooperative manufacturers and their production figures, how rapidly this small farm equipment industry has been growing (from scratch) in West Sumatera in the past few years.

This successful experience has encouraged ILO to fund a study on the diffusion of small farm equipment technology that was taking place in West Sumatera. A copy of their report is enclosed :- appendix # 3.

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* B.I. - Bank Indonesia

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b. South Sulawesi.

Our experience in South awesi has been different and did not prove as successful as in West Sumatera. According to our judgement less enthusiasm and less involvement of the local DIPERTA staff in our project activity was perhaps one of the majour factors. Besides they were already committed and involved in introducing imported Japanese 4 Wheel tractors.

However, in Luwu (a district in the province) USAID, Jakarta has requested this project to undertake a comparative study of the suitability and profitability of employing the above mentioned imported Japanese tractors Vs locally produced IRRI type hand tractors spread over a period of two years (May '81 to May'83) covering four seasons.

Under this scheme, 10 hand tractors with attachments were shipped to Luwu, and a total number of 30 respondents were selected consisting of mini-tractor owners, hand - tractor owners, farmers hiring the above equipment for land preparation and farmers using traditional land preparation. Detail cost figures were collected for every operation from the above respondents and were analysed at the end of the study. It has clearly come out that locally produced hand tractors proved most suitable because of the least cost of land preparation, easy to operate and maintain and more versatile with the usage of trailers etc.....

Infact more than 150 farmers have indicated their readiness to purchase the hand tractors with the bank credit. One local small workshop in Luwu has been assisted to build these hand tractors, and it has produced and sold two units. However, the local banks have not yet come forward to provide the necessary credit facilities

to the farmers, which is proving the majour obstacle presently.

Meanwhile, three other local workshops have been able to produce 35 paddy threshers which is stimulating further demand for threshers. With more sustained extension efforts and credit facility this province also shows the promise to reach a take-off-stage like West Sumatera in next few years.

c) South Kalimantan :

Of the various IRRI products introduced, axial flow pump has caught on rather impressively. This province having large tracts of swampy areas, found the immediate use of these low cost pumps to pump water into the narrow dug channels (in the summer mainly) to provide boat transportation to nearby towns & markets from the remote fields, in addition to of course irrigating the fields. Since each such water channel is used by hundreds of small boat owners, the total cost of the pump (about $400) is recovered within a season. Due to the remoteness of these areas where these pumps are fabricated & used, we are unable to get the correct statistics. The rough estimate is that about one hundred units are now under use, produced by about three fabricators.

Few samples of threshers, hand tractors, weeders have been fabricated by the project assistance. In this province also we have the handicap of not so active provincial staff participating in our extension efforts, hence less progress achieved in the introduction of other farm equipment.

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The Government of Indonesia has, however, been encouraged by the successful usage of pumpsets in this province, has provided funds for 250 more pumpsets to be introduced in other provinces with swampy areas.'

d) West Java

The strategy of this project has been to introduce only manually operated equipment in Java mainly because of its high density population and to avoid the possibility of adding to its present un-employment & under-employment rate as the social scientists have been urging.

Therefore this project has mainly concentrated on developing a suitable pedal operated thresher and* winnower, in addition to building rolling injection planters, weeders and transplanters for which the designs have been procured from IRRI - Los Banos.

After succeeding in developing suitable models of pedal thresher & winnower, few units have been distributed to land-less labourers & carpentors in the two districts of this province to encourage them for the local fabrication. We have recently conducted a training programe in which 8 carpentors participated from three districts of this province. During the training, each one of the participant was able to build one pedal thresher and one winnower which was tested and was taken back to their villages. The spread effect of this effort is beginning to show the results.

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* it was already successfully being produced and sold in West Sumatera by the local initiative.

Training Programme :

Training courses conducted in Indonesia essentially are two types.

The first type is conducted in Jakarta where the participants are from provinces working in the extension field in Government departments. The course content is mainly familiarisation of the equipment, the cost analysis and benefits of using the equipment in the country and the effective extension methodology to be adopted.

The second type is conducted in provinces and the participants are from small workshops and operators of the equipment. This training course concentrates mostly regarding the manufacture and testing of the equipment in the field. All the training programmes are conducted in Indonesian language. The main details of this training programme conducted are given in the table below.

As mentioned above, the DITPROD staff attached to the project are being continuously trained in the fabrication of proto-types carrying out modification work & in field testing throughly.

Then these trained central staff go to the provinces for conducting the second type of training couses mentioned above, which is essentially of practical nature. This strategy is yielding good results, in terms of more number of small fabricators are taking up the manufacture of IRRI designed farm equipment in four selected provinces.

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The training courses conducted in Indonesia :

No.	FROM - UP TO	PLACE OF TRAINING	NO OF PARTICIPANTS	MAIN SUBJECTS COVERED
1.	Oct. 6th to Oct. 12th '80	Jakarta	12	Familiazisation of IRRI designed equipment
2.	Apr. 6th to Apr. 11th '81	Jakarta	22	
3.	May 31st to June 4th '82	Jakarta	17	Analysis of the equipment, extention methodology and credit requirement .... etc.
4.	Jan. 24th to Jan.28th '81	Bukittinggi W. Sumatera	19	Blue print reading, jigs and fixtures usage, cost of manufacturing and field testing and quality control.
5.	No.v. 12th to Nov.19th'81	Bone-Bone S. Sulawesi	12	
6.	Oct. 19th to Oct.21th '81	Banjar Baru S. Kalimantan	17	
7.	Mar.25th to Mar.28th '82	Maros S. Sulawesi	16	
8.	May 31st to June 4th '82	Jakarta	17	Agricultural Mechanisation course
9.	Jan 9th to Jan 4th '84	Bukittinggi W. Sumatera	12	Training for making hand tractors.
10.	May 15th to May 26th '84	Jakarta (Participants	8	Training for making pedal thresher/winnower
11.	Sept.9th to Sept.14th '85	Banda Aceh	12	Training for making quality TH6 Thresher in collaboration with FAO

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List trainees sent to IRRI Los Banos for Agricultural Engineering training course :

NO.	FROM - UP TO	NAME	ORGANISATION AND DESIGNATION
1.	March 12 - 28, 1980	Busyra + Subrata Sudarga	DITPROD + DIPERTA W. Sumatera
2.	June 1981	Suwardi + Tabran	DIPERTA SUKAMANDI
3.	June 1981	Koes Sulistiadji	DITPROD
4.	December 1981	Haryono	DIPERTA SUKAMANDI
5.	December 1981	Zulkarnain	DIPERTA SUKAMANDI
6.	June 7 - June 18,'82	Ir. Zaidir Said	DITPROD
7.	June 7 - June 18,'82	Ir. A. Deni	DIPERTA S. KALIMANTAN
8.	Dec.6 - Dec. 17,'82	Ir. Effendi Hamdani	DIPERTA S. SULAWESI
9.	Dec.6 - Dec. 17,'82	Made Dasnaya	DITPROD
10.	July 25- August 12,'83	Asparmin Junus	W. SUMATERA (MANUFACTURER).
11.	July 25- August 12 '83	Suhardi	DIPERTA S. KALIMANTAN
12.	Nov.17 - Oct. '84	Dahlan Wiwoho	DIPERTA ACEH
13.	May 27 - June 14,'85	Ir. Syamsuri	DIPERTA S. SULAWESI
14.	May 27 - June 14,'85	Syamsir Salim	DIEPRTA W. SUMATERA
15.	August 15-August 27,'85	Ir. Astu Unadi	DITPROD.

National farm machinery development strategy :

With the experiences gained through this project's implementation, an approach to the National strategy for the development of farm machinery industry has been prepared. A copy of our 'guidelines for a development strategy of farm mechanisation in Indonesia" appendix # 4
Summary of recommendation made in the above paper are as following :

1. Learning approach through pilot scale trials in the initial stages is likely to be more successful and cost effective than a large scale "Blue-print" approach in the introduction work of new farm equipment at the "Grass-roots' level in the new areas.

2. Choosing simpler technology of farm equipment which can be locally fabricated by small workshops area likely to spread more rapidly in the rural areas.

3. Preparation of a list of farm equipment (at different levels of technology such manual/animal/power driven) showing their order of priority which are to be developed/adapted within the country. (detail note enclosed).

4. Networking the local R & D institutions and guide/coordinate their output by the technical committee of NFMC.

5. To prepare a map of the country showing the priority areas for introducing new farm equipment (and their priority) for taking up intensive field extension work.

6. Socio-economic surveys to be conducted, in order to determine farmers 'Constraints' and the priority needs of farm equipment and later their impact keeping in view the walfare of small farmers and land-less labour.

7. With the given man power and financial resources available, it is important to concentrate and continue the programme until the "take off-Sustainable growth" stage is reached.
8. Effective field extension methodology that has evolved from IRRI-DITPROD industrial extension project is briefly as following :
   a). Initial farmers'demand is to be created through extensive demonstrations of the new farm equipment being introduced in farmers'fields.
   b). At least 2 or 3 potential fabricators in the selected provinces are to be identified amd assisted initially until their production and sales steadily rise.
   c). Training programme to be conducted one for the provincial Government extension staff (preferably at the centre with the participation of similar provinces) and the other to the operators/repairers/ fabricators of the farm equipment at the provincial level.
   d). Annual field days to be organised both at the centre and at the provinces and conduct group meeting/ seminars not only to exchange useful information, but also to review and evaluate the progress made so far in implementation and in making plans for the future.

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e) Synchronizing the activities funded through DIP among the various Government agencies which have to work in an integrated manner is quite essential.
(Gudelines suggested in enclosure 11)

f) Professionally a well-done periodical Newsletter as a media for a two-way communication can play a vital role to strengthen national networking and keep up the tempo of farm mechanisation in the country.

9. Formation of a strong technical committee/coordinating body supported by a small permanent secretariat to advise National Farm Mechanisation Communittee (NFMC) and to act as the "dynamo" in the development of farm mechanisation in Indonesia is the first important step to be taken.

10. The above technical committee to take the initative to prepare the detail plans for the proposed National Farm Mechanisation Development Institute which is essential in view of the increasing important role the farm mechanisation will have to play in the long term development of the country's economy.

Finally a long term plan of this nature to be successful has to be a continuous process integrated with its implementation and with a built in feed back loop for continuous renewing and amending the course as it may necessitate.

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Evaluation of the project :

The first evaluation in Feb '84 was conducted by a four member team from USAID Washington. In addition to the detailed discussions with USAID- Jakarta mission officers, and the DITPROD officials in Jakarta, the team has visited several workshops assisted by the project and the farmers using the equipment in the provinces of West Sumatera, Aceh, West Java. They have concluded that the successful strategy and implementation of this project can be replicated in other developing countries with desirable results. A copy of their memorandum to USAID-Jakarta mission is enclosed herewith, ependix # 5.

A second evaluation of the project was also conducted from Jan.16,'85 to Feb. 12, '85 by another team counsisting of :

1. Dr. Joseph K. Campbell
2. Dr. Sam H. Johnson
3. Prof. Dr. Siswadhi Soepardjo
4. Dr. Faisal Kasryno

A copy of their summary of their detailed report is enclosed, appendix # 6.

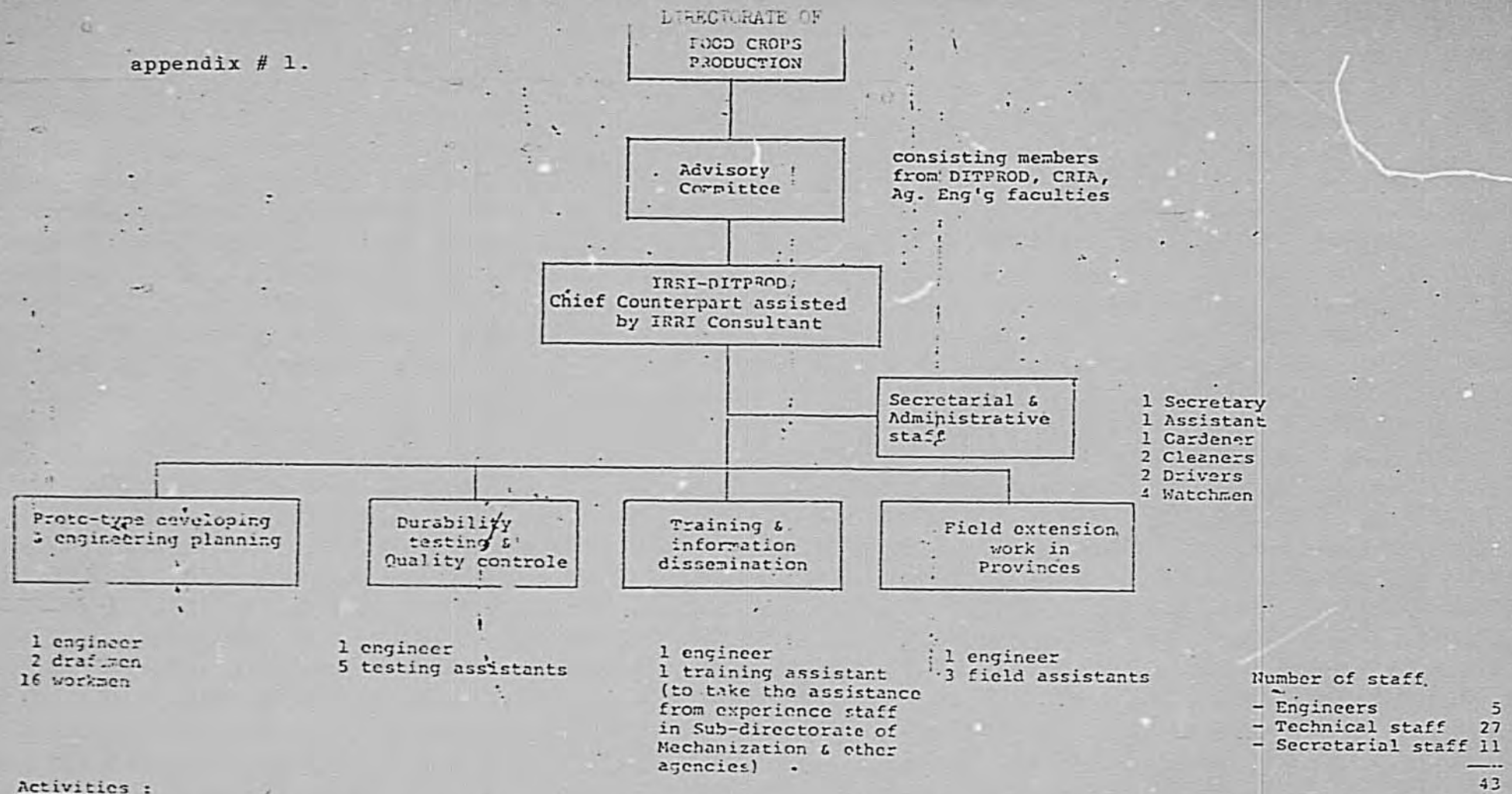
Audio visual materials prepared.

Two sets of slides are prepared, one set used for the training programmes, and the other set mainly showing the range and type of activities undertaken by the project along with the traditional practices, is used acquaint the Government policy makers and visitors from other international agencies, etc.....

8 m.m. movie (without sound) running for about 15 minutes is also prepared (by the project staff without professional experience) from the various activities of the project to inform generally about the project.

A 30 minute video was recently completed with the help of outside professional staff mainly showing: the drudgery and in-efficiency of traditional agricultural practices in Indonesia, the disadvantages of importing highly sophisticated farm technology into the country, and finally the activities undertaken in introducing the appropriate small farm equipment technology through this project and some of the encouraging results achieved by the project are high-lighted.

appendix # 1.



Activities :

- Building proto-types production aid like jigs, fixtures, guages
- Translation of drawings into Bahasa Indonesia
- Standardisation of materials components & drawings etc.
- Material planning & cost reduction methods

- Durability & performance testing of locally built IRRI type equipment and suggest improvements
- Help in testing & training of operators in provinces

- Translating & preparing materials for training course.
- Conducting training programmes at Jakarta (at least twice/year0 & in provinces (at least once/year in each province selected
- Publishing biannual; project news bulletins
- Supervising library
- Coordinating workshop seminars

- With the help of DIPERTA staff selection of 'Desas' for initial demonstration work
- Conduct initial bench mark studies
- Identify cooperators from KUDs, Kelompok Tani & enterprising farmers for hiring of equipment
- With the help of Perindustrian staff, identify cooperator manufacturers
- Coordinate with credit agencies for needy purchasers of equipment

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PROGRESS OF MANUFACTURE OF IRRI SMALL FARM EQUIPMENT IN INDONESIA — Appendix # 2.

UNTIL AUGUST 1984

NO	MANUFACTURERS	Hand Tractors up-to 79/83	Hand Tractors up-to 83/84	Axial Flow Pump up-to 79/83	Axial Flow Pump up-to 83/84	Transplanters up-to 79/83	Transplanters up-to 83/84	Threshers up-to 79/83	Threshers up-to 83/84	Dryers up-to 79/83	Dryers up-to 83/84	Other Implements up-to 79/83	Other Implements up-to 83/84	REMARKS
	WEST SUMATERA													
1.	P.T. Sutan Kasim, Padang	-	-	-	-	-	-	45	-	-	-	10*	-	* weeder
2.	P.T. Sarasah Industri, Bukittinggi	1	-	-	-	-	-	158	150	-	-	85*	-	* weeder
3.	Bengkel Tembok Jaya, Agam	1	-	-	-	-	-	60	120	-	-	20*	25*	* weeder
4.	Bengkel Altan Gadut, Agam	-	1	-	-	2	-	32	80	-	-	-	50*	* weeder
5.	Bengkel Sarasah Indah, Sijunjung	1	1	-	-	-	-	[illegible]	[illegible]	-	-	32*	40*	* weeder
6.	KUD Dewi Sri, Padang pariaman	-	-	-	-	-	-	9	125	-	-	-	150*	* weeder
7.	Bengkel Dragon, Sei Sarik	-	1	-	-	-	-	20	90	-	-	-	15*	* weeder
8.	Bengkel Karya Bakti, Sicincin	-	-	-	-	-	-	15	-	-	-	-	-	
9.	Bengkel Medan Teknik, Padang	-	-	-	-	-	-	10	10	-	-	-	-	
10.	Bengkel Arjuna	-	-	-	-	-	-	19	-	-	-	-	-	
11.	P.T. Tani Makmur, Padang	-	-	-	-	-	-	5	-	-	-	-	-	
12.	Bengkel Batu Batagak, Agam	-	-	-	-	-	-	6	-	-	-	25*	-	* weeder
13.	Bengkel Muchtar, Bukittinggi	-	-	-	-	-	-	18	-	-	-	-	-	
14.	Bengkel Konstruksi DSM Bukittinggi	-	3	-	-	-	-	6	15	-	-	-	-	
15.	Bengkel Pandai Besi UMA, Bukittinggi	-	-	-	-	-	-	6	-	-	-	200*	-	* weeder
16.	Bengkel DIPERTA, Bukittinggi	4	6	3	-	4	-	10	[illegible]	-	-	200*	-	* weeder
17.	Bengkel Aden, Padang	-	-	-	-	-	-	-	10	-	-	-	-	
18.	Bengkel Karya Jaya, Padang	-	-	-	-	-	-	-	6	-	-	-	-	
19.	Bengkel Karya Ilahi, Lubuk-Basung, Agam	-	-	-	-	-	-	-	12	-	-	-	-	
20.	Bengkel Usaha Ibu, Padang Luar Bukittinggi	-	-	-	-	-	-	-	-	-	-	-	-	
	Sub Total	7	12	3	-	6	-	440	677	-	-	592	280	
	NORTH SUMATERA													
28.	Banda Aceh, 8 workshops	-	-	-	-	-	-	-	120	-	-	-	-	
35.	Pidie, 7 workshops	-	-	-	-	-	-	-	115	-	-	-	-	
42.	Aceh Utara, 7 workshops	-	-	-	-	-	-	-	75	-	-	-	-	
43.	Aceh Timur, 1 workshop	-	-	-	-	-	-	-	5	-	-	-	-	
45.	Aceh Tenggara, 3 workshops	-	-	-	-	-	-	-	2	-	-	-	-	
	Sub Total	-	-	-	-	-	-	-	315	-	-	-	-	
	SOUTH KALIMANTAN													
[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]
47.	Bengkel Johan Negara	-	1	51	34	-	-	1	-	-	-	-	-	
48.	Bengkel Antosa, Kandangan	-	-	-	-	-	-	1	-	-	-	2*	-	* weeder
49.	Bengkel Pancaran Amanah, Barabai	-	-	-	-	-	-	-	15	-	-	2*	1* 20**	* weeder ** pedal thresher
	Sub Total	1	1	70	34	-	-	8	15	-	-	26	21	
	SOUTH SULAWESI													
50.	Bengkel Sidoladi, Palopo	2	2	-	-	-	-	-	-	-	-	10 $	-	$ 2 trailers 8 puddlers
51.	Bengkel Usaha Tenaga Maju, Massepe, Sidrap	-	-	-	-	-	-	2	-	-	-	-	-	
52.	Bengkel Diana, Rapang	-	-	-	-	-	-	1	-	-	-	-	-	
53.	Bengkel DIPERTA SULSEL, Ujung Pandang	1	-	1	-	-	-	10	20	-	-	[illegible]	[illegible]	
	Sub Total	3	2	1	-	-	-	13	20	-	-	10	-	
	J A V A													
54.	P.T. TUGAS, Jakarta	49	20	6	10¢	5	-	8	-	2	-	37*	-	¢ 6 " * 20 weeders, 4RIP, 13 transmission box
55.	P.T. NEW Ruhnak, Jakarta **)	160*	-	-	1,435	-	-	-	-	1,000$	-	-	-	**) an information not supplied * imported type with rotovator $ Husk burner different design
59	4 carpentors	-	-	-	-	-	-	12*	-	-	-	-	12¢	* pedal threshers ¢ pedal winnowers
60.	P.T. Kubota, Semarang	81	140*	-	-	-	-	-	-	-	-	-	-	* DM 711
61.	P.T. KARYA HIDUP SENTOSA, Yogyakarta **)	1664*	-	530	-	-	-	690	-	-	-	-	-	* Thai type **) an information not supplied
62.	P.T. Suratman, Solo *)	60	-	6	-	-	-	199	-	5	1500*	-	-	*) Data not supplied for 82/83
63.	Bengkel Jatibarang	-	-	6	-	-	-	-	-	-	-	-	-	* weeder
64.	Bengkel TANJUNG KARYA, Jakarta	9	5	12	1	10	-	12	2	1	-	25	45	Hand tractor attachments & pedal threshers & winnowers ....etc.
	Sub Total	2023	165	560	1446	15	-	921	2	1008	1500	62	57	
	Grand - Total	2034	180	634	1480	21	-	1382	1029	1008	1500	690	358	
	Cumulative - Total	2214		2114		21		2411		2508		1048		

GRAND TOTAL NUMBER OF COOPERATIVE FABRICATORS = 64

TOTAL NUMBER OF UNITS PRODUCED = 10,316

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IRRI-DITPROO
MENUJU SWADAYA DAN SWASEMBADA
PERBANGAN ALAT-ALAT PERTANIAN

Enclosure I.

SUGGESTIONS FOR THE RESEARCH & DEVELOPMENT PRIORITIES FOR THE FARM EQUIPMENT IN INDONESIA

This is an attempt to describe the present status and suggest further research and development work that needs to be carried out on each category (including manual, animal & machine power) of appropriate farm equipment required for the various agricultural operations by the farmers in the country.

I. Land Preparation :

a). Manual :

At present various types of hoes (cangkul) are used in different parts of the country which are produced locally by the hundreds of thousands of blacksmiths spread all over the country. It has been reported that since past several years a fairly large percentage of the country's requirements of hoes are also being imported.

In view of this being a basic implement and that this implement is likely to be used for quite some time to come, it would be advisable to improve the present types and standardise them into fewer types. It would seem highly desirable to encourage the local blacksmiths

/fabricators to produce the desired quality of hoes to meet the full requirements within the country itself.

At the same time it may be desirable to experiment with a few manually pulled puddlers (gelobak type) to increse the farmer's productivity for the land preparation.

b). Animal Drawn Implements :

Scope for improving and standardising ploughs, cultivaters, puddlers and levellers that are simple and can be fabricated locally also exists. The present trend is to build a basic "tool carrier" which can be fitted with the above mentioned attachments, including a rubber-tyred cart. To our knowledge, no adaptative work in this regard has yet been taken up in Indonesia. It therefore deserves priority, especially in the provinces where animal power is more often used for example in Sulawesi, Sumatera, Bali, Madura, etc.

c). Tractors :

Four to five sizes of tractors are recommended for standardisation in order to meet the entire range of needs of the country.

i). Small light weight hand tractor with 4/5 H.P. petrole/kerosene engine with complete set of attachments (mold board plough, harrow, puddler, including 1,0 meter reaper for harvesting and 1/2 ton trailer for rural transportation.) Four proto-types of IRRI designed models have been built at Tanjung Barat workshop and one in West Sumatera, and they are now under extensive field testing stage. Within a year this model should be ready to be released for the extension work.

Since this model is a multipurpose, simpler, and inexpensive machine (about Rp. 900.000,- including engine and attachments for the land preparation) to build locally, it has great potential to become popular in the various parts of the country, especially for the the terraced rice and vegetable cultivation.

ii). Hand tractor with 6/7 H.P. diesel engine, with a complete set of suitable attachments as mentioned above. This model (IRRI-design) has been used for the extension purposes during the last 3 years. With the assistance of M.I.D.C., standardisation of components using local mate-

rials available along with the production aids was accomplished and the detail drawings are released to the interested manufacturers.

So far about 180 units IRRI type and 650 units Bangkok type (mainly in Java) have been manufactured by about* 10 manufacturers. Presently intensive field extension drive is being under taken (by IRRI-DITPROD Project) in West Sumatera, South-Sulawesi and West Java. However, greater inputs in terms of extension staff and money are required to accelerate and make a bigger impact not only in these three provinces but in the other provinces where the onstraints for the land preparation exist.

iii). Riding tractor (4 wheels) with 16/18 H.P. diesel engine, a simpler and an inexpensive model which can be locally fabricated. This type is being manufactured in Thailand very successfully.

We recommend that some of these models (with various-attachments including a reaper for harvesting and a 3 ton capacity trailer for transportation) are imported for extensive field testing.

* Refer "table progress of manufacture of IRRI designed small equipment in Indonesia" enclosed here.

This tractor type can be manufactured only by the medium size and fairly well equipped workshops unlike the above mentioned hand tractors which can be produced by smaller workshops. Even collaboration arrangements between Thai-manufacturers and Indonesian entrepreneurs for the local manufacturing programme could be encouraged by BKPM, after these models are successfully field tested in the country.

iiii). Bigger H.P. tractors (above 15 H.P.) probably have to be imported for some time to come. After identifying the suitable types, these could be encouraged for gradual local assembly/manufacturing programmes if there is likely to be sufficient demand mainly by the large plantations, estate farmers etc.

II. Seed Drilling/Transplanters and Fertiliser Applicators :

a). Manual :

1). Proto-types of manually pushed rolling injection planters (RIP) single row, two row, three row have been fabricated at Tanjung Barat, Ragunan workshops at Pasar Minggu and are under field tests by SURIF at Sukamand and at Lampung in FAO assisted project.

This implement RIP for seed drilling paddy and secondary crops (palawija) looks very promising in sandy loam soils for upland conditions, therefore needs to be

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taken up on priority for the extension work (in such soil/crop conditions) specially in rogo-ranca fields and transmigration areas and for seed drilling palawija crops.

ii). Proto-types of manually operated low land paddy transplanters (IRRI-design) have been built and tried out at Tanjung Barat workshop. The modified version is functioning satisfactorily. It needs field testing for one or two seasons in the farmers' fields before releasing it for field extension.

iii). IRRI at Phillippines is presently field testing a few models of manually operated fertiliser placers in wet paddy fields which are showing great promise. Few proto-types of them will be imported and tested here in Indonesia by IRRI-DITPROD project in the near future.

b). <u>Animal Drawn Seeders/Fertiliser Applicators</u> :

Several successful designs of animal drawn seed cum fertiliser applicators for upland soils have been developed and are being used by large number of farmers in India and Pakistan. These models can be imported along with the tool carriers from the above countries (perhaps with the assistance of RNAM) and could be taken up for field testing by SURIF and MORIF.

For low land conditions plow sole fertiliser applicator has been developed by IRRI, which needs to be tested further under local conditions before releasing for extension.

c). Power Driven Transplanters/Seeders/Fertilisers :

For low land transplanters, several high technology and expensive models are available from Japan/Taiwan, which may not yet be suitable for Indonesian conditions. Besides (to our knowledge), it is not yet reported as the major constraint in the country.

For upland conditions, however, there are many successfully tested tractor attachments of different sizes which can be readily adapted for the local needs.

III. Weeders :

a). Manual :

Low land weeders of different types are being used in different parts of the country. Even simple rotary weeders which are found to be quite efficient have yet to be popularised in several parts of the country. A major constraint seems to be that transplanting at present is still not being done in rows in many areas of the country specially in the outer islands.

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We found the cost of hand hoeing (one to three times to be done in the paddy fields during the crop) is quite substantial and sometimes as high as the cost of land preparation (as reported from South Kalimantan). Therefore the introduction of row transplanting and weeding are substantial could be taken on priority.

A successful design of an upland weeder, to our knowledge is still not available. In thailand, however, we believe recently a manuaaly operated upland weeder has been successfully field tested. These drawings can be procedured and after building proto-type and field tested locally, it can be released for the extension work on a priority basis in the areas where the need is felt to be more urgent.

b&c); Animal Drawn and tractor drawn weeder attachments are simple to attach to "tool carrier" and tractor wherever their need is felt.

IV. Sprayers :

a). Hand sprayer :

This type of sprayer is already being used in large numbers in several parts of the country. Also these are sucessfully being manufactured locally by the small-scale industries mainly in Java.

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Considering the total area under cultivation in the country, the present number of sprayers being used in the country is still very small. There exists much potential for further field extension work and encourage many more small-scale manufacturers to take up the manufacture of these simple hand-sprayers with better quality. To our knowledge, M.I.D.C. has already taken the initiative to develop the production process with the necessary production aids to train the interested small-scale units.

b). Power Sprayers :

Since the average farm holding size is quite small, the need for the power sprayers is not so large at present. However, for the requirement of estate farms, horticultural plantations, and to fight the large state insect/pest attacks during certain seasons, the power sprayers are perhaps required which are presently being imported. Fewer types could be standardised and can be encouraged for the local assembly and manufacture in collaboration with well-known makes as the demand steadily increases.

V. Harvestors :

a). Manual :

Lighter and more efficient hand sickles from Taiwan and Japan have been imported and tried out in the fields.

However, thorough field studies are yet to be undertaken as to the productivity differences and the post-harvest losses if any between the old and the new sickle-harvesting. This new design sickle unfortunately does not lend itself to be manufactured by the local blacksmiths as it needs special dies and heat-treat- ut. To our knowledge two units (one in Bandung and the other in Jakarta) have produced the proto-types and gearing up htemselves for the mass production. While this is in one way a desirable development, but at the same time this tendency may add to the under-employment of hundreds and thousands of balcksmiths all over the country. Therefore it would be desirable to investigate if the present type sickles could be standardised and simpler improvements to be incorporated which could be produced by the blacksmiths.

b). Animal drawn reapers are not common because they have not proved economical.

c). Tractor drawn reapers/harvestors, however, are increasingly becoming popular and successful in other countries. As mentioned earlier proto-type of 1 meter reaper attachment for 4/5 H.P. small hand tractor and 1,6 meter reaper attachment for 6/7 H.P. hand tractor have been built at Tanjung Barat workshop and are now under the field testing stage. Within a years'period these will be released for the extension work. A great deal of interest is being

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shown from several provinces like West Sumatera, Aceh, South Sulawesi, etc.

VI. Threshers :

a). Pedal type :

Considering that the vast majority of farmers are still threshing and winnowing in the age old traditional manner which is not only less productive (more drudgery) but also causing substantial post harvest losses, the first priority could be given to popularise pedal threshers and pedal winnowers, through out the country and specially in densenly populular inner islands.

These are several designs available (both within the country and from outside) but we believe there is scope to do some more development work to make them more productive, less expensive and simpler, so that they can be fabricated in the Desa by the carpenters/black smiths and are readily accepted by the traditional farmers.

Few proto-types have been built at Tanjung Barat and Ragunan workshops which need to be field tested after minor modifications. After testing them successfully in the farmers'fields for one or two seasons, in view of the present national priority to reduce post-harvest losses a campaign ought to be launched to popularise them (pedal threshers and pedal winnowers) specially in Java/Bali/Madura where the present high unemployment/under employment that exists in their rural areas.

b&c). Animal / Power Threshing :

In certain countries animal trampling is done to assist in threshing, (as also tractors are used) but this practise is neither efficient nor so common.

As mentioned earlier a small thresher (IRRI design, TH 6 model) driven by 5 HP engine has become very popular in West Sumatera and its use is spreading to the neighbouring province of Jambi, Riau, Aceh. As and when the need is felt for bigger threshers, IRRI model TH 8 which has proved quite popular in Phillippines and Thailand, can also be introduced here at a later stage.

VII. Dryers :

Several batch dryers of 1 ton, 2 ton and now 4 ton capacity, are being fabricated in the country commercially. Earlier several proto-types were built by DITPROD and tested in the field conditions. While they seem to function satisfactorily as per their technical specifications, they have not yet proved to be very popular amongst the users (farmers, rice millers, cooperatives etc.). The reasons could be many, being too big and too expensive it may not be yet economical for the commercial use.

It appears to us, the logical sequence to be followed in this case is first to conduct survey/market research and ditermine if there is a clear need and by whom, for what

capacity and at what price ? Only after that some more hard-ware research and the field extension work could be taken up justifiably.

VIII. Agro Processing Machinery :

In this category, rice milling units are the predominant need of the country and to a great extent it seems to have been fulfilled by the imported small rice milling units. For replacement of imported milling units and for the future expansion locally procedured rice milling units need to be encouraged and included as a policy measure. For the local manufcture, adaptation and standardidation work, the initiative could be taken up by M.I.D.C./Perindustrian department.

IX . Rural Transportation :

a). Manual :

There is a need to improve and standardise one wheel barrows and two wheel carts (manually pushed) that could be popularised in the rural areas. Industries/ transports departments could perhaps take the initiative to build standard models and encourage small industries to produce them in the remote parts of the country.

b). Animal Drawn old carts are changing slowly to old automobile exles with rubber tyres. As mentioned earlier, standart animal drawn "tool carrier" that can be used

for attaching farm implements, can also be used to convert it into a cart. This versatile "tool carrier" with all the attachments deserves to be given greater attention.

c). Tractor trailers are not yet popular in Indonesia. Automobile trucks are very expensive for rural transportation considering the shortage of capital and the condition of the rural roads. Therefore we recommend simpler forms of mechanised transportation like hand-tractor-trailer to be encouraged for short distance haulage both in the rural areas and in the semi urban towns. The cost per ton per KM by the hand tractor-trailer comes to 1/3 of the regular automobile transportation cost. Tractor-trailers are a very common phenomena in developing countries like China, India, Korea, Taiwan, etc.

Our experience in Luwu where 10 hand tractors are used 3 to 4 months for the land preparation and the remaining 8 to 9 months for the transportation of farm-grain, construction materials, etc. is proving to be extremely popular. There is encreasing demand (more than 100 units presently) for such hand tractors with trailers from the district of Luwu alone.

This policy of encouraging such low cost transportation could give a spurt to the local informal sector dealing

in short-distance-transportation and encourage small workshops to take up fabrication and repair work in the rural areas. Therefore we strongly recommend the standardisation of such trailers, and launching a campaign for their popularisation and providing for the availability of credit from the Banks in order to increase the purchasing power of small entrepeneuer/ custom hirers/farmers in the rural areas.

X. Lift Irrigation :

At present two types of pumps (centrifugal type for over and above 4 meters head and axial flow type up to 4 meters head) are commercially produced in the country. Large number of low head pumps are being used presently in the coastal (brackish water) fish farms mainly with the Government supported funding.

Considering the lift-irrigation potential of the country for agriculture the present usage and manufacture of these pumps is rather insignificant. Most of these pumps in the field are donated to the cooperative and the farmer groups by the Government and these too (as we saw them in the field) are not being used optimally.
Therefore the greater priority we feel ought to be in carrying out more vigorous extension work.

As mentioned earlier a map of the country is to be prepared showing the lift-irrigation potential and the

suitable types of pumps needed in those areas. In the selected priority areas, intensive field extension work to be carried out by creating the initial demand and simultaneously identifying and assisting small local workshops to fabricate them/ We have a successful example in South Kalimantan where the local fabrication and the usage of axial flow pumps is steadily increasing.

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VRR-Th

Oct'83

GUIDELINES FOR PREPARING THE ANNUAL* WORKPLANS AND THE BUDGET (DUP/DIP)

I. Proto-type building, testing and modification work

The priority list of equipment to be taken up at the centre and regional centres to be prepared year wise.

Each proto-type needs perhaps approximately 2 to 3 functional tests and 1 to 2 modifications depending upon the complexity and the present stage of designs of the equipment available.

N.B. For budgeting purpose the cost of this development may come to about 3/4 times the cost of the equipment.

II. Sending the equipment to "farmers" fields for the demonstration cum field testing preferably for a season or two with Kelompok Tani/KUD/NGO, etc. (At least 3/4 [illegible] of the same equipment in to 3/4 areas is recomended). Monitoring atleast once/month by the local DIPERTA officials is essential.

III. To identify and assist atleast 2/3 local manufacturers in the province for the manufacture of the equipment, Perindustrian staff to be involved M.I.D.C. could help in giving production aids, drawings/samples Wherever needed.

* (For the various agencies involved in Agricultural Mechanisation in Indonesia such as Subdit PAMP, SURIF, MORIF, Perindustrian, DIPERTA, M.I.D.C., SAF wherever applicable)

IV. 1). Training of the provincial extension staff to be conducted at the centre atleast once/year. One week duration may be adequate. Training material should be prepared before hand, mainly consisting of the feasibility studies of the equipment to be introduced in their areas and the extension methodology to be adopted and the feed back information to the centre.

The training participants to be advised to bring lot of the field information from the provinces such as inventories, local daily wages, costs of agricultural operations, prevailing raw material prices, successful cooperatives/non Government organisations working in their areas.etc.

2). Atleast one training in each selected province to be conducted, mainly for the fabricators-Perindustrian/ M.I.D.C. to take the major initiative and responsibility in organising this training programme. Detail fabrication methods, material lists, blue-print reading, production aids and their quality specification to be taken up. Field operation, repairs/maintenance could be included. Duration may extend 2 to/3 weeks depending upon the complexity of the product..

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V. Yearly Seminar (with one follow up meeting in between) is preferably conducted on a field day at the centre. An exhibition of the locally manufactured equipment, and the proto-type of new equipment under development could be displayed on this occasion. Representatives from the research and development centres, extension staff (including Perindustrian, DIPERTA, NGO, Koperasi), Alsintan &SAE, representative from farmers'organisation etc. are to be invited on this occasion to discuss the yearly evaluation/performance reports from each agency/province involved and deciding the work to be taken up for the coming year.

VI. Since an integrated approach is being recommended for the development of farm mechanisation in the country, it is important to hold annually DUP preparation cum coordination meeting among the various agencies such as Subdirectorate PAMP, Perindustrian, M.I.D.C., SURIF, MORIF, Provincial DIPERTA/Perindustrian staff.

VII: The budget to be provided for the quarterly in-house news letter and its distribution to all the concerned including PPIS, L.K.M.D. in the provinces. A detail list of addresses to be prepared.

VIII. Socio-economic studies to be undertaken (atleast one in-each of the potential province) each year to determine the priority areas and the priority equipment needed, and also to study the impact of the technology introduced. Agency such as survey Agro Economy can play the leading role in such studies.

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Appendix # 3.

DIFFUSION AND COMMERCIALIZATION OF RICE POSTHARVEST EQUIPMENT IN WEST SUMATERA

Working paper

Cooperative Research Project Between :

CAER, DITPROD, IRRI and ILO

by

V.R. Reddy & Faisal Kasryno

IRRI-DITPROD
MENUJU SWADAYA DAN SWASEMBADA
PROYEK PENGEMBANGAN ALAT-ALAT PERTANIAN

Center for Agro Economic Research

Agency for Agricultural Research and Development

December 1984

SUMMARY AND CONCLUSION OF FINDING

This study has focussed essentially on two different types of commercial dissemination of two post harvest equipment that has recently taken place in West Sumatera. One is Lumbo (winnower) which was developed through the initiative of local artisan and then its use has spread throughout the province spontaneously during last 15 years and without any assistance of outside extention agencies/institutions. Unfortunately it has not been possible to get the quantitative data on its usage. But the degree of its spread can perhaps be guaged from the fact that it was difficult to find non-users of Lumbo in this study.

In trying to understand as to how this phenomena has been brought about, it seems to us that the enterprising quality of local 'Minang-kabau' people is perhaps the majour factor in the sense that they have adopted this new improved implement readily and commercially exploited this innovation profitably both in making and leasing it out to other farmers. However, it is strange that a similarmanually operated thresher has not taken birth and spread as Lumbo in this province, whereas in some pockets of East and central Java, local versions of pedal threshers have caught on but not Lumbos.

The dissemination of paddy thresher (IRRI type) was brought about essentially through the extension/intervention programme of IRRI-DITPROD project. Other agencies that were actively involved and played important role in this extension effort are DIPERTA, PPMU of Bank Indonesia and machinery dealers.

DIPERTA 's staff particularly has very enthusiastically organised several field demonstrations, participated actively in all the training programmes and in the coordination meetings. Therefore the extension factor in the dissemination of threshers has come out significant. What is more significant is the confidence this department has gained in this process in not only extending threshers to other districts of the province but also has started introducing other small farm equipment such as hand tractors, water pumps, transplanters, maize shellers ..etc. within the province. Infact it is now assuming the role of regional leadership for the entire island of Sumatra.

Inspite of the initiative taken by the PPMU section of Bank Indonesia in providing the needed credit for the purchase of equipment, so far less than 6 % of the total thresher purchasers have been able to secure the bank credit. However, with the increasing awareness and pressure from farmers and provincial Government staff more credit is likely to flow for the purchase of equipment and also for the expansion of the local workshops.

Since many small fabricators are located in small towns and spread out in the interior areas, most of the sales are taking place directly from the fabricators. That is why it may be seen from the map of the province (Fig.2) that most threshers are sold around the location of these fabricators. However, few dealers who have become active in Padang, capital of the Province have started selling (about 56 units Until Jan'83) to other districts and outside the province. With the increasing flow of credit from the banking institution, dealers are

likely to do more business buying and selling of locally made farm equipment. It may be noted that most of these machinery dealers at present are selling imported equipment.

It is significant to note that in West Sumatera unlike in Java's bawon system, the post harvest operations are desegregated which made the introduction of winnower and paddy thresher possible.

Other important factors that seem to have caused the rapid growth of threshers and winnowers are the scarcity of labor and higher wages prevailing in West Sumatra, and higher profitability of the equipment in addition to of course higher entrepreneurial content of Minangkabau people as pointed out earlier.

The data of this study has brought out that the unemployment factor in the province seems very minimal since they are able to find work for 315 days in a year and the increasing availability of off-farm jobs. However, this being the most important aspect, another study in depth will perhaps be more desirable to look into this aspect specifically and more carefully.

The critical extension inputs that have enabled this extension dissemination process to reach the self-sustaining growth can be summarised as follows :

1. Creating the farmers'acceptance through the initial demonstrations in their fields and thus creating the local demand.
2. Identifying local fabricators, motivating them and providing technical assistance through the several training programmes and field testing their equipment.

3. Coordinating and communicating with all the concerned agencies & representatives through the periodical workshop meetings, and creating the suitable environment of growth.

Experiences gained from the industrial extension project in West Sumatera could prove valuable for replicating in other developing countries.

IRRI-DITPROD
MENUJU SWADAYA DAN SWASEMBADA
PROYEK PENGEMBANGAN ALAT-ALAT PERTANIAN

Appendix # 4.

GUIDELINES

FOR

A DEVELOPMENT STRATEGY OF FARM MECHANISATION IN INDONESIA

BY

V.R. Reddy

(Consultant IRRI)

P.O. BOX 18/KBYPM

Jakarta-Indonesia

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Summary of the above Suggestions :

1. Learning approach through pilot scale trials in the initial stages is likely to be more successful and cost effective than a large scale "Blue-print" approach in the introduction work of new farm equipment at the "Grass-roots"level in the new areas.

2. Choosing simpler technology of farm equipment which can be locally fabricated by small workshops are likely to spread more rapidly in the rural areas.

3. Preparation of a list of farm equipment (at different levels of technology such as manual/animal/power-driven) showing their order of priority which are to be developed/adapted within the country. (detail-note enclosed).

4. Networking the local R & D institutions and guide/coordinate their priorities and their output by the technical committee of NFMC.

5. To prepare a map of the country showing the priority areas for introducing new farm equipment (and-their priority) for taking up intensive field extension work.

6. Socio-economic surveys to be conducted, in order to determine farmers 'Constraints" and the priority needs

of farm equipment and later their impact keeping in view the walfare of small farmers and land-less labour.

7. With the given man power and financial resources available, it is important to concentrate and continue the programme until the "take off-Sustainable growth" stage is reached.

8. Effective field extension methodology that has evolved from IRRI-DITPROD industrial extension project is briefly as following :

   a). Initial farmers'demand is to be created through extensive demonstrations of the new farm equipment being introduced in farmers'fields.

   b). At least 2 or 3 potential fabricators in the selected provinces are to be identified amd assisted initially until their production and sales steadily rise.

   c). Training programme to be conducted one for the provincial Government extension staff (preferably at the centre with the participation of similar provinces) and the other to the operators/repairers/ fabricators of the farm equipment at the provincial level.

   d). Annual field days to be organised both at the centre and at the provinces and conduct group meeting/ seminars not only to exchange useful information, but also to review and evaluate the progress made so far in implementation and in making plans for the future.

e) Synchronizing the activities funded through DIP among the various Government agencies which have to work in an integrated manner is quite essential. (Gudeliness suggested in enclosure II)

f) Professionally a well-done periodical Newsletter as a media for a two-way communication can play a vital role to strengthen national networking and keep up the tempo of farm mechanisation in the country.

9. Formation of a strong technical commitee/coordinating body supported by a small permanent secretariat to advise National Farm Mechanisation - Communittee (NFMC) and to act as the "dynamo" in the development of farm mechanisation in Indonesia is the first important step to be taken.

10. The above technical committee to take the initative to prepare the detail plans for the proposed National Farm Mechanisation Development Institute which is essential in view of the increasing important role the farm mechanisation will have to play in the long term development of the country's economy.

Finally a long term plan of this nature to be successful has to be a continuous process integrated with its implementation and with a built in feed back loop for continuous renewing and amending the course as it may necessitate.

Background Information :

During the final seminar (on August 8,'83) organised by IRRI at the end of its 3 year survey on "Social Consequences of Mechanisation", the need for a national strategy for the future development of farm mechanisation has been stressed and a team has been appointed by the chairman* to prepare the guide lines for a long term strategy and to suggest an action programme for the Government's consideration.

Having gained valuable experience in the implementation of our (IRRI-DITPROD) industrial extension project during the last five years (Since May'78) in the four selected provinces (West Sumatera, West Java, South Kalimantan, South Sulawesi) we wish to put forward our views/suggestions to the above team (as input material) for their consideration in the preparation of development strategy of farm mechanisation in Indonesia.

Learning Approach and not a Blue-print Approach :

In all such centralised planning efforts, there is a tendency to make major and most of the decisions at the top by the few "Knowledgeable" people (at the centre) thus, a blue-print (top-down) approach is most often adopted. As a result, we find many plans (specially in the developing countries) are seldom successful in their implementation. Adopting a learning approach by starting on a pilot/small scale basis has taught us a great deal about the local priorities of equipment and the extension methodology that is more effective.

* Mr. Syarifuddin Baharsja Secretary General of Agriculture-Ministry Government of Indonesia.

This bottom-up approach may seem a slow process in the early stages, but is likely to spread more rapidly and will prove cost-effective, according to our experience.

Choice of Technology :

Again from our experience, to achieve a wide spread effect at the grass-roots level, the technology chosen has to be simpler and be fabricatable locally by a myriad of small workshops spread throughout the interiors of the country. This concept is finding favour with many developing countries. Government of Indonesia also seems now convinced of this approach and has started laying greater stress on local manufacturing programmes, as a national policy.

The next question is what are all the farm tools/machinery that are appropriate for Indonesian conditions. We have made an attempt to list (enclosed herewith) such farm equipment (for food crop-production) indicating their present stage of development and future priorities for different areas of the country.

Determining Priorities :

What are the priorities for taking up the research and development work (until they are ready to be released for

extension work) and which organisations in the country (like Subdirectorate PAMP or BPTP Sukamandi, BPTP Maros, IPB/ Gajah Mada/ITB, LIPI, M.I.D.C., etc.) can be assigned with this assignment and under what time-frame ?

Here we may add, from our experience, that even after bringing the tested designs and technical detail drawings from IRRI-Phillippines, a lot of modifications and changes had to be made here, in order to use locally available materials, and a completely new set of drawings were made ready for distribution to local manufacturers. In this local standardisation effort, and in making production aids we have taken the assistance of M.I.D.C. Bandung. Infact we have been able to develop a close cooperative working relationship with M.I.D.C. and Provincial Perindustrian offices in training and assisting small workshops in South Kalimantan and West Sumatera provinces.

For determining research and development priorities we feel the above mentioned appropriate farm equipment list needs to be expanded after careful deliberation, specially with the agricultural departments in provinces who are in touch with local farmers and are aware of their constraints and needs. For exemple, we find the first priority now in South Sulawesi is for land-preparation, in South kalimantan for water pumping, and in West Sumatera (after paddy threshers havebeen successfuly introduced) land preparation equipment is needed on priority.

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We, are aware that with the limitation of trained man power and financial resources, it is very important to choose the priorities correctly. We found it to be a better strategy. Use this instead of lines to concentrate in few selected priority areas and carry out the extension work in a concert manner until a "take-off Sustainable growth" stage is reached.

However, we have to be clear about the criteria and the methodology in selecting priority areas for the introduction of new farm equipment.

A few important factors/reasons that could determine the selection of priority areas are :

1. Actual food crop production compared to the potential of the area. Higher the difference, greater the priority could be.
2. Major constraints, like insufficient availability of labour resulting in high local wages, (as in outer islands compared to inner islands), resulting in large areas of cultivable land not being cultivated (as being reported from South Sulawesi and West Sumatera).
3. To increase the cropping intensity, by decreasing the turn around time between the crops as identified in Jatiluhur irrigation area of West Java, or by providing lift irrigation can increase one more crop (and also assured crop) in swampy areas of Jambi, South Kalimantan and West Kalimantan, etc.

These are only few examples cited here. For national planning, a detail exercise has to be carried out involving provincial governments to prepare a map showing priority areas and the type of farm equipment required in each contiguous area and their order of priority. To carry out this function satisfactorily, the existing secondary data alone may not be adequate. More detailed economic surveys are perhaps needed, to be carried out in certain potential areas with the help of institutions like Agro Economic Survey at Bogor involving the concerned provincial government staff.

Field Extension Methodology :

The major experience that we gained through our project (IRRI-DITPROD ; ATA 220) implementation has been in developing the field extension methodology to a successful "take-off -Sustainable growth stage", which we think West Sumatera has reached in the case of paddy threshers. In other words, the production and sales of these threshers is continuously expanding there on its own momentum without further assistance /support from the Government or outside agencies. The latest production figures in West Sumatera show that 14 small workshops are engaged in the fabrication which have produced more than 450 threshers (from '79 until August '83) and continuing to increase in geometric progression. Their quality has improved, while their selling price has decreased (from Rp.-550.000,- to Rp. 350.000,- without engine).

Infact through a few active dealers, some of the local manufacturers have started exporting their products to the neighboring provinces like Jambi, Riau, Aceh, etc. We are now intensifying our efforts in this province to introduce Hand Tractors with all its attachments not only for land preparation but also for harvesting and rural transportation(with a trailer). This model Hand Tractor with the attachments has started showing promising results in kabupaten Luwu of South Sulawesi. Similarly in South Kalimantan axial flow pumps are gaining momentum.

These cases are mentioned only to show the effectiveness of the extension methodology we have pursued. Briefly the extension methodology that has evolved from our work is as following :

1. Before we introduce any new farm equipment in a new area, it is very important to make sure that the equipment is thoroughly tested and is found suitable under local conditions. Necessary training to operate and repair the equipment is to be imparted to the local DIPERTA staff who are going to be involved in the extension work.
2. Creating the initial demand for such farm equipment is very crucial. For this purpose extensive demonstrations in farmers'fields are to be carried

out initially. We found that due to the limitation of staff and budget in DIPERTA offices, one of the effective ways to create demand is to identify a few progressive farmers/cooperatives in the area(to be popularised)and encourage them to use the equipment for a season or two in their fields and also allow them to lease the equipment to their neighbouring farmers. However, it is important to monitor and support this activity carefully by the staff of DIPERTA. From our experience in West Sumatera and South Sulawesi this creates the chain reaction of interest among the farmers.

In areas where local initiative is lacking, it may be helpful to form commercially oriented public organisations (like P.T. Tani Makmur under Bank - Pembangunan Daerah in West Sumatera) or Non Government organisations (NGO) to hire/lease out farm equipment to needy farmers and later to initiate the local manufacturing process. This may be necessary for example in transmigration areas where the Government feels the need to introduce such equipment to increase the full utilisation of the land allotted and the income of the transmigrants.

3. Simultaneously to identify a few (at least 2 or 3 to start with) potential fabricators (with the participation of Perindustrian staff) in the province

and assist them technically and financially (by providing a sample and for purchasing the materials) to fabricate the first proto-types. They need to be carefully nursed in initial stages. They should infact be encouraged to lease out the first pieces of equipment to nearby farmers for a season or two under their close supervision so that they learn about few modifications/ quality improvements they may have to carry out in their products. Also this should help them in creating their own market. We have successful examples of this approach in West Sumatera and South Kalimantan.

4. We found two kinds of training for the field extension work useful

   i). For the provincial staff engaged/connected with field extension work in departments like DIPERTA, Perindustrian, Koperasi, Banks, Local Government and also non-government organisations(NGO) which are working actively with the farmers,a training programme for about a week's duration preferably at the centre to be organised. It's main objective is to acquaint the staff with the farm equipment (to be introduced in their areas), and to discuss their feasibility studies and the extension methodology to be adopted.

   ii). The second type of training is for local fabricators at the provincial level. These are to be conducted as detail technical training

programmes lasting for 2/3 weeks, mainly to train them in the fabrication, repairing and operation of the farm equipment, preferably in collaboration with the industries department.

5. Coordination/networking functions with the various concerned agencies can best be done by organising periodically (at least once a year) a field day exhibiting/demonstrating improved farm equipment, to be followed by a group discussion /seminar to exchange useful information both at the centre and at the provincial level.

At the centre this opportunity can be very well utilised (in addition to informing high Government officials of the various ministries to show the progress made) for networking/coordinating with agencies like Subdirectorate PAMP, Directorate of small industries development, M.I.D.C., B.P.T.P., I.P.B., I.T.B., Gajah Mada, B.I., B.R.I., BULOG, Koperasi, Alsintan, etc. Agenda of such a meeting/seminar/workshop could review the progress made in the implementation work and discuss future plans, priorities and policy recommendations to be made to the National Farm Mechanisation Council (NFMC).

At the Provincial level such an annual opportunity (preferably on farmers'day, "Krida Tani") can bring the leading farmers'representatives, local manufacturers,

concerned government officials from various departments like DIPERTA, Perindustrian, Bank, Koperasi, etc., face to face and exchange very useful information like the farmers'response and priorities and their difficulties in the popularisation work of the farm equipment. This useful information can be fed back to the Secretariat of NFMC at the centre.

We found one follow up meeting after every seminar/workshop is a very useful exercise to keep up the continuity both at the centre and at the regional level.

6. We feel it is very important to synchronize all activities budgeted through DIP towards specific goals set for the year not only within the department but also between the coordinating deparments. In order to make this point clear, may we illustrate it with an example. If certain number of provinces/areas have been chosen to introduce selected farm equipment on priority basis, the activities of say Subdirectorate PAMP (such as providing materials/equipment, conducting training and guidance visits to the areas, etc.) are directed towards attaining the specific goals, at the same time the other coordinating agencies like DIPERTA, Perindustrian both at the centre and at the provinces should also have similar activities which are budgeted through their DIP. In other words at the time of DIP preparation also, close coordination is required between the departments/agencies of the Government which have to work together to synchronize their activities in the field.

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7. We are all aware of the vital role an inhouse Newsletter can play in networking with several agencies/individuals involved in this task. Recently Subdirectorate PAMP has taken the initiative in this direction, and has brought out two issues. In order to make it into a two-way communication media, we perhaps need to up grade it by taking professional advise and assign it to professionally qualified /trained personnel who can devote sufficient time for it. Circulation list in addition to several agencies mentioned above may desirably include PPLS and LKMD in the selected provinces. Well prepared technical brochures/leaflets and service manuals also play an important role in the extension process.

National Policy Making/Coordinating Body :

To prepare the background material/reports for NFMC meetings and to advise them on policy decisions to be taken by the Government of Indonesia, it is essential (as-advised by RNAM) to have a technical committee/coordinating body with a small but effective permanent secretariat (which is yet to be formed). For the integrated and rapid development of farm mechanisation in Indonesia, there is no doubt that this proposed technical committee has to play the key role of a "dynamo" specially in the early stages.

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Appendix # 5.

*COMMENTS ON MEMORANDUM OF M/S. MONICA K. SINDING DATED-FEBRUARY 27, 1984 TO A.A./ASIA & DIRECTOR USAID-JAKARTA.

Having participated fully during the visit of PPC study team lead by M/S. Monica K. Sinding and having had the opportunity earlier to react informally with the team members on the first draft of their report in Jakarta, now I wish to put the following comments in writing on their various observations, conclusions and recommendations made in this memorandum.

1, 2, & 3 ; The team has expressed the fear of labour displacement aspect (most argued and debated issue in recent years in developing countries) with the inroduction of more productive farm equipment and specially that it will spread to the densely populated islands of Java & Bali, causing undesirable social consequences.

This fear is misplaced one in relation to this project for the following reasons. First of all the technology this project is transferring(as acknowledged by the team in the report) is simpler and locally produced with lesser labour displacement content unlike the imported and more sophisticated farm equipment with higher social subsidy built in it.

Secondly, the wide spread diffusion of any technology at grass roots level is a slow and time consuming process involving lot of extension /promotion effort for several years.

Thirdly, in the absence of locally produced equipment, there is a danger of creating vacume and encourage indiscriminate importation in a short span of time as it happened in the case of small rice-milling units without leaving any scope for the local production of this equipment until today. This rapid spread of rice milling equipment (⊙ 99 % of rice milling has been mechanised wihin a decade between 1967 & 1977) was mainly due to the high cost and low quality of hand pounded rice compared to the milled rice in addition to the reasons of rising wages and hi-pressure salesmanship of the private dealers of Japanese imported equipment.

*) By V.R. Reddy, IRRI Agricultural Engineer, Jakarta ; March 24, 1984

⊙ Refer to the study of Dr. Peter Timmer on"Choice of rice-milling Technique in Indonesia"

With the continued rising labour wages even in Java (specially in West-Java, the agricultural daily wage has increased from Rp. 600,- to Rp. 1.200,- wihin last 3 years) similar demand for imported farm equipment such as hand-tractors at least in few pockets is already visible. In other words the promotion and development of indigenous small farm equipment industry is both essential and is in accordance with the policy of the Government.

Now G O I has become aware of the importance of developing indigenous capability of simpler farm equipment including hand tractors and has banned its importation since the year 1983/1984.

However, the selection and introduction of appropriate farm equipment and their priorities in different parts of the country should be an important consideration and is to be clearly spelt out after careful consideration and study in depth in the** National Strategy plan of farm mechanisation for the entire country.

4, 5 & 6 ; With regard to the proposal of Japanese support for the "National Centre for Development of Appropriate Engineering Technology" in Indonesia, the latest situation as I gather from Mr. Jafri Jamaluddin (secretary of Directorate General Food Crops Production) and Mr. Sihombing (Director of Directorate Food Crops Production) is as following : They said, it is still at a proposal stage and no further assurance has been received from the Japanese Government in this regard. Further they have mentioned if it does materialise, it will be essentially for establishing a National testing and training centre for agricultural engineering at Sukamandi in West Java. It may be also noticed from the proposal (a copy of the same is enclosed herewith) that the total assistance of U S $ 6.620.000 is earmarked for the building and equipment costs only. Strangely enough no line item budget for the expatriate consultants and for the training abroad of local counter part staff is indicated in it

*) Certain influence of this project can be claimed in this regard including stopping of 1.000 mini-tractors importation to W. Sumatera

**) Refer this projects recommendations made in " Guidelines for A Development Strategy of Farm Mechanisation in Indonesia" by V.R. Reddy

Since this project's emphasis is essentially on industrial extension and taking the appropriate small farm equipemnt technology to the field level, it could very well complement the establishment of the above national centre for testing and training as and when it comes into existance. However, in my opinion, the building & equipment for the centre in the above proposal seem very much on high side and too sophisticated and elaborate for the kind of farm equipment technology that needs to be introduced on priority in Indonesia.

It may not be out of place to mention here that due to the successful diffusion of the technology this project has introduced in W. Sumatera, it can be seen that it has generated sufficient interest in the other provinces like Aceh, North Sumatera, North Sulawesi, Central Sulawesi, N.T.B....etc. for undertaking similar field extension work intensively which is being communicated to us through DITPROD. In other words, my understanding is that G.O.I is very much interested in developing a "follow-on-project" and seeks continued and perhaps a bigger programme from IPRI/USAID.

7. From the experience gained and lessons learnt through the implementation of this project, we have outlined the strategy* for choosing the appropriate technology and the priorities for selecting the farm equipment and the areas along with the level of effort required to reach a self-sustaining stage in the selected areas of the country, which seems to have completely escaped the notice of the team while making their recommendations for the consideration of "follow-on-project".

The team's specific recommendation for building a more formal role with M.I.D.C./BIPIK (under the Ministry of Industry) for the follow-on-project is a good one.

The observation that we over-extended in undertaking three other provinces for field extension work considering the limited staff & the budget available to the project is well taken and therefore perhaps less visible results are to be seen in these extended provinces. All the same, the lessons learnt in this attempt have been quite valuable to the project and for developing its future strategy.

*) Refer to "Guidelines for A Development Strategy of Farm mechanisation in Indonesia".

8. I entirely agree with the team that the commitment of G O I in terms of bigger budget and more staff members to work with the project has to be substantially more than it has been in any future' cooperative agreement.'

9. Under the present set up, Agricultural Ministry (at the Sub-Directorate level in DITPROD) has the responsibility for the introduction and the development of farm mechanisation in the country. The need to have a formal tie up with BIPIK/M.I.D.C. for the follow-on-project is desirable as mentioned above.

10. I felt rather flattered and at the same time embarassed a little at the team's very complementary references made on my role but at the cost of my institute's ! Wihout going into details I can only say that this project has received the necessary technical and administrative assistance from IRRI Los Banos and without which it would not have been possible to show the results to the extent we are able to. Of course, there is scope for improvement and that can be identified and stressed in any future tie up.

To my knowledge there is no other institute (other than IRRI) which has developed such a range of appropriate small farm equipment technology and gathered so much experience in the transfer of its technology to the developing countries.

There is no doubt that a fresh approach is advisable for the consideration of a follow-on-project. In order to make a greater impact a more comprehensive and a bigger programme is to be formulated in consultation with the concerned G.O.I. officials.

Before the time runs out, if I may be permitted to suggest, it would perhaps be useful at this stage to start the dialogue at a senior level between the USAID mission and G O I officials to find out whether there is sufficient interest in the follow-on-project and if so to spell out the broad terms and conditions. I personally feel it would be very unfortunate to abondon this project in mid-stream and let this opportunity go away to make a fuller impact and greater contribution to the Indonesian Economic development .

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Appendix # 6.

Evaluation of IRRI-DITPROD Small Scale Agricultural Equipment Extension Project

January-February 1985
Indonesia

Evaluation Team Members

Sam H. Johnson III, Team Leader

Assistant Professor, International Agriculture
Department of Agricultural Economics
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Joseph K. Campbell

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Executive Summary

The four person evaluation team conducted a one month (January 15 - February 15, 1985) study of the Indonesian portion of the Extension of Small Scale Agricultural Equipment IRRI Project that is scheduled for completion in September, 1985. The main purpose of the evaluation was to describe and analyze IRRI's activities to assist small manufacturers of farm implements and to examine impacts on the production of agricultural machinery as well as increases in employment opportunities within the targeted areas.

Summary - The team found that the project has far exceeded its goals in W. Sumatra but while meeting its goals to work with local manufacturers, has been less successful in S. Sulawesi and S. Kalimantan. Building on the success of this project, JICA is now planning on establishing within DITPROD a multi-million dollar agricultural mechanization development center. The project has made an impact on GOI policy toward agricultural mechanization although, to date, it has been unable to persuade credit organizations to provide funds for purchasing or producing agricultural machinery.

Evaluation Methodology - As specified in the original project documents, the evaluation was organized to determine if the project had met its defined objectives. In addition, it was also made in order to provide USAID/Jakarta with information needed to decide what, if any, follow-up actions should be taken by the mission. The study team spent one week each at two of the four outreach sites and also met with key GOI officials both in Jakarta and in the outer islands. Data were collected from manufacturers, farmers and government officials but no attempt was made to apply statistical rigor either to the collection process or the analysis.

External Factors - Over the life of the project (1978-1985) tremendous changes have occurred in agriculture in Indonesia. Of most importance to this project is the wide adoption and diffusion of brown plant hopper resistant high yielding varieties (HYV's) of rice. The phenomenal production increases resulting from the use of HYV's had led the GOI to change both its policies and priorities toward agricultural mechanization. These changes have significantly helped increased importance of the project and have also made the results more valuable to the GOI. The original assumption that the outer islands with their higher wage rates are more appropriate for selective mechanization appears to continue to be valid.

Inputs and Outputs - As indicated in the following table value of the output from local manufacturers has far exceeded project expenditures. The ratio of project expenditures to sales has fallen over time indicating that the project has had a significant multiplier effect.

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Input-Output Data for IRRI Industrial Extension Project - Indonesia

Year	Power Thresher	Hand Tractor	Axial-Flow Pump	Dryer	MISC	Total	Total Values of Sales (U.S. $)	Total Project Expenditure[1] (U.S. $)	Ratio Expen Sales
1978-79	25	76	21	23	85	230	128,425		
1979-80	36	44	37	--	208	535	84,460	107,120	1.27
1980-81	237	39	1,212	36	1,326	2,850	604,100	113,118	0.19
1981-82	501	168	321	73	513	2,326	681,350	95,991	0.14
1982-83	608	119	---	0		2,330	526,100	126,750	0.24
1983-84	1,117	207	1,480	0	358	4,662	1,405,000	132,555	0.09
T O T A L	2,524	653	3,071	132	2,490	12,933			
$ Selling Price	1,640,600	718,300	921,300	105,600	43,635		3,429,435		

[1] Excluding V. R. Reddy's Salary and Logistics and Local DITPROD staff salaries.

Purpose - The original purpose of this project was to carry out field extension work to create demand for locally made IRRI type equipment and to identify local small workshops and guide them technically in manufacturing and maintaining quality of such equipment. This project was to be institutionalized by building a cadre of young engineers and technicians at the center and in selected provinces who are trained to do adaption work, design and build and test prototypes of farm machinery suitable for local conditions. In addition, the project was to help in the formulation of long range national mechanization policy and its implementation.

With the rapid expansion of rice production in Indonesia the GOI has placed higher priority on agricultural mechanization. This is indicated by statements in the Fourth Five Year Plan and by current plans to raise the Sub-Directorate for Agricultural Equipment and Machinery Development to a full Directorate under the Ministry of Agriculture. The GOI is also planning, with support from JICA, to build a $6 million Center for Development of Appropriate Agricultural Technology. Both of these actions are a direct result of the IRRI-DITPROD project and indicate that project activities will continue after September, 1985.

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Goals/Subgoals - Performance goals for the project were as follows:

--- A minimum of two fabricators in each of the target provinces were to be promoted.

--- Training programs to include about 30 trainees per year within the country and 3 per year outside of the country were to be organized and completed.

--- To assist in the preparation of background material for the formulation of national mechanization policy and programs.

To date more than 45 fabricators have been directly assisted and another 20-30 have been indirectly helped. In W. Sumatra, their production is showing an increasing trend and in value for exceeds the costs of the project. In terms of training both goals have been met with 163 trainees trained on Java and the outer islands and 15 trained at IRRI in the Philippines. Activities carried out to influence policy include participation in 13 seminars and field days, development of two slide sets, completion of a 15 minute 8 mm. movie and professional filming of a 30 minute video. In addition, Mr. V. R. Reddy has prepared a number of policy and professional papers related to the project.

Beneficiaries - Direct beneficiaries of the project include fabricators and technicians that work for them, farmers in the target areas and machinery operators. Indirect beneficiaries include parts dealers, small engine sales outlets, sheet metal suppliers and BULOG. To date, for W. Sumatra, more than 12,000 hours of technical labor were generated, farmers were able to save over $.75 million of production costs and fabricators have made profits of more than $165,000. In addition supply shops have sold $200,000 worth of materials and $225,000 worth of small engines. In the process more than .61 million person days of labor have been displaced. However, the economy in W. Sumatra appears to have increased sufficiently to absorb this labor without depressing the labor market or causing social unrest. In W. Sulawesi the project has yet to reach a point of takeoff and, therefore, there are presently no identifiable direct or indirect beneficiaries.

Unplanned Effects - The only known unplanned effects have been the rapid takeoff of mechanization in nontarget areas such as Aceh and North Aceh. This is such a strong trend that the project has had to recognize the significance and make limited adjustments. Yet, the project has not changed its target areas although if the trend in Aceh continues this is an option that needs to be explored.

Lessons Learned - The project has provided a number of important lessons. One of the most important has been to reinforce the necessity of using an entrepreneur to work with entrepreneurs. This type of individual is needed both to work with private firms and to elicit cooperation of numerous GOI agencies. Another important lesson is that Washington based regional projects are only justified if Washington continues to be actively involved and the technology to be developed can clearly benefit from the wider regional focus. In the case of this project, USAID/Washington did not continue its active involvement and the project eventually fell into a bureaucratic crack from which it continued for more than two years. The end result of this was to create an orphan that belonged to no one and, consequently, normal activities such as development of work plans, annual evaluations and project reviews were not carried out. Given its orphan status, the project was surprisingly successful but this must be attributed more to Mr. V. R. Reddy's persistence than to USAID/Washington's or IRRI's planning and management.

Other lessons learned include a reinforcement of the fact that mechanization cannot be successful without the presence of a minimal set of conditions that must exist prior to introduction, that one piece of equpment does not necessarily fit all situations, and potential labor displacement by machinery vary widely, not only by area but also by gender and age.

Special Comments - Having agreed that selective mechanization is necessary for agricultural development in Indonesia, the GOI has yet to establish priorities, either by type of machine or by area. In evaluating this project it became obvious that there is a need to establish policies and priorities for agricultural mechanization in Indonesia. USAID and IRRI have an opportunity to assist the GOI in this process and the team feels strongly that this is important. Therefore, the team has recommended that, prior to the development of any additional mechanization projects, a study be made of the micro and macro aspects of agricultural mechanization. This study should provide the basis for policy and priorities related to the further development of agricultural mechanization in Indonesia.

OUTREACH PROGRAM

Thailand

The Thai program was terminated on September 30, 1986. The program has made good progress toward establishing a national program of Industrial Liaison and the activities are continuing in the country after the termination of the project. IRRI will continue to work with the Agricultural Engineering Division of the Department of Agriculture in Thailand.

Following is a report on activities in Thailand including the result of a Socio-Economic study for the Northeast of Thailand and a report on the research of an inclined plate planter.

THAI-IRRI INDUSTRIAL EXTENSION AND SMALL FARM MECHANIZATION

Semi-Annual Report

October 1, 1984 - March 31, 1985

Prepared by

Chak Chakkaphak
DOA-AED Co-Leader

Bill Cochran
IRRI Co-Leader

Date: April 8, 1985

Semi-Annual Progress Report

The IRRI-THAI Industrial Extension and Small Farm Mechanization Project continued activities of Demonstrations, Exhibition, Training and Cooperation with various government agencies. The amount of involvement in each categery has increased significanly during the past 6 months. A brief description of these activities are as follows.

DEMONSTRATIONS:

A number of demonstrations were conducted by the project staff to farmer groups, training programs and in conjunction with national exhibitions. All rice production equipment were not demonstrated each time but selected machines were used based on the interest of the groups. An increased number of request came from extension officers and project leaders.

EXHIBITIONS:

The project participated in three major exhibitions since October 1984. The exhibits included arranging for literature distribution and demonstration of machines.

1) Northern Agricultural Mechanization Exhibition at Pitsanuloke. The exhibition included 3 days with field demonstrations of all IRRI developed machines.

2) National Agricultural Week - at Kampang Saen for 6 days with field demonstrations of plowing, transplanting and direct

seeding. Soil boxes were located at the exhibition sites to demonstrate hand seeders and weeders by interested observers.

3) Workshop on Technology and Technology Transfer for Rural Women at the Asian Institute of Technology for 3 days. There were no field demonstrations although the machines were discussed in detail during the workshop.

TRAINING:

Training continues to be a major part of the project. There is a continuous need to train AED staff, government agency staff, manufacturers and farmers. Each of these groups have received some training during the semi-annual reporting period. These training programs are summarized as follows.

1) Agricultural Engineering Division Staff: Training for the AED staff included seminars held each month beginning January 1985. The seminar programs are selected by an AED-IRRI staff committee and is normally scheduled for 2 hours duration. A list of proposed future seminar topics are as follows:

ORGANIZATION OF AED SEMINAR

1. Frequency: 1 per month
2. Time: First Monday 9.00-10.00 A.M.
3. Suggested Topics:
   a) Agricultural Efficiencies
      1. field 2. machine 3. machine capacity

b) Mechanical Drives
   1. V-Belt 2) Universal joints 3) Gears
   4) Chain & sprocket 5) Hydraulic

c) Dimensions & Dimensional Analysis

d) Development of Pi terms

e) Models and Similitude

f) Design of Transport Systems

g) Alternate Fuels

h) Research Methodology

i) Post Harvest Technology

j) Development of Experimental Machinery Prototypes

   a) Fertilizer applicators b) Improved moldboard plow

   c) Soybean thresher d) Groundnut Digger

k) Potentials for Advanced Degree Training

l) Automatic Sensing-Controls

m) Computer Applications

n) Field Testing Designs for Statistical Analysis

o) Government Policy and Marketing and its Effect on Mechanization.

p) Agricultural Extension Program in Thailand

q) Graphical Methods
   a) Curve plotting b) Histograms c) 3 dimensional plots
   d) Nomographs

r) Other: 1) Writing Project Proposals
   2) Ideas from AED Seminar Committee

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The first seminar was entitled "Introduction to Computers". An outside resource person was invited to participate in addition to the IRRI staff. The second seminar was entitled "Research Methodology" presented by a resourse person from Chulalongkorn University. The objective of these seminars are to provide the professional AED staff with appropriate topics to improve their capability.

2) Government Agency Staff: In order for the project to effectively cooperate with projects and government agencies, appropriate individuals must have some training in mechanization. Training not only assures the machines will be used properly by the agency staff but they are also capable of including some training of farmers in their programs. The following training programs were conducted for government agency staff.

Participants	Location	Duration	No. of participants
a) District Agri. Officers	Lampang	3 days	26
b) Agricultural officers	Chiangmai	3 days	50
c) Extension-Specialists	Prae	4 days	15
BAAC staff			16

SMALL FARM MACHINERY TRAINING COURSE

At

Prae Rice Research Center

February 19-21, 1985

SUMMARY OF COURSE EVALUATION

1. Thirty-one persons were attending the training course. Fifteen participants were government officers and the rest were BAAC officials. Three government officers and four BAAC officers had participated in a similar course before.

2. The participants already knew or were familiar with the following equipment before attending the course.

Equipment	No. of Government Officers	No. of BAAC Officers
1) Buffalo plow	10	13
2) PT with moldboard plow	7	12
3) PT with disk plow	5	
4) Ridger	5	
5) Jab Planter	9	
6) Inclined Plate Planter	7	
7) Star Wheel Weeder	8	
8) Sprayer	12	
9) Rice Thresher	7	
10) Soybean Thresher	5	

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3. After completion of the course, the participants obtained the most information and/or got the most understanding of the following equipment.

Equipment	No. of Government Officers	No. of BAAC Officers	Total Votes
1. PT with moldboard plow	1	3	4
2. PT with disk plow	4	5	9
3. Jab Planter	4	6	10
4. 2-row RIP	4	12	16
5. Inclined Plate Planter	10	11	21
6. PP Weeder	5	4	9
7. Star Wheel Weeder	8	7	15
8. Sprayer	7	5	12
9. Rice Thresher	3	5	8
10. Soybean Thresher	8	11	19
11. Groundnut Digger	7	10	17
12. Groundnut Stripper	8	12	20
13. Groundnut Sheller	11	11	22

(Note: The participants could select up to six machines)

4. The most promising equipment for respective areas of the participants are as follows:-

Equipment	No. of Government Officers	No.of BAAC Officers	Total Votes
1) PT with disk plow	1	6	7
2) Jab Planter	9	7	16
3) 2-row RIP	7	12	19
4) Inclined Plate Planter	6	10	16
5) PP Weeder	4	6	10
6) Star Wheel Weeder	8	4	12
7) Sprayer	2	5	7
8) Rice Thresher	5	7	12
9) Soybean Thresher	7	9	16
10) Groundnut Digger	5	5	10
11) Groundnut Stripper	7	11	18
12) Groundnut Sheller	7	9	16

Note: The participants could select up to six machines.

5. In order to promote the use of small farm machinery to farmers, the participants suggested the following approaches.

- Set up pilot plots in farmer's fields in collaboration with village leaders and BAAC officers. Close monitoring must be done. The machines to be promoted should be available for farmers to buy. However, they must be suitable for local conditions.

- Demonstration and exhibition program for farmers and training program for progressive farmers.

- AED should distribute the promising machines to related organizations more widely.

6. Twenty-three participants indicated the topics for training were suitable, while no answer was received from the rest of the participants. However, some participants would like to have more information on the following topics.

- Sprayer
- Chemicals and chemical residue
- Rice transplanter
- Weeder
- Land preparation for different types of soil
- Water pump
- Power tiller

7. Twenty-six participants indicated the handouts were suitable and useful, three participants indicated a fair amount of usefulness. However, two participants suggested more details and pictures should be included in some of the handouts.

8. The participants suggested the following changes and/or improvement in the training course.

- More time should be allocated for sprayer and more information should be included in the handouts.

- There should be more information on power tillers and attachments

- There should be more information on the use and maintenance of the equipment

- There should be more demonstration plots so the participants can see the results of the use of different equipment.

9. Twelve participants indicated the laboratory practice was suitable, another ten participants also agreed but suggested more time and for the laboratories.

10. Fifteen participants indicated the duration of training was suitable. But twelve indicated the training was too short compared with the course contents. A more suitable duration should be 4-5 days.

11. General comments from the participants are as follows:-

- There should be posters of each machine during the display. Sources of availability should also be indicated.

- Drawings of simple equipment should be distributed to farmers during demonstrations so some interested farmers could build the equipment themselve.

- Problems, cause, and remedy for each machine should be emphasized.

- Movies and/or video should be shown in the training course (if possible)

- More equipment should be distributed to BAAC
- There should be more training for BAAC officers, especially for each province or region.
- Achievement of participants should be evaluated.
- All lecturers were friendly.

3) Manufacturers: A course to train manufacturers in machinery production technology was held in cooperation with the Industrial Services Division in Bangkok. IRRI cooperating manufacturers were selected to attend the 12 day training program. The ISD provided classroom and laboratory facilities which were very effective for the course objectives. All lectures and handout materials were in the Thai language.

CURRICULUM

for

MANUFACTURERS TRAINING PROGRAMME

12-23 November, 1984

Monday, 12 November

0900	Welcome Address
1000	General Introduction to Metal Working Industry
1330-1630	Farm Machinery Industry

Tuesday, 13 November

0900-1200	
1330-1630	Principle of Engineering Drawing

Wednesday, 14 November

0900-1200	
1330-1630	Engineering Drawing

Thursday, 15 November

0900-1200	Heat Treatment of Steel (Demonstrate & Practice)

Friday, 16 November

0900-1200	
1330-1630	Foundry Technology (Demonstration using Aluminium)

Monday, 19 November

0900-1200	
1330-1630	Welding Technology - Oxyacteleane: Electric -: Demons- TIT : tration

Tuesday, 20 November

0900-1200	Jigs & Fixtures for Welding
1330-1630	

Wednesday, 21 November

0900-1200	
1330-1630	Plant Layout and Material Handling

Thursday, 22 November

0900-1200	Safety
1330-1630	Factory visit (The Siam Kubota Diesel Co., Ltd.)

Friday, 23 November

0900-1200	Practice on Plant Layout & Material Handling
1330-1630	Discussion & Conclusion (AED director)

MANUFACTURERS TRAINING COURSE

SUMMARY OF EVALUATION

Evaluation of the training course was done in four parts; participants, curriculum, lecturers, and general. The results are summarized below:

Part I: Participants

Twelve out of eighteen participants had never participated in any training course before. The course was moderately useful to ten participants and highly useful for the rest. All of the participants agreed the arrangements provided were good.

Part II: Curriculum

1) Most important topics
   - -Heat treatment (5)
   - -Drawing (5)
   - -All topics (2)
   - -Welding (2)
   - -Jigs and Fixtures (2)
   - -Foundry (2)

2) Least important topics
   - -None

3) Most interesting topics
   - -All topics (5)
   - -Heat treatment (2)
   - -Drawing (2)
   - -Jigs and Fixtures (2)

4) Least interesting topics
   -None

5) Topics that should be expanded
   -Heat treatment (6)
   -Foundry (4)
   -Drawing (2)
   -Welding (2)

6) Topics that should be included in the next training
   -Die and cast
   -Forging
   -Machining
   -Cost analysis
   -Safety
   -Extension and marketing

7) Topic that should be deleted.
   -None

8) Suggestions/comments
   -There should be more time for factory visits
   -There should be more practice time for the participants
   -High technology which is not applicable to the manufacturer such as TIG and MIG welding should not be emphasized.

Part III: Lecturers

All participants indicated the number of lecturers, lecture notes, and content covered during the lecture were suitable. However, eleven participants suggested there should be more practice and utilization of laboratory equipment.

Part IV: General

The training duration of 2 weeks was desirable for most participants (14). Three participants suggested one week training because of their lack of free time. Only one participant would like to have 4 weeks training. The number of

participants for the training course should be 15-20 (10 choices). The training environment at ISD was perfect (all participants).

4) Farmer Training: The farmer training programs were not as formal as those for manufacturers and agency staff. The training normally consisted of one day lectures and laboratory excercises on selected machines. Each program was organized by a cooperating agency or a manufacturer. A summary of the major programs presented to farmers are as follows.

Cooperator	Date	No. of participants	Location
1) Prae Rice Research Center	Sept. 19	48	Prae
2) Prae Rice Research Center	Sept. 27	52	Prae
3) Jakpeth Tractor Co.	Jan. 7	550	Muang
4) Jakpeth Tractor Co.	Jan. 8	400	Lamsak
5) Jakpeth Tractor Co.	Jan. 9	200	Lamkoo
6) Jakpeth Tractor Co.	Jan. 10	350	Chandam
7) Appropriate Technology Association	Jan. 27	52	Chiangmai

The project staff assisted Jakpeth Tractor Co. in extending the inclined plate planter to farmers. An individual from the tractor company was assigned to assist in the lectures and demonstrations so he could be trained and could continue with

their program without the project involvement. This company is manufacturing the inclined plate planter and is working with the Bank of Agriculture an Agricultural Cooperatives to properly introduce the machine to farmers.

PUBLICATIONS:

The following publications were written and presented during the period of October 1 through March 31.

1. "Implementation of Mechanization to Small Rice Farms in Thailand" by Dr. B.J. Cochran, paper presented at the Industrial Extension Workshop, Peoples Republic of China. October 9-24, 1984.

2. "Small Farm Mechanization in Thailand Present and Future" by Dr. B.J. Cochran and Mr. Chak Chakkaphak, paper presented at the Farm Machinery and Rural Industry in SE Asia and the Pacific Conference, Pattaya, Thailand. November 26-28, 1984.

3. "THAI-IRRI Industrial Extension Program for Small Farm Mechanization" Industrial Extension Conference, Agri. Engr. Dept., IRRI, Los Banos, Philippines, Oct. 10-13, 1984.

4. "Implementation of Mechanization to Small Rice Farms in Thailand" by B.J. Cochran, Paper presented at American Society of Agri. Engr., New Orleans, La., Dec. 11-14 1984.

5. "Methodology for Technology Extension of Small Farm Mechanization", by B.J. Cochran, paper presented to workshop on Identification of Appropriate Technologies and Methods of Technology Transfer for rural Women", Asian Institute of Technology, Bangkok, Thailand, Feb. 25 - Mar. 8, 1985.

6. "Annual Report-IRRI-THAI Industrial Extension Program for Small Farm Mechanization" by B.J. Cochran and Chak Chakkaphak.

STATUS OF MACHINE ACCEPTABILITY:

An important part of the extension program has been to survey the farming areas, introduce appropriate machines for the farming conditions and extend machines indicated to have potential acceptability by farmers. As of now there are five machines not previously accepted by farmers which are now commercially available.

1) Inclined Plate Planter - This machine is having the greatest success in that there are three quality manufacturers selling to farmers. The BAAC has accepted this machine as a product they will purchase for farmers. The three manufacturers have produced in excess of 300 units during the past 6 months and they estimate more than 1000 units will be sold during 1985.

The Inclined Plate Planter was designed by the IRRI Agricultural Engineering Department and was introduced through the project loan program to national projects. The planter is capable of planting rice, soybeans, mungbeans, sorghum, corn or peanuts plus can be used to apply fertilizer to upland crops. An operators manual has been developed by the project in both English and Thai languages. The retail value now ranges from 2,900 Baht ($110.00) to 5,000 Baht ($185.00) depending on the manufacturers. The price should reach a more constant level as free marketing competition continues.

2) Rolling Injection Planter - The Agricultural Engineering Division and a Small Farm Machinery FAO project has modified and developed a 2-row Rolling Injection Planter. It has been used in the projects exhibitions, demonstrations, and training programs. More than 2000 rai (300 ha) has been planted by farmers in the rainfed areas of the north. A manufacturer can now produce the machine and sells to farmers for approximately 2,200 Baht.($82.-)

3) Cyclone Seeder - Previous work has been done by the project in extending the cyclone seeder but during the past year it has become a machine being accepted by small farmers. A manufacturer has been trained to produce the seeder commercially for 500 Baht ($20.00). Approximately 100 units have been distributed among farmers, projects and government agencies. The seeder is capable of broadcast seeding rice in paddy and upland, plus any free flowing granular material, including fertilizer. The versatility of the machine increases the acceptability potential.

4) Push-Pull Weeder: The push-pull weeder may be reffered to by several names but it is a tool that originated in Europe. It was introduced into Thailand by an FAO Farm Machinery project and is being accepted as a light, inexpensive tool to reduce the drudgery of weeding upland crops. The weeder is most effective when weeds are 10 cm high or less in light soils.

Observations comparing the push-pull weeder with the standard hoe indicates the standard hoe is out of the soil and producing no effective work 85 percent of the time. The push-pull weeder is in the soil producing effective work 85 percent of the time. A manufacturer produces this machine and sells for 80 Baht ($3.00). More than 200 units have been produced during the past 6 months.

5) Improved Buffalo Plow: The Thai-IRRI project improved the design of the conventional buffalo plow more than 2 years ago. Test results showed the improved plow to be more efficient with a higher field capacity compared to the conventional plow. The plow has not been widely accepted but farmers who use it agree it is an improvement but more expensive. The project worked with the manufacturer to develop a mold so the plow could be cast which reduced the purchase price. Farmers in the northeast are most interested and approximately 100 new models have be produced by a manufacturer in Khon Kaen.

VI. MECHANIZATION-ECONOMIC STUDY

A special study was implemented to determine the mechanization and economic status of the farmers in the northeast.

Three hundred and thirty three farmer households from 17 villages in 5 provinces were sampled. A questionnaire for each village leader was used to provide village level statistics. The

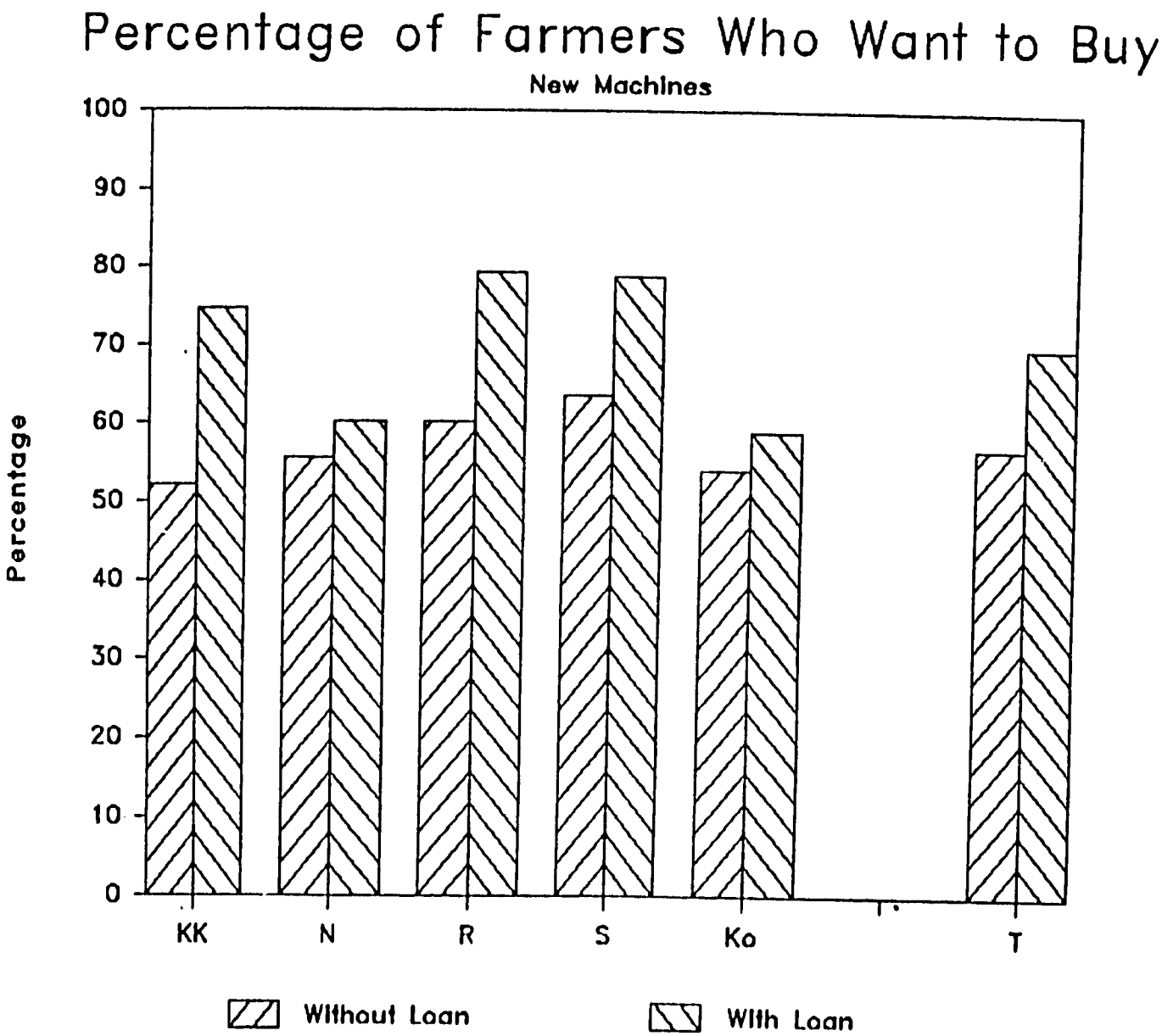
survey also included a questionnaire for 18 manufacturers to determine the size, type and amount of equipment produced. It was conducted by a staff of one study leader and 6 enumerators. All data has been collected, edited and entered on PC computer diskettes. A complete set of data will be given to the IRRI Agricultural Engineering Department and shared with the Department of Economics as a source for more detailed Socio-Economic Analysis.

Results of the study presented as Figure 1, shows more than 50 percent of the farmers in all provinces want to invest in mechanization. Most of the farmers indicated they would need loans to purchase equipment.

Tables 1 and 2 summarizes the reasons farmers gave for wanting to buy machines or not buying machines respectively. The farmers who wants to buy machines listed the constraints presented in Table 3. Table 4 presents the farmers attitudes toward mechanization.

These preliminary results indicate mechanization would be accepted by farmers in the northeast. Additional analysis of the survey results should indicate the level of mechanization that would be most acceptable.

A full report of the Mechanization Economic study will be made and published as a separate publication.


Percentage of Farmers Who Want to Buy
New Machines
Percentage
100
90
80
70
60
50
40
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20
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Without Loan
With Loan

Figure 1

TABLE 1. Main Reasons of Farmers (by percentage) for Buying New Machines.

Reasons	PROVINCE					
	Khon Kaen	Nakorn-panom	Roi Et	Srisaket	Korat	Overall
Plant on time	14.0	26.3	42.6	28.8	2.0	23.0
Do better job	8.0	21.1	9.3	19.2	8.2	12.8
Easier	22.0	18.4	9.3	19.2	16.3	16.9
Save time	20.0	5.3	7.4	7.7	6.1	9.5
Increase income	8.0	10.5	14.8	-	24.5	11.5
Versatile	10.0	7.9	7.4	3.8	34.7	12.8

TABLE 2. Reasons Farmers Not Buying New Machines.

Reasons	Khon Kaen	Nakorn-panom	Rot-Et	Srisaket	Korat	Overall
Too expensive	50.0	57.1	85.2	66.7	39.5	57.7
Less use	-	10.7	-	4.2	-	2.7
High cost for fuel & oil	12.5	7.1	-	8.3	5.3	6.7
Not suitable for areas	3.1	10.1	-	16.7	7.9	7.4
Small land	18.8	7.1	11.1	4.2	7.9	10.1
Hard to operate	-	-	-	-	7.9	2.0
Many reasons	12.5	3.6	-	-	31.6	11.4

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TABLE 3. Constraints of Farmers Who Want to Buy Machinery

Reasons	Khon Kaen	Nakorn-panom	Roi-Et	Srisaket	Korat	Overall
No money	77.8	87.3	77.9	78.8	71.1	77.8
No operator	23.9	33.3	20.6	21.2	13.3	21.9
Land limitation	20.9	49.2	30.9	34.8	14.5	29.1
Hard to operate	13.4	47.6	32.4	31.8	34.9	32.0
Expensive	80.6	71.4	73.5	74.2	73.5	74.6
Hard to repair	67.2	76.2	73.5	81.8	77.1	75.2

TABLE 4. Attitude Toward Mechanization of Farmers Who Want to Buy Machinery With Loans Provided.

Reason	Khon Kaen	Nakorn-panom	Roi-Et	Srisaket	Korat	Overall
Save time	94.0	81.0	83.8	89.4	79.5	85.3
Plant on time	88.1	76.2	75.0	89.4	66.3	78.4
Easier activity	80.6	61.9	73.5	81.8	68.7	73.2
Increase yield	64.2	68.3	70.6	80.3	63.9	69.2
Increase income	73.1	77.8	69.1	75.8	68.7	72.6
Do better job	80.6	74.6	69.1	77.3	73.5	74.9

FUTURE PLANS:

Six months remain before the project terminates. During this time the following activities will be initiated and/or completed.

a) A manufacturers training course will be held in Khon Kaen in the northeast during July. The training will be conducted in cooperation with Khon Kaen University Industrial Engineering Department, Industrial Services Institute (Khon Kaen) and Industrial Services Division (Bangkok)

b) The Agricultural Engineering Division seminar will be continued and will include topics selected from the proposed attached list.

c) A Farmer Training Course will be conducted in cooperation with the Northeast Region Agricultural Office Irrigation Project.

d) During the 1985 rainfed rice crop planting season, demonstrations will be made to farmers in cooperation with provincial extension officials. The Cyclone Seeder will be emphasized along with the RIP and inclined plate planters.

e) Follow up with the Prae training course to assist with activities the extension officers and BAAC staff initiated in the northern provinces.

f) Terminate the project and produce the final project report.

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A SOCIO - ECONOMIC MECHANIZATION STUDY IN NORTHEAST OF THAILAND

IRRI - USAID
PROJECT NO. 498-0265

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SOCIO-ECONOMIC MECHANIZATION STUDY IN NORTHEAST OF THAILAND

SUMMARY REPORT
BY

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SEPTEMBER 1985

This study was conducted under the IRRI-THAI SMALL FARM MECHANIZATION INDUSTRIAL EXTENSION PROJECT FUNDED BY USIAD PROJECT NO.498-0265

Report prepared
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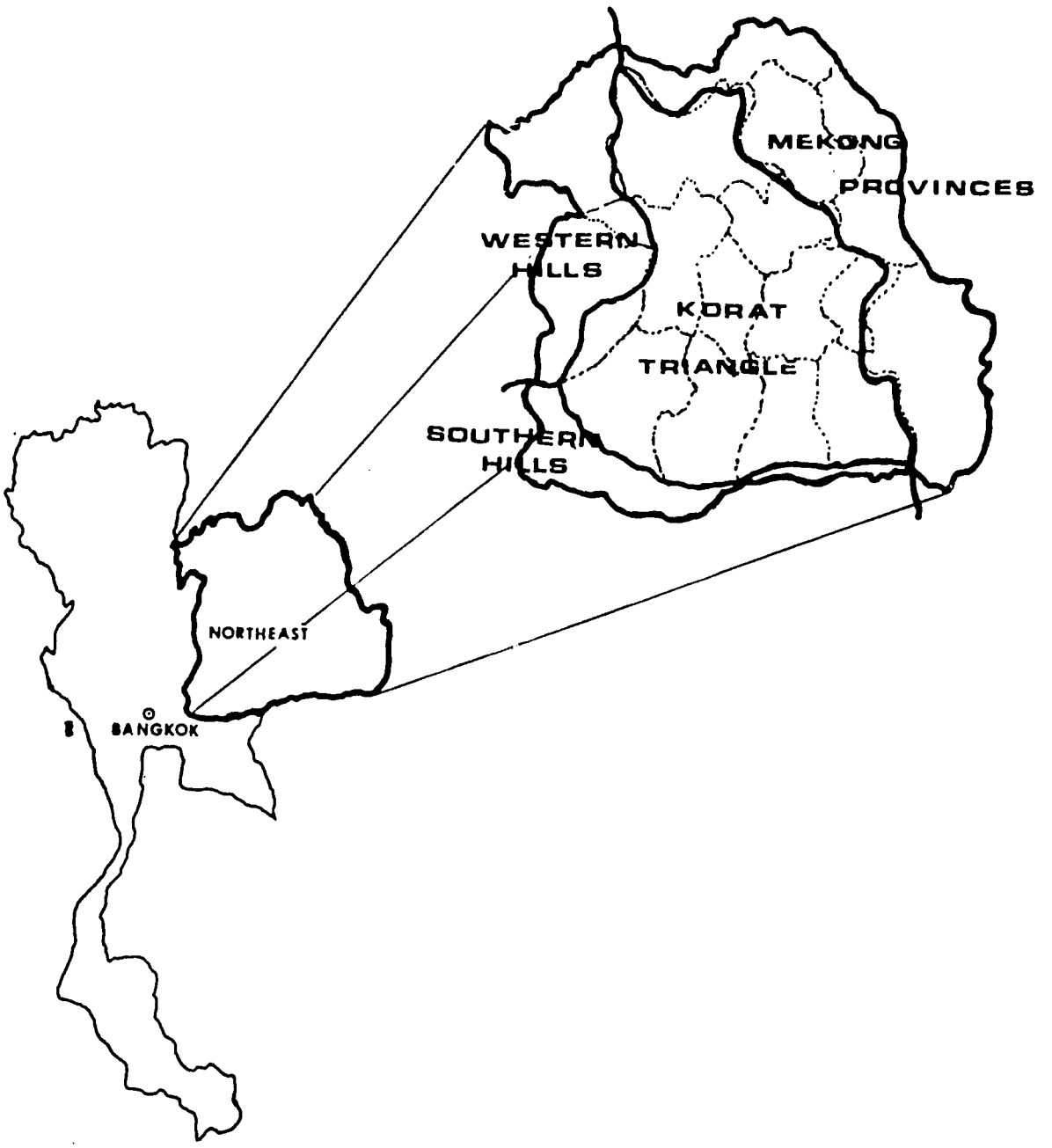
MAP 1 MAP OF THAILAND
MAP 2 MAP OF THE NORTHEAST REGION

APPENDIX A

MAP.1 MAP OF THAILAND



MAP.2 NORTHEAST REGION

A SOCIO-ECONOMIC MECHANIZATION STUDY IN THE NORTHEAST REGION OF THAILAND

BACKGROUND

INTRODUCTION

The adoption of farm mechanization in Thailand is evidenced by an increase in farm machines, mostly tractors, water pumps and threshers. This is most evident in the Central Region where extensive use of farm machinery has resulted in high cropping intensity. However, the same is not true of the Northeast region.

A distribution of farm holdings and and cropping intensities for Thailand is presented in tablel.l. Despite having the highest percentage of paddy land, the Northeast Region has the lowest cropping intensity, a low level of mechanization and the lowest income. Comparatively, the Central region has a much lower percentage of paddy land but conversely, the highest level of mechanization, cropping intensity and income.Differences in the geographic location, biological, social environment and level of education have been cited as possible areas of study. A socio-economic study should help determine constraints to the adoption of Farm Machinery in the Northeast Region.

TABLE 1.1 : DISTRIBUTION OF FARM HOLDING LAND
AVERAGE CROPPING INTENSITY, INCOME AND
HORSE POWER PER HECTARE

REGION	% OF FARM HOUSEHOLD	% OF PADDY LAND	CROPPING INTENS. %	AVE. INCOME BAT/HH	HP/HA
NORTHEAST	40.1	48.45	94-98	499.4	0.038
NORTH	26.2	21.7	110-114	832.6	0.100
CENTRAL	19.8	23.7	99-128	869.7	0.194
SOUTH	13.8	6.6	98-110	605.2	0.029

CONSEQUENCE OF SMALL RICE FARM MECHANIZATION PROJECT
SOURCE : AGRICULTURAL STATISTICS CROP YEAR 1979/1980

PROJECT DESCRIPTION

The proposal for the study was jointly approved by the Engineering Division of the Royal Thai Government and by the Thai-IRRI Small Farm Mechanization and Industrial Extension Project. Funds were provided by the Thai-IRRI project. Work on the project began during June 1984 and ended March 1985. The actual collection of survey data occurred during the period September through November, 1984. Separate surveys were conducted for farm households and for manufacturing firms, The analysis and only results of the household survey will be presented in this report.

SAMPLING DESIGN

The study used a modified multistage stratified sampling design. In the first stage, provinces were selected using the following criteria; (a) respresentativeness of the region's dominant cropping systems, (b) accessibility, and (c) possibilities for comparative analysis. Preliminary data was taken from an agroecosystem analysis done by the KKU-Ford Cropping System Project. Provinces selected for the study included Khon-Kaen, Roi-Et, Nakornpanom, Srisaket and Nakornratchasrima (Korat).

The second stage involved selection of villages. Villages selected were based on information gathered from village headman interviews. Eighteen villages presented in tablel.2 were selected to be sample sites. Four in Khon-Kaen

province, five in Korat province, three each in Nakorpanom, Roi-Et and Srisaket province.

TABLE 1.2 : VILLAGES IN PROJECT'S SURVEY

Province	District	Sub-district	Village name	Vill No.	HH.in Village	H.H.in sample	Enumerator
Khon Kaen	Banphai	Koksamran	Koksamran	1	192	14	7
			Koksamran	11	91	14	
	Nampong	Sa-ad	Kambong	8	113	17	7
			Kambong	9	187	17	
Korat	Pakchong	Nongsarai	Submong	4	83	20	6
		Jantuk	Tamanao	11	325	20	
	Srique	Kudnoi	Banmai	11	139	19	6
		Nongyakaw	Subchumpon	6	116	7	
			Subchumpon	11	148	16	
Nakorn-panom	Nawa	Nawa	Nakoy	5	111	21	7
			Nagua	8	103	21	
			Tarua	1	123	21	
Roi-Et	Muang	Nangkaew	Nongkawa	12	140	28	7
			Nongtone	13	65	13	
			Laononthan	18	105	20	
Sri-saket	Uthum-pornpisai	Tae	Tae	1	134	33	7
		Taket	Banduc	1	63	16	
			Kasamsuk	7	53	14	
						331	7

The third stage involved the selection of households. Census lists and other information obtained from each village headman formed the basis for stratifying the households by machine use, water supply and existence of farm lands. Households were randomly selected from each strata based on a fixed sample size assigned to each village and a fixed proportion computed for each strata. Three groups of villagers were separated by existance of farm land. The first group was the farmers who had less than 10 rai of farm land. The second group was the farmers greater than or equal to 10 rai and less than 30 rai. The farmers who had farm land greater than 30 rai or equal to 30 rai was included in the last group.

A total of 331 households were selected. Sixty-two in Khon Kaen, eighty-two in Korat, sixty-three in Nakorpanom, sixty-one in Roi-Et and sixty-three in Srisaket.

QUESTIONNAIRE DESIGN

A total of sixteen questionaires were designed and used to measure patterns of production,resource use, labor and machinery use and inventory change. These forms are described in detail as appendix A.

DATA PROCESSING

Data for the project was processed partly using Statpac and Lotus 1-2-3 software with an IBM-PC and partly, with SAS (Statistical Analysis System) on an IBM 4361 mainframe computer. Analysis of the data assumed a simple random sample and thus, independence of the observation units. Data comparisons were made among provinces and by type and level of mechanization.

OBJECTIVES

The study's main objective was to assess the potential role of new or improved engineering techniques in alleviating resource constraints, improving resource use efficiencies and reducing small farm input costs. The goal was to increase production, incomes and enhance gainful employment opportunities for the rural population of Northeast Thailand.

SCOPE OF THE STUDY

Since rice is the major crop in Thailand, the emphasis of this study was on rice farms. Only households with at least one plot planted with rice were selected survey samples.

SAMPLE CLASSIFICATION

Farms were classified based on the degree machinery was used in land preparation. Non-mechanized farms used only animals, usually buffaloes, in land preparation. The other extreme was the classfication of mechanized farms, which used 2-wheel small, 4-wheel or large 4-wheel tractors for land preparation. Farms using a combination of animals and machines were classified as partially mechanized.

DEFINITION OF TERMS

1. Dependency Ratio : The ratio of family labor members to the number of children and old persons who did not work.
2. Cropping intensity : The percentage of the ratio of annual planted area to the farmer's planted area.
3. Farm operations

   Focus is placed on the following operations basic to rice production:

   a. Land preparation, used for seedbed preparation and tranplanting
   b. Planting
   c. Care and cultivation, during seedling development and after planting.
   d. Harvesting, included cutting the stock and carrying the crops to the threshing area.
   e. Post-production: includes threshing, winnowing, bagging and transportation to crop storage.

4. Productivity : An index measuring the average return to a particular input. Land productivity was mesured in term of yield(kg) per hectare. Labor productivity was yield per human labor use. It can used as and indicator of agriculural growth and is associated with land productivity and/or land area per labor unit through the following relationship;

$$Y/L = (Y/A)(A/L)$$

Y/L = LABOR PRODUCTIVITY

Y/A = LAND PRODUCTIVITY

A/L = LAND AREA PER WORKER

SURVEY OF LITERATURE

FACTORS AFFECTING FARM MACHINERY ADOPTION AND DIFFUSION: A PREVIOUS STUDY

A study made by Jongsuwat (1980) indicated that regions where labor cost is high tend to be more mechanized. Further, regions with higher incomes were more able to afford tractor plowing. Regional variations in water pump utilization resulting from variations in farm income and labor costs were not found to be important. This case study for the central region also indicated that farmers in this area enjoy the advantages of abundant irrigation water, very fertile soil and higher returns on investments in farm machinery. Four-wheel tractors were also found to be more suitable for upland crop cultivation while two-wheel tractors were utilized primarily in rice production due to time constraints in double cropping the areas.

Montrevit S. (1983) concluded that mechanical power is used mainly in the Central Region compared to other regions largely because irrigation facilities available in the region support the double cropping system. Further, farm incomes are higher thus, farmers can afford the high cost of farm machines. She also indicated that mechanical power inputs are good substitutes for animal and human labor. The increase in the relative price of animal to mechanical power input leads to a higher proportion of mechanical to animal

power input used. Similarly, the increase in the relative price of human labor to mechanical power input leads to a change in the same proportion of mechanical power input to human labor used. Fertilizer and pesticides were introduced to compliment animal and mechanical power in increasing the output level and also to substitute for human labor in crop caring.

Sukharoma (1983) also reported that machines are often introduced in conjunction with fertilizer and irrigation, all of which contributed to an increase in the productivity of land and labor. A modern technology package, which includes mechanization, has made double cropping of rice possible on well-irrigated farms which in turn increases productivity. In contrast, in areas where double cropping is not possible, farm mechanization is seldom practiced.

PHYSICAL CONSTRAINTS TO CROP PRODUCTION IN NORTHEAST THAILAND: A REVIEW

The Northeast region has 49.6% of its area planted to rice by contributed only 34% to the country's total rice production in 1981-82. Only 80% of the regional rice area is planted while 20% remains idle.

Typology, soil and water resource are the major physical constraints. Rice production in this region is almost entirely rainfed. Rice grown in this area has a greater risk of inadequate water supply for land preparation and crop growth.

The most extensive soil type in the Northeast is sandy loam that frequently becomes waterlogged in the rainy season and dries out to considerable depth in the dry season. The soil fertility is moderate to low and rainfed rice is the main crop on this soil. The undulating plains and river terraces provide drained area for diversified cropping of kenaf and cassava during the rainy season. Generally, the soil is highly responsive to fertilizer application, but high risks are involved where the soil's waterholding capacity is low and rainfall is unreliable.

In some years, if heavy rains come in rapid succession, floods quickly develop and all crops, including rice are damaged. If the rains are irregular, more than 5-6 days apart, the sandy soil surface is quickly dried by evaporation and drought damage follows. Thus the two major hazards to crop production in the Northeast are flood and

drought, often within a single field in the same year. This has convinced Northeast farmers that the best strategy is to wait until the next year when the rains may be sufficient to grow rice.

The average regional rice yield is only 1187.5 kg/ha, a result of the poor soil and variability of the rainfall. Glutinous rice is the predominant subsistence rice grown in the better fields. Typical glutinous varieties include both local and government recommended varieties (i.e., sanpatong, improve varieties). Non-glutinous rice is mostly the homali variety and improved varieties are widely grown.

In addition to rice, other crops grown in the region are cassava, kenaf, corn, sugar cane, mungbean, watermelon and tobacco. These crops give farmers additional cash income. Crops grown by province differ depending on the soil and the environment.

RESULTS AND DISCUSSIONS

FARM PROFILE

Except for Korat province, most of the households sampled in each province were rice farms as shown in table 1.3. Within this sub-sample, 89% were non-mechanized while 6.5% were mechanized and 4% were partially mechanized.

TABLE 1.3 : DISTRIBUTION OF SAMPLE

PROVINCE	FARM TYPE A	M	M-A	TOTAL OF RICE-FARM	NON-RICE FARM	TOTAL SAMPLE
KHONKAEN	48	6	5	59	3	62
NAKORNPANOM	62	0	1	63	-	63
ROI-ET	59	0	2	61	-	61
SRISAKET	63	0	0	63	-	63
KORAT	17	12	3	32	50	82
TOTAL	249	18	11	278	53	331
%	89.6	6.5	4.0	100.0		
% OF SAMPLE				84.0	16.0	100.0

Korat, had the highest level of mechanization among the five provinces sampled while Khon Kaen was the second highest. In Nakornpanom and Roi-et provinces, some few farms were using a combination of animal and machine labor on their farms. Srisaket was virtually, non-mechanized.

The average age of the farmers sampled as presented in table 1.4 were 46, 49 and 55 for non-mechanized, mechanized and partially mechanized farms respectively. Overall eighty percent of the farmers had obtained an education level of four year (Table 1.5). Ninety percent of the partially mechanized farmers 87.8% and 77.6% of non-mechanized and mechanized farmers respectively had an education level of four year.

The average household size for the region was 5.9 persons and the average number of permanent laborers per household was 3.8 (Table 1.4). These numbers do not vary much among the different levels of mechanization. Non-mechanized farms show the highest dependency ratio of 2.0% while mechanized farms had the lowest ratio of 1.2%. Ninety-nine percent of the farmers were permanent residents of the area.All the farmers mechanized farms sampled from were permanent residents For non-mechanized and partially-mechanized farms, 0.7% were non-residents or temporarily took residence in the area.

TABLE 1.4 : CHARACTERISTIC OF HOUSEHOLD SAMPLES

AVERAGE	FARM TYPE A	FARM TYPE M	FARM TYPE M-A	OVERALL
TOTAL SAMPLES	249	18	11	278
FAMILY SIZE	6.0	6.1	5.7	5.9
LABORER PER FARM	3.9	3.3	3.5	3.8
DEPENDENCY RATIO	2.0	1.2	1.6	1.9
AGE OF HH HEAD	49	46	55	49
EXPERIENCE OF HH HEAD	38	34	43	36
RESIDENTAL STATUS :				
RESIDENT	98.0	100	98.4	99.1
TEMPORARY LEAVE	1.7	-	1.6	0.7
NON-RESIDENT	0.3	-	-	0.2

DEPENDENCY RATIO = HOUSEHOLD LABORER/CHILDREN AND OLD PERSON
FAMILY SIZE = AVERAGE OF FAMILY MEMBERS

TABLE 1.5 : AVERAGE EDUCATION OF HOUSEHOLD HEAD BY PERCENTAGE DISTRIBUTION BY FARM TYPE

LEVEL	FARM TYPE A	FARM TYPE M	FARM TYPE M-A	OVERALL
NONE	4.1	-	-	
< GRADE4	3.2	5.6	-	
GRADE4	87.8	77.6	90.9	87.3
> GRADE4	4.8	6.8	9.1	5.1

sets of the farmers from the 5 provinces sampled were from various sources. The main source of assets was tural land, productive animals and draft animals. e non-mechanized farms, household applicances was major source of assets and was almost at the same s agricultural land. Mechanized farms, however, put a value on farm machinery. Non-mechanized farms showed west average value of assets with only 74,602 baht usehold. While partially mechanized farms had the average value of assets at 380,783 baht per ld. Assets of 351,293 baht per household for zed farms was slightly lower than the partially zed farms at 351,293 baht per household. (Table 1.6)

TABLE 1.6 : VALUE OF ASSETS
AVERAGE PER HOUSEHOLD
DISTRIBUTION BY FARM TYPE

(BAHT PER HOUSEHOLD)

ITEM	FARM TYPE			TOTAL
	A	M	M-A	
DRAFT ANIMAL	12608	5111	7727	11929
PRODUCTIVE ANIMAL	11179	29390	89414	15454
FARM BUILDING	5040	10256	3318	5310
HAND TOOLS	1482	1502	790	1456
AGRICULTURAL LAND	20217	258861	257295	45050
VEHICLE	4131	5885	3879	4234
HOUSEHOLD CONVENIENCE	15060	6603	5396	14153
FARM MACHINERY	4885	33686	12364	7046
TOTAL	74602	351293	380783	104632
PERCENTAGE				
DRAFT ANIMAL	16.9	1.5	2.0	11.4
PRODUCTIVE ANIMAL	15.0	8.4	23.5	14.8
FARM BUILDING	6.8	2.9	0.9	5.1
HAND TOOLS	2.0	0.4	0.2	1.4
AGRICULTURAL LAND	27.1	73.7	67.6	43.1
VEHICLE	5.5	1.7	1.0	4.0
HOUSEHOLD CONVENIENCE	20.2	1.9	1.6	13.5
FARM MACHINERY	6.5	9.6	3.2	6.7
TOTAL	100.0	100.0	100.0	100.0

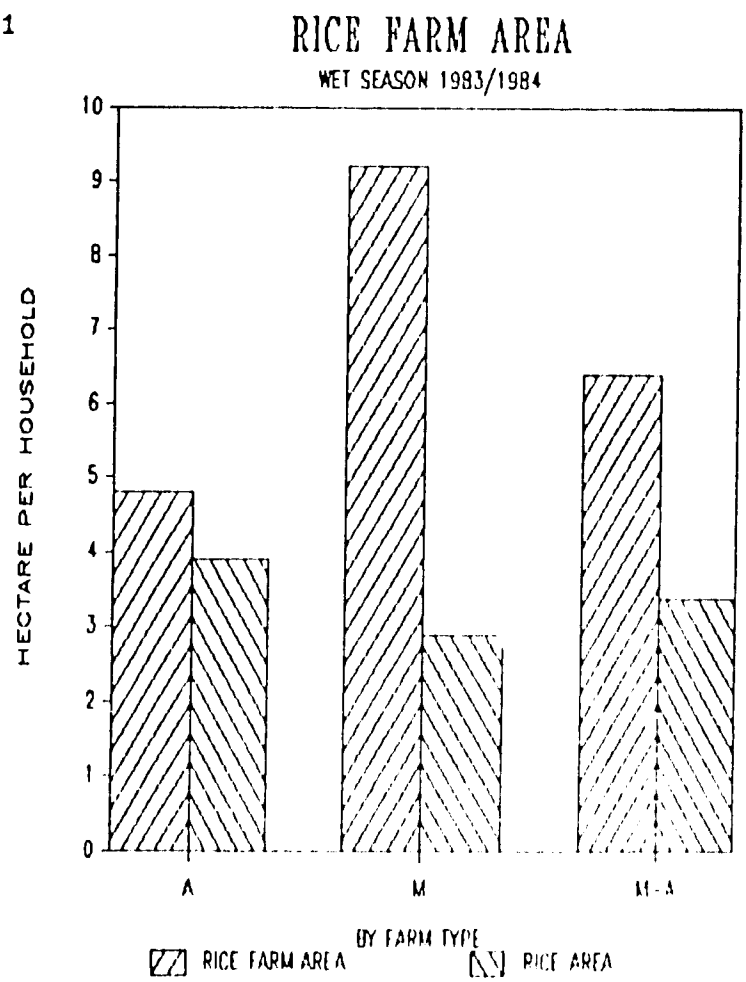
The total farm area of all households included in the survey was 1385.4 hectares. The average size of farm holding was different for each farm type (Table 1.7). Mechanized farms had the highest average farm holding of 9.2 hectare per household. However, the mechanized farms averaged 2.9 hectare which was why they had the lowest farm area, among the farm types. The non-mechanized farm holdings had the lowest average farm area of 4.8 hectare, but had the highest average of 3.9 hectare per household planted to rice, Approximately 81% of the total average farm holding was non-mechanized. Partially mechanized farms had average farm holdings of 6.4 hectare per household. About half of this area or 3.4 hectare per household was planted to rice. (Table 1.7 & figure 1)

TABLE 1.7 : FARM HOLDING AND AREA CULTIVATED DISTRIBUTION BY FARM TYPE

AVERAGE PER hh & ha	FARM TYPE			
	A	M	M-A	TOTAL
FARM AREA (ha/hh)	4.8	9.2	6.4	5.2
RICE FARM AREA(ha/hh)	3.9	2.9	3.4	3.8
%OF RICE FARM AREA PER HH	80.0	31.7	52.5	73.1
RICE HARVESTED PER HH	3.9	2.9	3.4	3.8

HH= HOUSEHOLD
HA= HECTARE
KG= KILOGRAM

FIGURE.1



LAND TENURE AND OTHER CHARACTERISTICS

Eighty-seven percent of the farmers owned their land. Only 4.5% were rent-in farms. Korat had the highest percentage of 16.9% rent-in farms. Most of the farms in Korat province included in the study were owned by the military thus farmers had to pay and average of 10 baht per rai every year as rent for these lands (Table 2.1).

Ninety-two percent of all the farms relied on rain as their main source of water. Only 4% of the farms were located near canals and about 2.1% had irrigation. (Table 2.2)

The distribution of three dominant types of soil in the the Northeast Region including sandy, sandy loam, and clay are presented in table 2.3. Non-mechanized farms had 46.2% sandy loam and 36.2% sandy soil. Mechanized farms had 35.4% sandy, 25.7% sandy loam and 25.6% clay soil. Partially mechanized farms had 79.3% sandy loam and 18.2% clay soil.

Other characteristics of the land such as color, topology and restriction factors are shown in Tables 2.3 to 2.5. Twenty-nine percent of the farm types in the region had black soil, while 26% had brown soil and 21% was red. This was most evident in the provinces of Khon Kaen and Korat and on the mechanized and partially mechanized farms. The typology of farms within the area was mostly flat (61.5%), 26.2% had some sloping and 11.3% were rated steep. Generally, the soil was tasteless. In Khon-Kaen and Korat

provinces, the land was considered fertile. In the other provinces,a larger percentage of the land available for planting was considered unfertile. For partially mechanized farms, there are almost equal amounts of fertile and unfertile soil. (Table 2.6)

Much of the land owned was acquired mainly through inheritance 72.6% while a 16.9% was bought and 9.9% rented free of charge. Factors enumerated and discussed above may help determine the actual physical constraints to rice production. Land in the region may be more suitable for other crops which when combined with a higher level of mechanization may result in increased productivity.

TABLE 2.1 : LAND OWNERSHIP DISTRIBUTION BY FARM TYPE BY PERCENTAGE

	F-TYPE			OVER ALL
	A	M	M-A	
OWNER	87.1	85.4	90.9	87.1
RENT-IN	5.1	2.1	4.5	4.8
RENT-OUT	1.1	6.3	-	1.5
RENT-IN FREE	6.4	2.1	4.5	5.9
RENT-OUT FREE	0.4	4.2	-	0.7

TABLE 2.2 : SOURCE OF WATER DISTRIBUTION BY FARM (PERCENTAGE)

	F-TYPE			OVER ALL
	A	M	M-A	
RAINFALL	92.8	89.6	86.4	92.3
ARTESIAN WELL	-	4.2	-	0.4
CANEL	4.2	2.1	9.1	4.2
SUB-IRRIGATION	1.5	2.1	4.5	1.7
MAIN-IRRIGATION	0.4	-	-	0.4
OTHER	1.1	2.1	-	1.1

TABLE 2.3 : TEXTURE OF SOIL DISTRIBUTION BY FARM TYPE BY PERCENTAGE

	F-TYPE			OVERALL ALL
	A	M	M-A	
SANDY	36.2	35.4	4.5	34.9
SAND LOAM	46.2	25.0	77.3	45.6
CLAY	9.5	25.0	18.2	11.3
SALINE	-	4.2	-	0.4
LOAM	2.3	-	-	2.0
CLAY-SANDY	2.5	2.1	-	2.4
OTHER	3.2	8.3	-	3.5

TABLE 2.4 : COLOR OF SOIL DISTRIBUTION BY FARM TYPE (PERCENTAGE)

	F-TYPE			OVER ALL
	A	M	M-A	
RED	20.3	27.1	22.7	21.0
BROWN	25.6	25.0	36.4	26.0
BLACK	27.3	43.8	40.9	29.3
GREY	14.0	4.2	-	12.5
WHITE	0.2	-	-	0.2
RED-BLACK	10.8	-	-	9.4
OTHER	1.7	-	-	1.5

TABLE 2.5 : TYPOLOGY
DISTRIBUTION BY FARM TYPE
(PERCENTAGE)

	F-TYPE			OVER ALL
	A	M	M-A	
FLAT	49.6	70.8	50	61.5
SLOP	25.6	27.1	36.4	26.2
STEEP	12.3	2.1	9.1	11.3
VERY STEEP	0.6	-	4.5	0.7
TERRACED	0.2	-	-	0.2
FLAT-SLOPE	0.6	-	-	9.6

TABLE 2.6 : RESTRICTION FACTOR
DISTRIBUTION BY FARM
(PERCENTAGE)

	F-TYPE			OVER ALL
	A	M	M-A	
FERTILE	16.9	33.3	18.2	18.5
SALINE	6.4	4.2	27.3	7.0
TASTELESS	44.3	26.0	27.3	41.9
UNFERTILE	25.4	12.6	18.2	24.0
DROUGH	4.9	10.4	9.1	5.5
OTHER	2.1	14.6	-	3.1

TABLE 2.7 : LAND AQUIRED
DISTRIBUTION BY FARM TYPE
(PERCENTAGE)

	F-TYPE			OVER ALL
	A	M	M-A	
INHERIT	74.6	63.0	52.4	72.6
RENT-FREE	10.3	4.3	14.3	9.9
BUY	14.5	32.6	33.3	16.9
OTHER	0.7	-	-	0.9

CROPPING INTENSITY

The average cropping intensity within the study area was 92.3% since farms in the area were mostly rainfed and had no water supply during the dry season (Table 2.8). Partially mechanized farms had the highest average croppping intensity of 117.1%. Non-mechanized farms had an average of 95.3% while mechanized farms had the lowest average cropping intensity of 92.5%.

The highest cropping intensity of partially mechanized farms could be due to the smaller average holding area and the higher irrigated area which was 13.6% of the total area planted in this farm type. The farmers with partially mechanized farms could plough some of their land with animals and some with machines.

Crops other than rice were grown in the region and provide additional sources of income (Table 2.9 - 2.10). Upland crops grown in mechanized and partially mechanized farms were mostly cassava, corn and kenaf. These crops were also grown in non-mechanized farms but more land was devoted to growing watermelons and horticultural crops. This case was particularly true in Srisaket province. Tobacco, was more intensively grown in Roi-Et province. Only one factory in Roi-et gave credits for seed and fertilizer and in return purchase the tobacco from the farmers.

TABLE 2.8 : CROPPING INTENSITY
WET SEASON 1983/198

(HECTARE)

AREA (HECTARE)	FARM TYPE			TOTAL
	A	M	M-A	
TOTAL AREA	1206.0	166.4	70.3	1442.7
RICE AREA	964.7	52.8	36.9	1054.4
NON-RICE AREA	184.5	101.2	45.4	331.1
TOTAL PLANTED AREA	1149.2	154.0	82.3	1385.5
CROPPING INTENSITY	95.3	92.5	117.1	96.0

**CROPPING INTENSITY = PLANTED AREA/TOTAL AREA*100

TABLE 2.9 : TYPE OF CROP PLANTED
BY PERCENTAGE

ITEM	FARM TYPE			TOTAL
	A	M	M-A	
RICE	67.2	37	48.3	60.5
UPLAND CROP	12	57.5	37.9	16.2
OTHER	20.8	5.5	13.8	23.3

TABLE 2.10 : TYPE OF CROP PLANTED
BY FARM TYPE AND PROVINCE

CROP	PROVINCE					FARM TYPE			TOTAL
(NO.)	KK	NP	RO	SR	KO	A	M	M-A	
RICE	77	121	119	132	33	448	20	14	482
CORN	-	-	-	-	18	7	9	2	18
CASSAVA	25	-	-	-	24	31	14	4	49
KENAF	34	-	14	-	1	40	5	4	49
COTTON	-	-	-	-	1	-	1	-	1
MUNGBEAN	-	1	-	1	4	3	2	1	6
SWEET CORN	-	-	-	1	-	1	-	-	1
SESAME	-	1	3	-	-	4	-	-	4
POTATO	-	-	-	2	-	2	-	-	2
WATER MELON	3	9	20	46	-	76	-	2	78
CUCUMBER	5	5	-	-	1	10	1	-	11
VEGETABLE	-	3	-	45	-	48	-	-	48
FRUIT	2	2	-	-	-	4	-	-	4
SUGARCANE	10	-	-	-	-	7	2	1	10
TOBACCO	-	1	31	-	-	31	-	1	32
MULBERY	-	-	1	-	-	1	-	-	1
OTHER	-	-	-	-	1	1	-	-	1
TOTAL	156	143	188	227	83	714	54	29	797

FIGURE.2.1

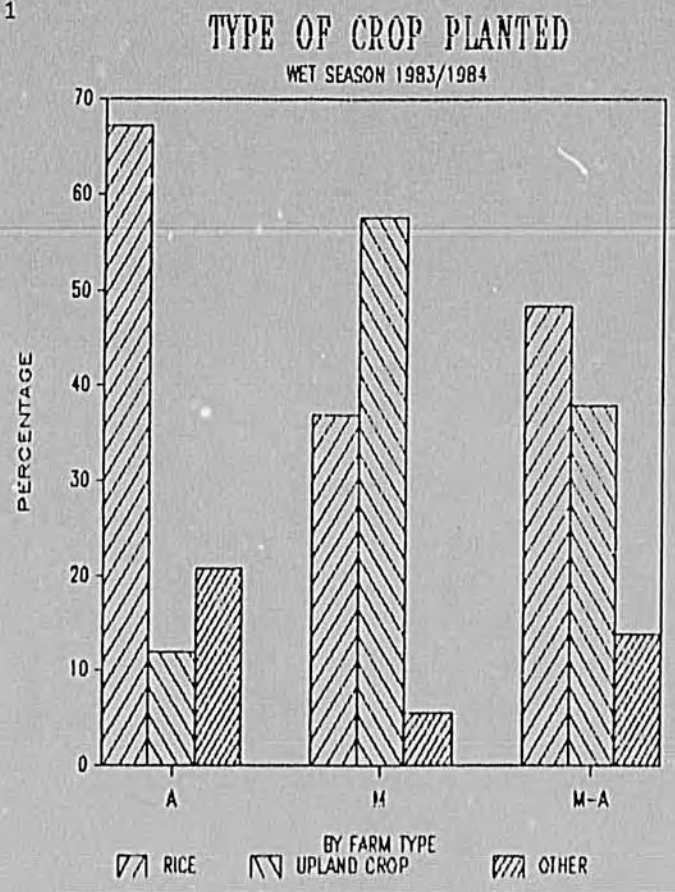
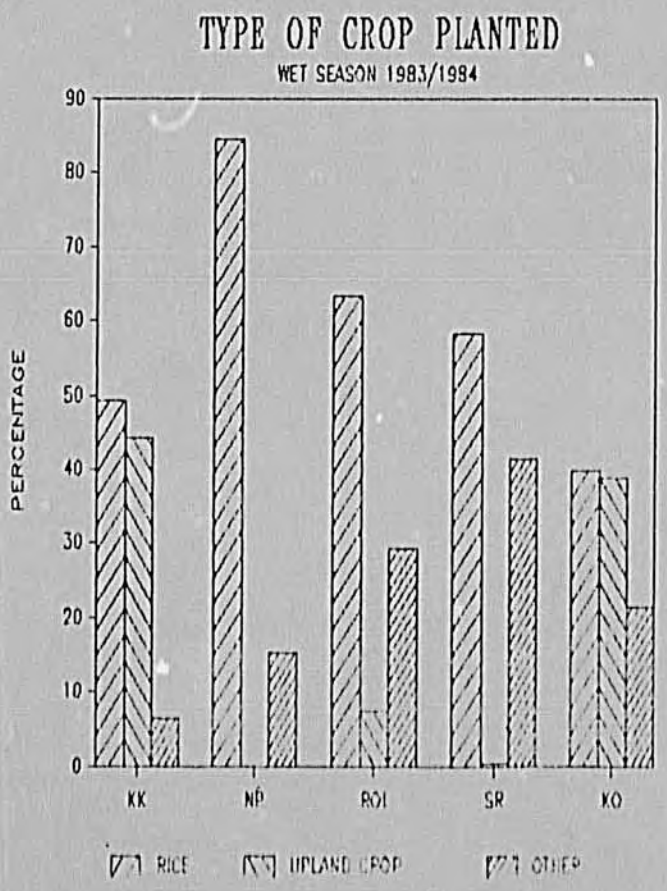


FIGURE.2.2



RESOURCE INPUTS

1. HUMAN LABOR

Table 3.1 presents various frequency distributions of labor input according to farm type. The average total labor requirement for the production of rice in the region was 535.5 man-hour/ha. More labor was required and used on animal and non-mechanized farms (541.5 man-hour per hectare, compared to 459.1 man-hour per hectare for mechanized or partially mechanized farms. Partially mechanized farms had a lower labor input requirement compared to mechanized farms.

Of the total labor requirement, 79.3% was due to family labor, 6.7% to exchange labor and 14% to hired labor. The proportion of hired labor used was greater than exchange labor which was in contrast to traditional societies where exchange labor is more widely available and used than hired labor.

TABLE 3.1 : LABOR INPUT
DISTRIBUTION BY FARM TYPE
(Hours)

AVERAGE PER hh & ha	FARM TYPE			
	A	M	M-A	TOTAL
ALL TYPE OF LABOR	541.5	459.1	431.4	533.5
FAMILY LABOR	422.9	202.4	221.93	423.1
EXCHANGE LABOR	36.9	4.2	52.2	35.8
HIRED LABOR	61.8	252.4	157.3	74.7
LAND PREPARATION	82.3	36.0	37.5	78.4
PLANTING	180.3	201.1	155.4	180.5
CARE & CULTIVATION	5.2	5.7	4.2	5.21
HARVESTING	215.18	162.6	191.9	211.7
POST PRODUCTION	58.6	53.7	42.4	57.8
LP: FAMILY LABOR	76.5	12.9	31.7	71.7
EXCHANGE LABOR	5.7	0	2.1	5.3
HIRED LABOR	0.11	23.1	3.7	1.4
PL: FAMILY LABOR	143.2	97.3	68.9	138.3
EXCHANGE LABOR	8.0	0	14.7	7.8
HIRED LABOR	29.1	103.8	71.9	34.4
CA: FAMILY LABOR	5.08	3.0	4.0	4.9
EXCHANGE LABOR	0.1	2.7	0	0.26
HIRED LABOR	0.02	0	0.3	0.03
HA: FAMILY LABOR	178.8	67.1	101.1	170.5
EXCHANGE LABOR	10.2	0.8	23.7	10.2
HIRED LABOR	26.3	94.7	67.1	31.1
PO: FAMILY LABOR	39.4	22.1	16.3	37.7
EXCHANGE LABOR	12.9	0.7	11.8	12.2
HIRED LABOR	6.3	30.9	14.4	7.8

FIGURE. 3

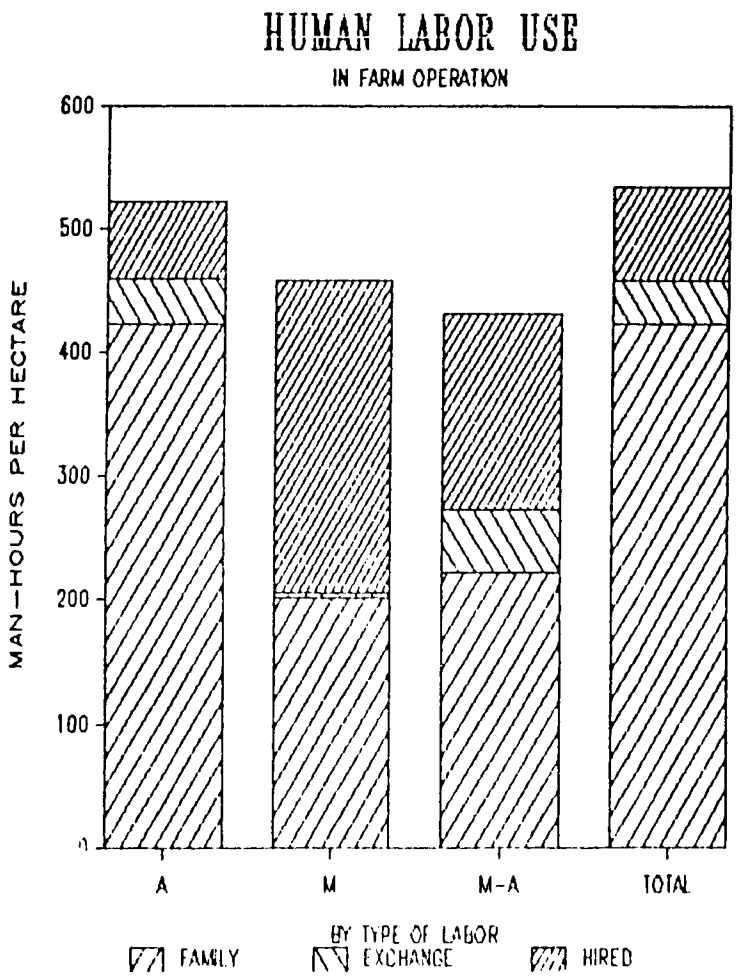

HUMAN LABOR USE
IN FARM OPERATION
MAN—HOURS PER HECTARE
600
500
400
300
200
100
0
A
M
M-A
TOTAL
BY TYPE OF LABOR
FAMILY
EXCHANGE
HIRED

FIGURE. 4

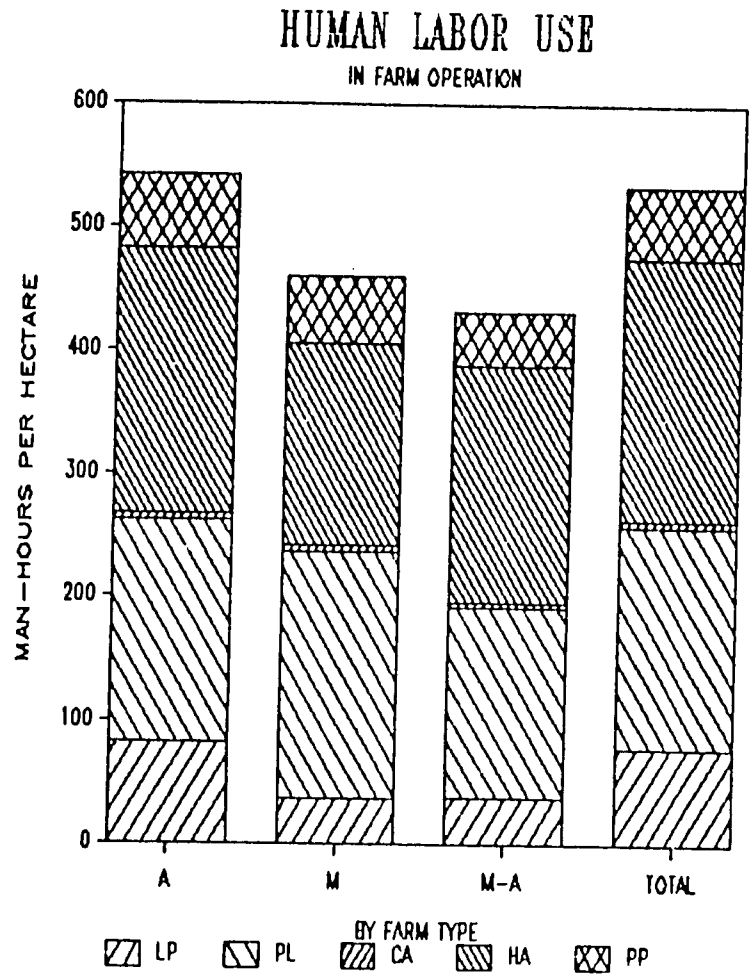
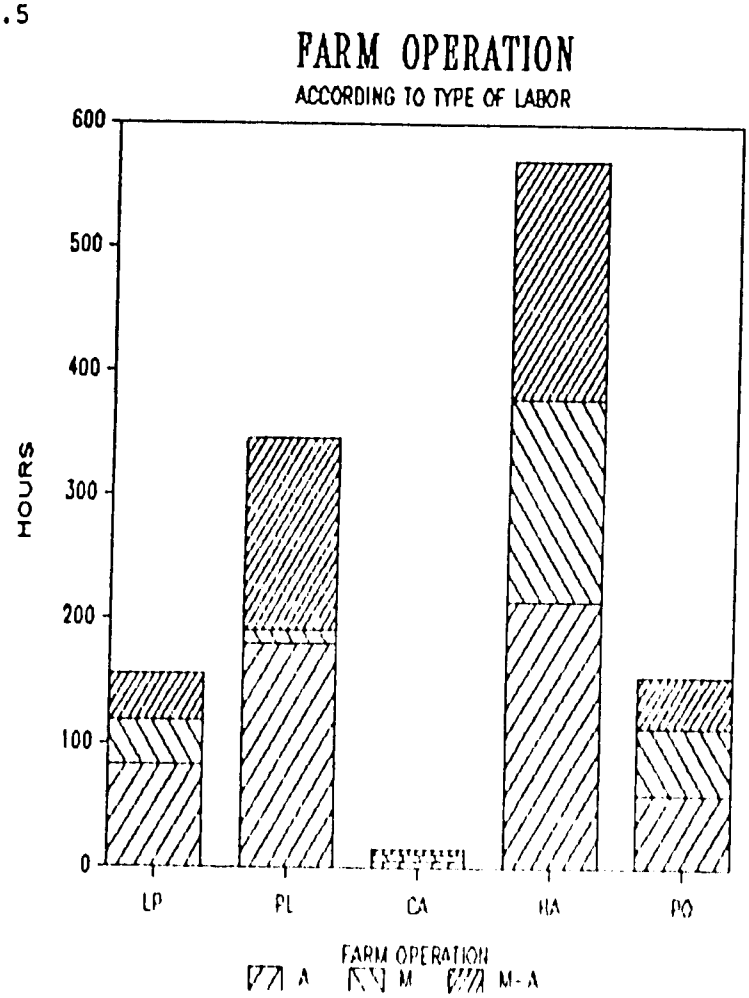


FIGURE.5



The most of the labor used, in non-mechanized farms was family labor. Family labor dominated all aspects of rice production. Only a minimal amount of labor was hired to help in labor-intensive activities such as planting, harvesting and post-harvest activities. The inverse of this pattern was observed in mechanized farms. Labor used in mechanized farms was mostly hired although family labor took an active role in crop production. The hired labor was employed mostly during planting and harvesting. Mechanized farms hired labor for land preparation. Land preparation is an activity which is normally the domain of the farmer/owner of non-mechanized farms. Partially mechanized farms emerged on the same pattern as non-mechanized farms although larger quantities of hired and exchange labor was used. Among the three farms types, partially mechanized farms use the largest proportion of exchange labor. These results support an earlier observation where more mechanized farms had lower dependency ratios and depended on labor sources outside the farm for some farm operations.

Among the basic farm activities, demand for human labor was greatest during the planting and harvesting periods, Therefore, there was a need to hire-in additional labor during these periods. The main source of water for farms in the region was rainfall, which was relatively variable. Faced with such a constraint, farmers needed to finish planting as soon as possible when the rains came. The farmers trade-off the cost of hiring additional labor with the cost of poor yields due to lack of rainfall.

Another factor considered was the wage rate. Wage rate was estimated by adding up the amount paid for labor and its corresponding value over all households and dividing by the total labor hours. However, wages paid in kind, e.g. food, cavans of rice, were not included since figures available were the aggregate for an entire group of workers. The average wage rate was 32 bahts per day which was comparatively low with respect to the official standard minimum wage of 50 bahts per day in the Northeast region (Table 3.2). The official standard minimum wage rate was not included in the agricultural sector. The wage rate did vary much among types and levels of mechanization. However, there were differences among provinces. Non-mechanized farms in Khon Kaen and Nakornpanom province had the lowest average wage rate of 25 baht per day while wage rates for the same farm type in Srisaket and Korat province were 35 baht per day. This supports the observed pattern of labor use by province where smaller amounts of labor are hired-in in Narkornpanom and Khon Kaen while much larger quantities are used in Srisaket and Korat.

TABLE 3.2 : WAGE RATE
KIND OF PAYMENT = CASH
WET SEASON 1983/1984

BAHT/DAY

PROVINCE	FARM TYPE			
	A	M	M-A	TOTAL
KHONKAEN	25.5	34.3	31.8	29.9
NAKHONPANOM	25.2	-	-	25.2
ROI-ET	31.0	-	34.3	31.5
SRISAKET	34.9	-	-	34.9
KORAT	35.1	33.9	35.1	34.6
TOTAL	31.6	34.2	33.7	32.2

** 8 HOURS PER DAY

2. ANIMAL POWER

Draft animals used by farmers in Thailand are mostly buffaloes. These animals can work in flooded field so the farmers wait for the rain to plough the land.

3. HAND TOOLS

Hand tools commonly used in crop production were shovels, spades and hoes for land preparation, sprayers for crop caring, sickle for harvesting and threshing sticks for threshing.

4. FARM MACHINES

Farm machines used on the selected farms were water pumps, 2-wheel tractors, small 4-wheel tractors, large 4-wheel tractors, threshers, rice mills and farm trucks.

Water pumps were the most widely used machines among the selected farms. The farms that were irrigated partially or partially irrigated used 0.83 water pumps per household while the rainfed farms used only 0.36 water pumps per household. (Table 3.3-3.4)

2 wheel tractors which are machines suitable for rice farm conditions were used very little. The survey showed 16 two-wheel tractors owned among the farm sampled within region. Nine farmers rented two-wheel tractors from the other farmers. One farmer used one engine to operate his two-wheel tractor and water pump.

Small and large 4-wheel tractors were rented. No farmers sampled owned four wheel tractors. Twenty-three farmers rented four-wheel tractors for land preparation. The hired rate for a tractor for land preparation ranged from 80 to 150 baht per rai. The most common price was 100 baht.

The axial flow thresher, widely used for rice in the central region, was used by only one farmer in the selected area on a rental basis. Mechanical threshing is not used in the Northeast because of low wage rates and availibility of exchange labor.

Transportation seemed to be quite important since the utlization of small farm trucks was relatively high. Eight farmers owned one farm truck and forty-eight farmers used farm trucks by renting or borrowing.

TABLE 3.3 : MACHINE USE

TYPE OF MACHINE	A					I	M				I	M-A		
	1	2	3	4	TT	I	1	2	3	TT	I	1	2	TT
WATER PUMP	29	6	6	1	42	I	-	-	-	-	I	-	-	-
THRESHER	-	-	-	-	-	I	-	-	-	-	I	-	-	-
2WT	3	1	-	-	4	I	4	3	-	7	I	-	-	-
4WT	-	3	-	-	3	I	-		-		I	-	2	2
LARGE MACHINE	-	8	-	-	8	I	-	5	-	5	I	-	5	5
THAI TRUCK	5	37	1	1	44	I	1	2	-	3	I	3	6	9
THRESHER	-	-	-	-		I	-		-		I		1	1
MILLER	7	-	-	-	7	I	1	-	-	1	I	1	-	1

1= OWNER
2= RENT
3= BORROW
4= PARTNERSHIP
TT=TOTAL
** NUMBER OF MACHINE

TABLE 3.4 : MACHINE USE

	RAINFED AREA			IRRIGATED AREA		
	A	M	M-A	A	M	M-A
OTAL HOUSEHOLD	222	13	8	27	5	[illegible]
H WITH MACHINE	65	13	8	22	5	2
YPE OF MACHINE	(number of machine)					
WATER PUMP	27 26 OWNER 1BORROW	4 OWNER	-	15 13OWNER 1RENT	4 OWNER	2 OWNER
2WT	2 1RENT 1OWNER	9 5OWNER 4RENT	5 3OWNER 2RENT	2 OWNER	4 3OWNER 1RENT	2 1OWNER 1RENT
4WT	3 RENT	-	2 RENT	-	-	-
LARGE MACHINE	6 RENT	3 RENT	4 RENT	2 RENT	-	1 RENT
THRESHER	-	1 RENT	-	-	-	-
MILLER	7 OWNER	-	1 OWNER	-	-	-

5. CHEMICAL FERTILIZER

Fertilizer use on the farms average 78.2 kg/ha (Table 3.5). Differences existed among farms by farm type and by province. Mechanized farms exhibited the lowest average rate of fertilizer use at 26.8 kg/ha. Partially mechanized farms had an average of 67.6 kg/ha and Non-mechanized farms use the most fertilizer with average of 81.4 kg/ha.

Among the provinces, Srisaket non-mechanized, ranked as the highest user of fertilizer with an average of 208.1 kg/ha while Roi-Et ranked second with an average of 64.7 kg/ha. Fertilizer was used the least in Nakornpanom province, which used an average of 35.7 kg/ha. The application of fertilizer in the region is normally done during seedbed preparation and after planting.

TABLE 3.5 : NUMBERS OF FERTILIZER BY FARM TYPE AND PROVINCE

Kg/Ha

PROVINCE	FARM TYPE			TOTAL	PLANTED AREA	AVE. PER Ha
	A	M	M-A			
KK	4307	200	1407	5914	146.9	40.3
NP	12724	-	100	12824	360.8	35.5
RO	16166	-	725	16891	261.2	64.7
SR	43403			43403	208.5	208.2
KO	1965	1214	264	3443	77	14.7
TOTAL	78565	1414	2496	82475	1054.4	78.2
PL.AREA	964.7	52.8	36.9	1054.4		
AV.PER Ha	81.4	26.8	67.6	78.2		

FIGURE.6

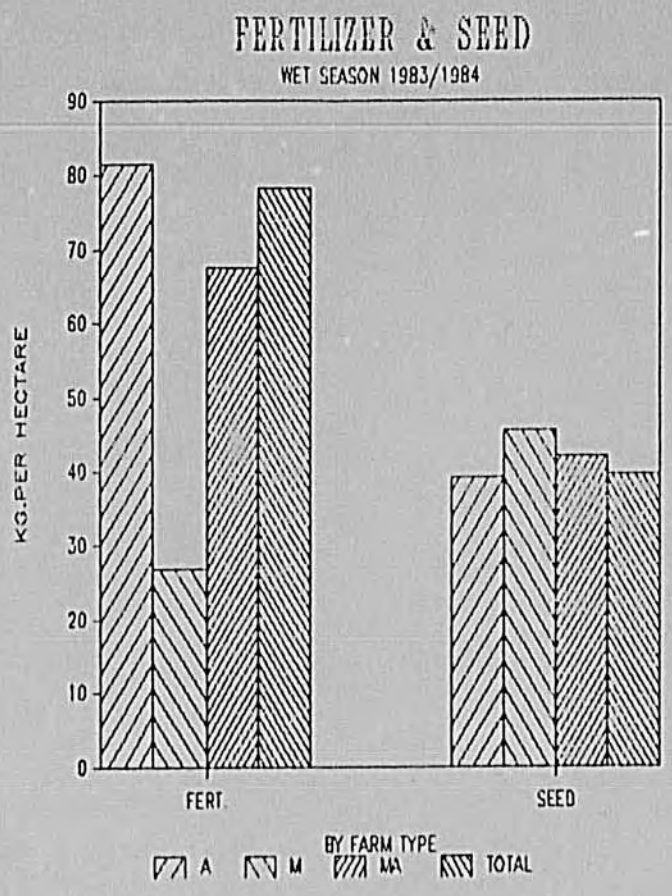
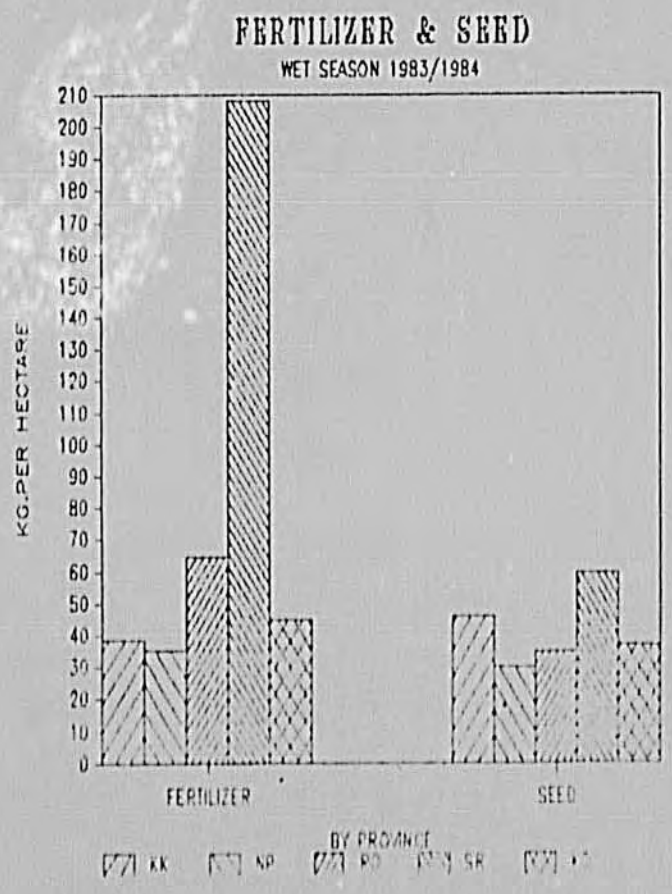


FIGURE.7



6. SEED AND VARIETIES

Rice seed are normally collected and saved from the previous harvest season. On the average, 39.7 kg/ha were collected among all farms. Table 3.6 shows Srisaket province as having the highest average amount of seed collected, 59.6 kg/ha, while Nakornpanom had the lowest amount, 30 kg/ha. The same pattern as was be observed regarding fertilizer use.

Rice varieties are classified as high yielding improved varieties or local varieties. High yielding varieties normally require higher levels of inputs than local varieties. HYV are further classified as being glutinous or non-glutinous. The type of rice produced by a household is a function of the household's needs which are basically either for consumption or for selling. Tables 3.7 and 3.8 show that high yielding varieties are more widely used than local varieties. Survey results show non-glutinous rice was produced comparative to glutinous rice particularly in areas such as Srisaket and Korat.

TABLE 3.6 : NUMBERS OF SEED (Kg)
BY FARM TYPE AND PROVINCE

Kg/Ha

PROVINCE	FARM TYPE A	FARM TYPE M	FARM TYPE M-A	TOTAL	PLANTED AREA	AVE. PER Ha
KK	4403	1695	589	6687	146.9	45.5
NP	10709	-	100	10809	360.8	30.0
RO	8719	-	390	9109	261.2	34.9
SR	12426	-	-	12426	208.5	59.6
KO	1665	700	475	2840	77	36.9
TOTAL	37922	2395	1554	41871	1054.4	39.7
PL.AREA	964.7	52.8	36.9	1054.4		
AV.PER Ha	39.3	45.4	42.1	39.7		

TABLE 3.7 : RICE VARIETIES
(PERCENTAGE)

VARIETY	FARM TYPE A	FARM TYPE M	FARM TYPE M-A	OVER ALL
RD7	-	5.0	-	0.2
RD8	0.7	-	-	0.8
RD11	1.6	-	-	1.5
RD16	25.7	20.0	20.0	25.3
RD25	21.0	10.0	20.0	20.5
KAMPAI	6.4	10.0	26.7	7.2
KAWDOKJAN	0.9	5.0	-	1.0
SANPATONG	10.4	-	6.7	9.9
HOMALI	29.4	20.0	13.3	28.5
KASET	1.8	30.0	-	2.9
MIXED	0.2	-	-	0.2

TABLE 3.8 : RICE VARIETIES
(PERCENTAGE)

VARIETY	FARM TYPE			OVER ALL
	A	M	M-A	
HIGH YIELD VARIETIES				
GLUTENIOUS	36.8	20	26.7	36
NON-GLU.	53.8	65	33.3	53.6
TOTAL	90.6	85	60	89.6
LOCAL VARIETIES				
GLUTENIOUS	7.3	15	26.7	8.2

HYV = RD, HOMALI, SANPATONG, KASET
LOCAL= KAMPAI, KAWDOKJAN

LAND AND LABOR PRODUCTIVITY

Mechanization did have an effect on labor and land productivity. This is shown in Table 3.9 and 3.10 where both of land and labor productivity was highest for mechanized farms. Data partially for non-mechanized farms were slightly lower. Non-mechanized farms had the lowest productivity with outputs of 2.8 kg/mh of labor and 1543 kg/ha of land. Srisaket province, which is virtually non-mechanized, had the lowest value for labor productivity at 2.8 kg/man-hour but had a land productivity value of 1964.6 kg/ha compared to the more mechanized areas of Nakornpanom and Roi-Et provinces. These data show productivity was not a function of mechanization alone but of other interrelated factors effecting production.

TABLE 3.9 : PRODUCTIVITY OF LAND AND LABOR DISTRIBUTION BY FARM TYPE

FARM TYPE	Y/A	Y/L	A/L	FERT. KG/HA	SEED KG/HA
A	1543.1	2.8	0.002	81.4	39.3
M	2412.0	5.3	0.002	26.8	45.4
M-A	1820.7	4.2	0.002	67.6	42.1
TOTAL	1596.4	3.0	0.002	78.2	39.7

TABLE 3.10 : PRODUCTIVITY OF LAND AND LABOR DISTRIBUTION BY PROVINCE

PROVINCE	Y/A	Y/L	A/L	FERT. KG/HA	SEED KG/HA
KK	2310.0	3.6	0.002	38.8	45.5
NP	878.7	2.2	0.003	35.5	30.0
RO	1551.9	3.0	0.002	64.7	34.9
SR	1964.6	2.8	0.001	208.2	59.6
KO	2754.0	5.5	0.002	44.7	36.9
TOTAL	1596.4	3.0	0.002	78.2	39.7

**

Y= AGRICULTURAL OUTPUT KG.
L= HUMAN LABOR MAN-HOUR
A= CULTIVATION AREA HA.

Y/L=LABOR PRODUCTIVITY KG/MAN-HOUR
Y/A=LAND PRODUCTIVITY KG/HA
A/L=AREA PER WORKER HA/MAN-HOUR

FIGURE.8

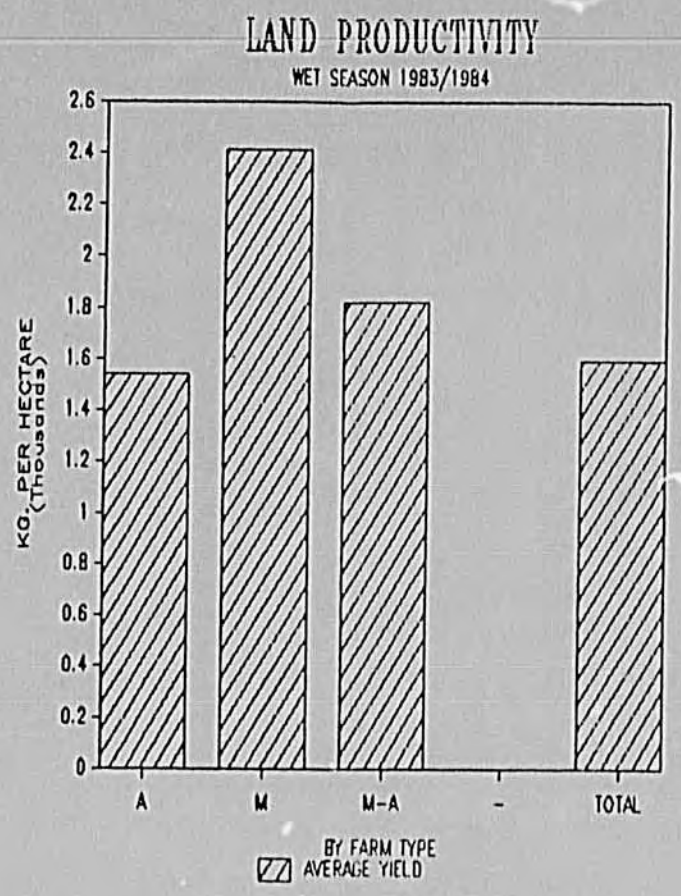
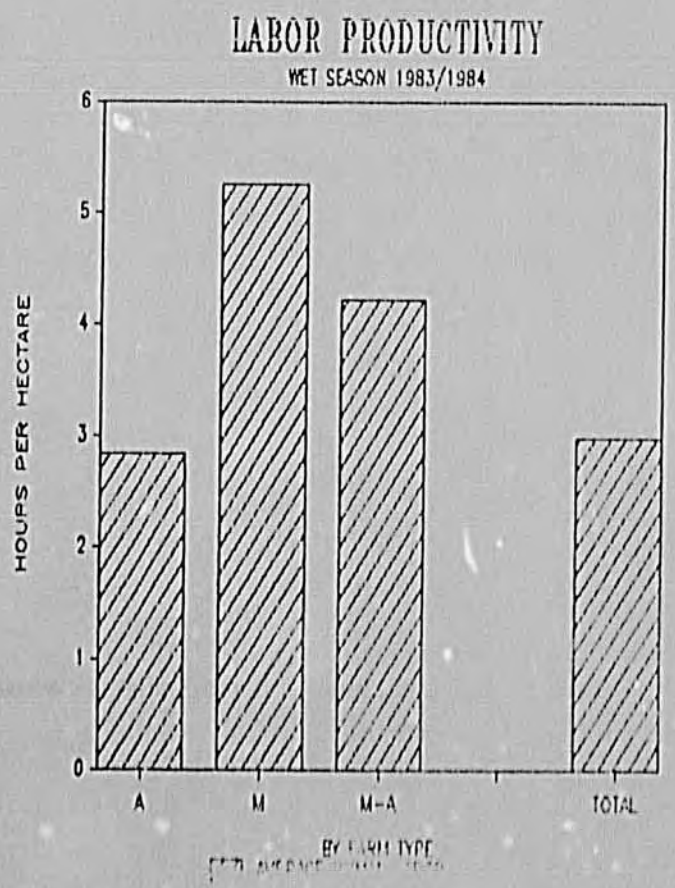


FIGURE.9



COST OF RICE FARMS

Farm costs are divided into two categories, fixed cost and variable costs. Fixed cost include land rent and land tax. Variable costs include material cost, labor cost, and power cost.

Material cost includes the value of seed, fertilizer and insecticides.The labor costs were determined by calculating the mean cost for labor of all farms, all activities from all sources and using the value of 32.2 baht per day to compute a value for hiring machines, transportation and fuel costs. (Table 4.1 and figure 11).

Variable costs, by province and by farm type, are also presented table 4.1. No definite trend could be observed among the different levels of mechanization. Variable costs of 1971 baht per hectare were highest for mechanized farms. Partially mechanized farms had an average of 1817 baht per hectare of variable costs. Non-mechanized farms had the lowest average of 814 baht per hectare. Partiallly mechanized farms had slightly higher for average value of output per hectare 1.0 baht/kg, compare to mechanized farms which had 0.82 baht/kg. The lowest output average was for non-mechanized farms which produced only 0.53 baht/kg.

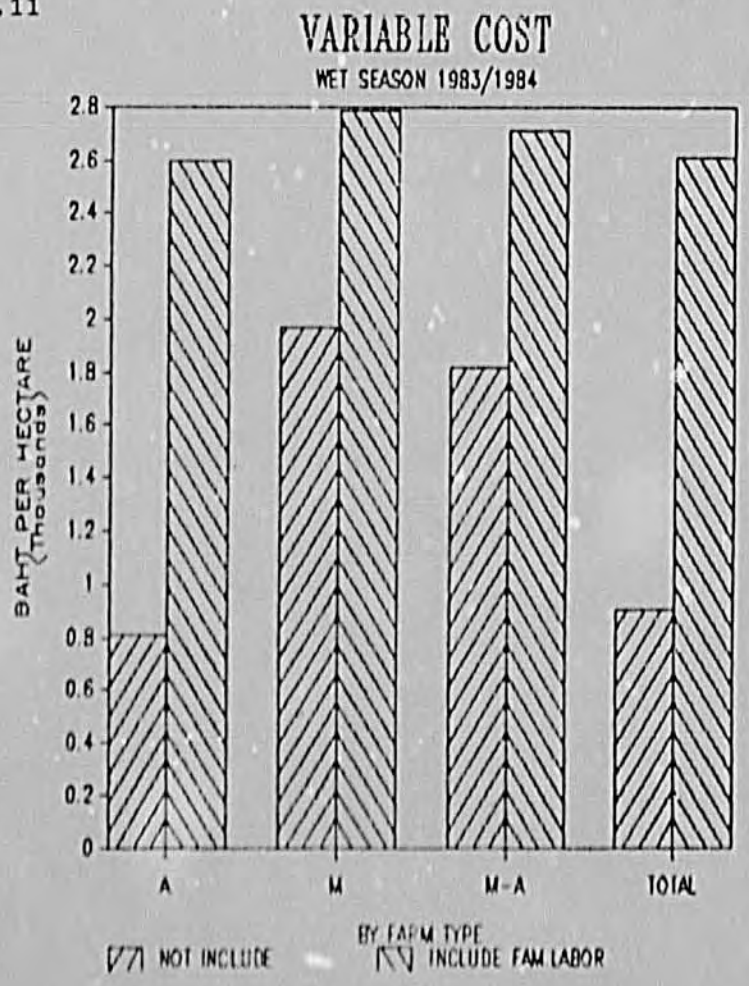
Although mechanized farms were been hypothesized to have more expenditures than non-mechanized farms, Srisaket province was non-mechanized but had the highest average variable cost per hectare at 1864 baht/ha or 0.95 kg/ha. The high rate of fertilizer used contributed to the high variable costs. Korat province had the second highest variable cost with 1537 baht/ha or 0.56 baht/kg. The higher variable costs resulted in a higher average yield compared to other non-mechanized farms in other provinces of the region.

TABLE 4.1: VARIABLE COST
WET SEASON 1983/1984

	NOT INCLUDE FAMILY LABOR		INCLUDE FAMILY LABOR	
	VARIABLE COST BAHT/HA	VARIABLE COST BAHT/KG	VARIABLE COST BAHT/HA	VARIABLE COST BAHT/KG
A	814	0.53	2596	1.68
M	1971	0.82	2787	1.15
M-A	1817	1.00	2709	1.49
TOTAL	907	0.57	2610	1.64
KK	1098	0.48	3066	1.33
NP	357	0.41	1688	1.92
RO	611	0.39	2442	1.57
SR	1864	0.95	4071	2.08
KO	1537	0.56	2672	0.97
TOTAL	907	0.57	2610	1.64

VALUE OF FAMILY LABOR=HOUR OF FAMILY*STANDARD WAGE RATE
32.2 BAHT/DAY

FIGURE.11



SOURCES OF INCOME

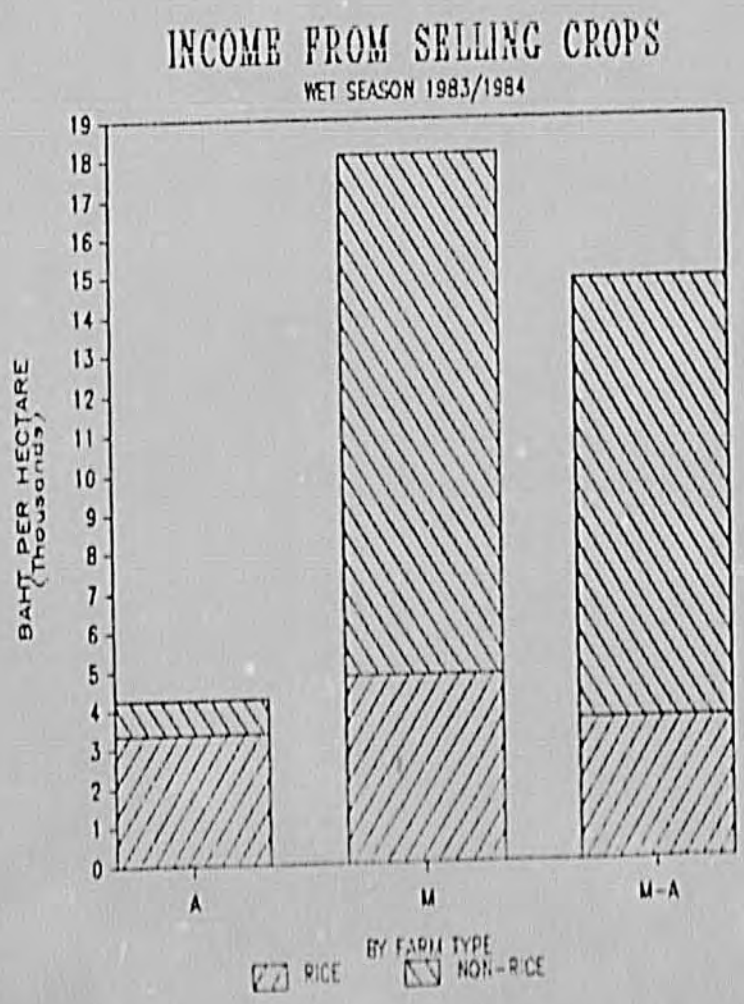
The difference of selling all crops and all variable costs was computed to be gross income. Income derived from the sale of crops was the main source of income for most of the households. The average income for the region derived from crop yields was 5335 baht per hectare. A downward trend in income was observed among levels of mechanization. Mechanized farms exhibited the highest average income of 18102 baht/ha. (Table 4.2) Partially mechanized farms had an average income of 14838 baht/ha while non-mechanized farms had the lowest income of 4272 baht/ha.

TABLE 4.2 : INCOME FROM SELLING CROP PLANTED
DISTRIBUTION BY FARM TYPE AND PROVINCE
(BAHT/HECTARE)

	NO. OF HH	PLANTED AREA (HA)	GROSS INCOME :RICE	GROSS INCOME :NONRICE	TOTAL
KHONKAEN	59	146.9	4671	2832	7502
NAKORNPAN	63	360.8	1881	239	2120
ROI-ET	61	261.2	3392	840	4232
SRISAKET	63	208.5	4652	673	5325
KORAT	32	77.0	5533	14491	20024
TOTAL	278	1054.4	3459	1876	5335
A	249	964.7	3378	894	4272
M	18	52.8	4804	13298	18102
M-A	11	36.9	3633	11205	14838
TOTAL	278	1054.4	3459	1876	5335

** GROSS INCOME = VALUE OF CROP SOLD - VARIABLE COST OF CROPS

FIGURE.12



RETURNS FROM RICE FARMS

The same downward trend was observed regarding farm returns (Table 4.3). Return was the difference of total value of rice produced and total variable costs. Mechanized farms had the highest average farm returns of 4804 baht per hectare. Partially mechanized farms had 3633 baht per hectare while non-mechanized farms have an average of 3378 baht per hectare. Srisaket province ranked second to Korat province with 4652 baht per hectare. The lowest average return was observed in Nakornpanom province which had 1881 baht per hectare.

These data imply that yields in the region were more of a result of the level of fertilizer used on the farm than on the level of mechanization used. Further analysis should be made to relate physical factors such as soil and typology and inputs to production to mechanization.

Some of household selection had off-farm and non-farm activities which were mostly being laborer on farm, raising silk warms or mat weaving.

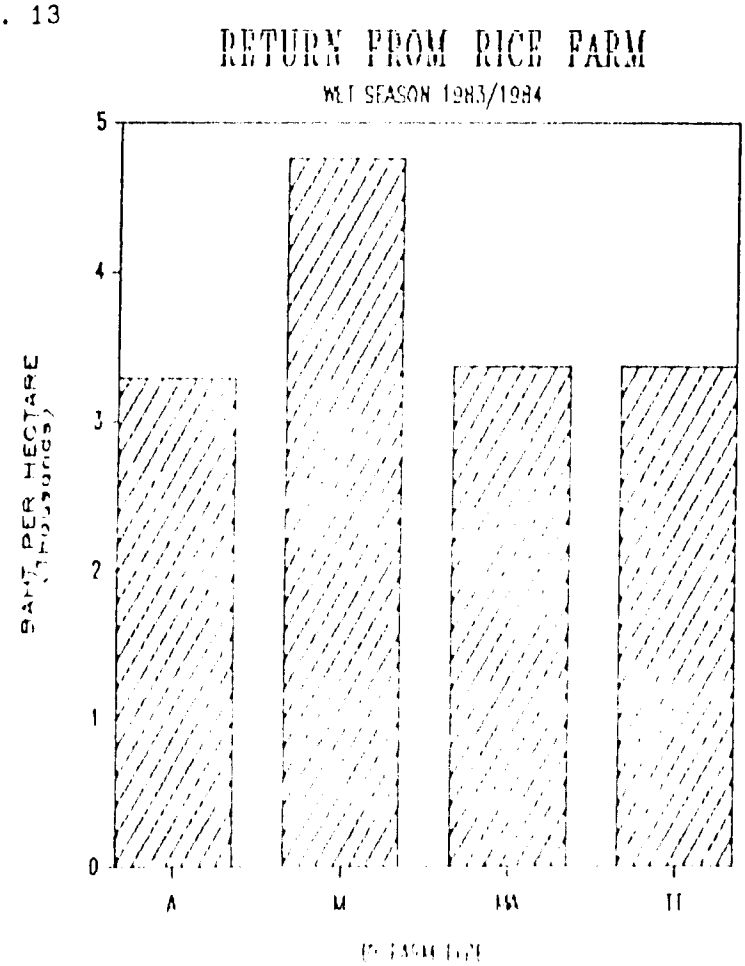
TABLE 4.3: RETURN FROM RICE FARM
WET SEASON 1983/1984

(BAHT/HECTARE)

		1 PLANTED AREA	2 VALUE FROM RICE	3 TOTAL FIXED COST	4 TOTAL VARIABLE COST	5 RETURN (2-3-4)/1	6 RETURN (2-4)/1
KK	59	146.9	847384	40203	161277	4397	4671
NP	63	360.8	807375	12193	128642	1847	1881
RO	61	261.2	1045537	16928	159481	3327	3392
SR	63	208.5	1358693	9286	388660	4608	4652
KO	32	77.0	544379	18520	118368	5292	5533
TT	278	1054.4	4603368	97130	956428	3367	3459
A	249	964.7	4044522	85212	785306	3290	3378
M	18	52.8	357756	2123	104087	4764	4804
MA	11	36.9	201090	9795	67035	3367	3633
TT	278	1054.4	4603368	97130	956428	3367	3459

** RICE : TOTAL VALUE OF PRODUCT
(BAHT)

FIGURE. 13



CREDIT

About 57% percent of the farms were indebted. (Table 5.1) Loan were available in cash and in credit. Credit loans were mostly for fertilizer. The main source of credit was a financial organization such as a cooperative, private bank, or agriculture cooperative bank. Farmers prefered to borrow from these institutions because interest rates of 14% were lower than other credit sources. Most of the farmers who obtained loans were able to repay the debts within a period of one year after harvesting. (Table 5.4 and 5.7)

The survey showed 81.7% of the farmers main reason for borrowed for agricultural investment (81.7%). Other reasons cited were 11.47% for family expenses for seasonal farm expenses 1.9% for other investments and 0.5% for consumption. (Table 5.6) More than 61% of the farmers personal notes was the main form of loan security. Other forms of collateral included 33.7 used land and 4.91% used agricultural products. (Table 5.8) Tables 5.9 show the amount and type of credit loaned within each province. Credit was most common in non-mechanized farms and least used by partially-mechanized farms. This was due mainly to the high level of fertilizer used on non-mechanized farms.

LOAN CHARACTERISTIC: SELECTED PROVINCE IN NORTHEAST REGION : WET SEASON 1983-1984

TABLE 5.1 : NUMBERS AND PERCENTAGE OF INDEBTED FARM DISTRIBUTION BY PROVINCE AND FARM TYPE

FARM TYPE	PROVINCE KK	NP	RO	SR	KO	TOTAL	NO. OF FARM	%
A	25	37	27	41	9	139	249	55.8
M	4	-	-	-	9	13	18	72.2
M-A	4	1	2	-	1	8	11	72.7
TOTAL	33	38	29	41	19	160	278	
NO.FARM	59	63	61	63	32	278		
%	55.9	60.3	47.5	65.1	59.4			57.6

TABLE 5.2 : LOAN TYPE (PERCENTAGE)

TYPE OF LOAN	FARM TYPE A	M	M-A	OVER ALL
LOAN	54.3	75.0	46.2	55.4
CREDIT	41.6	18.8	53.8	40.6
MIXED	4.0	6.3	-	4.0

TABLE 5.3 : SOURCE OF BORROWING (PERCENTAGE)

	FARM TYPE A	M	M-A	OVER ALL
PRIVATE BANKS	1.7	12.5	-	2.5
COOPERATIVE BANK	48.6	43.8	30.8	47.0
INDUSTRY	4.6	-	15.4	5.0
RELATIVE	11.6	-	7.7	10.4
NEIGHBOR	2.3	-	30.8	4.0
MIDDLEMAN	11.0	25.0	7.7	11.9
AGRI.COOPERATIVE	18.5	18.8	7.7	17.8
OTHER	1.7			1.5

TABLE 5.4 : PEROID OF TIME
(PERCENTAGE)

YEARS	FARM TYPE			OVER ALL
	A	M	M-A	
<=1	75.7	82.5	76.9	76.7
>1	19.1	-	7.7	16.8
WHENEVER	5.2	12.5	15.4	6.5

TABLE 5.5 : INTEREST RATE OF CASH LOAN
(PERCENTAGE)

Bht PER YEARS	FARM TYPE			OVER ALL
	A	M	M-A	
<=14	77.2	76.9	33.3	75.0
15-60	10.0	23.1	16.7	11.7
>60	3.0	-	-	2.5
CANNOT SPECIFY	9.9	-	50.0	10.8

TABLE 5.6 : PURPOSE OF LOAN
(PERCENTAGE)

PURPOSE	FARM TYPE			OVER ALL
	A	M	M-A	
INVEST IN AGRI.	79.8	100	84.6	81.7
OHTER INVEST	2.3	-	-	1.9
FARM EXPENSE	5.2	-	-	4.5
FAMILY EXPENSE	12.1	-	10.4	11.4
CONSUMPTION	0.6	-	-	0.5

TABLE 5.7 : METHOD OF PAYMENT
(PERCENTAGE)

	FARM TYPE			OVER ALL
	A	M	M-A	
SINGLE PAID	30.5	37.5	30.8	31.2
WHENEVER	9.8	12.5	23.1	10.9
AFTER HARVESTING	32.4	25.0	23.1	31.2
END OF YEAR	26.0	25.0	23.1	25.8
OTHER	1.2	-	-	0.9

TABLE 5.8 : TYPE OF COLLATERAL SECURITY
(PERCENTAGE)

	FARM TYPE			OVER ALL
	A	M	M-A	
PERSON	61.8	50.0	69.2	61.4
LAND	32.9	50.0	23.1	33.7
ARG.PRODUCT	5.2		7.7	4.9

TABLE 5.9: CREDIT IN SITE SELECTION
(BAHT/HECTARE)

AVERAGE	FARM TYPE			TOTAL
	A	M	M-A	
IN CASH	1664.7	1385.0	1240.5	1597.0
IN KIND	242.2	42.0	0.2	216.5
MIXED	170.5	78.4	-	146.3
TOTAL	2077.3	1505.4	1550.1	1959.7

ATTITUDE TOWARDS FARM MACHINERY

Table 6.1 shows 57% of the farmers on non-mechanized farms were willing to buy new machines without obtaining loans. If loans are provided, the percentage increases by 15%. In partially mechanized areas, 84.8% farmers are willing to buy machines with loan and 69.2% without loans. Farmers who have achieved a relatively high level of mechanization show the least interest in obtaining new machines.

Water pumps, 2-wheel tractors and small and large 4-wheel tractors were the types of equipment most farmers were most willing to procure. These machines were used mainly for land preparation. Farmers from the less mechanized areas express preference for water pumps while those from fully mechanized areas prefered tractors, particularly two-wheel tractors. (table6.2)

Reasons cited for wanting to buy machinery are (a) to save time, (b) to be able to plant on time, (c) to relieve farmers of back-breaking farm activities such as land preparation and (d) to increase yields and income. (Table 6.3) Those who did not want to buy machines cited the machines were too expensive and were not suitable for their land. Other constraints cited were lack of money, small land areas and difficulty in obtaining repairs. (Table 6.4) If the machines sold were suitable to the land areas were more fairly priced, and if the farmers could be trained to repair the machines themselves more farmers would be willing to invest in mechanization.

TABLE6.1: PERCENTAGE OF FARMERS WHO WANT TO BUY NEW MACHINES WITH AND WITHOUT LOAN PROVIDED DISTRIBUTION BY FARM TYPE

FARM TYPE	WITHOUT LOAN PROVIDED	WITH LOAN PROVIDED	% INCREASE
A	57.6	72.5	14.9
M	38.9	55.6	16.7
M-A	69.2	84.8	15.6
OVERALL	55.23	70.97	15.74

TABLE6.2: TYPE OF MAJOR EQUIPMENTS BY PERCENTAGE WHICH FARMERS WANT TO BUY

EQUIPMENT	FARM TYPE			OVERALL
	A	M	M-A	
WATER PUMP	40	-	9.1	36.5
2WT	36.3	20	9.1	34.1
SMALL TRACTOR	4.7	20	27.3	6.6
LARGE TRACTOR	6.3	10	27.3	7.6
TOTAL	87.3	50	72.8	84.8

TABLE6.3: MAIN REASON OF FARMERS FOR BUYING NEW MACHINES (BY PERCENTAGE)

REASON	FARM TYPE			OVERALL
	A	M	M-A	
PLANTED ON TIME	27.9	-	18.2	26.1
DO BETTER JOB	15.3	20	8.1	13.3
LESS TIRED	17.4	40	18.2	18.5
SAVE TIME	10.5	10	18.2	10.9
INCREASE INCOME	7.9	20	27.3	9.0
VERSATILE	7.4	10	9.1	7.6
OTHER	13.6	-	-	14.6

TABLE6.4: MAIN REASON OF FARMERS FOR BUYING NEW MACHINES (BY PERCENTAGE)

DISTRIBUTION BY FARM TYPE

REASON	FARM TYPE A	FARM TYPE M	FARM TYPE M-A	OVERALL
TOO EXPENSIVE	66.7	45.5	50.0	27.6
LESS USE	4.5	-	-	1.4
HIGH COST FOR FUEL	6.3	18.2	25.0	3.4
NOT SUIT. FOR AREA	8.1	9.1	-	3.4
SMALL LAND	10.8	-	25.0	4.4
HARD TO OPERATE	0.9	-	-	0.3
OTHER	0.9	27.3	-	59.5
WANT TO BUY				

TABLE6.5: ATTITUDE TOWARD MECHANIZATION OF FARMERS WHO WANT TO BUY MACHINERY WITH LOAN PROVIDED

	FARM TYPE A	FARM TYPE M	FARM TYPE M-A	OVERALL
SAVE TIME	85.5	77.8	100.0	85.7
PLANT ON TIME	81.3	61.1	76.9	79.9
EASE OUT ACTIVITY	72.9	72.2	76.9	73.0
INCREASE YIELD	69.5	72.2	69.2	69.6
INCREASE INCOME	72.5	66.7	84.6	72.7
DO BETTER JOB	74.4	66.7	78.9	74.1

TABLE6.6: CONSTRAINTS OF FARMERS WHO WANT TO BUY MACHINERY DISTRIBUTION BY FARM TYPE

	FARM TYPE A	FARM TYPE M	FARM TYPE M-A	OVERALL
NO MONEY	81.7	72.2	76.9	80.9
NO OPERATOR	24.4	11.1	23.1	23.5
LAND LIMITATION	35.5	5.0	100.0	32.1
HARD TO OPERATE	32.4	16.7	23.1	31.3
EXPENSIVE	76.3	55.6	69.2	74.4
HARD TO REPAIR	75.6	55.6	69.2	74.1

LIVESTOCK RAISING

Livestock produced on the farms include buffaloes, cows, pigs, ducks and chickens (Table 7.1). Buffaloes were used mainly for farm activities. Cows and pigs were raised and later sold for additional income. Farmers prefer raising cows since a single cow can earn more from the market due to milk meat being available and cow meat being more highly priced. Cows also have a high life asset value similar to the buffalo. Cow raising was mostly confined to Srisaket province while pig-raising was the main livestock activity in Nakornpanom province. Only small numbers of ducks and chicken are raised since they are used mostly for household consumption. When there was a need for extra income, the animals also were sold at the market. (Table 7.2)

The main investment in livestock raising was time. This activity was done by the children and older persons who did not work on the farm. This saves the time of the farmers and maximizes the labor resources of the household.

Non-mechanized farms engaged in livestock raising more than mechanized farms. This is either a function of excess labor being available or low yields which cause the farmers to look for other sources of farm income.

LIVESTOCK RAISING

TABLE 7.1 : PERCENTAGE AND NUMBERS FOR EACH TYPE OF ANIMAL BY PROVINCE AND BY FARM TYPE

NO. COL.%	ANIMAL						TOTAL
	COW	BUFF.	PIG	DUCK	CHICK.	OTHER	
KK	15	51	7	15	28	1	117
	13.2	20.5	13.7	11.8	14.1	50.0	15.8
NP	21	59	19	34	51	-	184
	18.4	23.7	37.3	26.8	25.8		24.8
RO	26	62	15	36	47	-	186
	22.8	24.9	29.4	28.3	23.7		25.1
SR	45	61	8	31	46	-	191
	39.5	24.5	15.7	24.4	23.2		25.8
KO	7	16	2	11	26	1	63
	6.1	6.4	3.9	8.7	13.1	50.0	8.5
A	106	237	47	119	183	1	693
	93.0	95.2	92.2	93.7	92.4	50.0	93.5
M	2	7	2	5	10	1	27
	1.8	2.8	3.9	3.9	5.1	50.0	3.6
M-A	6	5	2	3	5	-	21
	5.3	2.0	3.9	2.4	2.5	-	2.8
TOTAL	114	249	51	127	198	2	741
	15.4	33.6	6.9	17.1	26.7	0.3	100.0

TABLE 7.2 : PURPOSE OF KEEPING

NO. COL.%	ANIMAL						TOTAL
	COW	BUFFALO	PIG	DUCK	CHICKEN	OTHER	
WORK	21	233	2	3	3	-	262
	18.3	94.0	3.9	2.4	1.5		35.5
MILK	1	-	-	-	-	-	1
	0.9						0.9
BREED	13	3	7	-	10	-	33
	11.3	1.2	13.7		5.1		4.5
EGG	-	-	-	60	20	-	80
				47.2	10.1		10.8
SELL	78	10	40	30	60	1	218
	67.8	4.0	78.4	23.6	30.3	50.0	29.5
CONSUME	2	-	2	30	95	1	129
	1.7		3.9	23.6	48.0	50.0	17.5
MULTI.	-	2	-	4	10	-	16
		0.8		3.1	5.1		2.2
TOTAL	115	248	51	127	198	2	739
%	15.6	33.6	6.9	17.2	26.8	0.3	100.0

SUMMARY AND CONCLUSIONS

Most farms sampled in the Northeast region were multiple enterprise farms. Rice and vegetables were grown mostly for subsistance, while upland and horticulture crops were grown as supplementary sources of income. Agriculture is the major occupation of farmers in this region.

Different techniques were used to produced crops. Animals were the dominant power source used on rice farms while farms that grew upland crops used some farm machinery, Particularly in land preparation. Water pumps were widely used in areas which have controllable water.

The education level of farmers was quite low. Ninety - six percent of the farmers had an education level of four years or less. This should effect the farmer's decision toward mechanization. Within this education level, farmers had no significant knowledge about mechanization. The size of the household averaged 5.9 persons and the number of permanent labors averaged 3.8 persons. There was no difference detected in family size among the farm types. Ninety-nine percent of the farmers were permanent residents of the area and the principle assets found were agricultural land, livestock and household appliances.

Most rice lands were small areas surrounded by bunds which would hinder small and big 4-wheel tractors from working effectively. Two wheel tractors suitable for working in small areas were used on a small percentage of the total cropland.

Eighty-seven percent of the farmers owned their land while 4.5% were rent-in farmer. Most of the land owned was acquired through inheritance, 72.6%, while 16.9% was bought and 9.9% rented free of charge. Results indicate hired labor was more widely used than exchange labor, particularly during the planting and harvesting operations. This indicates a significant change from the traditional society has taken place.

Ninety-two percent of the farms sampled relied on rain as a source of water. Only 4% were located near canals and 2.17% used irrigation. The average cropping intensity within the study area was 92.3% due to the water supply. Partially machanized farms had the highest average cropping intensity of 117.1%. Non-mechanized farms had an average cropping intensity of 95.3% while mechanized farms had the lowest at 92.5%. The higher cropping intensity of the partially mechanized farms compared to the mechanized farms was reflected by the smaller average farm holdings and higher irrigated planted area which was 13.6% of the total area planted in partially mechanized farms. Partially mechanized farmers could plough part of their land with animals and part with machines.

Crops other than rice provided additional sources of income. Upland crops grown on the mechanized and partially mechanized farms included cassava, kenaf and corn. The non-mechanized farmers grew these crops plus watermelons and other horticultural crops.

The labor requirement for rice production in the region was 535.5 man-hours/ha. The labor required among the three farm types included 541.5 mh/ha, 459.1 mh/ha and 431.4 mh/ha for the non-mechanized, mechanized and partially mechanied farms respectively. The family contributed 79.3% of the total labor, 6.7% was exchange labor and 14% was hired labor. Traditionally more excahnge labor was used than hired labor. Family labor dominated the non-mechanized farm labor requirements while the mechanized farms used mostly hired labor. Partially mechanized farms used the largest porportion of exchange labor.

Faced with the constraint of water, farmers needed to plant as soon as possible after the rains. The farmers traded off the cost of hire-in additional labor with the cost of poor yields due to lack of water.

The average wage rate was 32 baht/day which was low compared to the official minimum wage of 50 baht/day. This figure did not vary much among farm types and levels of mechanization, however there was a difference among provinces.

Hand tools commonly used were shovels, spades and hoes for land preparation, sprayers, sickles and threshing

sticks. Mechanical powered machines included water pumps, 2-wheel tractors, small 4-wheel tractors, large 4-wheel tractors, threshers, rice mills and farm trucks. Water pumps were the most widely used machine. Two wheel tractors were used relatively little but should have good potential for the future. Small and large 4-wheel tractors were only rented and not owned by farmers. Threshers were used very little due to low wage rates, availability of exchange labor and social traditions.

Mechanization had an effect on labor and land productivety. Non-mechanized farms had the lowest productivity of 2.8 kg/mh while mechanized farms had the highest productivity of the farms sampled at 5.3 kg/manhour. Off-farm and non-farm activities were found among the mechanized farms. The production of silk worms, weaving and the production of native crafts was possible due to labor relieved by mechanization.

Fifty-seven percent of the selected farms were in debt. Both cash and credit loans were available. The main source of credit was cooperatives, private banks or BAAC. The main reason for borrowing was for agricultural investment followed by family expenses, seasonal farm expenses, and consumption. Personal notes were the main form of loan security while other forms of collateral were land and agricultural products.

In partially mechanized areas 84.8 % of farmers were willing to purchase machines through loans and 69.2% without loans. For non-mechanized farms 72% were willing to buy

with loans and 57% without loans. Farmers who had machines showed the least interst in obtaining new machines. Reasons for wanting to purchase machine include a) plant on time b) some time c) reduce drudgery d) increase yields. Those who did not want machines indicated the cost was the major contraint. If the machines bought were suitable to the land area, were fairly priced and if the farmer was properly trained to operate maintain and repair the machines themselves, most farmers would be willing to invest in mechanization.

Recommendations for the future work

To access the potential of mechanization in the Northeast of Thailand, survey data should concentrate more on :

1. The data should be well justified about cropping intensity among the farmers with different level of mechanization. Cropping intensity should be a good mesurement to access the potential of mechanization.

2. The mechanization level should claasified by the machine used by farmer other than by land preparattion. The improved timeliness obtain by machines such as planters, weeders, havesters and threshers should be included in the classification.

3. Data should be collected in sample areas that will represent good comparisons. For this survey,the condition of the selected areas were quite different and to good comparisons could not be made data should be collected for more than one season. If data is collected only in one season and adequate rainfall is available in that season, the timeliness of some planting operations would not be found. The crop should also be specified since the water requirements of different crops are not the same.

To access the potential of mechanization, labor use, the cropping conditions of lowland and upland areas should be well justified. The farms selected to be survey for comparison should be considered in the required numbers of lowland and upland areas.

APPENDIX A: QUESTIONAIRE

DATA REFEREANCE

PROVINCES

1=	Khon Kaen
2=	Nakornpanom
3=	Roi-et
4=	Srisaket
5=	Korat

AMPHUR

1=	Uthumpornpisai
2=	Muang
3=	Nawa
4=	Srique
5=	Parkchong
6=	Nampong
7=	Banphai

TAMBON

1=	Nongsarai	6=	Taket
2=	Jantuk	7=	Nawatnegua
3=	Koksamran	8=	Nongkeaw
4=	Sa-ad	9=	Kudnoi+nongyakow
5=	Tae		

VILLAGE NO.

11=	Submoung 4	71=	Nakoy 5
21=	Tamanao 11	72=	Nangua 8
31=	Koksamran 11	73=	Tarua 1
32=	Koksamran 1	81=	Nongkaew 12
41=	Kambong 8	82=	Nongtone 13
42=	Kambong 9	83=	Laononthan 18
51=	Tae 1	91=	Banmai 11
61=	Bandue 1	92=	Subchumpon 6
62=	Kasamsook 7	93=	Subchumpon 11

FORM	CODE
A1	91 Household Labor
B1	92 Land Information
B2	93 Cropping Pattern
B3	94 Resource Utilization
B4	95 Disposal of Product
B5	96 Disposal of Product (Cont.)
C1	81 Type of Animal Product
C2	82 Type of Building
C3	83 Vehicles and Assets
C4	84 Status of Outstanding Loans
D1	71 Hand Tools
D2	72 Machine Use
D3	73 Machine Use (Cont.)
D4	74 Machine Intensive
D5	75 Machine Breakdown
E1	61 Inventory Charge

FORM A1 : HOUSEHOLD LABOR

ITEM	NAME.....	NAME.....
1 Relationship	/_/_/	/_/_/
2 Sex	/_/	/_/
3 Age	/_/_/	/_/_/
4 Marital Status	/_/	/_/
5 Education	/_/_/	/_/_/
No.of year	/_/	/_/
Currently attending	/_/	/_/
6 Residental status		
1=Resident	/_/	/_/
2=Temporary leave		
3=Nom-resident		
7.1 On-farm activity	/_/_/	/_/_/
On-farm status		
1=Employee	/_/	/_/
2=Owner		
On-farm experience	/_/_/	/_/_/
7.2 Off-farm activity	/_/_/	/_/_/
Off-farm status	/_/	/_/
Amount of working day	/_/_/_/	/_/_/_/
Off-farm income	/_/_/_/_/_/_/	/_/_/_/_/_/_/
7.3 Non-farm activity	/_/_/	/_/_/
Non-farm status	/_/	/_/
Amount of working day	/_/_/_/	/_/_/_/
Non-farm income	/_/_/_/_/_/_/	/_/_/_/_/_/_/
8 Type of work for non-resident	/_/_/	/_/_/
Site of work		
1=in town, 2=out of town	/_/	/_/
3=aboard		
9 Sending money back home	/_/	/_/
1=Yes, 2=No,		
10 Amount	/_/_/_/_/_/_/	/_/_/_/_/_/_/
SKIP CARD NO.	/_/	/_/

FORM B1 : LAND INFORMATION

ITEM	PARCEL 1	PARCEL 2
1 Parcel ID	/_/_/_/	/_/_/_/
2 Total area	/_/_/_/_/_/	/_/_/_/_/_/
3 Planted area	/_/_/_/_/_/	/_/_/_/_/_/
4 Type of ownership 1=owner, 2=rent-in 3=rent-out, 4=rent-in free 5=rent-out free, 7=other	/_/	/_/
5 Crop planted 1=Rice, 2=Upland crop 3=Fruit, 4=Vegetable 5=Mixed, 6=housing area 7=Other	/_/	/_/
6 Texture of soil 1=Sandy, 2=Sandy Loam 3=Clay, 4=Saline 5=Loam, 6=Clay+Sandy 7=Other	/_/	/_/
7 Color of soil 1=Red, 2=Brown, 3=Black 4=Grey, 5=White, 6=Red+Black, 7=other	/_/	/_/
8 Topology 1=Flat, 2=Slope 3=Steep, 4=Very steep 5=Terraced, 6=Flat+Slope	/_/	/_/
9 Restriction factor 0=Fertile soil, 1=Saline soil 2=Tasteless, 3=Unfertile 4=Drought, 5=Other	/_/	/_/
10 Water Source 1=Rain, 2=Artesain well 3=Pump from canal 4=Sub-irrig.canal 5=Main irrig.canal, 7=Other	/_/	/_/
11 Value of land	/_/_/_/_/_/_/	/_/_/_/_/_/_/
12 Land acquired 1=Inheritance 2=Rent-free land 3=Buy, 7=Other	/_/	/_/
13 Occupied period	/_/_/	/_/_/
14 When did farmers use this land		
15 In case of rent-out land Return from rent-out Rental period	/_/	/_/
16 In case of rent-in land Cash pay for rent	/_/_/_/_/_/_/	/_/_/_/_/_/_/
Kind pay for rent	/_/_/_/_/_/_/	/_/_/_/_/_/_/
How long did farmers rent	/_/_/	/_/_/
SKIP CARD NO.	/_/	/_/

FORM B2 : CROPPING PATTERN

ITEM	FORM B2	FORM B2
1 Parcel/Subparcel ID	/_/_/_/	/_/_/_/
2 Planted area	/_/_/_/_/_/	/_/_/_/_/_/
3 Main crop planted	/_/_/_/	/_/_/_/
4 Second crop planted	/_/_/_/	/_/_/_/
5 Method of planting 10=Broadcasting 20=Transplanting 30=Direct Seeding 40=Furrow Seeding 77=Other	/_/_/	/_/_/
6 Date of planting	/_/_/	/_/_/
7 Cropping Season	/_/	/_/
SKIP CARD NO.	/_/	/_/

FORM B3 : RESOURCE UTILIZATION FORM

	FORM B3	FORM B3
1 Enterprise	/_/_/_/	/_/_/_/
2 Parcel/Subparcel ID	/_/_/_/	/_/_/_/
3 Type of input	/_/_/_/	/_/_/_/
4 Activity	/_/_/_/	/_/_/_/
5 Date (Month & Week)	/_/_/_/	/_/_/_/
6 Amount in hour & kg	/_/_/_/_/_/	/_/_/_/_/_/
7 Kind of Payment 1=cash, 2=kind 3=cash+kind	/_/	/_/
8 Value	/_/_/_/_/_/_/	/_/_/_/_/_/_/
SKIP CARD NO.	/_/	/_/

FORM B4 : DISPOSAL OF PRODUCT

	FORM B4	FORM B4
1 Parcel/subparcel ID	/_/_/_/	/_/_/_/
2 Type of crop planted	/_/_/_/	/_/_/_/
3 Harvested area	/_/_/_/_/_/_/	/_/_/_/_/_/_/
4 Total area	/_/_/_/_/_/_/	/_/_/_/_/_/_/
5 Unit of yield		
0=Drough, 1=Kilogram	/_/	/_/
2=Ton, 8=Whole sell		
6 Price per unit	/_/_/_/_/_/_/	/_/_/_/_/_/_/
7 Total value of product	/_/_/_/_/_/_/	/_/_/_/_/_/_/
8 Product is paid to landlord		
1=Yes, 0=No,	/_/	/_/
Amount paid to landlord	/_/_/_/_/	/_/_/_/_/
Total value paid to landlord	/_/_/_/_/_/_/	/_/_/_/_/_/_/
9 Product is paid to deptor		
1=Yes, 0=No,	/_/	/_/
Amount paid to deptor	/_/_/_/_/	/_/_/_/_/
Total value paid to deptor	/_/_/_/_/_/_/	/_/_/_/_/_/_/
10 Product is paid to other		
1=Yes, 0=No,	/_/	/_/
Amount paid to other	/_/_/_/_/	/_/_/_/_/
Total value paid to other	/_/_/_/_/_/_/	/_/_/_/_/_/_/
11 Amount of product sold	/_/_/_/_/	/_/_/_/_/
Total value sold	/_/_/_/_/_/	/_/_/_/_/_/
SKIP CARD NO.	/_/	/_/

FORM B5 : DISPOSAL OF PRODUCT
(CONT.)

	FORM B5	FORM B5
1 Parcel/Subparcel ID	/_/_/_/	/_/_/_/
2 How many time did they sell product	/_/	/_/
3 Price per unit	/_/_/_/_/_/	/_/_/_/_/_/
4 Selling Place 1=On farm, 2=Within village 3=Outside village, 4=Town 7=Other	/_/	/_/
5 Retaining Product 1=Yes, 0=No,	/_/	/_/
6 Purpose of retaining 01=Home consumption 02=Future sell 03=Consumption & sell 04=Seed 05=Consumption+Seed 06=Sell & Seed, 07=Other 08=Consumption+Seed+sell	/_/_/	/_/_/
7 Amount of retaining	/_/_/_/_/_/_/	/_/_/_/_/_/_/
8 Value of retaining	/_/_/_/_/_/_/	/_/_/_/_/_/_/
9 Type of by product 1=straw, 2=Hay 3=Cobs, 4=Husk 7=Other	/_/	/_/
10 Value of by product	/_/_/_/_/_/	/_/_/_/_/_/
11 Cropping season	/_/	/_/
SKIP CARD NO.	/_/	/_/

FORM C1 : TYPE OF ANIMAL PRODUCED

	FORM C1	FORM C1
1 Type of animal 441=Cow, 442=Boffalo 443=Chicken, 446=Horse 447=Other	/_/_/_/	/_/_/_/
2 Numbers of animal	/_/_/_/_/	/_/_/_/_/
3 Price per unit	/_/_/_/_/_/_/	/_/_/_/_/_/_/
4 Total value	/_/_/_/_/_/_/	/_/_/_/_/_/_/
5 Type of caring 1=Pasture, 2=Paddocking (pen) 3=Tied, 4=Feeding 5=Loose, 7=Other	/_/	/_/
6 Purpose of keeping 1=Work, 2=Milk 3=Breed, 4=Egg 5=Sell, 6=Consume 7=Multi-purpose	/_/	/_/
SKIP CARD NO.	/_/	/_/

FORM C2 : BUILDING

	FORM C2	FORM C2
1 Type of building 11=House, 12=Livestock house 13=Farm house, 14=Crop storage 77=Other	/_/_/	/_/_/
2 Age of building	/_/_/	/_/_/
3 Value	/_/_/_/_/_/_/	/_/_/_/_/_/_/
4 Ownership 1=Owner, 2=Partnership 3=Rent, 4=Free 7=Other	/_/	/_/
5 Cost of repairing	/_/_/_/_/_/_/	/_/_/_/_/_/_/
SKIP CARD NO.	/_/	/_/

FORM C3 : VEHICLES & ASSETS

	FORM C2	FORM C2
1 Type of vehicles & assets	/_/_/	/_/_/
2 Numbers	/_/_/	/_/_/
3 Unit 1=HP, 2=Cun, 3=Un 4=Kreang, 5=Lem, 6=Piece, 7=Other	/_/	/_/
4 Age	/_/_/	/_/_/
5 Buying price	/_/_/_/_/_/	/_/_/_/_/_/
6 Buying Place 1=Household, 2=Neighbor, 3=Amphur 4=Province, 5=Bangkok 6=Aborad, 7=Other	/_/	/_/
7 Buying person	/_/_/	/_/_/
SKIP CARD NO.	/_/	/_/

Type of vehicles & Assets

01 = Car
02 = Jeep
03 = Motor cycle
04 = Bicycle
06 = Tricycle
07 = Television
08 = VDO
09 = Radio

10 = Ster~~i~~eo
11 = Refrigerator
12 = Sewing
13 = Motor
14 = Furniture
15 = Fan
16 = Clock
17 = Camera
18 = Jar
19 = Box
20 = Cart

FORM D1 : HAND TOOLS

	FORM D1	FORM D1
1 Type of hand tool	/_/_/	/_/_/
2 Numbers	/_/_/	/_/_/
3 Reciept 1=Buy, 2=Homework 3=Free, 4=inherited 7=Other	/_/	/_/
4 Age	/_/_/	/_/_/
5 Value	/_/_/_/_/_/	/_/_/_/_/_/
SKIP CARD NO.	/_/	/_/

11=Haft dipper
12=Dipping up water
13=Spade
14=Shovel
15=Hoe
16=Plough
17=Harrow
18=Rake
19=Basket
20=Knife
21=Sprayer
22=Sickle
23=Bag
25=Trailor

FORM D2 : MACHINE USE

	FORM D2	FORM D2
1 Machine	/_/_/_/	/_/_/_/
2 Type of machine	/_/_/_/	/_/_/_/
3 Horse power	/_/_/_/	/_/_/_/
4 Enterprise	/_/_/_/	/_/_/_/
5 Owner		
1=Owner, 2=Rent, 3=Borrow, 4=Partnership, 5=Hire-out, 7=Other	/_/	/_/
6 In case of owner		
Reciept		
1=Buy, 2=Made 3=Free, 4=Second hand 7=Other	/_/	/_/
Buying price	/_/_/_/_/_/	/_/_/_/_/_/
Age	/_/_/	/_/_/
Current price	/_/_/_/_/_/	/_/_/_/_/_/
7 In case of hiring or borrow		
Source of hiring/borrow		
1=Father 2=Father/Mother in law 3=Relative, 4=Neighbor 5=Middleman 6=brother/sister 7=Government Office	/_/	/_/
Reason		
1=Free, 2=Can not borrow 3=Low cost, 4=Comfortable, 5=No choice	/_/	/_/
Wage rate	/_/_/_/_/_/	/_/_/_/_/_/
Unit		
1=Hour, 2=Rai, 3=Day 4=Season, 5=Time, 6=Ton 7=Other, 8=Whole sale	/_/	/_/
Total cost	/_/_/_/_/_/	/_/_/_/_/_/
8 In case of rent-out		
Rental charge	/_/_/_/_/	/_/_/_/_/
Unit of rent-out	/_/	/_/
Value charge	/_/_/_/_/	/_/_/_/_/
9 For all type of ownership		
Total working hour	/_/_/_/	/_/_/_/
Operation with		
1=Human. 2=Animal 3=Both	/_/	/_/
SKIP CARD NO.	/_/	/_/

FORM D3 : MACHINE USE (cont.)

	FORM D3	FORM D3
1 Machine ID	/_/_/_/	/_/_/_/
2 Type of machine	/_/_/_/	/_/_/_/
3 Fuel power use 1=Gasoline, 2=Diesel 3=Kerosine, 4=Electricity 5=Human labor, 6=Animal labor	/_/	/_/
4 Expense for machine		
Total liter of fuel use	/_/_/_/_/	/_/_/_/_/
Total cost of fuel use	/_/_/_/_/_/	/_/_/_/_/_/
Total liter of oil use	/_/_/_/_/	/_/_/_/_/
Total cost of oil use	/_/_/_/_/_/	/_/_/_/_/_/
Total numbers of litres use	/_/_/_/	/_/_/_/
Cost repair	/_/_/_/_/	/_/_/_/_/
Total cost of other cost	/_/_/_/_/_/	/_/_/_/_/_/
5 Supplement attach machine	/_/_/	/_/_/
6 Person involve decision making 1=member, 2=Government officer 3=Machine dealer, 4=Village headman 5=Neighbor, 7=Other	/_/	/_/
7 Activity using 01=Prepare plough 02=Irrigation, 03=Threshing 04=Transportation, 05=Milled rice 07=01+02, 08=01+03 77=Many Activity	/_/_/	/_/_/
8 Reason for using machine	/_/_/	/_/_/
9 Total family working hour	/_/_/_/	/_/_/_/
10 Total hire labor working hour	/_/_/_/	/_/_/_/
11 Total animal working hour	/_/_/_/	/_/_/_/
12 Total cost paid to hire labor	/_/_/_/_/_/	/_/_/_/_/_/
SKIP CARD NO.	/_/	/_/

Supplement attach machine

21 = Mouldboard
22 = Disc Plough
23 = Rotovator
24 = Trailor
25 = Disc harrow
26 = Harrow
27 = Tranplanter
28 = Irrigation Pipe
29 = 3 Bottom Disc
30 = 7 Bottom disc
31 = Ridger
32 = Cultivator
33 = Rotary
34 = Pipe
35 = Irrigation hose
36 = 29+31+32
37 = 30+32
38 = 29+31
77 = Other

FORM D4 : MACHINE INTENSIVE

	FORM D5
1 Do farmer want to buy new machine 0=No, 1=Yes,	/_/
2 If farmers do not want to buy new machine 01=Too expensive, 02=Hard to operate 03=Use short time, 04=More animal labor 05=High cost, 06=Not suitable area 07=Small land, 08=Breakdown easy 09=No water enough, 10=Many reason 77=Other	/_/_/
3 Do farmers want to buy if loan provided? 0=No, 1=Yes	/_/
4 Type of machine farmers want to buy	/_/_/_/
5 Reason to buy new machine	/_/_/
6 How much farmers can afford	/_/_/_/_/_/
7 Thinking on machine	
Save time 0=No, 1=Yes	/_/
Plant on time 0=No, 1=Yes	/_/
Easier 0=No, 1=Yes	/_/
Increase yield 0=No, 1=Yes	/_/
Increase income 0=No, 1=Yes	/_/
Do better job 0=No, 1=Yes	/_/
8 Thinking on constraint to buy new machine	
No money	/_/
No driver	/_/
Constraint on his land	/_/
Hard to operate	/_/
High cost	/_/
Hard to repair	/_/
SKIP CARD NO.	/_/

FORM E1 : INVENTORY CHANGE

	FORM E1	FORM E1
1 Which form had change ?	/_/_/_/	/_/_/_/
2 Type of main group had changed	/_/_/_/	/_/_/_/
3 Type of change 1=Birth, 2=Dead 3=Sell, 4=Consumption 5=Purchase+construct 6=Get back, 7=Pay to debtor	/_/	/_/
4 Month of change	/_/_/	/_/_/
5 Week of change	/_/	/_/
6 Numbers	/_/_/_/_/_/_/	/_/_/_/_/_/_/
SKIP CARD NO.	/_/	/_/

Relationship

01 = Head
02 = Wife
03 = Son/Daughter
04 = Son/Daughter in law
05 = Father/Mather in law
06 = Grand father/Grand mother
07 = Cousin
08 = Nephew/Niece
09 = Servant
10 = Trainee
11 = Unrelated
77 = Other

Marital Status

1 = Single
2 = Married
3 = Separated
4 = Divorce
5 = Widow

On-farm activity

00 = Did not work on farm
01 = Agriculture
02 = Foresty
03 = Fishery
77 = Other

Off-farm activity

00 = None
01 = Construction
02 = Industry
03 = Government Officer
04 = Merchant
05 = Mat weaving
06 = Service
07 = House wife
08 = Unemployed person
09 = Silk weaving
77 = Other

Non-resident activity

01 = Handicraft
02 = Construction
03 = Industry
04 = Government officer
05 = Laborer in aboard
06 = Worker

RICE VARIETY

16=RD 16
17=Kampai
18=Reanthong
19=Kowtahang
20=Kowdoakjan
21=Sanpathong
22=Hammali
23=RD 8
24=RD 11
25=Kaset (Kawkaw)
26=RD 7
27=RD15
14=Var. for Penut
10=Corn Suwan 1
11=Corn Suwan 2
12=Corn Local Var.
13=Corn Pasific
15=Corn Super sweet
30=Var. for Sugar-Cane
40=Tobacco Local Var.
41=Tobacco Turkee
35=Cotton Local var
36=Cotton Tadfa
37=Cotton DI5
38=Cotton Kee
50=Kenaf Red var.
51=Kenaf Kow var.
52=Jute
60=Var. for Cassava
66=Mixed
70=Fruit
80=Vegetable
88=Don't Know
90=Horticulture

METHOD OF PLANTING

10=Broadcasting
20=Tranplanting
30=Direct Seeding
40=Furrow Seeding
50=Digging
77=Other

DATE OF PLANTING(MONTH)

01=Jan
02=Feb
03=March
04=Apr.
05=May
06=Jun
07=Jul
08=Aug
09=Sep
10=Oct
11=Nov
12=Dec
88=Don't know

PACEL ID

010=1st land
011=1st plot of 1st land
012=2nd plot of 1st land
013=3rd plot of 1st land
014=4th plot of 1st land
016=6th plot of 1st land
020=2nd land
021=1st plot of 2nd land
022=2nd plot of 2nd land
023=3rd plot of 2nd land
030=3rd land
031=1st plot of 3rd land
032=2nd plot of 3rd land
033=3rd plot of 3rd land
040=4th land
041=1st plot of 4th land
042=2nd plot of 4th land
050=5th land
060=6th land

TYPE OF INPUT (FORM B3)

(RESOURCE UTILIZATION)

441=Oxen/Cattle
442=Buffalo
001=F. Farmer
002=F. Spouse
003=F. Children<11 y
004=F. Male>11 yrs.
005=F. Female>11 yrs
020=CART
101=001+442
102=002+442
104=004+442
105=005+442
133=033+442
134=034+442
201=001+441
202=002+441
204=004+441
223=023+441
021=C. Undet Labor
022=C. Children<11yr
023=C. Male>11 yrs.
024=C. Female>11 yrs
031=E. Undet. Labor

032=E. Children<11yr
033=E. Male>11 yrs.
034=E. Female>11 yrs
290=Organic Fert.
301=001+2WT
304=004+2WT
323=023+2WT
401=001+4WT
404=004+4WT
421=021+4WT
423=023+4WT
501=001+TRACTOR
504=004+TRACTOR
523=023+TRACTOR
601=001+THAI TRUCK
604=004+THAI TRUCK
623=023+THAI TRUCK
723=023+6W TRUCK
823=023+4W TRUCK
901=001+MACHINE
904=004+MACHINE
921=021+MACHINE
923=023+MACHINE

111=Hand pump
112=Water Pump
113=Seeder
114=Weeder
115=Peanut Sheller
116=Share
117=Cyclone Seeder
118=Thresher
120=2 WT
121=Small 4WT (<45 HP)
122=Large Tractor (>45 HP)
123=Sprayer
124=Engine
125=Thai Truck
126=6W Truck
127=4W Truck
128=Rice Miller
129=10W Truck
130=Corn Sheller
131=Chipper
132=Corn Planter
150=Plant,Seedling
151=Seed

152=Stalk
250=Undetermine
260=Liquid Fert.
270=Powder Fert.
280=Granular Fert.
350=Undetermine Insect.
360=Liquid Shape
370=Powder Shape
380=Granular Shape
450=Undet. Fungicide
460=liquid Shape
470=Powder Shape
550=Undet. Weedicide
560=Liquid Shape
570=Powder Shape
650=Undet. Rodicide
660=Liquid Shape
670=Powder Shape
851=Oil
852=Fuel
853=Irrig. Fee
854=Tran. Fee
855=Meals

856=Bag
857=Boxes
858=Marketing Fee
859=Broken rice
860=Bran
861=Paddy
950=Undet. Output
951=Grain
952=Cobs
953=Kenaf Tubers
954=Fruit
955=Cassava Tuber
956=Sugar-cane stalk
957=Tobacco Leaves

ACTIVITY (FORM B3)

(RESOURCE UTILIZATION)

010=Seed Prep.
011=Land prep for seed prep
012=Seedbed Prep.
013=Seeding
014=Pre-sowing Irrig
015=Apply Fert.seed
016=App.Fert+Insect
017=Select Variety
020=Land Preparation
021=First Plough
022=Second Plough
023=Harrowing
024=Plough+Harrow
025=Pudding
026=Cultivation for upland crop
030=Planting
031=Broadcasting
032=TP+Trans+Pull
035=Replanting
036=Ridger
037=Direct Seeding
038=Land prep for SC,K,T,Cas
040=Care/Cultivation

041=Weeding
042=App. Fung+Weed
043=App. Fert.
044=App. Rodicide
045=App. Insect.
046=App. Fungicide
050=Irrigation
051=Regular Irrig.
052=Irrig. by Hand
053=Rain
060=Harvest/Prossing
061=Harvesting
062=Bund+trans.
063=Trans. to Truck
064=Threshing/Winnow
065=Bagging
066=Drying
067=Milling
068=Marketing
069=Trans.to crp.str
070=Livestock Act.
071=Cut+Bund Sugar C
072=Loading Truck

073=Press Tobacco
074=Soaking
075=Ribboning
080=Tend animals
@

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RESEARCH

ON

EFFECT OF PLANTER SPEED UPON SEEDING RATE

OF

THE INCLINED PLATE PLANTER

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Effect of Planter Speed upon Seeding Rate of the Inclined Plate Planter

Introduction

The inclined plate planter, designed and developed by the International Rice Research Institute (IRRI) has been introduced in Thailand since 1982. There are now six manufacturers in different parts of Thailand producing the machine. The machine price to the farmers ranges from 2900-3500 baht depending on the manufacturers. The machine was designed to be attached to the two wheel tractor, therefore, it is suitable for the farm size of 20-50 rai for soybean, mungbean etc. or upto 100 rai for upland rice and maize. In actual operation, the operator tends to operate the machine at the fastest speed that he can still control the two wheel tractor in order to obtain the highest work rate. It is therefore necessary to know the maximum critical speed that will give required seeding rate with minimum seed damages. Because the inclined plate planter has gains popularity from the farmers quickly during the past two years, some manufacturers or researchers may want to adapt the designed principle of seed metering mechanism for building the bigger machine that can be attached to the four wheel tractor. The planter speeds used in the test range from 3-9 km/hr (1.875-5.625 MPH) which is the span of the oprational speed of the 2W and 4W-tractor.

Objective

To study the effect of planter speed upon seeding rate of the inclined plate planter using seedplates for soybean and corn for the speed range of 3-9 km/hr.

Machine specification

The inclined plant planter fabricated by Jakkapeth Tractor Co., Ltd. was used for the test. The manufacturer has built the machine according to the IRRI specification except the seedplate set and seed buffer plate. The original IRRI designed seedplate set and seed buffer plate were used in the test because the ones made by the manufacturers caused excessive seed damage (breakage) in the preliminary test. The machine specifications are

Weight	65 kg
Dimension	80 x 130 x 60 cm (W x L x H)
Row spacing	Adjustable 30-90 cm.
Hopper capacity	5 litres/hopper
Hill spacing	adjustable (upto the seedplate)
Dept of furrow	adjustable
Seedplate	Circular shaped plate - 165 mm dia (6.5"), 7/32" thick having 5 seed cells 5/8" dia each (for soybean) - 165 mm dia (6.5"), 7/32" thick having 2 seed cells 6/8" dia each (for corn)

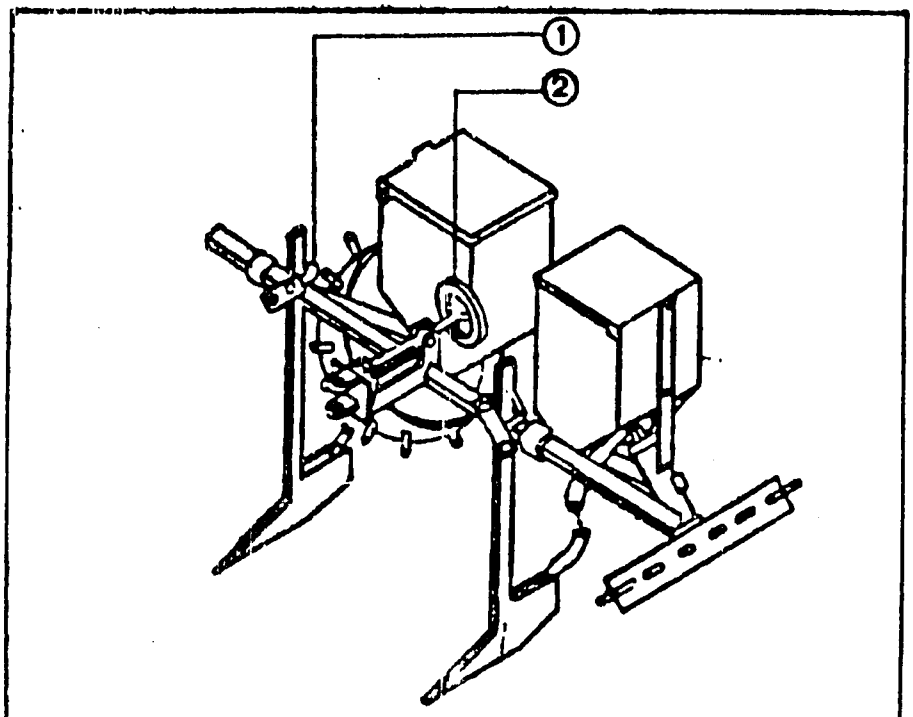
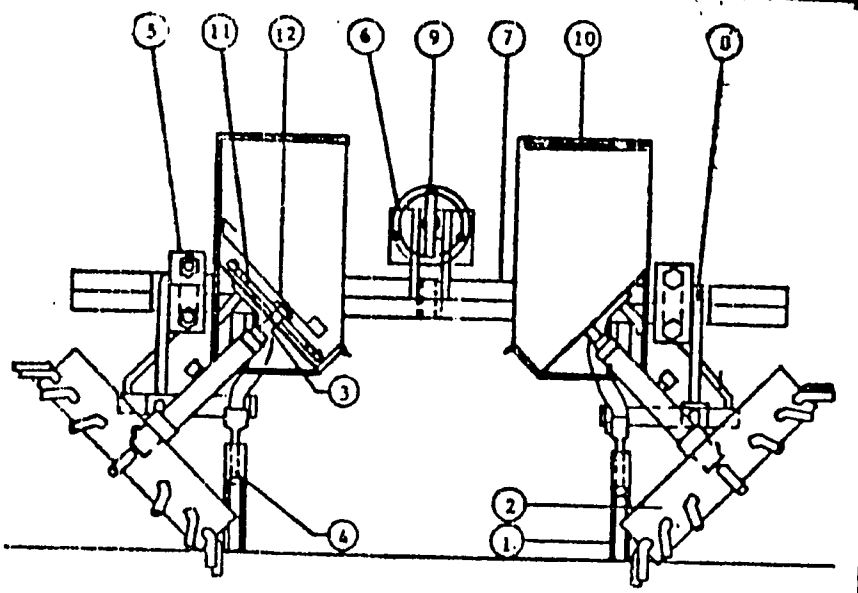


Fig. 1 Overall view of the planter

Machine description

The planter is named inclined plate according to the position of the drive wheel and seedplate which incline 45 degrees to the horizontal. The major components of the unit include the furrow opener, hopper, seedplate, ground wheel or cover wheel, seed tube and mainframe bar. A furrow depth control screw and hitch pont for two wheel tractors are positioned at the mid point of th main frame bar.



Name of parts

1. Furrow opener
2. Ground drive wheel andspress wheel
3. Driving shaft
4. Seed tube
5. U-bar clamp for hopper and ground wheel
6. Hitch point assembly
7. Main frame bar
8. Depth control rod
9. Furrow depth control screw
10. Hopper
11. Seedplate
12. Seed buffer plate

Fig. 2 Rear view of the planter

1. Furrow Opener

The furrow opener is fixed on the main bar by a U bar clamp. It is positioned in front of seed tube. The furrow depth can be adjusted by loosening the U-bar clamp (No. 1 in Fig. 1) or revolving the furrow depth control screw (No. 2 in Fig 1.). The opener consists of a v-shpae front blade and followed by vertical wings. The seed tube is positioned between the furrow opener wings. Seed is conveyed from the hopper through the seed tube and dropped the bottom of the furrow by gravitational force.

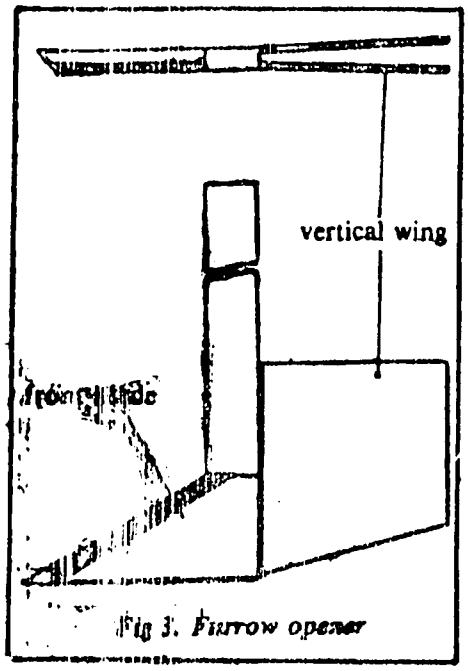


Fig 3. Furrow opener

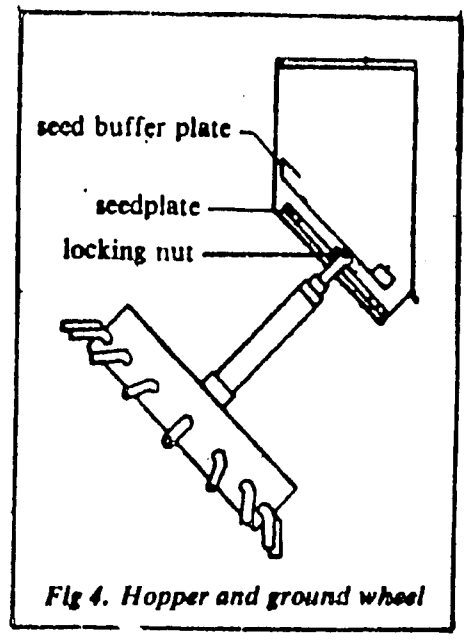


Fig 4. Hopper and ground wheel

2. Hopper

The hopper is also fixed on the main bar by a U bar clamp. It can be slid along the main bar to adjust the desired row spacing. One hopper contains approximately five litres of seed. The seedplate and seed buffer plate are located at the bottom of the hopper. The seed buffer plate allows seeds to enter the seed cells at the bottom of the hopper only. There is an opening at the bottom of the hopper for removing the unused seed.

3. Seedplate

The seedplate set is assembled on the ground driven wheel shaft inside the hopper and rotates at the same speed as the ground wheel. A circular shaped seedplate is clamped between the cover plates as shown in figure 5. The size and number of seed cells can be varied depending on the number of seed per hill and hill spacing required.

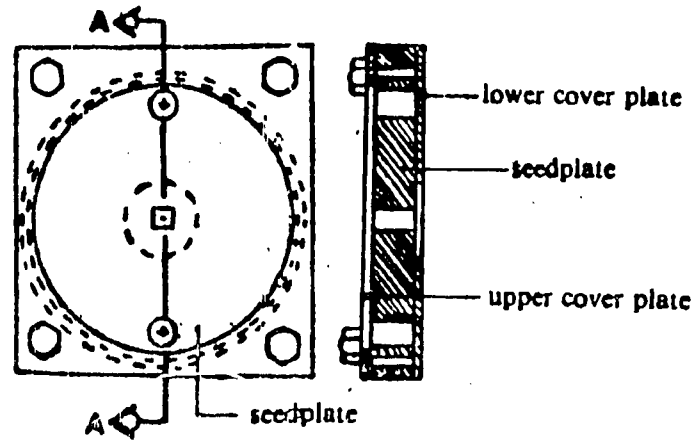


Fig 5. Seedplate set

4. Ground drive/Press wheel

The ground wheel drives the seedplate in the hopper to meter the seed into the seed tube. A series of spikes around the wheel perimeter provides traction and prevents slip. The ground wheel or press wheel also serve as the seed covering device. It can move up or down automatically by adjusting the depth control rod (No.8 in Fig 2). This enable the ground wheel to be continuously in contact with the soil surface under uneven soil condition.

Methodology

The seeding rate is influenced by a number of factors as listed below:

1. Maximum seed size in relation to cell size.
2. Range of seed size
3. Shape of the seed
4. Shape of the cell
5. Exposure time of a cell to seed in the hopper
6. Linear speed of the cell.

The test was done using soybean and corn seed. The soybean was graded by sieve set to obtain the uniform seed size. The soybean seed passing throught the 16/64 inch sieve and retaining on 14/64 inchg neive was used in the experiment. Commercial corn seed, called CP-1, produced by CP company was used in the experiment and a hundred of CP-1 corn seed weigths 27.93 gram.

The seedplate was rotated by a variable speed motor to complete two hundred revolutions for each setting speed. The rpm of the seedplate was calculated based on the fact that the travel distance of the machine per one revolution of the ground wheel is one metre. Seven speed settings range from 3-9 km/hr with five replications for each speed were performed, hence, there were thirty-five test runs for both seeds totalling seventy test runs in the whole experiment. The seeding rate was calculated based on the conventional row spacing of 40 cm and 75 cm for soybean and corn respectively. The equivalent linear speed of the cell and exposure time of a cell to seed in the hopper were calculated as shown in table 1 below:

Table 1

Speed(1)		No.of cells min(2)		RPM(3)	Exposure time(4) Sec	Linear Speed(5) cm/sec
km/hr	MPH	Soybean	Corn			
3	1.87	250	100	50	0.3	35.6
4	2.50	333	133	66.67	0.22	47.5
5	3.12	416	166	83.33	0.18	59.3
6	3.75	500	200	100	0.15	71.2
7	4.37	583	233	116.67	0.13	83.1
8	5.00	666	266	133.33	0.11	94.9
9	5.62	750	300	150	0.10	106.8

1. forward speed of the planter
2. no. of cells passing the seed discharge opening. The calculated no. are rounded figures
3. rpm of the seedplate
4. exposure time of a cell to seed in the hopper in second
5. linear speed of the cell in cm/sec.

The percentage of damaged seed or broken seed was also recorded in the test. The seedpalte set was examined and adjusted to assure the smooth rotation prior to the test. The total time that a cell passing the seed discharge opening was also taken into account in the analysis of the test result along with other important factors.

Results and Discussion

Weight of seeds, soybean and corn, obtained from 200 revolutions of seedplate at different speeds are shown in table 2 below

Table 2. Weights of Soybean and Corn for 200 revolutions.

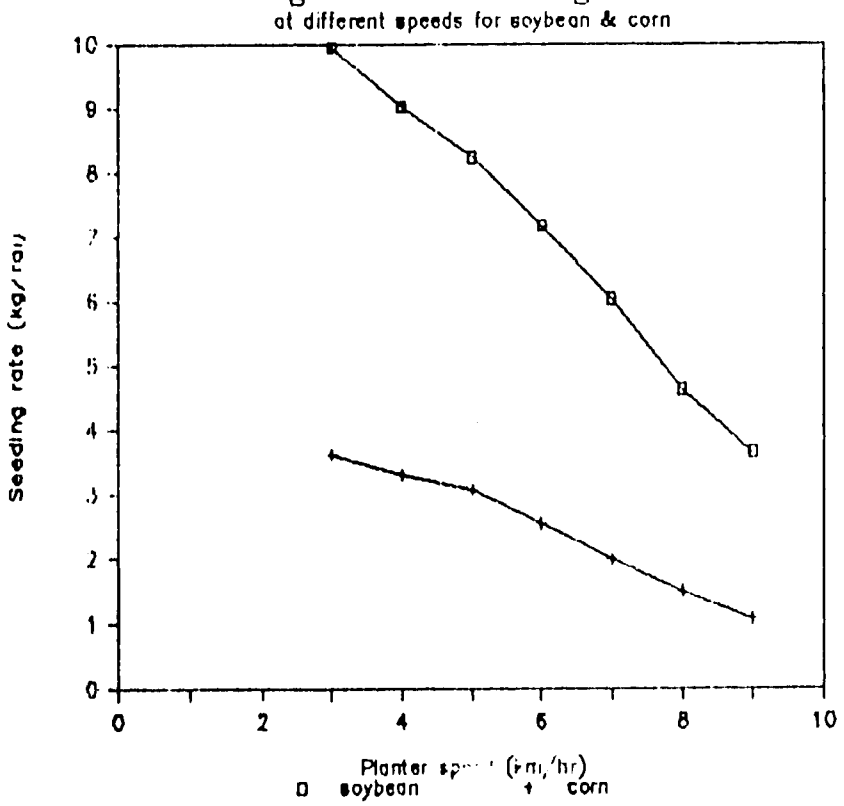
Speed (km/hr)	Soybean (gram)	Av.	Corn (gram)	Av.
3	483.8 504.5 500.5 503.3 496.0	497.6	324.7 337.5 345.3 341.5 339.1	337.6
4	449.0 450.2 451.6 452.3 455.3	451.7	303.7 304.5 312.9 312.8 307.0	308.2
5	407.5 408.2 413.8 417.8 415.3	412.5	295.0 282.2 284.2 288.5 285.4	287.1
6	355.8 358.6 354.5 359.2 366.8	358.9	230.5 243.3 220.9 253.0 240.7	237.7
7	301.7 307.1 297.6 301.7 300.5	301.7	197.8 185.9 174.0 200.2 182.3	188.0
8	229.9 222.0 230.4 231.0 239.8	230.6	140.8 149.8 141.7 137.0 140.7	142.0
9	182.8 184.0 184.5 178.9 179.8	182.0	92.5 88.8 102.9 99.5 88.6	94.5

Assuming the row spacing for soybean and corn are 40 cm and 75 cm respecitvely, the seeding rate were calculated and percentage of seed damaged were also recorded. The summary of seeding rate at different speeds and percent damaged seed was shown in Table 3

Table 3 Summary of seeding rate and percent seed damaged at different planter speeds.

Speed km/hr	Soybean seeding rate (kg/rai)	Soybean % damaged	Corn seeding rate (kg/rai)	Corn % damaged
3	9.95	none	3.60	none
4	9.03	none	3.29	none
5	8.25	none	3.06	none
6	7.18	none	2.54	0.40
7	6.03	0.20	2.00	0.94
8	4.61	0.87	1.51	2.55
9	3.64	2.24	1.08	4.37

Figure 6. Seeding rate at different speeds for soybean & corn



The seeding rate at different speeds for soybean and corn were plotted as shown in figure 6. From Table 3 the seeding rate of soybean at 3 km/hr was 9.95 kg/rai and decreased to 8.25 kg/rai at 5 km/hr. The recommended seeding rate for soybean is between 8-10 kg/rai, therefore it can be said that the planter gave the desired seeding rate at the speed of 3-5 km/hr. However the planter speed may be increased to 6 km/hr, at which the seeding rate was measured to be 7.18 kg/rai, which is an acceptable rate if high germinability is guaranteed. The further increase of speed beyond 6 km/hr resulted in rapid decrease of seeding rate. The seeding rate at 8 km/hr, measured to be 4.61 kg/rai, decreased 53.67 % compared with the seeding rate at 3 km/hr which was 9.95 kg/rai. Seed breakage was not occured until the speed was upto 7 km/hr which gave the percent breakage of 0.20%. It can be concluded that the optimum speed range for soybean planting with the inclined plate planter was 3-6 km/hr without any significant seed damages percentage.

For corn, the seeding rate at 3 km/hr was 3.60 kg/rai and decreased to 3.06 kg/rai at 5 km/hr. Futher increase of speed beyond 5 km/hr caused rapid decrease of seeding rate. The seeding rate at 3 km/hr decreased 57.7% to 1.51 kg/rai at 8 km/hr. From figure 4, it can be seen that the decreasing rate

was relatively constant at the speed range from 6-9 km/hr. The recommended seeding rate for corn is 3-4 kg/rai or 5000-9000 seeds per rai (8533 seeds/rai or 2 seeds per hill for 50 x 75 cm spacing and 1 seed/hill for 25 x 75 cm spacing : recommended by seed supplier)

Because a hundred of CP-1 corn seed used in the test weights 27.93 gram, therefore the 3.60 kg/rai rate at 3 km/hr is equivalent to approximately 12889 seeds which was considered to be too high as far as the number of seed per unit area was concerned. The seeding rate at 6 km/hr was 2.54 kg/rai or approximately 9094 seeds/rai which was an acceptable rate. The seeding rate further decreased to 2.0 kg/rai or approximately 7160 seeds/rai at 7 km/hr with 0.94% damaged. Damaged seed increased considerably at 9 km/hr at which 4.37% damaged was recorded. It was therefore concluded that the optimum speed range for corn planting using the inclined plate planter with the said seedplate specification was 3-6 km/hr which gave the seeding rate between 2.54-3.60 kg/rai. In case of the number of seed per unit area was concerned, the optimum speed range for corn was 6-7 km/hr. However the number of seed per rai required could be easily obtained by reducing cell diameter that will give the required rate at practical operational speed of 2W-tractor (4-5 km/hr). Furthermore if other corn varieties are going to be

used such as local varieties which is rather bigger size than CP-1 seeds used in this test, it is, therefore, necessary to perform the similar experiment in order to obtain the correct seeding rate.

Apart from the linear speed of the cell, cell size and seed size that affected the seeding rate, other important factors that influenced the seeding rate were exposure time of a cell to seed in the hopper and the total time that the cell pssing the discharge opening. At 3 km/hr, the exposure time (in Table 1) was 0.3 second then decreased to 0.18 second at 5 km/hr and to 0.11 second at 8 km/hr. The time that allowed seeds to enter the cells was very critical as well as the time that the cell passing the discharge opening which was measured to be 0.2 second at 3 km/hr, 0.1 second at 6 km/hr and only 0.07 second at 8 km/hr.

Conclusions and Recommendations for further study

For Soybean

1. The inclined plate planter gave the required seeding rate of 7-10 kg/rai at 3-6 km/hr without any percentage of damaged seed.

2. The seeding rate decreased 17.08% at 5 km/hr and 53.66 % at 8 km/hr compared with the seeding rate at 3 km/hr. (The seeding rate at 3,5and 8 km/hr were 9.55, 8.25 and 4.61 kg/rai respectively)

3. Damaged seed was observed at the speed of 7 km/hr with 0.2% damaged and increased to 0.87% at 8 km/hr.

For Corn

1. The planter speed of 3-6 km/hr gave the seeding rate between 2.54 - 3.60 kg/rai.

2. The seeding rate decreased 15% at 5 km/hr and 57.7% at 8 km/hr compared with the seeding rate at 3 km/hr. (The seeding rate at 3,5, and 8 km/hr were 3.60, 3.06 and 1.51 kg/rai respectively)

3. If the number of seeds per unit area was concerned, the optimum speed range using 6/8 inch diameter seed cell, 7/32 inch thick plate, was 6-7 km/hr which gave 9094 and 7160 seed/rai respectively.

4. Percentage of damaged seed was observed at the speed of 6 km/hr and beyond. A high percentage of breakage was recorded at 9 km/hr which was 4.37%.

It was observed during the test that most of the damaged seed occured at the discharge opening therefore the effects of total time that a cell passing the discharge opening and the exposure time of a cell to seed in the hopper on the seeding rate and seed breakage should be studied. The necessity to enlarge the discharge opening length should be verified and the test for different seed sizes and cell sizes must be performed.

OUTREACH PROGRAM

India

The project in India has been extended to September 30, 1986. Much progress has been made and there is great potential for success in the Southern region around Coimbatore, the location of the project. However, assistance is needed to maintain the momentum of the activities so that the project can be an integrated part of the mechanization development program.

A report of activities follows.

Report No. IEP/5
Official Use Only

ANNUAL REPORT

OCT. 1984 TO DEC. 1985

CIAE-IRRI

INDUSTRIAL EXTENSION PROJECT
Lawley Road, Coimbatore 641 003

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Report No. IEP/5

For Official Use Only

A N N U A L R E P O R T O F

CIAE-IRRI INDUSTRIAL EXTENSION PROJECT

COIMBATORE - 641 003

OCT. 1984 - DEC. 1985

For presentation at

XV Annual Workshop of the Coordinated Scheme on R & D of Farm Implements and Machinery and Production of Prototypes and Evaluation Under Different Agro-Climatic Conditions

(21-24 January, 1986)

at

ANDHRA PRADESH AGRICULTURAL UNIVERSITY

HYDERABAD - 500 030

347

GENERAL INFORMATION

1. Name of the Project : CIAE-IRRI Industrial Extension Project on Small Farm Machinery

2. Location of the Project: Tamil Nadu Agricultural University Campus, Coimbatore, India

3. Sanction Document : No. 9-5/79-AE dated 6-6-1983 and No. 9-5/79-AE dated 25-7-1985 of Indian Council of Agricultural Research, New Delhi

4. Duration

   (a) Date of Start : 31-10-1983

   (b) Date of expiry of present sanction : 30-9-1985

5. Staff position : As on 31st December, 1985

S. No.	Designation	Scale of pay	No. of posts	Present incumbent	Date of joining the Project
				S/Shri/Smt.	
1.	Project Engineer (S-3)(Project) Leader	1500-2000	1	P. Datt*	31-10-1983
2.	Agro-Industrial Engineer (T-7)	1100-1600	1	Vacant	-
3.	Design & Test Engineer (S-2)	1100-1600	1	Vacant	-
4.	Economist (S-2)	1100-1600	1	Vacant	-
5.	Draftsman (T-II-3)	425-700	1	Vacant	-
6.	Technician (T-1)	260-430	3	Vacant	-
7.	Driver (T-1)	260-400	1	S.K.Gurusamy	2-7-1984
8.	Accountant	425-700	1	M. Velu	15-12-1983
9.	Stenographer	425-700	1	V.S.Santha	1-12-1983
10.	Clerk-cum-Typist	260-400	1	Vacant	-
11.	Messenger	196-232	1	Vacant	-
12.	Security Guard	196-232	2	Vacant	-

*Transferred temporarily from Central Institute of Agricultural Engineering, Bhopal, to organise the activities of the Project.

The expatriate consultant, Mr. Fred E. Nichols, joined the Project with effect from 6-8-1984.

6. Unaudited appropriate expenditure upto 31-12-1985

I. Establishment Charges				
i) Salary of Establishment	3,926.00	74,016.90	70,632.75	1,48,575.65
ii) Allowwnces				
a) Medical charges	-	752.80	493.90	1,246.70
b) T.A.	-	1,924.00	725.50	2,649.50
iii) Bonus	-	871.00	2,431.70	3,302.70
II. Other Charges				
1. Assets acquired	69,973.34	1,75,027.74*	25,869.48	2,70,870.56
2. Expenditure on Stationery	510.37	991.60	785.70	2,287.67
3. Expenditure on postage	296.50	585.00	556.05	1,437.55
4. Other office expenditure	307.20	452.55	208.60	968.35
5. Expenditure on casual labour	1,100.00	1,463.00	2,029.50	4,592.50
6. Other Contingencies	1,315.57	13,317.30	13,059.62	27,692.49
7. Expenditure on Non-consumable stores	240.00	3,028.02	300.67	3,568.69
	77,668.98	2,72,429.91	1,17,093.47	4,67,192.36

Note: *An amount of Rs.1.40 lakhs has been transferred to DGS & D for procurement of Matador Van. The Van has not been received yet.

OBJECTIVES

(a) To provide continuous technical and marketing assistance to small scale manufacturers to conduct economic and market evaluation studies to determine which of the improved designs offer the greatest potential for helping the farmers.

(b) To carryout through field testing programme, determination of the performance characteristics of equipment under field condition.

(c) To modify and adapt designs and carryout development work to suit field conditions.

(d) To promote the use of appropriate mechanical technology through demonstrations involving both farmers and manufacturers.

(e) To liaise with the local manufacturers/entrepreneurs in taking up the manufacture of adapted equipment.

WORK PLAN FOR FIRST YEAR

October, 1983 to September, 1984

The strategy statement for the Industrial Extension Project stipulates following work plan for the first year of the Project.

(a) The unit will be established and located.

(b) Needed personnel will be recruited/hired. The Project Engineer and IRRI Consultant will be appointed. Other engineers and technicians and other personnel will be recruited/hired.

(c) Needed facilities will be developed.

1. Offices established.
2. Shop facilities located.
3. Equipment and transport procured.

(d) Liaison will be established with manufacturers in the Coimbatore area.

(e) Bench mark survey will be carried out on the farm machinery industry in the area.

(f) Depending on the priority needs for equipment designs from the International Rice Research Institute, from Central Institute of Agricultural Engineerign and other institutions will be introduced to local manufacturers. Assistance will be given in fabrication, testing and demonstration of the first models.

(g) Project Leader and Engineers appointed to the Project will be sent to International Rice Research Institute for industrial extension training.

(h) Design from IRRI and other locations will be tested under local conditions and modified as needed.

FACILITIES DEVELOPED

The Project is housed in two buildings provided by Tamil Nadu Agricutlural University, with total plinth area of 390 sq. m. One of the buildings is used as Project Office and other as Workshop.

The Project Office has been equipped with necessary furniture, a typewriter and a hand operated duplicating machine. Three phase electric supply has been obtained from the Workshop. Machines like lathe, drill, grinder, hand shear, welding set, compressor, pipe bending machine, etc. have been procured and installed. Necessary hand tools and measuring instruments like tachometers, micrometers, stop watch, screw gauges, etc. have also been purchased.

A soil bin has been constructed for testing transpalnter, before demonstrations and for helping manufacturers in testing their product. An underground storage space has been converted into a water tank for storage of water needed for growing nursery.

A petrol jeep has been transferred from Central Institute of Agricultural Engineering, Bhopal, to the Project. A car has been procured by the Consultant.

SUMMARY OF PROGRESS REPORTED IN INTERIM CONSOLIDATED REPORT PRESENTED DURING XIV ANNUAL WORKSHOP OF THE COORDINATED SCHEME ON R & D OF F.I.M.

Status of Farm Machinery Industry of Coimbatore

A survey of 17 farm machinery manufacturers of Coimbatore was conducted by the Project. The manufacturers can be classified as given below:

Type	No.
Those manufacturing mainly tractor operated conventional implements	4
Those taking up miscellaneous jobs including orders for fabricating farm machines, to given specifications	12
Those manufacturing one or more types of farm machines as a regular production	1

The status of farm machinery manufacturing industry in Coimbatore can be shown by following figures, estimted on the basis of the bench mark survey:

1.	Total investment in installed machinery & Equipment	(Rs.) 20,00,000/-
2.	Labour employment in production (Man days/year)	56,250
3.	Total turnover in the year 1983	(Rs.) 65,00,000/-

Identification of Machinery Needs

The engineers of the Project contacted the farmers and visited the paddy growing areas and identified the machinery needs of the rice farmers. The Universities and Research Institutions were contacted to determine the availability of

designs. Based on the farmers' opinion, design availability and expert advice, the Project decided to work on the following machines:

1. Vertical Conveyor Reaper (1.0 m on PT-5 Power Tiller)
2. Thresher (Axial Flow)
3. Rice Transplanter (Manually Operated)
4. Puddling Equipment

Product Development Activity

The Project worked with eight manufacturers for manufacturing reaper (RE-2) on PT-5, thresher (TH-8) and transplanter (TR-4). More economical diesel prime mover was tried for reaper and recommended. An Engineer from one of the manufacturers was sent for training to International Rice Research Institute. Three local manufacturers were given drawings of the 1.0 m reaper (RE-2) and PT-5 power tiller. Three self-propelled reapers were ready for initial trials. Axial Flow Thresher (TH-8) was tested.

Market Development Activity

One demonstration of the self-propelled reaper was arranged at Kottur Malayandipattinam (70 km)

WORK PLAN FOR SECOND YEAR

October, 1984 to September 1985

The strategy statement for the Industrial Extension Project sets following targets for the second year of the Project.

(a) The activities initated in the first year will be continued.

(b) The contact with manufacturers will be extended to include other areas of the Coimbatore region.

(c) Training programmes will be established for manufacturers to be conducted by the Industrial Extension Project Personnel

(d) Demonstrations will be conducted to introduce needed machinery to farmers and to assist manufacturers in establishing their markets.

(e) Project engineer and Consultant will participate in the Annual Workshop of the ICAR Coordinated Scheme on Farm Implements and Machinery.

PRODUCT DEVELOPMENT ACTIVITY

Production Progress

Several manufacturers were contacted for production of the machines identified as priority needs of the rice farmers of South India. The progress of product development activity is shown in Table 1.

Table 1. Progress of Product Development Activity

	Model*	No. of manu-factu-rers	Total production No.
1. Self Propelled Vertical Conveyor Reaper	RE-2 on PT-5	4	14
2. Axial Flow Thresher	TH-8	3	4
	TH-7	1	2
3. Rice transplanter	TR-4	3	8
	TR-5	1	1

*For specifications, see Appendix II to VI

Defects in the Product

Low production limits the use of jigs and fixtures and the procurement and storage of raw materials of correct specification. Low production is the result of low demand which is not because of low need but due to low or no investment in advertisement and marketing.

The manufacturers have good idea about the mechanical processes involved in manufacturing farm machines but generally lack knowledge of the farming operation for which the machine is utilized. This results in carelessness while following drawings and modifications are made just for manufacturing ease without understanding the implication of such minor modification on the performance of the machine. The production defects encountered in various machines are discussed below:

Self Propelled Vertical Conveyor Reaper (RE-2 on PT-5)

1. Lower belt conveyor lug fully depressed.
2. Thinner material used for lug (20 gauge instead of 16 guage).
3. No washer put before riveting lugs.
4. Angle of lugs reveresed.
5. Star wheel covers bent by 180° at edges instead of 90°.
6. Improper angles of pipe frames carrying star wheels resulting in improper minimum clearance between star wheel tip and flat belt conveyor (should be about 12 to 15 mm) and lowering of points of contact between star wheel tips and top flat belt lugs (should be at the centre).
7. Ledger plates projecting in front.
8. Star wheel supporting pipes not exactly on the axis of the knife guard resulting in irregular cut.

Fig. 1. Self Propelled Reaper (1.0 M) With Greaves Lombardini Engine Model 523 Demonstration at Sikazhi

Fig. 2. Axial Flow Threshr (III 8) With Mitsubishi AD 8V Engine Demonstration Near Vijayawada

9. Lower length of cutting stroke and improper register.
10. Quarter turn V-belt pulleys not made with deep groves resulting in frequent turning of V-belt.
11. Improper manufacturing/fixing of star wheel supporting frame resulting in improper clearance between tips of star wheels and nearest cover. The clearance should be 0 to 5 mm for the first and second star wheels from right hand side of operator and 15 to 20 mm for the third star wheel.
12. Lower and upper wire type pressure springs not fixed properly resulting in change of spacing between the pressure springs and the back plate supporting the crop. It should be 25 mm.

Axial Flow Thresher (TH-8)

1. Spacing of holes on both top and bottom sieves are not properly understood resulting in lower percentage open area as compared with the designed open area. Designed percentage open area is an essential requirement of the sieves for reducing losses and improving quality of grain.
2. The gap between casing of the blower and blades are not made according to design resulting in reduced air flow and hence higher percentage of trash in the grains.

3. Improper dimensions of corrugated grain pans resulting in faster and non-uniform movement of grains to sieves.
4. Open area at the top end of the lowest grain pan result in scattering of grains. Similarly improper clearance between the grain chute below the concave and frame of top sieve results either in loss of grain or touching of the moving parts resulting in cracking of sheets.
5. The top sieve is not fastened properly resulting in lateral movements and cracking of the sieve.
6. Enough attention is not paid while assembling the axle and leaf springs of the carriage of the thresher and this results in costly and dangerous breakdowns.
7. The pegs (bolts) on concave are not spaced and fixed properly resulting in bending of the concave pegs.
8. Welding of louvers cracked on one of the machines and requires to be done with more uniformity.
9. The threshing cylinders were not balanced properly resulting in avoidable vibration.

6-Row Rice Transplanter (TR-4)

1. Due to non-availability of suitable materials like square CR tube, the manufacturers have used a square section of different dimensions resulting in change of frame height and spacing between two sides of the frame. Since the transplanter is a precise machine, it is advised not to change any dimension.

Fig. 3. Rice Transplanter (6-row)
Demonstration at Aduthurai.

2. The maximum free swing of the fingers about the axis of the tube carrying the fingers has not been maintained according to drawings. The correct free movement can be achieved by having a clearance of 5 to 6 mm between the pivot arm lock and U-stopper.
3. Hinged clamps of finger carrying tube were not machined properly resulting in very tight or very loose tube movement.
4. Instead of proper pins, threaded bolts have been used at several places resulting in improper clearance at hinges.
5. Rubber pads have not been used on stoppers. The rubber pads must be used as they provide an oscillating motion to the planting tip at the end of planting stroke which ensures release of the seedling in the soil.
6. The position of welded clamps on the curved portion of the round pipes on the two sides of the frames have not been fixed as per design. This results in change in angle of the seedling tray and extent of penetration of fingers into seedling tray.
7. The planting fingers have been made roughly like the designed ones. The fingers require to be made exactly as per drawings for correct picking and releasing of seedlings.
8. One manufacturer used thick wall tubes instead of thin wall tubes for various parts. This increased the weight of the transplanter.

9. Width of seeding tray partitions varies in one of the transplanters. The width of all the 6 partitions should be equal within the tolerance limit of 1.0 mm.
10. The riveting of various components of the seeding tray is required to be done neatly as roughly riveted parts obstruct smooth downward movement of seeding mat.

Product Improvement

It is expected that some of the production defects may be removed by manufacturers when they see the performance of the machine in field. Some problems will be solved by using standard bought out components like knife sections and guards for which Industrial Extension Project has already connected the suppliers of North with users in South. But for some components, the use of jigs and fixtures cannot be avoided. The Industrial Extension Project will develop jigs and fixtures for these sub-assemblies and components and provide jigs and fixtures or finished sample components to the manufacturers and users (e.g. transmission for PT-5 and frame of manual transplanter) The Project has already developed forming jigs for making transmission housing and formed one transmission housing using 2 mm thick sheet metal. This process will reduce the time and cost of making the transmission of PT-5 power tiller used for propelling RE-2 reaper. As the technical staff join the Project, pace of this activity will increase.

MARKET DEVELOPMENT ACTIVITY

For development of markets, following methods can be adopted:

(i) Advertisement in National and local newspaper followed by booking lists with some advance deposit (like in case of cars)

(ii) Dealer development with 'Buy now, pay later' schemes (like for T.V. and Fridges)

(iii) Door to door demonstration (e.g. consumer goods). This method is used by conservative companies who are very sure of the performance of their product but are not sure of demand and increase their production as the demand picks up as a result of demonstration.

For demand development for agricultural machinery, most of the companies and all the Government and semi-Government organisations adopt the third method i.e. demonstration only and because of seasonal nature of agricultural machinery, use of this method of demand development takes a long time (several seasons). This can be best explained by time taken between development of the wheat thresher and its large scale accceptance in northern part of the country.

Considering the Capital intensive nature of the first two methods, this Project could not take up the first two approaches. But it is felt that at some stage, these methods may have to be followed to reduce the time in acceptance of the machines that we are demonstrating.

The project has demonstrated the three machines at locations in far flung areas of Tamil Nadu, Kerala and Karnataka as shown in Table 2. There have been very successful demonstrations and a few failures in adverse conditions. The performance of the machines have been witnessed by hundreds of farmers in each State but as our demonstrations finish, the harvesting season also finishes and most of the farmers postpone purchases to the next year.

Table 2. Progress of Market Development Activity - Demonstrations in Collaboration with Manufacturers and Government Agencies.

S. No.		No. of demon-stra-tions	Demon-stra-tion hour	Region in which demonstrated
1.	Axial Flow Thresher (TH-8)	19	52.5	Coimbatore, Pollachi, Thondamuthur, Palghat, Trichur, Haripad
2.	Self Propelled Vertical Conveyor Reaper (RE-2 on PT-5)	23	52.0	Tanjore, Kumbakonam Sirkali, Chamrajnagar, Chidambaram, Vijayawada, Tenali
3.	Axial Flow Thresher (TH-7)	1	2.0	
4.	Rice Transplanter (TR-4)	1	0.5*	Aduthurai

*Apart from this demonstration, arrangement has been made to keep a set of nursery always ready for demonstration of transplanter to the farmers and other visitors to the Project. The demonstration is done in the soil bin constructed for this purpose in the Workshop of the Project.

TRAINING

The adhoc nature of the Project, resultant uncertainties, shortage of staff and non-provision for financial incentive to trainees are some of the factors working against developemnt of a conventional training programme. To overcome these problems, training was limited to informal 'on the job' training during demonstrations and several operators ahve been trained in this way.

Mennonite Central Committee, a Voluntary Organisation at Calcutta, developed interest in 6-row rice transplanter. They were advised to send their engineers for training. Two engineers from Mennonite Central Committee, attended a three day training course on TR-4 rice transplanter. During the training, they studied the drawings, dismantled and assembled the transplanter, learnt the nursery growing technique, prepared nursery seeds, soil and frames and did sowing. They then transplanted the nursery already developed by the Project and learnt operation of the transplanter. While going, they purchased a transplanter from a local manufacturer and took it with them for demonstrating in West Bengal. They were encouraged to promote the manufacturing of this transplanter in their region.

WORK PLAN FOR THIRD YEAR

October 1985 to September, 1986

1. Market development activity through demonstration will be continued in selected areas where sales potential exists.

2. Manufacturing assistance will be provided to improve quality of the product by improving production processes and by use of standard components.

3. Ideas developed during field trials and demonstrations to further improve the machines, will be incorporated into designs and verified during further trials.

4. Drawings will be produced locally to incorporate all local modifications.

LIST OF MANUFACTURERS CONTACTED

1. Ms. Arasu Engineering Works
   35/467, Selvapuram
   Siruwani Main Road
   Coimbatore

2. Ms. Elseetee Industries
   P. O. Box No. 1808
   Singanallur
   Coimbatore - 641 005

3. Shri Krishna Engg. Trading Co.
   13/35, Velandipalayam Road
   Coimbatore - 641 011

4. Ms. Ganga Engg. Products
   4/460, Puliakulam road
   P.N. Palayam
   Coimbatore - 641 027

5. Ms. Ram Kumar Industries
   G.N. Mills P.O.
   Coimbatore - 641 029

6. Ms. V.C.S. Industries P. Ltd.
   G.N. Mill road, Tudialur
   Coimbatore - 641 029

7. Ms. Dineshkumar Engg. Works
   41, Tudialur Main Road
   Idigarai Post
   Coimbatore - 641 031

8. Ms. Sundaram Industries
   Idigarai Main Road
   Idigarai
   Coimbatore - 641 031

9. Ms. Tucas Ltd.
   Tudialur Post
   Coimbatore - 641 034

10. Ms. Vasavi Industries
    195, Thadagam Road
    Coimbatore - 641 040

11. Ms. Maruthamalai Andavar Industries
    Gokulam Colony, PN Pudur
    Coimbatore - 641 041

12. Ms. Swathi Industries
    262, Maruthamalai road
    P. N. Pudur
    Coimbatore - 641 041

13. Ms. Parasakthi Engg. Industries
    Maruthamalai Road
    P. N. Pudur
    Coimbatore - 641 041

14. Ms. Valampuri Industries
    1-B, Thiagi Kumaran Street
    P. N. Pudur
    Coimbatore - 641 041

15. Ms. Balamurugan Industries
    Maruthamali Road
    P. N. Pudur
    Coimbatore - 641 041

16. Ms. National Equipment Manufacturers
    36, Rangaswamy Road
    Coimbatore - 641 002

17. Ms. V. K. Devarajan Co.
    Sugarcane Breeding Institute Post Office
    Coimbatore - 641 007

18. Sri Karthic Industries
    3/9, Natesa Mudaliar St.
    Vadavalli
    Coimbatore - 641 041

APPENDIX - II

SPECIFICATIONS OF 1.0 M REAPER, RE-2 ON PT-5

Power	6 hp diesel engine
Weight, tiller, engine and skid	125 kilograms
Weight, reaper unit	40 kilograms
Length	218 cm
Width	117 cm
Height (minimum)	90 cm
Field capacity	0.25 ha/hr or approx. 2.4 hectares per day
Field losses	less than 1%
Minimum cut	7 cm
Forward speed	2.5 to 4.5 km/hr
Knife average speed	1.3 x forward speed
Construction	all steel except the non-metallic starwheels
Controls	engine throttle & clutch lever
Fuel consumption	approximately 1.0 liter per hour

SPECIFICATIONS OF TH-8 AXIAL FLOW THRESHER

Power	10 hp engine
Weight (with engine)	465 kg
Length	190 cm
Width (tray folded up)	150 cm
Height (tray folded up)	178 cm
Output (field capacity)	800-1000 kg/hr (rough rice)
Separation recovery	98%
Cylinder, spiketooth type	39.3 cm O.D. x 111 cm length
Concave	0.6 cm dia. steel rods with 16 mm spacing
Construction	all steel
Component speeds (no load):	
Cylinder	600 rpm
Fan	800 rpm
Screen & auger (safe shaft)	340 rpm
Oscillating screen (stroke)	3.2 cm
Adjustments	Air shutters on blowers, angle of windboard and engine speed
Labour requirement	3 - 4 men

SPECIFICATIONS OF TH- AXIAL FLOW THRESHER

Power	6 hp engine
Weight (with engine)	190 kg
Length	119 cm
Width (with tray folded up)	132 cm
Height	150 cm
Field capacity	400-500 kg/hr (rough rice)
Grain breakage	less than 4%
Separation recovery	98%
Cylinder (open type)	Spiketooth, 30.5 cm O.D. x 71 cm length
Construction	All steel
Component speeds	
Cylinder	600-650 rpm
Fan	800 rpm
Oscillating screen (frequency)	800 cycles/min.
Oscillating screen (stroke)	4.76 mm
Adjustments	Blower shutter, angle of windboard
Labour requirements	3 - 4 men

SPECIFICATIONS OF TR-4 RICE TRANSPLANTER

Power	1 person
Field capacity	0.3 - 0.4 ha per day
Planting depth	3 to 5 cm
No. of rows	6
Row spacing	20 cm
Tray displacement per stroke adjustment	1.0/1.3 cm
Field standing water depth	1 to 5 cm
Weight	20 kgs
Length	85 cm
Width	125 cm
Construction	steel and wood
Seedling preparation:	
Size of seedling mat	20 cm x 50 cm
No. of seedling mat per hectare	400 - 450
Size of seedbed per hectare	1.2 m x 45 m
Seed requirement per hectare	30 to 40 kgs

SPECIFICATIONS OF TR-5 RICE TRANSPLANTER

Power	1 person
Field capacity	0.3 - 0.4 ha per day
Planting depth	3 to 5 cm
No. of rows	8
Row spacing	20 cm for two central rows 15 cm for other rows
Tray displacement per stroke adjustment	1.0/1.3 cm
Field standing water depth	1 to 5 cm
Weight	20 kgs
Length	85 cm
Width	125 cm
Construction	steel and wood
Seedling preparation:	
Size of seedling mat	15 cm x 50 cm
No. of seedling mat per hectare	500 to 600
Size of seedbed per hectare	1.2 m x 55 m
Seed requirement per hectare	40 to 50 kgs

OUTREACH PROGRAM

Burma

The program in Burma terminated on December 31, 1985. Although not funded by USAID, te report for mechanization is included in this report. The program in Burma is funded by the Canadian International Development Administration.

The work in Burma is directed toward development of machines utilizing animal power. Following is a brief report of activities.

IRRI BURMA COOPERATIVE PROJECT FUNDED BY CIDA

REPORT ON THE SMALL SCALE FARM MACHINERY PROJECT

YEZIN, BURMA

October, 1980-1985

By MALCOLM M. HAMMOND, AGRICULTURAL ENGINEER

1.0 INTRODUCTION

Last year the project reported on the differences between Burma and other outreach countries. This report deals with the direction developments have taken.

1.1 GROUNDWORK

It takes time to build up a new organization which needs buildings, machines, mains services and the agronomists or engineers to run the operation. Up until the end of 1983 there was virtually very little show for any of the effort being put in. During 1984 there have been big changes so that there is a real presence of agricultural engineering on the ground. We are fast running out of accommodation and will require an increasing amount of working area, for men and machines, as the year proceeds.

1.2 Shipping of machines and materials purchased under the project have begun. Although the prime area of work will be simple technology, there will also be some higher technology not only looking to the future but also to make work easier and constant. For example solar panels that will provide water and some power for the many occassions when either the electric power or water is cut.

2.0 ARRIVAL OF AMD AT YEZIN

We have been very fortunate in having since July the Agricultural Mechanization Department to join in our progress with their complete cooperation.

2.1 SHOP DEVELOPMENT

The establishment of an Agricultural Mechanization Department machine shop at Yezin with U Mya Thein, Assistant Director and

U Htun Aung Phyo, Assistant Director in charge has been a step forward. They are assisted by U Aung Myint Aung, Agricultural Mechanization Assistant and U Hla Myint, Agricultural Mechanization Assistant and shop personnel. Materials will be provided in the interim period by AMD . Already drills lathes, oxyacetylene and electric welding etc. have been supplied to the A.M.D. shop from AMD in Rangoon. This will enable further research and development with some manufacturing capability to be started earlier. The Agricultural Research Institute and the Agricultural Mechanization Department shops and staff operate jointly and are under the ARI administration although AMD staff will continue to be paid by AMD.

2.2 STORES AND EQUIPMENT

Stores and equipment for the ARI shops have been ordered and will be shipped in during the course of the year. Further shop floor space than originally intended will be required. As well as the original metal working shop envisaged under the project plan there will be a woodworking shop, blacksmiths shop and foundry. Sufficient counterparts staff, and a permanent work force, are being alloted to the ARI Small Scale Farm Machinery programme. This is an essential element that must be supplied to run this machine shop which will be operational this year. Neither will it be wise to operate the new machines with a non permanent daily paid labour force. This is where our training programme will come into its own.

2.3 TRAINING IN COUNTRY

Training materials in the form of slides tape and reading matter have been assembled, so that it is now possible to teach either agriculture to the engineers, or engineering to the agriculturalists. A library/lecture room has been set aside and will soon be furnished and equipped. At the moment the training materials have to remain packed.

3.0 CHANGE IN THE LEVEL OF TECHNOLOGY

It has been necessary to go back and look at technology that was discarded. This may have been because fossil fuel become the principle motive power. Many of the ideas worked on at ARI may not be new but we are taking them and working on them to refine the mechanism, without going onto a too advanced stage of technological development, which would not be suited to the country at this stage.

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In the second phase of the Canadian funded IRRI Burma Project, with the agronomists being in control of the agricultural engineering, the requirements innovations and modifications are farmer oriented. The present level of technological development has been assessed and the required machinery for research development and fabrication has been ordered accordingly. With wood being the principal material for construction woodworking machines and tools will be of major importance. This was not envisaged in the preparation of the present project plan. In the third phase we will need more expertise on timber and more wood working machines and skills.

3.1 FACILITIES (see Fig 1)

A new go-down was alloted as the Small Scale Machinery shop. This has been provided with power and lighting, and soon a water supply, with stores, library/lecture room and office area. Three soil tanks have been constructed and will be fitted with rails and moving carriage for electronic testing of prototype implements. Three types of soil sandy, sandy loam and clay soils from representative areas in Burma can be used. Some test equipment has arrived, and electric motors are awaited. This and other equipment will be housed in a test laboratory to be built adjacent to the tanks. This will be completed by the end of 1984.

A cattle shed, adjacent to the machine shop described above, has been converted for use as blacksmiths shop and saw mill area. Some assembly also takes place in this shop. Later a foundry and generator will provide a very nice self contained agricultural engineering area.

3.2 FIELD TEST AREA

An area of land is cultivated and ready for sowing and will be used for transplanter testing, dry land seeding and water pumping. A field station is already taking shape. Various windmills will be erected.

4.0 DIRECTION OF RESEARCH & DEVELOPMENT

SMALL SCALE FARM MECHANIZATION WORKING GROUP

The group has expanded its membership since its inception. The aims are to meet at about 3 month intervals and in a different location each time so that local problems can be seen and an invited

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participant to represent that area. Membership is made up from our own SSFM staff, from the Agricultural Mechanization Department, from Cropping Systems and from Agricultural Extension. The group sets the programme of work and monitors its progress at each meeting throughout the year.

The group in setting the work plan has first and foremost the criteria -- bottlenecks in the farming year, shortage of fuel, manpower and materials but abundant animal power and a plentiful supply of wood for construction. Implements must as far as possible be designed so that they can be constructed in any of the many blacksmiths and carpenters shops up and down the country and that they must be very durable and inexpensive.

Our starting point is with the indigenous equipment. These are many and diverse. There is sometimes room for improvement, and sometimes one area of the country could well be provided with an implement that has been used with good results in another area of the country.

Visiting the different parts of Burma to learn of different soil conditions, weather pattern, crops and implement requirements is a vital part of SSFM development work.

4.1 COLLECTION OF IMPLEMENT FROM DIFFERENT REGIONS

This is steadily increasing and will require more accommodation. But it is the gene bank of development. This is a museum collection but has three aims:

4.1.1 To study what indigenous equipment is in use, and if it can be improved making it easier to construct, longer lasting and more efficient.

4.1.2 Equipment has evolved in different regions and there is equipment from one region that may be successfully introduced with benefits into another region.

4.1.3 To provide an understanding of the implement requirements of the different soil conditions, climate and crop in the widely varied ecological zones.

4.2 Information provided by this collection has been the basis for many innovations carried out at ARI. For example

4.2.1 The wooden plough is successfully using a cast iron turn furrow plough body and share. This body and share

is being made by very small village foundries. The next stage is to introduce a replaceable share blade. This will reduce the cost and provide for good ploughing throughout the life of the body. The normal share which includes the body costs about $4 but a replaceable share would cost only $1.50.

4.2.2 The planting of crops is often by hand which is laborious inaccurate and not always successful. Using the indigenous implements, such as the pendulum seeder, for the planting of crops is generally inaccurate, wasteful of seed and often damaging to the seed. This therefore has been an important area of work. The first prototype tried was a wooden roller with holes, size according to seed and rate of sowing, for each row to be planted. To avoid damage the seed was lifted from the seed in the seed box by the roller and dropped into the seed discharge tube. The whole construction was one box and roller mainly made of wood and could be attached to the frame of an animal drawn harrow. The roller could be turned by hand or a land wheel drive. The land wheel drive has not been a great increase in cost and makes for a far more efficient implement. Efficiency depended too much on the fineness of tilth of the seed bed.

From this improvement and for far greater accuracy and with a greater variety of seed another system was developed. Again using the basic wooden harrow as carrier and furrow opener.

This was found to be an improvement, but for greater accuracy and efficiency a separate box for each line of seed and seed dispensed by replaceable (according to seed and rate) wooden rollers. Damage through trapping the seed between the roller and the edge of the seed box was overcome by having a pliable plastic edge. The whole machine, is made up of independent seed boxes joined by a frame and drive shaft. It is mounted on a wooden toothed harrow. This is of indigenous design but allowance has been made for moving the wooden teeth to give a wide variety of row widths. The machine is driven by a chain and land wheel.

4.2.3 Although not part of the original project line of work there is a need for a lighter single animal cart. The traditional ox cart is very heavy and strong and requires two animals. As there was need for a small cart the SSFM shop designed one using the same type of light wheel used for the passenger carrying garis. The result has been most successful providing a cheaper cart for the smaller farmer or in instances where the loads do not require two animals to pull.

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5.0 NON INDIGENOUS DEVELOPMENT

Selected equipment imported evaluated. If suitable may be modified for Burmese conditions.

5.1 RICE TRANSPLANTER

Further evaluation by ARI and the arrival of the new IRRI 6 row transplanter have led to improvements of the ARI IRRI design. Currently the AMD workshops at Yezin in particular are working on improvements to the IRRI 6 row transplanter. Modification include the fitting of adjustable pickers and a cam to bring the picker arms backwards away from the seedling before raising the arm. Also to bring the pickers backwards as they rise so that seedlings in the tray are not misplaced. AMD are also improving on their continuous planting paddle wheel machine.

The IRRI Burma transplanter has usually been operated by a pulling strap. This is particularly useful with the present lighter 6 row model which is inclined to slip backwards when the machine stops its forward motion. The strap round the buttocks reduces this.

Although many thousand of the earlier type of transplanters have been made they are not used as much as they should be. Two reasons are the low output of work, and the limited conditions under which they will work. It should also be added that the quality of manufacture left much to be desired.

It will be of interest to know what improvements are currently being made by IRRI.

Unfortunately we are not yet in the position to produce blue prints or drawings so that we can pass on designs.

U Soe Tint the Burmese scholar who started this year an MS engineering course at the University of Manitoba under Dr. J. S. Townsend has as his project an improved rice transplanter.

5.2 FERTILIZER APPLICATOR

The various types of applicator designed and constructed by IRRI were sent to the project. Out of these models the vertical prilled applicator has proved the most used machine. This model was further adapted to reduce the application rate. This is achieved not by a straight forward reduction in drive and aperture.

The gear ratio has been changed so that either 1:2 or 2:1 is available for a 28 lb/acre or 56 lb/acre application. A steeper solid spiral was also required to achieve this lower rate.

The Extension department ordered 50 of these machines from the same shop that helped produce our original prototype.

5.3 CAAMS IRRI 1M REAPER

The 1M model was chosen because of its ease in handling and its smaller size. Even so observers remarked that the 1M would be easier to handle with steering clutches.

The first model produced in Rangoon by a private shop to our design was built as a reaper without the possibility of using it for tilling. The thinking behind this was that the demand was for peak work conditions that first occur with reaping. Land preparation, and planting, do not present such a problem. A machine for reaping was conceived that could be powered by the Burmese produced Kubota water cooled diesel.

The cost of producing the prototype was Kyat 8000 or approximately $1000 without motor. The high cost was due to this being made up of parts not normally manufactured in Burma.

As casting is favoured then whenever possible a part will be produced in this way. SSFM will be going through the reaper construction to see which parts could be satisfactorily and more cheaply made as a casting.

5.4 ANIMAL DRAWN REAPER

A great deal of the rice crop is spoilt in Burma because there are no means of cutting it. So there is wetting and drying, over ripening and shedding. What is left is cracked and discoloured grain.

Whilst in UK a design was worked out with a manufacturer to produce an animal drawn machine. This is an old type manufacturer who relies on weight for strength. It has been difficult to make sure thickness of plate, and belt drives used instead of bevel gears, to keep down weight and loss of power. It is hoped that the finished machine will be used during this next harvest.

Although this manufacture in UK (Alvan Blanch) have always maintained they produced a machi for animals in actual fact

this reaper has always been pulled by a tractor or powered by a donkey engine.

5.5 SLIT SEEDING

There has been no further developments since the last report. With the Penetrometer and DB test rig soon to be set up this work will go ahead.

5.6 ANIMAL POWER AND HARNESS

Actual animal power varies from animal to animal and depends on many factors of condition, feed, type of work, hours of work, harness. Figures for pulling power are available but not accurately arrived at quantified/qualified. Only in research establishments in temperate climates have accurate measurements been taken but we need figures for Burma. With the equipment we are installing this should be possible.

6.0 NEW PROJECTS

6.1 PUMPS

The IRRI axial flow pumps have their uses in Burma but there is almost a greater demand for the high volume low lift.

The indigenous systems are a manual scoop clung on a tripod and the archimedes screw which is much more productive. This latter has a low power requirement and is inexpensive - again it is almost entirely of wood construction. The SSFM shop has obtained an archimedes pump to examine more closely. The expertise of making this wooden screw is not now easy to find, but it is a machine that might well be spread further as it would meet needs in many areas.

The new 15" low lift pump from IRRI has only just arrived after one whole year of being on the way. It is under test but needs some modifications in flow, power drive, and possible flow reduction to reduce power requirements.

6.2 OIL EXPELLING

Vegetable oils are insufficient to meet the countries needs. The farming system will bring in more oil seed crops to the rotation.

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At the same time there is a great wastage in the extraction of oil. The village system is to use granite rollers. Improved methods using a Hander type screw crusher and a horizontal plate press do extract a better percentage. AMD has collected some indigenous locally manufactured expressing machines. The intention of AMD and SSFM is to improve extraction percentage so that less oil goes out in the cake for animal feed.

The first improved expeller will be a vertical press with a hydraulic jack. This system will copy that used for olive oil extraction.

7.0 EXTENSION

As implements are evaluated tested modified they are used at ARI. Duplication of equipment that is proved to be successful will undergo further testing on cropping system sites, central farms and in township programmes. Feedback of complaints or satisfaction or suggestion for improvement is expected to be fed back to the SSFM team.

8.0 EXCHANGE OF INFORMATION

In Burma the requirements may be different but we could benefit more from development taking place in other countries. A certain amount of information is gained through journals, but these often go astray, but otherwise we are rather cut off. There are other parts of the world that do have the same problems that we could exchange views on. Recently Paul Starkey working in the Sierra Leone on animal equipment called for people to get together to exchange ideas and share advances that have been made. In Burma we have collected a good deal of information on draught animals. We feel also that we should contribute on this or on say on the transplanter development, or on cart construction or even wooden plough construction.

9.0 TRAINING

No trainees were available to be sent to IRRI on the agricultural engineering course. It is hoped that U Arthur Mundt, my counterpart, and U Nyunt Sein from ARI General Service Workshop can attend the Nov/Dec course. They, and U Mya Thein and U Htun Aung Phyo from AMD will visit India in December to study implements that are in use and being developed in a similar environment.

No permanent staff have been provided so no serious training has been started. The daily paid labour get some practical training. Training material as has already been accumulated can be used as soon as staff can be provided. Training material also includes that required for teaching the English of Science and Mechanics.

OUTREACH PROGRAM

Egypt

The program in Egypt was under a subcontract with the University of California at Davis and is funded by USAID. The project terminated December 31, 1985.

A report of Egypt activities follows.

Mechanization

A. El-Serafy and S. Labro

The objective of the mechanization section is to identify and/or develop machines appropriate for the average rice farms. To train farmers in the proper operation and maintenance of small machines used in rice production and to extend technical assistance to local manufacturers in the fabrication of appropriate machines.

In 1984 the mechanization section concentrated efforts in the research and development on irrigation and transplanting machines during the first half of the period and on the harvesting and threshing machines during the second.

Fabrication of the machines were made at the Project workshop and at local manufacturers. Extensive testing was conducted at the project area and field demonstrations were made at farmers' fields.

Experiments

An experiment was designed to test different treatments on land preparation and different planting methods on strip-blocks with four replications.

A. Land preparation treatments

1. One moldboard plowing, followed by disc harrowing, dry leveling and flooding.
2. One chisel plowing, followed by dry leveling and flooding.
3. One chisel plowing, followed by flooding and puddling.
4. Minimum tillage.

B. Planting methods

1. Broadcasting
2. Mechanical drilling in dry soil followed by flooding
3. Recommended transplanting (20 x 20 cm)
4. Mechanical transplanting (IRRI transplanter)
5. Mechanical transplanting (Japanese transplanter)

Data shows that moldboard plowing, discing and dry leveling before flooding produced the highest yield. Minimum tillage produced the lowest yield. No significant difference in yield from either method of chisel plowing practices.

Results of the planting methods recorded the highest yield obtained from broadcasting followed by mechanical drilling and then the recommended transplanting. No significant difference was obtained from either type of mechanical transplanting method.

Combinations of land preparation and planting methods gave the best results with moldboard plowing, discing and dry leveling before flooding and broadcast planting, there was no significant difference with mechanical drilling.

Machinery tests

Low lift pump

The project acquired seven units of the 6 inch IRRI designed axial flow low lift pumps fabricated by a Cairo manufacturer. The pumps were fitted with 7 horsepower gasoline engines. Application of these pumps gave satisfying performance.

Farmers' reactions, however, were not enthusiastic. Many still prefer the centrifugal type pump mounted on wheeled carts and driven by 10-12 hp. diesel engines.

This centrifugal type pump is more costly than the axial flow pump but less costly in operation with diesel fuel at L.E. 0.03/liter and gasoline at L.E. 0.15/liter. The centrifugal pump draws water from a greater depth.

For low-head lift (about one meter) applications, the axial flow pump proved to be more economical because of its greater capacity. It has more potential, is much easier to set up for operation, is easy to maintain and repair for the average farmer and most of all, it can be fabricated easily by local workshops.

One meter reaper

Five units of the one meter reaper and power tiller were fabricated by E.T. Trade Co. of Cairo for the Project from IRRI design. Many modifications were introduced to the design for local conditions. A 5 hp. gasoline is used for power source.

Modifications were:

1. Lowering the position of the cutting blades by modifying the hitch of the reaper to the power tiller.
2. Raising the position of the upper conveyor belt. This also affected the inclination of the starwheels.
3. Extending the front board higher.
4. Adjustment of the ground speed of the unit to the blade travel ratio to make the reaper able to work on dense crops.

Extensive tests and demonstrations were made with the units. About 135 hours working time was recorded covering approximately 54 feddans of rice harvested.

Results show that:

1. Some slight improvements in manufacturer quality will make the reaper highly acceptable to the Egyptian farmer.
2. The average working time to harvest one feddan is about 2 hours.
3. Manpower requirement to operate all day is 2 men who alternate.
4. Average fuel consumption is 1 1/2 liter per hour.
5. A favorable reaction from farmers.

E.T. Trade Co., the manufacturer has been kept informed of the problems during the trials. The manufacturer has shown great interest and has made jigs and fixtures to improve the quality and facilitate production.

Threshers

The modified Th-7 thresher units were tested on "throw-in" threshing operations. Clogging up of the long straw was minimized but still the designed capacity of 600 kg/hour could not be obtained. On the "hold on" operation, clogging was eliminated but capacity was only 250 kg/hour and the unthreshed loss could be substantial depending on the operator. During field days the Th-7 thresher did not draw much farmer enthusiasm.

The mechanization section is fabricating two Th-8 threshing units with designed capacity of one ton per hour. One unit was earlier ordered from the Philippines, but was lost enroute. The replacement has not arrived. The new units being fabricated in the Project facilities are being made from blueprints. Testing will first be done during the wheat harvest. Any modifications can be made before rice harvest, although rice harvest is much more difficult than wheat.

Conclusions

1. Based on farmers' reactions, it is obvious that appropriate mechanization is much desired by the average rice producer. He recognizes this requirement not only because of the increasing shortage and cost of farm labor but also to shorten the turn-around time between successive crops.

2. It is observed that foremost among the equipment that the rice farmers desire are those for harvesting and threshing. The small power tiller with a one-meter reaper attachment appears to be ideal for their harvesting needs. For threshing, farmers indicate the need for a thresher with about a one ton per hour capacity. The Th-8 will fill this requirement.

3. It may be noted that the local workshops in Egypt do have the interest and capacity to fabricate agricultural machines that are appropriate for the average farmer. Given the technical assistance to build machine prototypes, the local manufacturers can turn out the product with standard quality. Provided with the necessary incentive by the government, they can contribute much to advance agricultural mechanization.

Budget and Expenditures

A report of the budget and the expenditures for the period September 1, 1980 to September 30, 1985 follows.

AID-492-CA-1707
Phil. Outreach
Statement of Expenditures & Commitments
For Fiscal Year Ending September 30, 1985

	Actual Expenditures 09/01/80 08/31/84	Actual Expenditures 09/01/84 09/30/85	Actual Expenditures Total	Commitments up to 09/30/85	Total Expend. & Commitments	Total Approved Budget*	Balance
1. Salaries & Wages	$ 74,521.95	$ 25,987.67	$ 100,509.62	$ 1,000.00	$ 101,509.62	$ 197,400.00	$ 95,890.38
2. Overhead	10,225.07	3,619.05	13,844.12	150.00	13,994.12	29,000.00	15,005.88
3. Fringe Benefits & Allowances	20,111.91	6,240.45	26,352.36	100.00	26,452.36	83,710.00	57,257.64
4. Travel & Transportation	89,732.25	31,706.80	121,439.05	1,250.00	122,689.05	170,990.00	48,300.95
5. Equipment, Materials & Supplies	48,085.70	47,780.04	95,865.74	500.00	96,365.74	55,000.00	(41,365.74)
6. Training	3,294.72	2,696.42	5,991.14	-	5,991.14	39,000.00	33,008.86
7. Studies	-	1,187.77	1,187.77	-	1,187.77	23,000.00	21,812.23
8. Workshop/Evaluation	-	574.41	574.41	-	574.41	-	(574.41)
TOTALS	$ 245,971.60	$ 119,792.61	$ 365,764.21	$ 3,000.00	$ 368,764.21	$ 598,100.00	$ 229,335.79

Certified Correct:

Paul A. Cooper
Director, Budget & Accounts

* Based on original approved budget for the period September 1, 1980 to September 30, 1985.

/mpr
1.9.86

AID-492-CA-1707
Phil. Headquarters
Schedule of Expenditures
For the period September 1, 1984 - September 30, 1985

Schedule #1. Salaries & Wages

a. Senior staff August 1984 - August 1985	$280,711.94
b. Local staff September 1984 - September 1985	17,218.68
	$297,930.62

Schedule #2. Overhead

- May 1984 - June 1985 (Senior staff) June 1984 - August 1984 (Local staff)	$ 45,572.50

Schedule #3. Fringe Benefits & Allowances

a. Senior staff	
1. IIE Perquisites July 1984 - July 1985	$ 60,572.70
2. Housing & Utilities allowances September 1984 - August 1985	24,674.89
3. Post Differential allowances September 1984 - August 1985	24,207.59
4. Educational allowances 1981 - 1985	5,693.64
5. Medical allowances	59.07
	$115,207.89
b. Local staff	
1. Cost of Living Allowances (COLA) September 1984 - September 1985	$ 5,056.51
2. Social Security System (SSS) August 1984 - August 1985	351.42

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3. Retirement Savings Plan (RSP) September 1984 - August 1985		$ 1,551.84
4. Insurance, 13th Month Pay, Medical Dental etc. September 1984 - August 1985		3,504.21
		$ 10,463.98
		$125,671.87

Schedule #4. Travel & Transportation

a. Local Travel August 1984 - September 1985		$ 874.88
b. International Travel		
1. South & Southeast Asia Travel		
- Trip to Bangkok		
- Per diem & travel expenses on Aug. 24-Sept.13, 1984	$ 269.78	
- Driving services	23.75	293.53
- ATO#85-0167 Trip to India		
- Per diem & travel expenses on Feb. 23-Mar. 7, 1985	$ 499.06	
- Driving services	20.26	
- Indian visa	4.37	523.69
- ATO#84-1352 - Trip to India		
- Per diem & travel exp. on Nov. 24-Dec.2, 1985	$ 477.34	
- Airticket - Mla/Delhi/ Madras/Coimbatore/Maa/ Sin/Mla	1,439.50	
- Driving services	19.30	1,936.14
- ATO#84-0854 - Trip to India		
- Airticket - Mla/Coim-batore	$ 652.00	
- Driving services	1.63	653.63
- ATO#0296- Trip to India & Thailand		
- Airticket - Mla/Bkk/Del/ Bkk/Mla	$1,242.00	
- Per diem & travel exp. on April 8-13, 1985	489.25	
- Indian visa	5.58	
- Driving services	11.41	1,748.24

.../over

2. ASAE Meeting

- ATO#85-500 - Trip to USA		
- Airticket - Mla/East Lansing Washington/Des Moines/ Copenhagen/Bkk/Mla	$2,310.00	
- Per diem & travel exp. on June 16 - Aug. 6, 1985	974.65	$ 3,284.65
		$ 9,314.76

Schedule #5. Equipment, Materials & Supplies

a.	CPD charges for printing & photography - October 11, 1984 - Sept. 30, 1985		$ 169.70
b.	Supplies issued by IRRI Supply Room - November 16, 1984 - Sept. 15, 1985		644.08
c.	Chemicals & Laboratory Supplies - July 16, 1984 - March 15, 1985		92.35
d.	Subscriptions, Books & Periodicals		
	- P.O.#4527 - 1 copy Wood & Bamboo ISBN-058-3	$ 5.27	
	#4628 - Various publications	32.88	
	#4685 - 1 copy Understanding Sterling engines	12.44	
	#5646 - Crossley Small Farm Book	280.15	
	#5912 - Appropriate Tech. for Dev. Countires	13.11	
	#5911 - CRC Handbook of Chem. & Physics	194.70	
	#6048 - Various publications	79.50	618.05
e.	Shipping charges - April 1, 1985 - Sept. 30, 1985		98.96
f.	Various Purchase Order issued:		
	- P.O.#04181- Bruning Revolute White Opaque Paper	$7,887.41	
	#5766 - 4 Units Printer	3,809.64	
	#22860 - 2 prs. black leather shoes for uniform	14.62	
	#24387 - 1 Unit Universal plate cutter	212.17	

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- P.O.#25776 - duplication of of slides	$ 177.22	
#27563 - 4 prs. black leather shoes for uniform	30.85	
#28594 - slides processing	5.04	
#27173 - 2 units 4-drawer filing steel cabinet & 1 unit storage file cabinet	314.27	
#28875 - Small Vogel Head Thresher w/Briggs & Stratton 3HP engine	738.11	$ 13,189.33
		$ 14,812.47

Schedule #6. Training

- Three-Week Agricultural Eng'g. Course on Nov. 19 - Dec. 7, 1984		
- Bonifacio Cabahug		
- ATO#84-1405-Mla/Cebu	$ 31.01	
- Training charges	402.57	$ 433.58
- Three-Weeik Agricultural Eng'g. Training Course on May 27 to June 14, 1985		
- C. Abrina		
- Training charges	$ 420.00	
- V. Barroga		
- Training charges	525.00	945.00
		$ 1,378.58

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AID-492-CA-1707
Phil. Headquarters
Schedule of Commitments
As of September 30, 1985

Schedule #1. Salaries & Wages

a. Senior staff - August - Septembr 1985	$ 30,259.07
b. Local staff - September 1985	37.83
	$ 30,296.90

Schedule #2. Overhead

- Senior staff - July - Sept. 1985 Local staff - Aug. - September 1985	$ 10,305.00

Schedule #3. Fringe Benefits & Allowances

a. Senior staff	
1. IIE perquisites August 1985	$ 2,942.73
2. Housing & Utilities Allowances August - September 1985	1,287.73
3. Post differential allowances September 1985	1,437.49
4. Educational allowances 1985	(2,740.45)
5. Vacation leave/Medical allowance	5,680.41
	$ 8,607.91
b. Local staff	
1. Cost of living allowances (COLA) September 1985	$ 27.95

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2.	Social Security System (SSS) September 1985	$ 18.55
3.	Retirement Savings Plan (RSP) September 1985	71.60
4.	13th Month pay, Insurance, Medical & dental benefits, etc.	220.61
5.	Accrued VL/Sl taken up in 1983	2,854.63
		$ 3,193.34
		$ 11,801.25

Schedule #5. Equipment, Materials & Supplies

a. Supplies issued by General Supply Room September 1985 $ 85.37

Schedule #6. Training

Schedule #7. Studies

Schedule #8. Workshop

Agricultural Engineering Workshop on September 2 - 6, 1985 on The Role of Engineering Technologies on Small Farm Agricultural Development Project $ 40,000.00

AID-492-CA-1707

Indonesia
Statement of Expenditures & Commitments
For Fiscal Year Ending September 30, 1985

	Actual Expenditures 09/01/80 08/31/84	Actual Expenditures 09/01/84 09/30/85	Actual Expenditures Total	Commitments up to 09/30/85	Total Expend. & Commitments	Total Approved Budget*	Balance
1. Salaries & Wages	$ 67,018.78	$ 16,843.94	$ 83,862.72	$ 2,338.35	$ 86,201.07	$ 86,690.00	$ 488.93
2. Overhead	9,532.80	2,436.63	11,969.43	702.13	12,671.56	11,840.00	(831.56)
3. Fringe Benefits & Allowances	10,583.95	3,665.53	14,249.48	1,952.52	16,202.00	37,040.00	20,838.00
4. Travel & Transportation	83,239.52	23,059.68	106,299.20	8,803.90	115,103.10	80,450.00	(34,653.10)
5. Equipment, Materials & Supplies	123,852.71	43,613.34	167,466.05	2,279.17	169,745.22	63,000.00	(106,745.22)
6. Training	18,744.95	9,256.11	28,001.06	209.01	28,210.07	29,280.00	1,069.93
7. Studies	-	-	-	-	-	29,000.00	29,000.00
8. Workshop/Evaluation	-	34,371.51	34,371.51	-	34,371.51	-	(34,371.51)
TOTALS	$ 312,972.71	$ 133,246.74	$ 446,219.45	$ 16,285.08	$ 462,504.53	$ 337,300.00	($ 125,204.53)

Certified Correct:

Paul A. Cooper
Director, Budget & Accounts

* Based on original approved budget for the period September 1, 1980 to September 30, 1985.

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AID-492-CA-1707
Indonesia
Schedule of Expenditures
For the period September 1, 1984 - September 30, 1985

Schedule #1. Salaries & Wages

a. Local staff - August 1984 - August 1985	$ 9,296.90
b. DITPROD staff - July 1984 - August 1985	4,503.07
c. Honorarium - July 1984 - September 1985	3,043.97
	$ 16,843.94

Schedule #2. Overhead

- Local staff - May 1984 - May 1984 - July 1985 DITPROD staff - May 1984 - July 1985 Honorarium - April 1984 - July 1985	$ 2,436.63

Schedule #3. Fringe Benefits & Allowances

- For local staff

1. Retirement Savings Plan August 1984 - August 1985	$ 774.24
2. Medical July 1984 - August 1985	789.28
3. Insurance Jan. 1985 - September 1985	1,005.07
4. Others (Lebaran Bonus, dismissal pay etc.) - August 1984 - September 30, 1985	1,096.94
	$ 3,665.53

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Schedule #4. Travel & Transportation

a. Local travel		
- July 1984 - August 1985		$ 8,959.03
b. Repairs & maintenance of motor vehicles		
- July 1984 - August 1985		858.67
c. International travel		
1. South & Southeast Asia travel		
- Trip to IRRI, Los Banos		
- Airticket - Jkt/Sin/Mnl/ Sin/Jkt	$ 475.00	
- Per diem & travel exp. Sept. 26-Oct. 2, 1984	265.25	
- Driving services	9.02	749.27
- Trip to IRRI, Los Banos		
- Airticket - Jkt/Sin/Mnl/ Sin/Jkt	$ 497.07	
- Per diem & travel exp. on Oct. 9-13, 1984	119.00	
- Driving services	8.31	624.38
- Trip to IRRI, Los Banos		
- Airticket - Jkt/Sin/Mnl/ Sin/Jkt	$ 475.00	
- Per diem & travel exp. on May 20-June 8, 1985	538.80	
- Driving services	21.69	1,035.49
2. Emergency travel		
- Evacuation of Mrs. Reddy to U.S. on October 1983		1,710.87
3. Scientific Meeting		
- ASAE Meeting in Knoxville, Tennessee		
- Per diem & travel exp. in June 1984	$ 398.78	
- ASAE Meeting in East Lansing		
- Airticket - Jkt/Sin/SFO/ Chicago/Lansing/Wash/SFO/ Sin/Jkt	3,073.40	
- Per diem & travel exp. on June 16-July 3, 1985	814.83	
- Penalty charge due to non-use of U.S. flag-carrier in 1981-1983	(2,272.04)	2,014.37

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4. Storage charges For the period September 1, 1980 to September 30, 1985		$ 7,107.60
		$ 23,059.68

Schedule #5. Equipment, Materials & Supplies

a.	Office rent, office supplies, telegram telex, photocopying services etc. July 1984 - August 1985		$ 9,192.06
b.	Raw materials & shop supplies July 15, 1984 - August 1985		5,168.34
c.	Shipping, delivery charges, mailing of various documents & machines June 1984 - August 1985		2,654.59
d.	Publications /Periodicals		
	- Int'l. Herald Tribune & Interface age	$ 323.60	
	- Appropriate Tech. Magazine	13.42	
	- Computer Books D Base III	9.12	
	- Library magazines	22.62	
	- Int'l Business Weekly Magazine	2.99	
	- 1 book IBM Personal computer	13.54	
	- 1 book Microsoft Softcard	8.14	
	- 1 book - The Power Lotus	11.76	
	- Annual subscription - Published Machinery Market - 1984 Oct.-1985 Sept.	45.34	
	- Far Eastern Eco. Review	25.63	476.16
e.	Others		
	- 3 sets reaper blades	$ 49.95	
	- 1 unit diesel engine 4HP	226.63	
	- 1 unit diesel engine 6HP	306.89	
	- Video tape, music, mixing & narration processing charges	260.62	
	- Standard version - Indonesian to English version	63.53	
	- 4 Threshers	1,512.29	
	- 3HP engine pulley	187.85	

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- 1 Unit IBP PC microcomputer & 1 printer inc. 1 year maintainance cost	$10,100.00	
- Editing & voice recording	339.30	
- 1 set table w/ mirror for computer	164.82	
- Voice recording over Indonesian version	138.76	
- Tapes used for voice recording	351.53	
- 2 units trailer - 3/4 ton	600.74	
- 2 units trailer 1/2 ton	554.53	
- 1 unit Hand tractor w/o engine	1,167.96	
- 2 units 4-wheel tractor Model JCT 0101 belt driven transmission system including shipment	8,488.81	
- 1 unit 2-wheel tractor 9HP w/cagewheel	1,329.63	
- 1 unit Inclined plate planter	111.11	
- 1 rolling injection planter	92.59	
- 1 cyclone seeder	22.22	$ 26,069.76
g. Miscellaneous		52.43
		$ 43,613.34

Schedule #6. Training

a. Three-Week Agricultural Eng'g. Training Course on Nov. 19-Dec. 7, 1984 (with extension up to Dec. 16, 1984)

- Dahlan Wiwoho		
- Airticket - Jkt/Sin/Mnl/Sin/Jkt & Banda Aceh/Jkt	$ 817.66	
- Training charges	718.07	
- Pre-& Post-departure allow.	150.00	
- Exit permit fee	216.46	$ 1,902.19
- K. Tastra		
- ATO#84-1459 - excess baggage		111.00

b. Three-week Agricultural Eng'g. Training course on May 27-June 14, 1985

- Syamir Salim		
- Airticket - Jkt/Sin/Mnl/Sin/Jkt	$ 475.00	
Jkt/Pdg/Jkt	180.10	
- Training charges	525.00	
- Pre-& Post-departure allow.	150.40	
- Exit permit fee	134.41	1,464.91

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- Mr. Syamsuri		
- Airticket - Jkt/Sin/Mnl/ Sin/Jkt	$ 475.00	
- Jkt/UPG/Jkt	245.28	
- Training charges	525.00	
- Pre & Post departure allow.	150.40	
- Exit permit fee	134.41	$ 1,530.09

c. Three-Week Agricultural Eng'g. Training charges on Aug. 15-29, 1985

- Mr. Astu Unadi		
- Airticket - Jkt/Sin/Mnl/Sin/ Jkt	$ 475.00	
- Training charges	379.17	
- Pre-&Post-departure allow.	75.00	929.17

d. Local training

- Local training held in Bukittinggi in June 1985 on the Design & Making Power Thresher	3,318.75
	$ 9,256.11

Schedule #7. Studies

Schedule #8. Workshop/Evaluation

- Evaluation Team (January 16 - February 12, 1985)

a. Dr. Joseph Campbell		
- Airticket - New York/London/Jkt/ Mnl/Tokyo/New York	$2,988.00	
- Consultancy fee	6,600.00	
- Per diem & travel exp.	2,454.37	$ 12,042.37
b. Dr. Sam Johnson		
- Airticket - Champaign, Ill./ Tokyo/Hkg/Jkt/Mla/Tokyo/ Chicago/Champaign	$3,647.82	
- Consultancy fee	6,800.00	
- Per diem & travel exp.	2,502.82	12,950.64

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c.	Dr. Siswadhi Soepardjo - Consultancy fee, per diem & travel expenses		$ 3,290.00
d.	Dr. Faisal Kasryno - Consultancy fee, per diem & travel expenses		2,982.75
e.	Others (Miscellaneous)		
	- Local travel of evaluation team Jkt/UPG/Jkt	$ 981.39	
	- Local travel (Domestic airticket while in Indonesia & Manila, typing, photocopying, postage gasoline, overtime of driver, toll fees etc.	2,124.36	3,105.75
			$ 34,371.51

AID-492-CA-1707
Indonesia
Schedule of Commitments
As of September 30, 1985

Schedule #1. Salaries & Wages

a. Local staff - September 1985	$ 2,026.24
b. DITPROD Staff - September 1985	312.11
	$ 2,338.35

Schedule #2. Overhead

- Local staff - August - September 1985 DITPROD staff - August - September 1985 Honorarium - August - September 1985	$ 702.13

Schedule #3. Fringe Benefits & Allowances

a. Retirement Savings Plan - September 1985	$ 55.65
b. Medical - September 1985	(4.64)
c. Insurance - September 1985	(119.05)
d. Others (Lebaran bonus, dismissal pay, etc.) - September 1985	2,020.56
	$ 1,952.52

Schedule #4. Travel & Transportation

a. Local travel - September 1985	$ 999.03
b. Repairs & maintenance of motor vehicles - September 1985	139.90

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c. International Travel

1. South & Southeast Asia travel

- Trip to IRRI, Los Banos		
- Airticket - Jkt/Sin/Mnl/ Sin/Jkt	$ 475.00	
- Per diem & travel expt. on Aug. 31-Sept.9, 1985	522.06	$ 997.06

2. Terminal travel

- V.R. Reddy & Mrs. U. Reddy		
- Airticket - Jkt/Sin/ Maa/Hyd	$1,206.00	
- Exit permit fee, airport pass, customs clearnace for shipment of personal effects, etc.	51.91	1,257.91

3. Shipment of Personal effects

- Airfreight & seafreight	5,410.00
	$ 8,803.90

Schedule #5. Equipment, Materials & Supplies

a.	Office rent, office supplies, telegram, telex, photocopying services etc. - September 1985	$ 1,027.97
b.	Raw materials & shop supplies - September 1985	205.40
c.	Shipping, delivery charges, mailing, of various documents & machines - September 1985	574.49
d.	Publications & Periodicals - Int'l. Herald Tribune	24.49
e.	Others	
	- 1 Pc. Beta - NTSC - Master Edit $ 312.78	
	- 3 Pcs. Beta -NTSC copies 67.02	
	- Transfercost - Umatic to VHS 67.02	446.82
		$ 2,279.17

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Schedule #6. Training

- Three-Week Agricultural Training Course on August 15-29, 1985

- Astu Unadi		
- Post-departure allow.	$ 75.20	
- Exit permit fee	133.81	$ 209.01

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AID-492-CA-1707
Thailand
Statement of Expenditures & Commitments
For Fiscal Year Ending September 30, 1985

	Actual Expenditures 09/01/80 08/31/84	Actual Expenditures 09/01/84 09/30/85	Actual Expenditures Total	Commitments up to 09/30/85	Total Expend. & Commitments	Total Approved Budget*	Balance
1. Salaries & Wages	$ 68,739.86	$ 35,898.29	$ 104,638.15	$ 1,944.89	$ 106,583.04	$ 107,170.00	$ 586.96
2. Overhead	8,908.85	5,774.66	14,683.51	984.20	15,667.71	14,600.00	(1,067.71)
3. Fringe Benefits & Allowances	17,096.48	6,733.66	23,830.14	2,833.12	26,663.26	45,800.00	19,136.74
4. Travel & Transportation	51,897.92	28,706.44	80,604.36	11,192.10	91,796.46	68,500.00	(23,296.46)
5. Equipment, Materials & Supplies	60,160.31	26,757.42	86,917.73	790.57	87,708.30	50,000.00	(37,708.30)
6. Training	12,673.62	9,502.92	22,176.54	2,325.14	24,501.68	25,630.00	1,128.32
7. Studies	288.39	14,335.45	14,623.84	175.00	14,798.84	24,000.00	9,201.16
	$ 219,765.43	$ 127,708.84	$ 347,474.27	$ 20,245.02	$ 367,719.29	$ 335,700.00	($ 32,019.29)

Certified Correct:

Paul A. Cooper
Director, Budget & Accounts

* Based on original approved budget for the period September 1, 1980 to September 30, 1985.

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1.9.86

AID-492-CA-1707
Thailand
Schedule of Expenditures
For the period September 1, 1984 - September 30, 1985

Schedule #1. Salaries & Wages

- Local staff July 1984 - August 1985	$ 35,898.29

Schedule #2. Overhead

- Local staff April 1984 - August 1985	$ 5,774.66

Schedule #3. Fringe Benefits & Allowances

a. Retirement Savings Plan (RSP) - July 1984 - August 1985	$ 2,479.04
b. Medical Plan & Allowances - July 1984 - August 1985	1,573.42
c. Insurance (Group Life Insurance) - July 1984 - August 1985	1,365.59
d. Vacation leave credits & other benefits - up to September 30, 1985	1,315.61
	$ 6,733.66

Schedule #4. Travel & Transportation

a. Local travel - July 1984 - August 1985	$ 17,332.30
b. Repairs & maintenance of motor vehicles - July 1984 - August 1984	1,656.42
c. International travel (B.J. Cochran)	
1. South & Southeast Asia travel	

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a. Trip to IRRI, Los Banos		
- Airticket - Bkk/Mla/Hkg/Bkk	$ 431.74	
- Per diem & travel expenses on Oct. 10-12, 1984	200.45	
- Driving services	1.85	$ 634.04
b. Trip to IRRI, Los Banos		
- Airticket - Bkk/Mnl/Bkk	$ 434.63	
- Per diem & travel expenses on Apr. 8-15, 1985	374.26	808.89
c. Trip to Kuala Lumpur, Malaysia		
- Airticket - Bkk/Kul/Bkk	$ 228.33	
- Per diem & travel expenses on May 6-8, 1985	283.44	511.77
d. Trip to IRRI, Los Banos		
- Airticket - Bkk/Mnl/Bkk	$ 301.85	
- Per diem & travel expenses on June 1-10, 1985	537.19	839.04
e. Trip to Indonesia & Manila		
- Airticket - Bkk/Jkt/Mnl/Bkk	$ 466.48	
- Driving services in Manila	15.51	481.99
2. Scientific Meetings		
a. ASAE Meeting in New Orleans, Louisiana and trip to Manila		
- Airticket - Bkk/Hkg/SFO/ New Orleans/Salt Lake City/ Tokyo/Manila/Bkk	$2,719.57	
- Per diem & travel expenses on Dec. 9-30, 1984	638.14	3,357.71
b. ASAE Meeting in East Lansing		
- Airticket - Bkk/Tokyo/SFO/ Detroit/SFO/Tokyo/Bkk	$2,466.30	
- Per diem & travel expenses on June 23 - July 20, 1985	617.98	3,084.28
		$ 28,706.44

Schedule #5. Equipment, Materials & Supplies

a. Share in Bangkok office expenses - July 1984 - August 1985	$ 6,080.42
b. Telex, long distance, cables & other charges - February 1984 - August 1985	1,180.84

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c. Office supplies
- July 1984 - August 1985 $ 2,256.66

d. Rental of photocopying machine
- July 1984 - August 1985 832.04

e. Printing
- April - August 1985 419.20

f. Others

- 3 units inclined plate planter	$ 456.52
- 10 units cyclone seeder	217.39
- 1 unit exp. cyclone seeder	30.43
- 1 unit datashield battery packup & amber screen monitor including freight	586.95
- 1 unit ink jet printer & 1 pc. cable	432.00
- 1 Think jet, parallel cable & think jet printhead	491.70
- 1 unit writing desk 1001 size 60" x 36"	152.17
- 1 unit Junior executive chair	59.30
- DOS 2.0 operating siplem	108.70
- Editing fee	252.17
- 2 boxes diskette 3M 5-1/4	139.13
- 2 boxes CSF Form	30.43
- 15 units Buffalo plow w/ frame	124.18
- 10 rolls bluepring paper	69.56
- 19 units cyclone seeder	413.04
- 1 unit exp. cyclone seeder	30.43
- Periodicals for the project	44.96
- 1 Unit IBM Computer 256K,2 diskette drive, 1 printer & accessories	6,604.55
- 1 Thai feature (Thai basic)	782.61
- 1 Sola power conditioners	2,565.22
- Computer diskettes	101.74
- Screen wire for planting seedlings	9.83
- Insurance Premium, tax for IBM computer	27.26
- 25 units push-pull weeders w/ pin & blade	69.44
- 1 Part 811 ML 111L-99 balde for Gestetner machine	7.78
- Brokergage charges for IBM Portable Computer (Handling & Processing	22.84
- 1 unit Thresher Model Thanya 100	611.11

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- 1 set pipe #103	$ 74.07	
- 20 units cyclone seeder	370.37	
- 1 unit Tropicultor operator manual	10.30	
- 4 units Inclined Plate planter	444.44	
- 4 units rolling injection planter	370.37	
- 1 unit video tape adaptor	58.00	
- miscellaneous	219.27	$ 15,988.26
		$ 26,757.42

Schedule #6. Training

1. Three-week Agricultural Eng'g. Training Course on Nov. 19- Dec. 7, 1984

- A. Therdteppitak & W. Amaritsut		
- Training charges	$1,015.14	
- Airticket - Bkk/Mla/Bkk	868.70	
- Pre & Post-departure allow.	300.00	
- Excess baggage allowance of W. Amaritsut	76.20	$ 2,260.04

2. Three-week Agricultural Eng'g. Training Course on May 27-June 14, 1985

- B. Kunjara		
- Training charges	$ 525.00	
- Airticket - Bkk/Mnl/Bkk	338.89	
- Pre & Post-departure allow.	150.00	
- Excess baggage	51.20	
	$1,065.09	
- D. Thongswatong		
- Training charges	$ 525.00	
- Bkk/Mnl/Bkk	338.89	
- Pre & Post-departure allow.	150.00	
	$1,013.89	2,078.98

3. Local Training

a. Machinery Training Course at Prae on Feb. 19-21, 1985	$1,278.86	
b. Manufacturers Training Course in Khon Kaen on July 15-20, 1985	3,885.04	5,163.90
		$ 9,502.92

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Schedule #7. Studies

- Salaries, benefits, local travel, supplies, car maintenance and training charges of Somporn Saitan & 7 enumerators for the period July 1984 to August 1985	$ 14,335.45

AID-492-CA-1707
Thailand
Schedule of Commitments
As of September 30, 1985

Schedule #1.	Salaries & Wages		
	- Local staff - September 1985		$ 1,944.89
Schedule #2.	Overhead		
	- Local staff - as of September 1985		$ 984.20
Schedule #3.	Fringe Benefits & Allowances		
	a. Retirement Savings Plan (RSP) - as of September 30, 1985		$ 3,270.96
	b. Medical Plan - As of September 30, 1985		(437.84)
			$ 2,833.12
Schedule #4.	Travel & Transportation		
	a. Local travel - as of September 30, 1985		$ 761.36
	b. Repairs & maintenance of motor vehicles - as of September 1985		9.03
	c. International travel (B.J. Cochran)		
	1. South & Southeat Asia travel		
	a. Trip to Indonesia & Manila - Per diem & travel expenses on Aug. 25-Sept. 11, 1985	$1,170.39	
	- Local travel while in Indonesia	44.65	1,215.04

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2. Terminal Travel

- Airticket - Bkk/Tokyo/SFO/ Dallas/Baton Rouge	$1,206.67	
- Shipment of personal effects	8,000.00	$ 9,206.67
		$ 11,192.10

Schedule #5. Equipment, Materials & Supplies

a. Share in Bangkok office expenses - September 1985	$ 492.07
b. Telex, telephone, cables, & other charges - September 1985	44.30
c. Office supplies - September 1985	211.97
d. Rental of photocopying machine - September 1985	5.19
e. Others - September 1985	37.04
	$ 790.57

Schedule #6. Training

a. Local training

- BAAC Training Course held in Chainat on September 24-26, 1985	$ 2,325.14

Schedule #7. Studies

- Other training charges of Somporn Saitan as of September 30, 1985	$ 175.00

AID-492-CA-1707

India
Statement of Expenditures & Commitments
For Fiscal Year Ending September 30, 1985

	Actual Expenditures 09/01/80 08/31/84	Actual Expenditures 09/01/84 09/30/85	Actual Expenditures Total	Commitments up to 09/30/85	Total Expend. & Commitments	Total Approved Budget	Balance
1. Salaries & Wages	$ -	$ 5,939.91	$ 5,939.91	$ 8,000.00	$ 13,939.91	$ 101,600.00	$ 87,660.09
2. Overhead	-	939.78	939.78	1,180.00	2,119.78	14,900.00	12,780.22
3. Fringe Benefits & Allowances	-	-	-	-	-	38,000.00	38,000.00
4. Travel & Transportation	3,166.39	21,017.15	24,183.54	120.00	24,303.54	113,200.00	88,896.46
5. Equipment, Materials & Supplies	8,403.50	41,301.61	49,705.11	2,700.00	52,405.11	113,000.00	60,594.89
6. Training	14,906.28	1,646.72	16,553.00	-	16,553.00	45,000.00	28,447.00
7. Studies	-	-	-	-	-	29,000.00	29,000.00
	$ 26,476.17	$ 70,845.17	$ 97,321.34	$ 12,000.00	$ 109,321.34	$ 454,700.00	$ 345,378.66

Certified Correct:

Paul A. Cooper
Director, Budget & Accounts

* Based on original approved budget for the period September 1, 1980 to September 30, 1985.

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1.9.86

AID-492-CA-1707
India
Schedule of Expenditures
For the period September 1, 1980 - September 30, 1985

Schedule #1. Salaries & Wages

- Local staff	
- July 1984 - December 1984	
- July 1984 - August 1985 (Hourlyhelp)	$ 5,939.91

Schedule #2. Overhead

- Local staff - July - Dec. 1984	
- Hourlyhelp - July 1984 - August 1985	$ 939.78

Schedule #3. Fringe Benefits & Allowances

Schedule #4. Travel & Transportation

a.	Local travel		
	- July 1984 - August 1985		$ 8,600.53
b.	Repairs & maintenance of motor vehicles		
	- March - August 1985		123.18
c.	International Travel (F.E. Nichols)		
	1. Joining travel		
	- Airticket - Philadelphia/ New York/India	$1,355.75	
	- Transp. of household goods	36.42	1,392.17
	2. South & Southeast Asia travel		
	- Trip to IRRI, Los Banos		
	- ATO#84-0928 - airticket Mnl/Delhi	$ 338.00	
	- Per diem & travel expenses on Aug. 16 - Sept. 7, 1984	1,118.77	
	- Driving services	18.59	1,475.36

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- Trip to IRRI, Los Banos w/ trip to Delhi & Madras up to Nov. 5, 1985		
- Per diem & travel expenses	$1,877.83	
- Driving services	1.85	$ 1,879.68
3. R&R Travel (w/ trip to IRRI, Los Banos)		
- Airticket Coimbatore/Madras/Mnl/ Coimbatore Coimbatore/Delhi/Greece/ Coimbatore	$2,152.13	
- Per diem & travel exp. to Manila & other provinces of India on May 22 - June 11, 1985	1,473.13	
- Driving services	19.37	
- Entry visa of FEN	4.37	3,649.00
4. Scientific Meetings		
- ASAE Meeting in East Lansing		
- Airticket - Coimbatore/ Bangalore/Delhi/NY/Phil/ Detroit/Lansing/Phil/Delhi Bombay/Coimbatore	$2,198.46	
- Per diem & travel expenses on June 18-July 13, 1985	711.70	2,910.16
5. Trip to IRRI, Los Banos (P. Datt)		
- Airticket - Coimbatore/Madras/ Mnl/Madras/Coimbatore		987.07
		$ 21,017.15

Schedule #5. Equipment, Materials & Supplies

a. CPD charges for printing & photography 1984	$ 6.20
b. Photo & photocopies August 1984 - August 1985	90.78
c. Office supplies July 1984 - August 1985	1,665.51
d. Mailing, delivery, telegram, freight, telex and other charges July 1984 - August 1985	1,573.60

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e.	Raw Materials - August 1984 - August 1985		$ 1,934.51
f.	Equipment & shop tools - July 1984 - August 1984		7,123.83
g.	Furnitures, Fixtures & Fittings - July 1984 - December 1984		2,596.77
h.	Vehicles including cycles - July 1984 - December 1984		12,558.11
i.	Library books and periodicals - July 1984 - December 1984		26.13
j.	Others		
	- 1 Unit Car - Indian Origin	$7,031.39	
	- 1 Unit Kelvinator Automatic Ref Model#K286 Type#119 Chassis #Cr 110176 Compressor #189815620 w/ stand	614.64	
	- Materials for bathroom - accrylic soap disc, yellow & accrylic towel rod 24"	10.36	
	- 1 Unit Venus automatic Water heater w/ pressure release valve Model#B35A S.N. 30L 3285 including installation	164.24	
	- Tarpaulin	49.76	
	- Stop Watch	45.15	
	- Home Furnishings		
	- Sofa set (3 seater)	503.38	
	- Centre table	71.49	
	- Wall unit	203.05	
	- 6 x 3 dining set w/o chairs	450.85	
	- Bed stand	180.88	
	- Bed table	75.30	
	- Mirror - square type	14.81	
	- Toilet paper holder	3.65	
	- Ixor line cooking range	414.55	
	- 2 units wardrobe 6½x4x2 half hanging & shelves covered w/ natural tick formica	839.00	
	- Small table	25.38	
	- 2 units - "MM" foam mattress 75"x36"x6"	202.92	

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- 1 steel cabinet	$ 136.00	
- Curtain, curtain rods inc. installation	203.31	
- 1 unit Axial Flow Thresher	1,068.97	
- 1 unit Axial Flow Thresher TH-8	1,409.60	$ 13,718.68
k. Miscellaneous		7.49
		$ 41,301.61

Schedule #6. Training

- Three-Week Agricultural Engineering Training Course on May 27-June 14, 1985

- Mr. Mangal Singh		
- Airticket - Delhi/Mla/Hkg/Delhi	$ 939.20	
- Luahiana/Delhi	17.52	$ 956.72
- Training charges		525.00
- Pre-departure allowance		75.00
- Excess baggage		90.00
		$ 1,646.72

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AID-492-CA-1707
India
Schedule of Commitments
As of September 30, 1985

Schedule #1. Salaries & Wages

- Local staff - Jan. - Sept. 1985
  Hourlyhelp - September 1985 $ 8,000.00

Schedule #2. Overhead

- Local staff - Jan. - Sept. 1985
  Hourlyhelp - September 1985 $ 1,180.00

Schedule #3. Fringe Benefits & Allowances

Schedule #4. Travel & Transportation

- Local travel for the month
  of September 1985 $ 120.00

Schedule #5. Equipment, Materials & Supplies

- Various supplies and other purchases $ 2,700.00

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AID-492-CA-1707
Summary
Statement of Expenditures & Commitments
For Fiscal Year Ending September 30, 1985

	Actual Expenditures 09/01/80 08/31/84	Actual Expenditures 09/01/84 09/30/85	Actual Expenditures Total	Commitments up to 09/30/85	Total Expend. & Commitments	Total Approved Budget*	Balance
1. Salaries & Wages	$ 894,949.53	$ 382,600.45	$1,277,549.98	$ 43,580.14	$1,321,130.12	$1,540,390.00	$ 219,259.88
2. Overhead	121,685.00	58,342.62	180,027.62	13,321.33	193,348.95	224,340.00	30,991.05
3. Fringe Benefits & Allowances	475,904.62	142,311.51	618,216.13	16,686.82	634,902.95	1,158,500.00	523,597.05
4. Travel & Transportation	274,302.45	113,804.83	388,107.28	21,366.00	409,473.28	569,860.00	160,386.72
5. Equipment, Materials & Supplies	254,925.63	174,264.88	429,190.51	6,355.11	435,545.62	364,000.00	(71,545.62)
6. Training	76,195.49	24,480.75	100,676.24	2,534.15	103,210.39	170,910.00	67,699.61
7. Studies	288.39	15,523.22	15,811.61	175.00	15,986.61	132,000.00	116,013.39
8. Workshop/Evaluation	-	34,945.92	34,945.92	40,000.00	74,945.92	190,000.00	115,054.08
TOTALS	$2,098,251.11	$ 946,274.18	$3,044,525.29	$ 144,018.55	$3,188,543.84	$4,350,000.00	$1,161,456.16

Certified Correct:

Paul A. Cooper
Director, Budget & Accounts

* Based on original approved budget for the period September 1, 1980 to September 30, 1985.

/mpr
1.9.86

AID-492-CA-1707
Phil. Outreach
Schedule of Expenditures
For the period September 1, 1980 - September 30, 1985

Schedule #1. Salaries & Wages

a. Local staff September 1984 - September 1985	$ 12,695.59
b. BPI Personnel (Honorarium) August 1984 - August 1985	13,292.08
	$ 25,987.67

Schedule #2. Overhead

- June 1984 - August 1985 (Local staff) May 1984 - August 1985 (BPI Personnel)	$ 3,619.05

Schedule #3. Fringe Benefits & Allowances

a. Cost of Living Allowances (COLA) Sept. 1984 - September 1985	$ 3,718.87
b. Social Security System (SSS) August 1984 - August 1985	200.64
c. Retirement Savings Plan (RSP) Sept. 1984 - September 1985	1,032.01
d. 13th Month Pay and other benefits July 1984 - August 1985	1,288.93
	$ 6,240.45

Schedule #4. Travel & Transportation

a. Local travel August 1984 - August 1985	$ 27,451.73
b. Repairs & maintenance of project vehicle September 1984 - August 1985	1,203.07

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c. International travel

- Attendance to Scientific Meeting
  - ATO# 85-0675 - Mla/London/Wash/Dayton Lansin/Chicago/Sta. Barbara/LA/ Tokyo/Mla to attend ASAE Meeting in East Lansing & to go to England $ 3,052.00

$ 31,706.80

Schedule #5. Equipment, Materials & Supplies

a.	Office supplies including supplies issued by IRRI supply room August 14, 1984 - August 1985		$ 840.33
b.	CPD charges for printing & photography July 27, 1984 - August 1985		592.56
c.	Chemicals & laboratory supplies August 16, 1985		9.64
d.	Shipping charges, mailing, photocopying services, telegram, etc.		1,865.21
e.	Raw materials & shop supplies August 14, 1984 - August 1985		10,668.04
f.	Shop tools April - August 1985		313.17
g.	Purchase Orders issued:		
	P.O.#24157 - Turtle Power tiller	$ 390.84	
	#24386 - 1 unit Jaspe Super tiller	335.01	
	#23721 - 2 units 6-row rice transplanter, 3 units 8-row transplanter	603.02	
	#03918 - 1 set general maintenance welding kit	312.66	
	#22860 - Plain black leather shoes for uniform	7.31	
	#25775 - Blow-up print mounted & slide processing	10.45	
	#26207 - 3 units 8-row transplanter	334.35	
	1 Unit Sharp Calculator Model CS 10653	81.34	

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P.O.#26442 - Adjustable wrench & slip joint plier	$ 53.09
#26763 - 1 unit Turtle power tiller (Mini)	305.03
#04209 - 1 unit Chimney type rice hull stove#2	372.41
#28304 - 5 units tapak-tapak pump & 1 unit thresher/sheller	698.71
#28035 - 6 units lowlift tapak-tapak pump & 4 unit 6-row rice transplanter	659.59
#04800 - 1 unit S-10 GM Pick-up Model CS-10653 Chevy	10,592.43
#28595 - 5 units open-well tapak-tapak pump	137.74
#28649 - Potato chipping machine, cage wheel (various sizes), traction tire, alternating angles & blades	479.34
#31786 - 1 pr. black leather shoes for uniform	7.71
#29158 - 1 unit grain master multi-crop thresher/sheller/husker	4,052.16
#29466 - 1 unit lathe machine	1,778.04
#29650 - 1 unit electric motor	84.57
#29635 - 4 pcs. Ga. 24x4x8 G.I. Plain sheel galva-bond	66.04
#29672 - Job order for bending single bend for size 3/16 x 4'	6.60
#29755 - 4 units TR4 transplanter 6-rows	484.31
#30156 - 1 unit TH-8 Axial flow thresher	986.81
#30225 - 3 units Mini-Thresher/Sheller	2,474.56
#30714 - Various tools	282.52
#31652 - 1 unit trailer & 1 set thresher/sheller	494.51
#31709 - 1 unit heated air system for Rotary dryer & 1 unit rotary dryer cylinder	4,556.96

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P.O.#32087 - Various tools & supplies	$ 113.64	
#32577 - 2 units floating power tiller & 3 units sipa pump	1,170.52	
#31948 - Pillow block size 5/8" for sipa pump	31.16	
#32576 - 1 unit drying cylinder & jacket conversion of dryer base	218.67	
#32215 - Job Order for modification of TH8 thresher & sheller	27.35	
#32853 - 5 sets tapak-tapak pump	355.19	
#32835 - 1 copy Chemical Eng'g. Handbook	15.59	
#32992 - 1 unit floating tiller	136.46	
04580 - 1 unit Caramte Projector Model 8344 complete w/accessories	515.10	$ 33,231.79
h. Miscellaneous		259.30
		$ 47,780.04

Schedule #6. Training

a. Three-Week Agricultural Engineering Training Course on Nov. 19-Dec. 7, 1984	
- Quirino de Sagun & Henry Icatlo - Training charges	$ 805.14
b. Three-Week Agricultural Engineering Training Course on May 27 - June 14, 1985	
- Mr. Gappi, Mr. V. Piamonte & Mr. Abalos - Training charges	1,365.00
c. Local Training Training for KABSAKA Members	526.28
	$ 2,696.42

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Schedule #7. Studies

- Honoraria in improving the design & fabrication of tapak-tapak pump for the period August 19-23, 26-30, 1985 for Mr. Gunnar Barnes, including charges for meals and driving services	$ 1,187.77

Schedule #8. Workshop/Evaluation

- Consultancy fee, travel expenses and others for the evaluation team	$ 574.41

AID-492-CA-1707
Phil. Outreach
Schedule of Commitments
As of September 30, 1985

Schedule #1. Salaries & Wages

- BPI Personnel (Honorarium) September 1985	$ 1,000.00

Schedule #2. Overhead

- Local staff & BPI Personnel	$ 150.00

Schedule #3. Fringe Benefits & Allowances

- Social Security System & Other benefits for the month of September 1985	$ 100.00

Schedule #4. Travel & Transportation

- Local travel, repairs & maintenance of project vehicle for the month of Sept. 1985	$ 1,250.00

Schedule #5. Equipment, Materials & Supplies

- Various purchases, supplies, CPD charges, etc.	$ 500.00

PROGRAM SCHEDULE

Three-Week Agricultural Engineering Training Course
May 27 - June 14, 1985

FIRST WEEK

May 27, Monday

8:00 - 8:15	Welcome (Seminar Room A, Chandler Hall)	M. D. Pathak
8:15 - 8:45	IRRI Agricultural Engineering and Industrial Extension Program	C. W. Bockhop
8:45 - 9:15	Slide Show on "The Rices of IRRI"	Visitor's Bureau
9:15 - 9:30	Preparation for Introduction of Trainees	Move to Ag. Eng'g. Conference Rm.
9:30 - 10:00	Introduction of Trainees and IRRI Staff	R. E. Stickney
10:00 - 10:30	Coffee Break	
10:30 - 11:00	Ticket Confirmation and Travel Schedule	Jet Travel
11:00 - 11:30	Stipend, Allowances and Excess Baggage Coupon Processing	A. Eleazar
11:30 - 1:00	Lunch Break	
1:00 - 3:00	Basic Concepts in Agricultural Economics: Farm Planning and Budgeting	Z. F. Toquero
3:00 - 3:15	Coffee Break	
3:15 - 5:00	IRRI Engineering Drawing System	F. Jalotjot

May 28, Tuesday

8:00 - 9:45	Farm Economics: Undiscounted Techniques for Investment Appraisal-Breakeven Analysis (BEP) and Payback Period (PBP)	Z. F. Toquero
9:45 - 10:00	Coffee Break	
10:00 - 12:00	Power Tillers	I. Manalili
12:00 - 1:00	Lunch Break	
1:00 - 5:00	Field Practice: Transplanter, Reaper, Thresher, Axial Flow Pump and Power Tiller (with plow, rotavator and harrow)	A. Vasallo

May 29, Wednesday

8:00 - 9:30	Tillers: Economic Analysis (using BEP)	C. Maranan
9:30 - 9:45	Coffee Break	
9:45 - 10:45	Extension Program: Past Experiences in the Philippines	R. E. Stickney
10:45 - 12:00	Power Tillers: Field Test and Measurements	A. Caballes
12:00 - 1:00	Lunch Break	
1:00 - 5:00	Shop Work: Power Tillers	IM/Dungo

May 30, Thursday

8:00 - 10:00	Manual Transplanter	G. Salazar/AV/ ED
10:00 - 10:15	Coffee Break	
10:15 - 12:00	Transplanter: Field Test and Measurements; Seedling Preparation	AV
12:00 - 1:00	Lunch Break	
1:00 - 2:00	Transplanter: Economics Analysis (using PBP)	L. Ebron
2:00 - 3:00	Economics of Manufacturing	H. Manaligod
3:00 - 3:15	Coffee Break	
3:15 - 5:00	Jigs and Fixtures	L. Kiamco

May 31, Friday

8:00 - 10:00	Threshers	M. Diestro
10:00 - 10:15	Coffee Break	
10:15 - 12:00	Threshers (Continuation)	A. Caballes
12:00 - 1:00	Lunch Break	
1:00 - 5:00	Threshers: Shop Work	MD/ED

SECOND WEEK

June 3, Monday

8:00 - 10:00	Farm Economics Discounted Techniques for Investment Appraisal -- NPV, B/C and IRR	ZFT
10:00 - 10:15	Coffee Break	
10:15 - 11:30	Threshers: Economic Analysis (using NPV)	F. Juarez
11:30 - 11:45	Briefing on Excess Baggage Allowance	S. Escalona

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11:45 - 12:00	Free Time	
12:00 - 1:00	Lunch Break	
1:00 - 2:00	Agricultural Machinery Testing and Evaluation	AC
2:00 - 5:00	Threshers: Field Test and Measurements	AC

June 4, Tuesday

8:00 - 10:00	Reaper	MD
10:00 - 10:15	Coffee Break	
10:15 - 12:00	Reaper (Continuation)	AC
12:00 - 1:00	Lunch Break	
1:00 - 5:00	Reaper: Shop Work	MD/ED

June 5, Wednesday

8:00 - 9:30	Reaper: Economic Analysis (using B/C)	FJ
9:30 - 9:45	Photograph of Course Participants	CPD/Photography
9:45 - 10:00	Coffee Break	
10:00 - 12:00	Shop Tools and Plant Layout	HM
12:00 - 1:00	Lunch Break	
1:00 - 2:00	Machinery Safety	AV
2:00 - 5:00	Reaper: Field Test and Measurements	AC

June 6, Thursday

8:00 - 10:00	Fertilizer Applicators	A. U. Khan/LK
10:00 - 10:15	Coffee Break	
10:15 - 12:00	Seeders	M. Aban
12:00 - 1:00	Lunch Break	
1:00 - 2:00	Seeder and Fertilizer Applicator: Economic Analysis (using IRR)	LE
2:00 - 5:00	Test Instruments	AM

June 7, Friday

8:00 - 12:00	Small Engines for Farm Machinery	Briggs and Stratton Rep.
12:00 - 1:00	Lunch Break	
1:00 - 5:00	Small Engines: Shop Work	Briggs and Stratton Rep.

June 8, Saturday

	Field Trip to Cooperating Manufacturers and Farmers	HM

THIRD WEEK

June 10, Monday

8:00 - 10:00	Cost Estimating for Small and Medium Scale Manufacturers	HM
10:00 - 10:15	Coffee Break	
10:15 - 12:00	Axial Flow Pump	MA
12:00 - 1:00	Lunch Break	
1:00 - 5:00	Free Time	

June 11, Tuesday

8:00 - 10:00	Rice Drying	A. Belonio
10:00 - 10:15	Coffee Break	
10:15 - 12:00	Rice Milling	AC
1:00 - 2:30	Drying and Milling: Laboratory Work	AB
2:30 - 2:45	Coffee Break	
2:45 - 5:00	Axial Flow Pump: Shop Work	GS/ED

June 12, Wednesday

Holiday - Philippine Independence Day

June 13, Thursday

8:00 - 9:30	Axial Flow Pump and Dryer: Economic Analysis	C. Maranan
9:30 - 9:45	Coffee Break	
9:45 - 11:00	Summary Discussion on Farm Economics	ZFT
11:00 - 12:00	Consequences of Mechanization Studies	J. B. Duff
12:00 - 1:00	Lunch Break	
1:00 - 2:00	Extension Program: Overview	C. W. Bockhop
2:00 - 3:00	Individual Country Report	I. Manalili

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June 14, Friday

8:00 - 10:00	Course Examination	IM
10:00 - 10:15	Coffee Break	
10:15 - 12:00	IRRI Tour	Visitor's Bureau
12:00 - 1:00	Lunch Break	
1:00 - 2:45	Questionnaire on Course Examination; Free Time for Discussion on Machines of Particular Interest	
2:45 - 3:00	Closing Remarks and Distribution of Certificates	C. W. Bockhop
3:00 - 3:30	Special Merienda	

IM/fe

900 - MACHINERY DEVELOPMENT AND TESTING

(900) MACHINERY DEVELOPMENT AND TESTING

The Machinery Development and Testing Program includes Machinery Development, Grain Drying Research, and the Industrial Liaison Programs.

Machinery Development

The objectives are:

1. To complete the design, development, and testing of fertilizer application machines and provide information and blueprints to Industrial Liaison groups at the National level and to manufacturers, so that machines become readily available to farmers.

2. To design and develop machines for the direct seeding of rice.

3. To develop seeders and planters for upland conditions.

4. To develop machines for the incorporation of organic materials into the soil.

Results:

1. A plunger-auger fertilizer injector for prilled urea and a press-wedge applicator for urea super-granules have been developed and tested and are being manufactured. Tests with farmers and researchers consistently show that less fertilizer is required than when applied to the surface in the traditional manner. Machines are being manufactured for around $50-$70. An extension program is now needed to make farmers aware of the advantages of the applicators in savings of fertilizer and in reducing costs of production.

2. Low cost direct seeders are being tested. The machine will insure more uniform seed rate and thus save approximately 50% in costs of seeds. The direct seeder also plants in rows which facilitates weeding.

3. Several planters for upland are being developed and are under test:

   (a) A Rotary Injection planter developed at the International Institute of Tropical Agriculture is being modified and tested. Although the planter has problems in moist soil, there is considerable interest by those who wish to plant a crop following rice without any tillage operations; i.e., planting directly in the stubble.

(b) A seeder/fertilizer applicator pulled by a carabao has been tested.

(c) An inclined plate planter has been introduced and is quite successful in Thailand. It is quite heavy and needs further improvement.

(d) A planter mechanism developed by staff at Massey University, New Zealand is being tested and shows great promise as a planter for upland crops. It includes a unique opener and seed metering mechanism.

4. Several devices are being developed for the incorporation of organic materials into the soil including the incorporation of legume crops, azolla, rice stubble, weeds, and straw:

(a) A minimum tillage puddler has been designed that tills the soil at a snallow depth thus saving considerable energy.

(b) A new weeder with conical shaped rotors has been developed; which appears to be more efficient in the incorporation of weeds into the soil and for incorporation of azolla.

(c) A knife attachment for the cage wheels of a power tiller were designed to cut the green manure crop for easy incorporation of the weeds by the plow.

Future Plans:

Future plans are to develop machines that will reduce inputs, both energy and labor.

1. An animal drawn puddler will be further tested in soft soils. Attempts will be made to include a seeder and fertilizer distributor so that the machine will have multiple use and thus reduce both labor and energy requirements.

2. A power tiller attachment is being developed to control the depth of tillage and for simultaneous application of seed and fertilizer along with the tillage operations.

3. The Rotary Injection planter will be improved to improve the seed metering mechanism and the seed covering.

4. A machine will be developed as a combination direct seeder, weeder and fertilizer applicator.

5. Work will continue to develop seeders and planters for upland crops.

6. The cono-weeder will continue to be developed with possible attachments for the application of fertilizer.

7. A machine will be developed for the application and incorporation of azolla 2 or 4 rows at a time.

8. The present TH8 thresher will be improved to eliminate one of the cleaning screens. This will reduce the cost of manufacture. It will also include an attachment for the shelling of corn.

9. An improved thresher for experimental plots will be tested.

DRYER DEVELOPMENT AND BIOMASS UTILIZATION RESEARCH

A. Dryer Development

We are continuing the development of new drying and storage technology which was initiated by the introduction of the warehouse drying systems using non-conventional energy sources.

Objectives

1. To further develop the warehouse drying systems for different applications;
2. To develop low cost construction materials for the dryers.

Results

Several types of IRRI warehouse drying systems were designed according to size and capacity. The drying system can be used as drying and storage facility conveniently provided with work space and pre-drying areas. It is applicable for multi-commodity drying in separate lots in one operation. The construction involves simple

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techniques using locally available materials which the farmers themselves can do.

1. One-ton capacity warehouse dryer for individual farmer operation.
2. 3-4 ton capacity warehouse dryer for farmers group or rice miller (greenhouse dryer and "winged" dryer).
3. Rotary drum dryers for pre-drying high-moistured grains and legumes.

Future plan

To conduct an extensive performance evaluation of the warehouse dryers and to introduce the developed drying and storing technology to the farmers, rice millers and other interested parties.

B. Biomass Utilization

There are two utilization schemes where we found agricultural wastes and residues essential, i.e. as heat source for drying and as substrate for biogas production.

Objectives

1. To design and develop a rice hull carbonizer for expanded utilization of rice hull.

2. To develop a simple rice hull char briquetting technique to provide solid fuel for direct-fired dryers.
3. To evaluate the biogas generation potential of different agricultural wastes and residues.
4. To design and develop a batch type biogas digester for the tropical region.

Results

B.1. Rice hull carbonizer and charcoal briquetting

The rice hull carbonizer can be integrated into a rice mill to minimize rice hull disposal problem and at the same time provide charcoal as solid fuel and hot flue gas for drying purposes.

The charcoal is mixed with paddy soil which serves as binder when briquetted. Briquetting can be by hand pressing or using a manually operated compacter.

Stoves were likewise designed for burning the rice hull charcoal briquette.

B.2. Biogas generation research

Rice straw, water lily, azolla, corn stalks, coconut husks and banana leaves were found as potential sources of biogas by anaerobic fermentation. Azolla and water lily were found as good substitute for manure as nitrogen source. This finding enables us to construct a simple household size batch type biogas digester.

Gas generation using rice straw and azolla substrate equalled that of rice straw and manure substrate. Effective production extended from 45 days to 70 days.

Future plan

1. To evaluate the efficiency of heat recovery from the carbonizer to the dryer.
2. To introduce the rice hull charcoal utilization technology among rice millers and dryer operators.
3. To continue developing the IRRI biogas generation system and introduce the technology to the rural areas.

Industrial Liaison Program

The Industrial Liaison Network includes programs in the Philippines, Indonesia, Thailand, and India funded by the Asia Bureau, USAID. The Indonesia and Thailand segments of the program terminated on September 30, 1985. The Philippine and India segments were extended until September 30, 1986 so that the National program staff and the local USAID country missions could develop a project for continuing the Industrial Liaison activity.

IRRI also had an Industrial Extension component in Burma supported by CIDA. This project terminated December 30, 1985.

The Agricultural Engineering Department also cooperated with a project in Sri Lanka supported by GTZ, Germany.

The objectives of the Industrial Liaison Program are:

(1) To develop the capabilities of the national program staff to conduct an Industrial Extension program on mechanization.

(2) To introduce new and improved machines for the small farmer through an exchange of prototypes and the supply of blueprints of fully developed and tested machines.

(3) To provide training to national program staff on IRRI designed machines, economics of machines, testing methods, design methods, and industrial extension methods.

Results:

Philippines

1. The Philippine program has been established and a network of engineers in the provinces has been organized.

2. The manufacturers of the small machines have been organized.

3. Several machines needed by the farmers have been introduced. These include the reaper, a fertilizer, planter for upland conditions, the Tapak-tapak pump, the Sipa pump, a corn sheller modification for the axial flow thresher, and the 6-row transplanter.

India

1. The India program has been established at Tamil Nadu University, Coimbatore.

2. A benchmark survey of small manufacturers has been completed.

3. The reaper and the transplanter has been introduced.

4. A training course for the transplanter has been conducted.

Indonesia and Thailand

The program in Indonesia and Thailand have been established and our project terminated September 30, 1985.

Future Plans:

The organization of the Industrial Extension office in the Agricultural Engineering Division of the Bureau of Plant Industry of the Philippines will be further developed. A counterpart project engineer will be appointed and a shop needs development.

The work of developing the small manufacturers to improve the quality of their output needs to be continued.

The Project in India will expand to the staff planned. Manufacturing assistance and training will be emphasized to improve the quality of manufacturing. The facilities will be established to produce drawings and blueprints.

1985
Progress Report
Machinery Design Section
Agricultural Engineering Department

Amir U. Khan

With the completion of the plunger-auger fertilizer injector for prilled urea and the press-wedge applicator for USG our work on the development of deep placement applicators is coming to an end. The Engineering Team that was engaged on fertilizer applicator development is now focussing on the development of a variety of machines for saving all kinds of purchased inputs in rice production.

During the year, we developed a number of machines which offer good potential for saving fertilizer, insecticides, herbicides, seeds, fuel and power in rice production. A brief description of the machines developed during the year is given below. The research assistants who worked with me on these projects are identified after the project title. Messrs. Andy Caballes and Artemio Vasallo, test engineers, provided test and evaluation support to the Design Team on the projects reported below.

A. Land Preparation Equipment

1) Minimum tillage puddlers (Rusty Bautista)

Currently available wetland tillage equipment work the soil to a much greater depth than necessary for obtaining satisfactory yields. This is resulting in a collosal waste of fuel and power. Under some conditions, two to three times excess power is being consumed in wetland preparation. A new animal drawn rotary land preparation machine (Fig. 1) was developed to reduce power inputs under soft paddy field conditions. The machine is based on the principle that when a cone shaped rotor with blades is rolled on the soil, displacement of soil by the blades located at different points along the axis of the cone, is different. This machine tills by subjecting the soil to a rapid horizontal back and forth action. The horizontal action of the blades limits the tillage zone to the top 10 to 12 cm soil layer. This saves power and energy. Recent tests of the prototype machine indicated that with the same power source, the machine can till more than twice as much area than with conventional tillage equipment. Further development work is continuing on this machine.

2) **Minimum Tillage Power Tiller** (Edwin Calilung)

Excessive sinkage and bogging of power tillers is a common problem in soft paddy fields. We developed a number of concepts for adapting standard commercially available power tillers for controlled depth tillage in soft wetland fields. Fig. 2 shows one of these concepts which is now being further evaluated. The design of the machine shown in Fig. 2 has been fabricated and is now being evaluated and further improved.

B. Crop Establishment-Equipment

1) Low-cost Drum Paddy Seeder (Lito Bautista)

Due to the high cost of transplanting, many farmers are now shifting to direct seeding. A 10-row machine for seeding pre-germinated paddy on puddled soils was developed last year. Two manufacturers have started test production of the machine which is now available for ₱2,300. We have now developed a new 8-row seeder (Fig. 3) which is much simpler and lighter than the earlier design. This machine is expected to sell for about ₱300.00.

Since uniform distribution of seed is a problem with manual broadcasting, farmers generally use a high seeding rate of 100 to 120 kg/ha. With the direct seeders, one man can evenly seed 50-60 kg of seed per hectare thereby saving 50% of the seed and ensuring a more uniform crop stand.

C. Crop Care Equipment

1) Manual Weeders (Lito Diestro)

A push type single row weeder with conical shaped rotors was developed (Fig. 4) which requires only 1/3 as much power to operate as conventional rotary weeders. One to four row models of this weeder were developed. One man can weed 4 times faster with the 2-row cono-weeder (Fig. 5) as compared to conventional weeders. Farmers' response to this machine has been overwhelmingly favorable. Many farmers who were loaned the machine for testing had it duplicated by local shops. A number of manufacturers have started fabrication of this weeder in the Philippines.

2) **Fertilizer and Chemical Applicators**

a) **Plunger-Auger Injector** (Lito Bautista)

During the year our efforts were directed on field testing the plunger-auger fertilizer injector (Fig. 6 & 7). This was done in cooperation with a number of Philippine Govt. agencies; NFAC, RIARS, Bureau of Soils, and PHILPHOS as well as with the TTTD and Agronomy Departments at IRRI. A total of 80 machines were obtained from three manufacturers in the Philippines. Each of the commerciall produced machine was checked, field tested and reworked to conform to the original specifications. Twenty of the commercially manufactured machines were sold to farmers at a price ranging from ₱500 to ₱1,000.

Results obtained so far from the field indicate that the machine can consistently equal or better the yields obtained with the researcher's split method. This is the practice currently recommended to farmers by the Institute and the Masagana 99 Program of

the Govt. of the Philippines. With the use of this machine farmers can now apply fertilizer after transplanting which was not possible with the researcher's split method.

A manufacturer, M/s American Spring & Pressing Works Private Ltd., Bombay, was assisted in producing this machine for testing and evaluation in India.

b) Press-wedge Applicator (Lito Bautista and Lito Diestro)

The design of this machine (Figs. 8 and 9) was completed in 1984. Twenty machines were obtained from SH Agric. & General Machineries in Naga City, for testing under the INSFFER Program. Assistance was provided in fabricating and modifying these units to conform to the original specifications.

c) Green Manure & Straw Incorporating Knives (Rusty Bautista)

Incorporation of tall green manure crop and paddy straw is difficult with power tillers because of excess accumulation of plant material on the plow. We developed special

ring knife attachments for power tillers (Fig. 10) which utilize wheel slippage and weight of the power tiller to cut trampled green manure crop or rice straw into small pieces for easy incorporation with plows. The knives can be easily installed on standard cagewheels of most popular makes of power tillers. The Multiple Cropping Dept. is now using these knives in their green manuring demonstrations.

d) Azolla Incorporator (Lito Diestro)

This implement was developed for incorporating azolla in freshly prepared or in row transplanted fields. This push type implement (Fig. 11) has two conical open type rotors mounted in tandem behind a specially designed skid to guide azolla under the rotors. Further testing and modifications of this machine is continuing.

D. Laboratory Equipment for Rice Research

1) Test Tube Mill (Rusty Bautista)

Some years ago we had developed a test tube paddy mill for the IRRI Plant Breeding Department. We have now developed a new test tube mill (Fig. 12) which has six times more milling output than the older machine. This machine has accelerated the milling of laboratory samples in the Plant Breeding Dept. at IRRI. Drawings are being sent to other rice research institutions in Asia.

2) Compact Self Cleaning Plot Thresher (Rusty Bautista)

The Vogel threshers are widely used by most agricultural research institutions worldwide for plot threshing work. This is a self-cleaning machine that was developed many years ago in the U.S. It is a costly machine and requires 3 men to operate. A new plot thresher was developed (Fig. 13) which is half as light as the Vogel thresher, can be fed by the operator while standing on the ground and requires only two men to operate. The machine is expected to sell for less than half the price of Vogel threshers. This thresher is now being tested and further improved in cooperation with concerned IRRI departments.

1986 PLANS

1) **An animal drawn minimum tillage puddler** is developed in 1985 which has shown promising performance in soft soils. Attempts will be made to mount a seeder and fertilizer distributor (Fig. 14) on this puddler for simultaneous operation of tillage, seeding and fertilizer incorporation. This machine will also be adapted for use as a pull type manual weeder for two men operation. This machine can also be used as an animal drawn trampling type thresher since it produces a rather aggressive sliding action between its blades and ground. The machine offers interesting possibilities for conducting almost all major rice production operations of land preparation, seeding, fertilizing and threshing. If it performs well it could be an economical machine for small paddy farmers who cannot afford separate machines for different operations.

2) Power Tiller Attachment for Controlled Depth Tillage

This machine will be developed as an attachment to standard commercially available power tillers for controlled depth tillage in soft paddy fields. In this machine a standard power tiller will be fitted with

a skid (Fig.15) for improved ground support and a rear mounted tilling rotor for controlled depth tillage and puddling operation. Special large dia. slow moving wheels will provide forward mobility whereas a higher speed tiller rotor will do shallow tillage.

3) Zero Tillage Dibbling Planter

Some years ago a push type rolling injection planter was developed at IITA, Nigeria for seeding under zero and minimum tillage conditions. This machine was tried in the Philippines for establishing a second crop after rice without doing any tillage. It could not function properly as the seed passage was blocked with moist soil and this interfered with proper seed placement. The proposed machine (Fig. 16) will be developed with separate mechanisms for punching holes, for dropping seeds and for covering the seed openings. A trip valve mechanism will be used to precisely index the seed drop into previously punched holes. A conical rotor will be used for covering the seed openings to improve moisture retention.

4) **Manually Operated Combination Seeder-Weeder-Fertilizer Incorporator**

We have developed separate machines for seeding, weeding and fertilizer injection. Attempts will be made to develop a combination machine (Fig. 17) which could handle all of the three operations. Farmers generally prefer to apply fertilizer 7-31 days after seeding. They also prefer to weed before applying fertilizer. This machine will be developed for use as a direct seeder and later for simultaneous weeding and fertilizer incorporation.

5) **Seeder for Upland Crops**

Much work has been done in the past on developing upland seeders at IRRI and elsewhere in Asia. There are many different types of seeders that has been developed yet no single machine has achieved a high degree of popularity. A survey will be conducted among upland farmers in two areas of the Philippines to generate design specifications of upland seeders which could find a good market among upland farmers. After the specifications have been developed, attempts will be made to design suitable multicrop seeder to meet market specifications.

6) Fertilizer Incorporating Cono Weeders

A cono-weeder was developed in 1985 for weeding wetland paddy. Farmer response on this machine has been most encouraging and it is now rapidly gaining popularity in some areas of the Philippines. Farmers generally prefer to apply fertilizer after the weeding operation. Attempts will be made to develop a simple fertilizer distributor on this weeder (Fig. 18) to spread fertilizer ahead of the weeding rotors. With proper water control such a machine will permit incorporation of fertilizer and weeding in one operation and result in 50 to 60% saving of fertilizer.

7) Multi-row Azolla Incorporator

A single row azolla incorporator with open type conical rotors was developed by us in 1985. This machine however takes too much labor for incorporating azolla. Attempts will be made to develop 2 & 4 row machines which could cover more area in a single pass. Since azolla floats on water, it is generally incorporated after the field has been drained. Usually some water is left on the field after draining and this interferes with complete incorporation of azolla. Attempts will be made to develop improved skid and deflectors to direct floating azolla under the rotors to ensure full incorporation.

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8) **Improved Single Screen Axial Flow Thresher**

The IRRI TH8 thresher, that was developed at IRRI some years ago has a double screen cleaner which is rather complicated. Most firms manufacturing the TH8 threshers mount a single screen cleaner on this machine to save costs and to simplify the design. The TH8 thresher will be modified and improved by incorporating the following features:

a) A single screen cleaner will be installed to reduce weight and minimize service problems.

b) The machine will be designed for convertible use as paddy thresher or a corn sheller by simply moving a lever.

c) The air blowers will be redesigned to produce a more uniform air blast across the full width of the machine.

d) Some parts will be reinforced and strengthened to withstand the increased loading of corn shelling.

9) **Plot Thresher for Agricultural Research**

A self-cleaning experimental plot thresher was developed in 1985 to replace the Vogel Threshers that are widely used on Agricultural Experiment Stations. This machine is more compact, is designed for feeding by the operatorr standing on the ground and needs only two men to operate. This machine will be further evaluated and improved for threshing a variety of agricultural crops.

Fig. 1 Prototype cono-puddler for animal or power tiller.

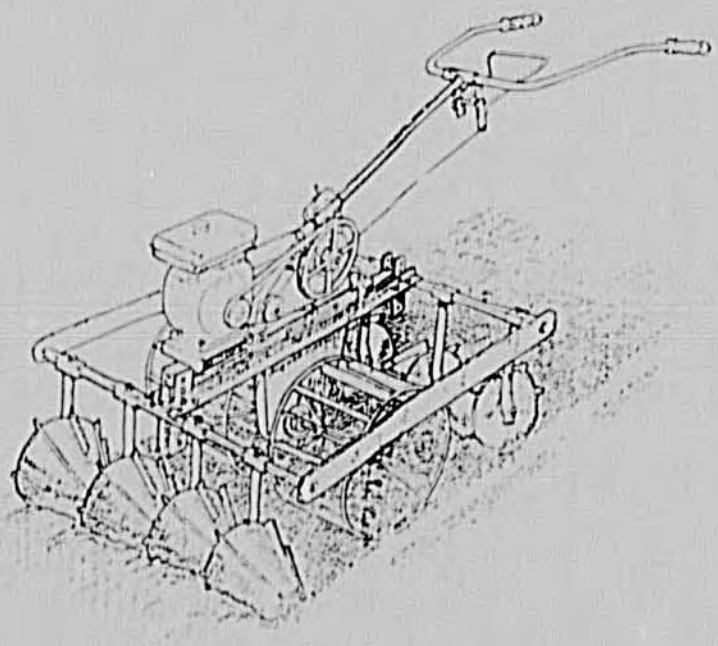

Fig. 2 Power tiller attachment for puddling.

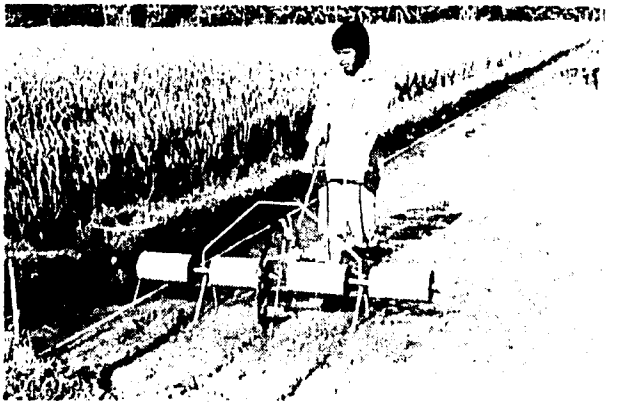

Fig. 3 Low-cost pull type paddy seeder (8-row unit illustrated).

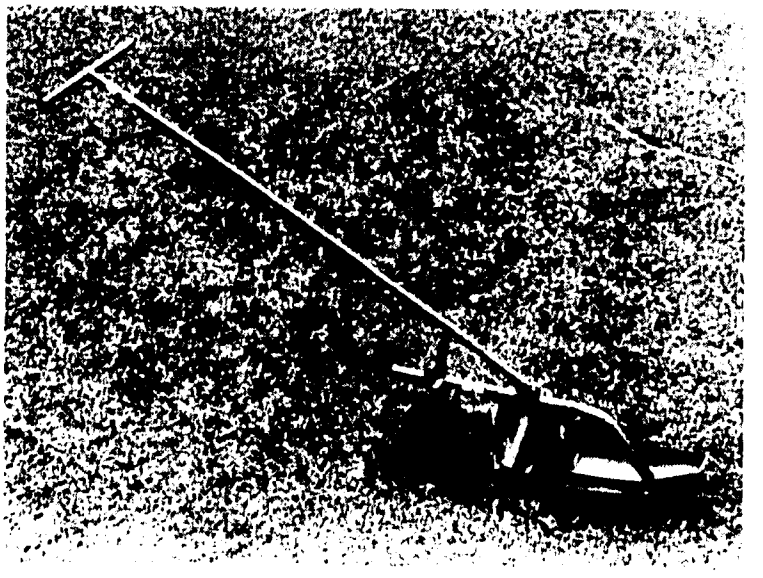

Fig. 4 IRRI single row cono-weeder.

Fig. 5 IRRI two-row cono-weeder operating in farmers' field.

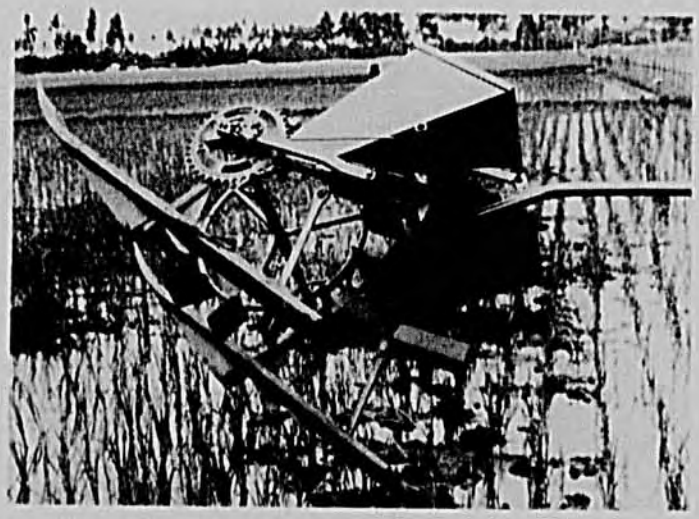

Fig. 6 IRRI two-row plunger-auger fertilizer injector.

Fig. 7 IRRI plunger-auger fertilizer injector operating in farmers' field.

Fig. 8 IRRI two-row press-wedge fertilizer applicator.

Fig. 9 IRRI two-row press-wedge applicator being used in farmers' field.

Fig. 10 Green manure incorporating knives on power tiller cagewheels being used for incorporating tall sesebania crop.

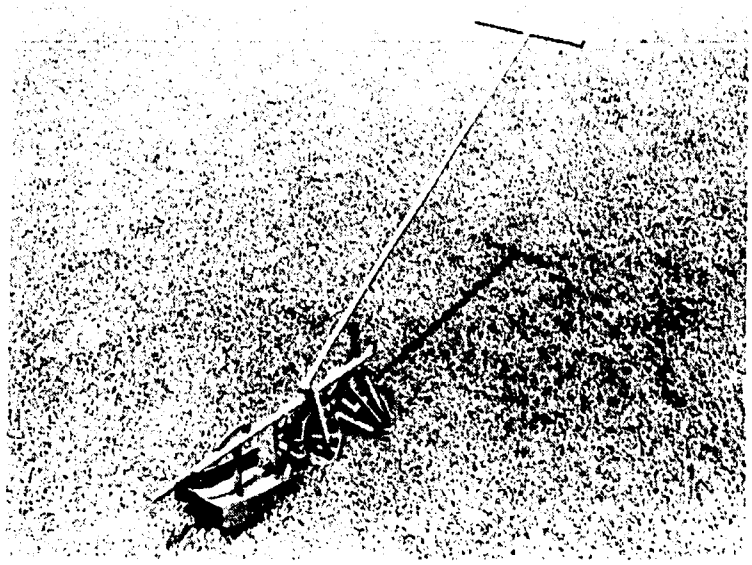

Fig. 11 IRRI single row azolla incorporator with open type conical rotor.

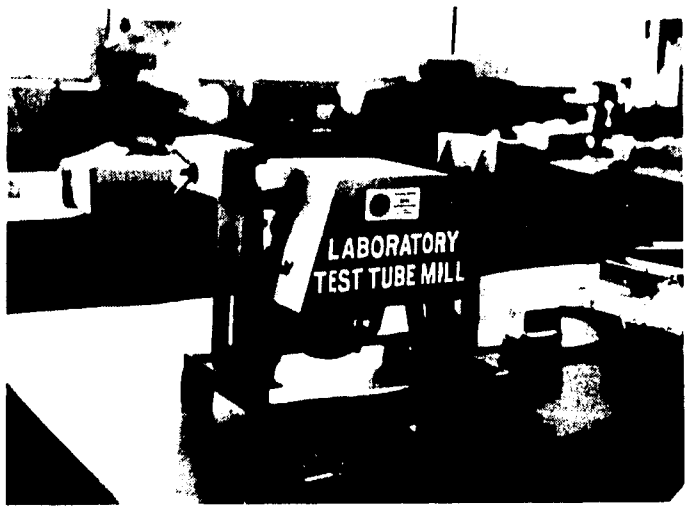

Fig. 12 Laboratory test tube mill.

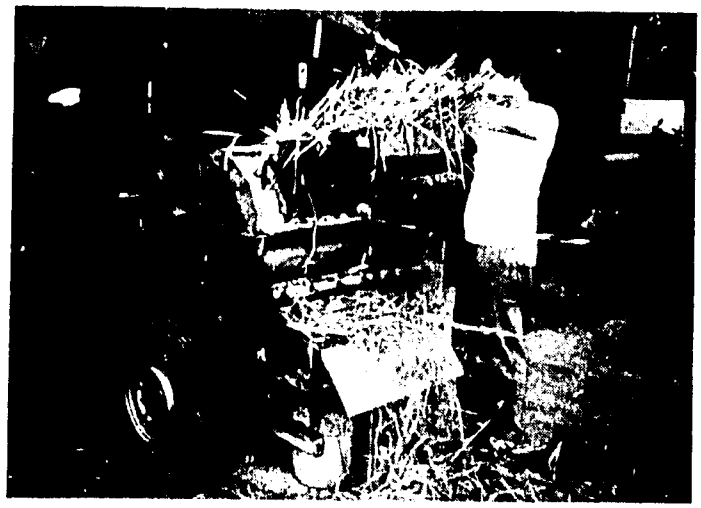

Fig. 13 IRRI compact self-cleaning plot thresher.

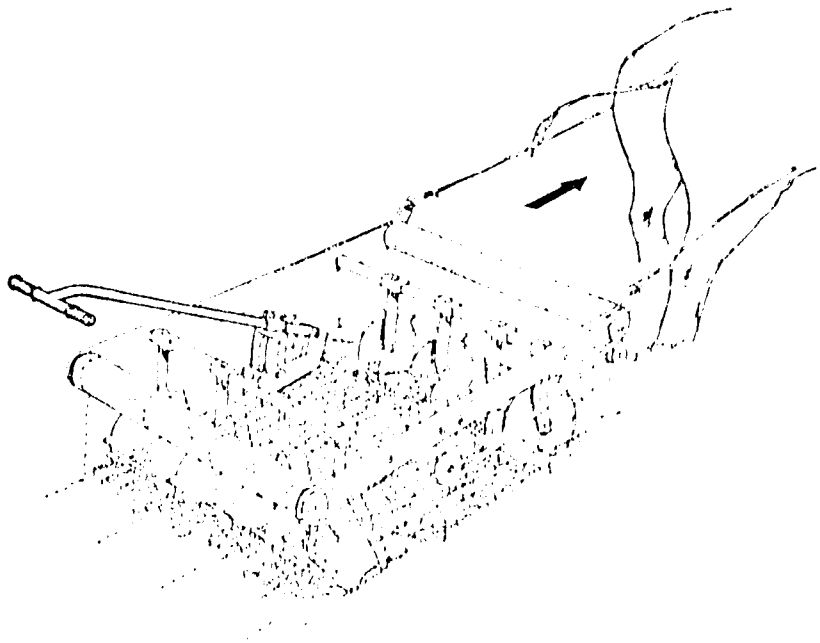

Fig. 14 Animal-drawn puddler mounted with a seeder and fertilizer distributor.

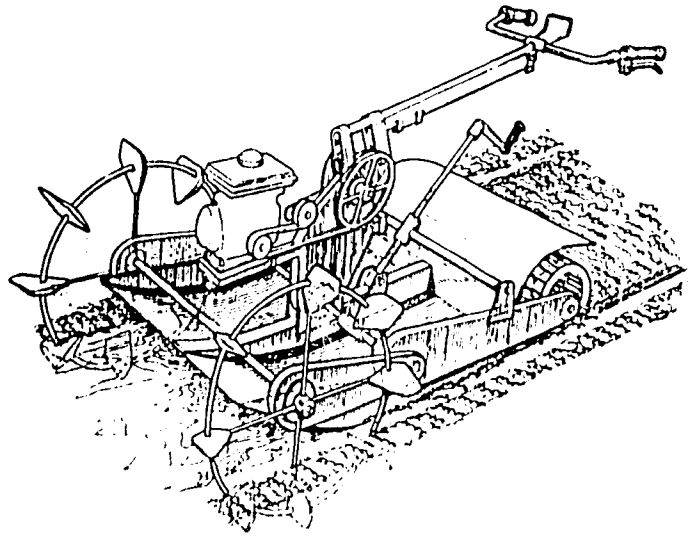

Fig. 15 Power tiller attachment for controlled depth tillage in soft fields.

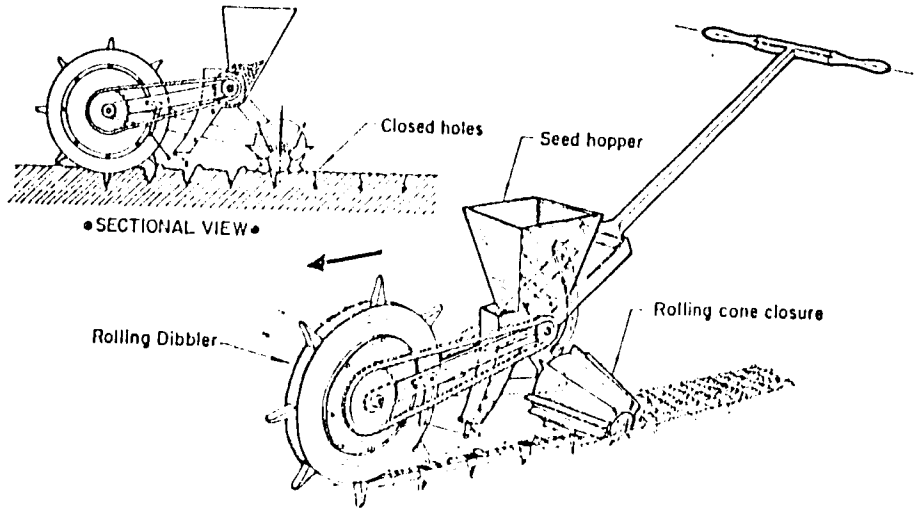

Fig. 16 Zero tillage dibbling planter.

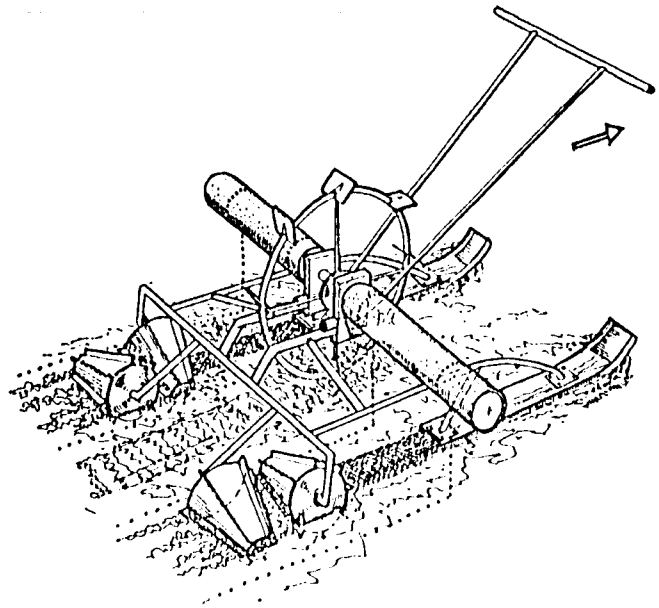

Fig. 17 Manually-operated seeder with combination weeder fertilizer incorporator.

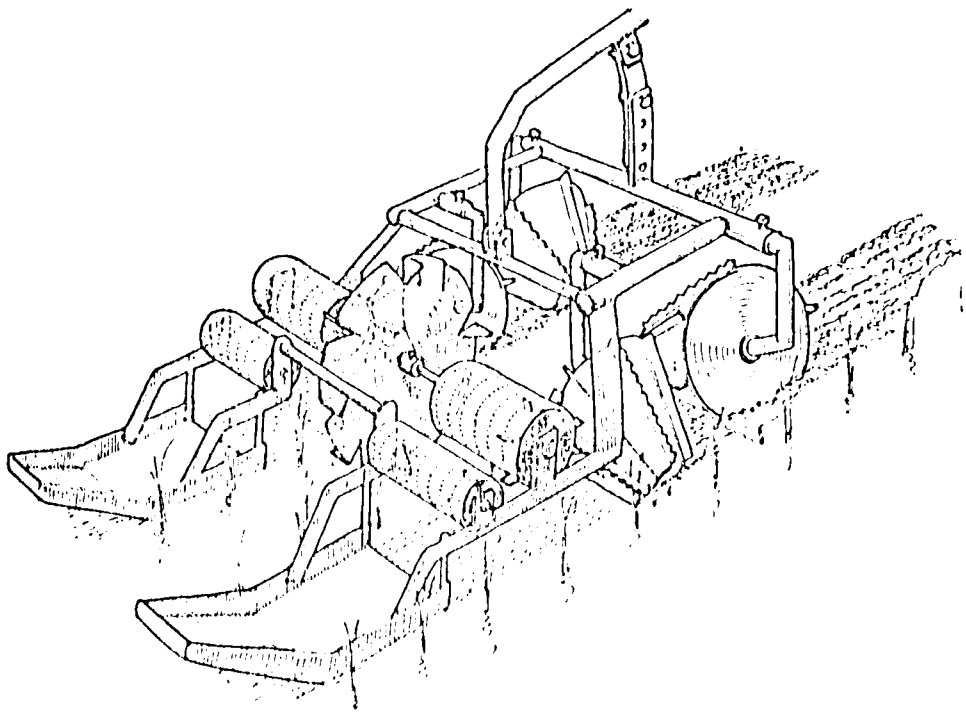

Fig. 18 Two-row cono-weeder mounted with fertilizer/insecticide distributor.

INVERTED-T MULTICROP SEEDER FOR RICE-BASED CROPPING SYSTEM

M. A. Choudhary

INTRODUCTION

Germination and seedling emergence are determined by soil physio-chemical environments. Where chemical inputs are adequate, soil edaphic factors e.g. moisture, temperature, oxygen and soil impedance can significantly affect emergence. With proper design of soil engaging implements these factors can be modified markedly.

Based upon experimental data, design criteria established for soil opener assemblies which create soil micro-environment best suited for improved seed germination are:

a. to create subsurface soil shattering to facilitate root and shoot penetration.

b. to provide improved seed-soil contact to enhance moisture conductivity at seed-soil interface.

c. To provide or retain existing residual mulch or soil cover for improving in-groove moisture vapour potential captivity (MVPC) while minimizing seed exposure to direct sun radiation and to bird damage.

A seeder (Fig. 1) was designed to give improved seed biological performance. The major components include:

Opener

The seeder utilizes an inverted-T opener, initially developed at Massey University, New Zealand. The opener creates seed grooves tolerant to wide range of field conditions in previously tilled and untilled soils.

Depth wheel

The depth wheel ensures proper seed depth. Emergence performance of various seed species, particularly small seeds, have been shown to be sensitive to sowing depth and field moisture at seeding. The wheel also serves as a press wheel providing required seed-soil contact and drives the seed metering mechanism.

Seed metering mechanism

A unique metering assembly meters seeds with a high degree of accuracy and with minimum periodicity. A range of seed species can be metered without any seed damage.

The mechanism includes a horizontally mounted circular foam pad (attached to a steel plate). The pad rotates along vertical part of a plastic hopper base. Seeds are delivered vertically downward through a throat-type opening moulded as an integral part of the hopper base. The hopper, made from galvanized iron sheet, is directly attached to the plastic base.

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The seed rate can be varied by changing the (bicycle) sprockets and the drive wheel.

FIELD TRIALS

The seeder was generally satisfactory in its major tasks; i.e. groove formation, seed placement, depth control and seed metering. In untilled soil, the plane disc (coulter) running ahead of the opener handled crop residues satisfactorily. In tilled soil (for carabao seeder) small wheel replaced the disc to help the opener avoid nose-diving.

Field trials conducted with corn, soyabean, and mungbean, (table 1) showed significant advantages in plant establishment and seed input saving. This trial was in an upland field previously under sorghum. Three methods of land preparation and seeding were compared; 1) conventional tillage (one plowing followed by two harrowing) and furrowing with lithao and hand planting; 2) conventional tillage and sown with the seeder; and 3) seeder sown in untilled soil.

The seeder sown plant emergence was significantly higher than hand planting. Tillage had no significant effect on establishment. Corn establishment was 65% superior and mungbean were over 300% better when sown with the seeder compared with hand sown respectively. Soybean

results, although slightly in favor of seeder, were not clear.

Further analysis (seed fate analysis) suggested that lower plant emergence with traditional hand sown method were due to uneven seed depth (and seed cover) and that a large proportion of unemerged seeds actually remained ungerminated. Conversely a significant proportion of unemerged seeds in seeder sown plots (Table 1) were still surviving at subsurface soil level. With more moisture (sowing moisture was quite low and no irrigation was applied), more plants were expected to establish.

TABLE 1. EFFECTS OF TILLAGE AND SOWING METHODS ON UPLAND CROP ESTABLISHMENT

		PLANT EMERGENCE %		
Tillage Status	Sowing Method	Corn*	Soyabean	Mungbean
Tilled Soil[1,4]	Hand sown[2]	41b (49)	29b (39)	15b (15)
Tilled Soil	Seeder sown[3]	67a (77)	24b (46)	49a (65)
Untilled Soil	Seeder sown	69a (73)	45a (58)	46a (56)

Unlike letters in each column show significant differences at P<0.05

[1]once plowed using carabao followed by two harrowing

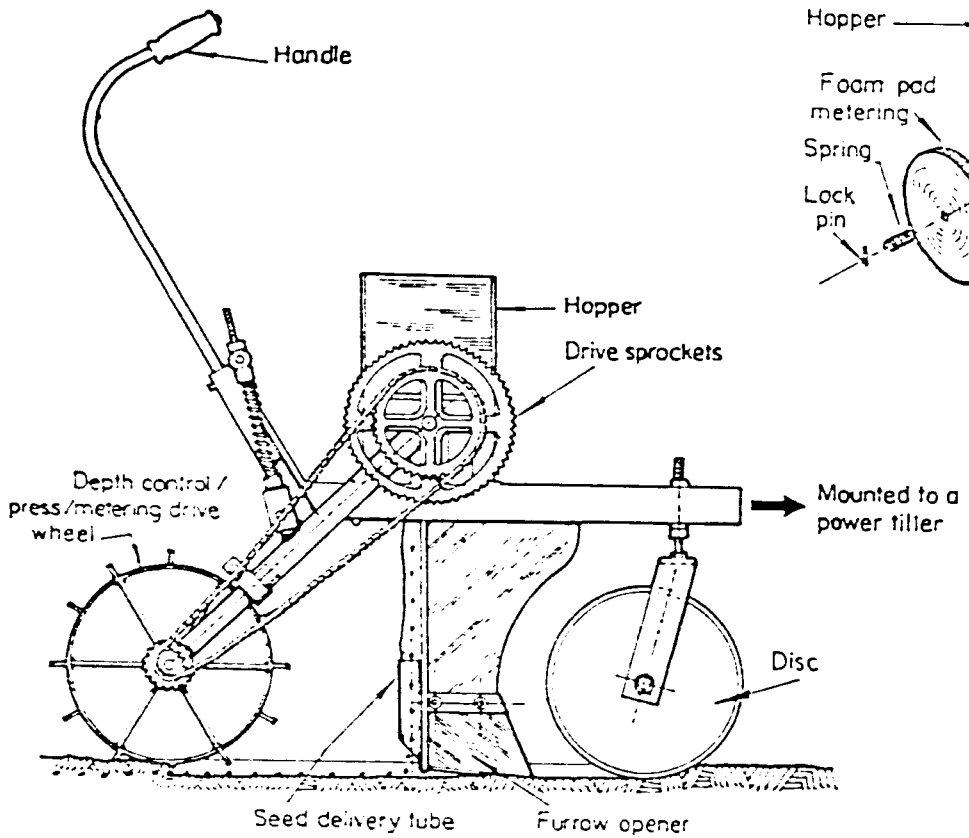
[2]seed furrows (grooves) made with lithao and hand sown.

[3]inverted-T seeder (power tiller and carabao operated) developed by M. A. Choudhary

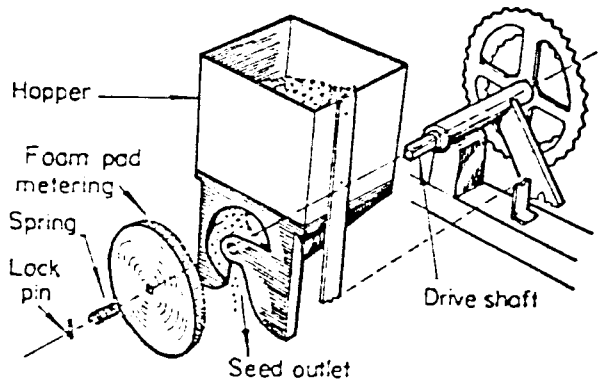
() plant emergence including subsurface surviving seedlings at day 12 after sowing

*Lab. seed germination: Corn, 97%; Soyabean, 47%; and Mungbean, 75%

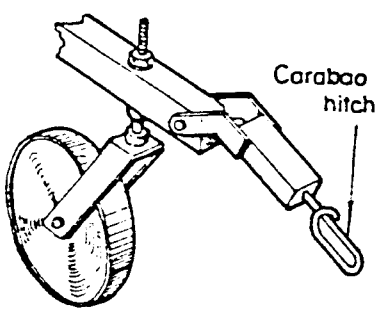
[4]Field UM2, IRRI



Side view of inverted-T multicrop seeder



Pictorial Drawing
(exploded view)



Depth wheel for carabao operation

1986 INTERNAL PROGRAM REVIEW

DRYER DEVELOPMENT AND BIOMASS UTILIZATION RESEARCH

Prepared by:

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1986 INTERNAL PROGRAM REVIEW

ACTIVITY REPORT

A. DESIGN AND CONSTRUCTION OF EQUIPMENT FOR BASIC RESEARCHES

B. FUEL AND ENERGY CONVERSION SYSTEM RESEARCH

C. DEVELOPMENT OF DRYERS

D. MOISTURE VARIANCE DETERMINATION FOR DIFFERENT IR-RICE VARIETIES

E. SOCIO-ECONOMIC STUDY

ACTIVITY REPORT
(ACCOMPLISHMENTS AND PLANS)

A. DESIGN AND CONSTRUCTION OF EQUIPMENT FOR BASIC RESEARCHES

1. Laboratory dryer

Rationale

Drying data found in literatures are mostly based on sub-tropical or temperate conditions and can hardly find application in the tropics. These data were established based on experiments where airflow direction is uni-directional.

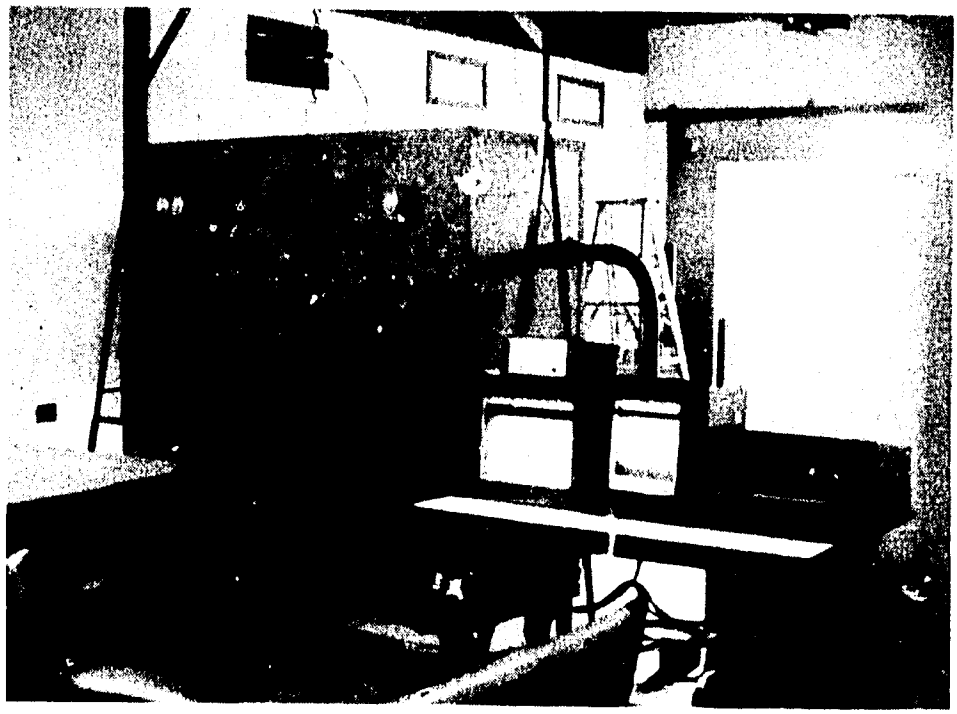
In the design of dryers for the tropical countries, some data has to be established. Hence, laboratory drying experiments were carried out and a laboratory dryer capable of providing different drying air conditions was designed and constructed.

Objectives/Target Output

1. To design and construct a laboratory dryer complete with air temperature, airflow and relative humidity controls;
2. To use the laboratory dryer in determining the drying characteristics of different kinds of commodities especially under tropical condition;

3. To establish dryer design guidelines for the commodities determined.

Description of the dryer



Laboratory Dryer

- Type: Laboratory cabinet dryer with electric heater and blower; operates by convection principle.
- Controls

Temperature	:	Up to 120°C
Airflow direction	:	Vertical, downwards
		Vertical, upwards
		Horizontal, left to right
		Horizontal, right to left
Air velocity	:	Up to 4.0 m/s
Relative humidity	:	Efficient up to 98 percent

Accessories

Automatic weighing scale which can be connected to a data logger

Humidifier and dehumidifier to control the relative humidity of drying air

Drying trays and/or hooks

Airflow deflectors for varying direction of airflow

Accomplishment

The laboratory dryer was used in conducting experiments on drying paddy, potato chips and cassava slices.

Future plan

Continue experimenting on other materials (grain, fish, vegetable, etc.) using the dryer.

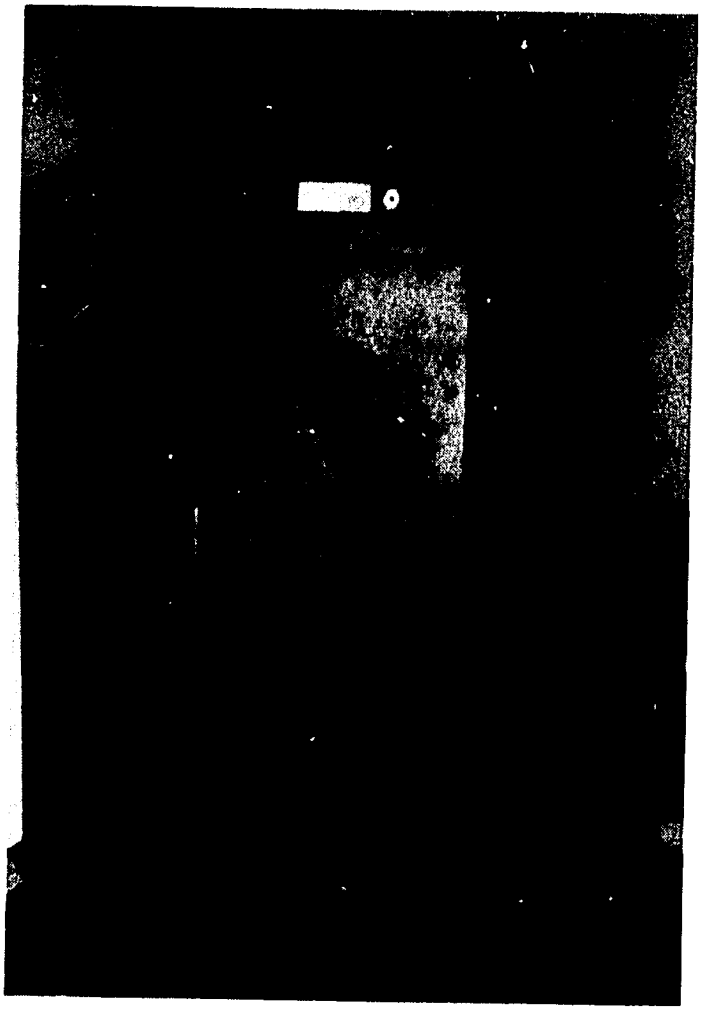
2. Laboratory Oven

Existing laboratory ovens have limited capacity and are not sufficient for our dryer tests requirement. This leads to the design of a locally manufactured oven which can hold up to 500 sample cans in one time.

Objectives/Target Output

1. To design and construct a laboratory oven for moisture content determination.
2. To provide a locally-made oven which can contain up to 500 sample cans in one load.
3. To use the oven during the drying experiments.

Description of the oven



Laboratory Oven

- Type: Air-oven equipped with electric fan and heater.
- Temperature control: Up to 200°C
- Other feature: Materials are held in tin sample cans or placed directly in the drying drawers.

Accomplishment

Preliminary result of the study on moisture variation within a variety of paddy during harvest for different IR-rice varieties.

Used oven during dryer tests in the determination of drying rates of paddy and corn.

Future plan

To use the oven continuously during drying tests.

3. Columnar Convection Laboratory Dryer

The warehouse dryer being developed essentially operates by natural convection. It is therefore necessary to simulate field conditions in the laboratory to observe the factors affecting its performance characteristics and to analyze the drying behavior of sample materials as well.

Objective/target output

1. To design and construct a columnar dryer capable of simulating drying air conditions of the warehouse dryer;

2. To study the effect of the drying air temperature and airflow rate on the drying rate of a column of paddy and other materials of different thicknesses.

Description of the dryer

The dryer is a cylindrical column equipped with a heat gun at the bottom and a suction fan at the top. The paddy is loaded in cylindrical or rectangular columns with different diameters and thicknesses, respectively. It is equipped with an automatic weighing system which can be connected to a data logger.

Accomplishment

The dryer was operated simultaneously with the one-ton warehouse dryer for drying paddy. The results confirmed the drying behavior of a natural-convection dried paddy.

Future plan

The unit will be used in conjunction with further dryer tests for paddy and other grains being lined up during year 2 of the project.

4. Miscellaneous Post-harvest Equipment and Others

4.1. Chipping/slicing device

Rationale

Increased production of staples such as rice and root crops demands an appropriate post-production technology particularly drying. In case of root crops, drying in reduced size will facilitate the process and will provide a more convenient method of handling, drying and storage. Thus, it is the object of this work to design and test a low-cost chipping/slicing machine.

Objectives

To provide a chipping/slicing device to be used in sample preparation of drying materials specifically root crops.

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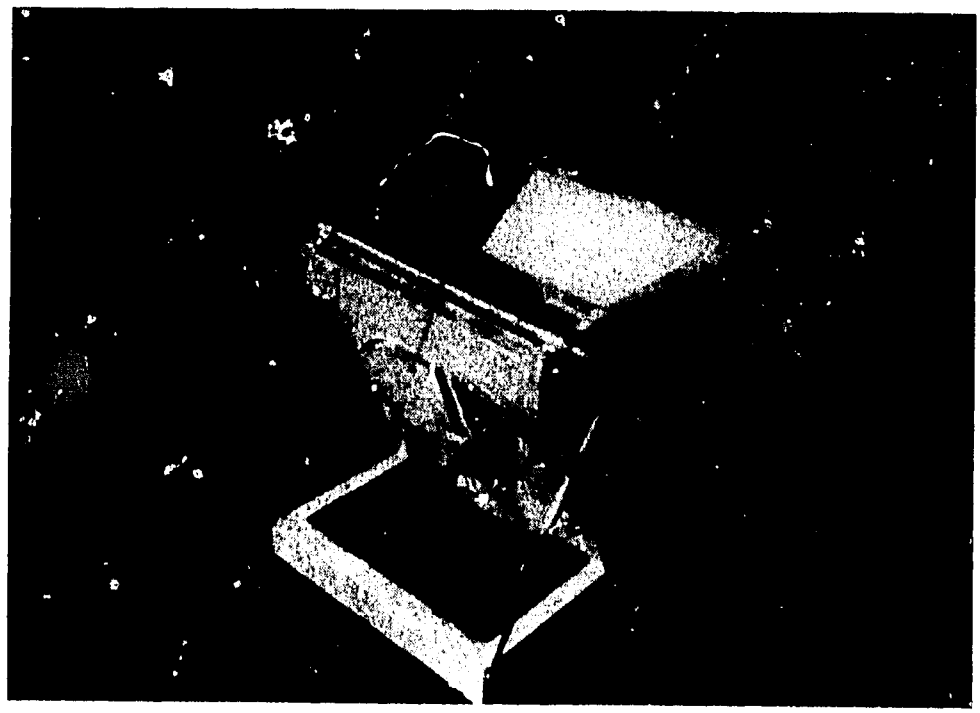
Description



Chipping/Slicing Device

The device is made of wooden frame equipped with a pair of slicing or chipping blades fixed to an inclined rotating plate. It is hand operated by one person and can chip at an average rate of 50-60 kg/hr.

Accomplishment

Comparison tests with other existing slicing devices was made possible. It has been

demonstrated that it is the best design in terms of simplicity and uniformity of slices. This gained acceptance to root crop growers in Southern Philippines and in other parts of the Philippines as well as IITA in Nigeria.

The results of laboratory tests made at IRRI and UPLB established critical design criteria for slicing/cutting action of the blades.

Future plan

The chipping machine will be introduced together with the drying technology for root crops. Some work has to be planned to design a bigger capacity machine and make it semi-mechanized.

4.2. Shattering device

Rationale

The shattering characteristic of paddy is a determining factor in harvesting the crop. Earlier studies have shown a certain maturity level where shattering begins. Considering minimizing shattering losses, farmers normally

harvest earlier which yields non-uniformly matured grains. This presents a problem in drying and dryer design.

Shattering characteristic of crop also relates to thresher design particularly the drum speed and threshing mechanism.

Objective/target output

1. To test the shattering characteristics of paddy and other materials and establish a thresher design information;
2. To study the optimum maturity level of paddy for harvesting with tolerable shattering loss;
3. Relate the shattering characteristics of the rice varieties with the moisture content at harvest;
4. To use above information in the development of a dryer.

Description of the device

Shattering Device

The device has a comb-like structure where the paddy still on panicle, is inserted. At the opposite end of the comb a grip is provided which is actuated in forward and reverse direction by chain links. A strain gauge measures the tensile strength of the panicle and the nodes where paddy grain is separated.

Accomplishments

Initial tests were done to calibrate the shattering capacity of the device.

Future plan

Study the shattering characteristics of paddy and relate to its harvest characteristics. This should relate to uniformity of moisture of paddy for drying. Other materials such as peanuts and beans will be tested for separation efficiency.

4.3. Loom (weaving device)

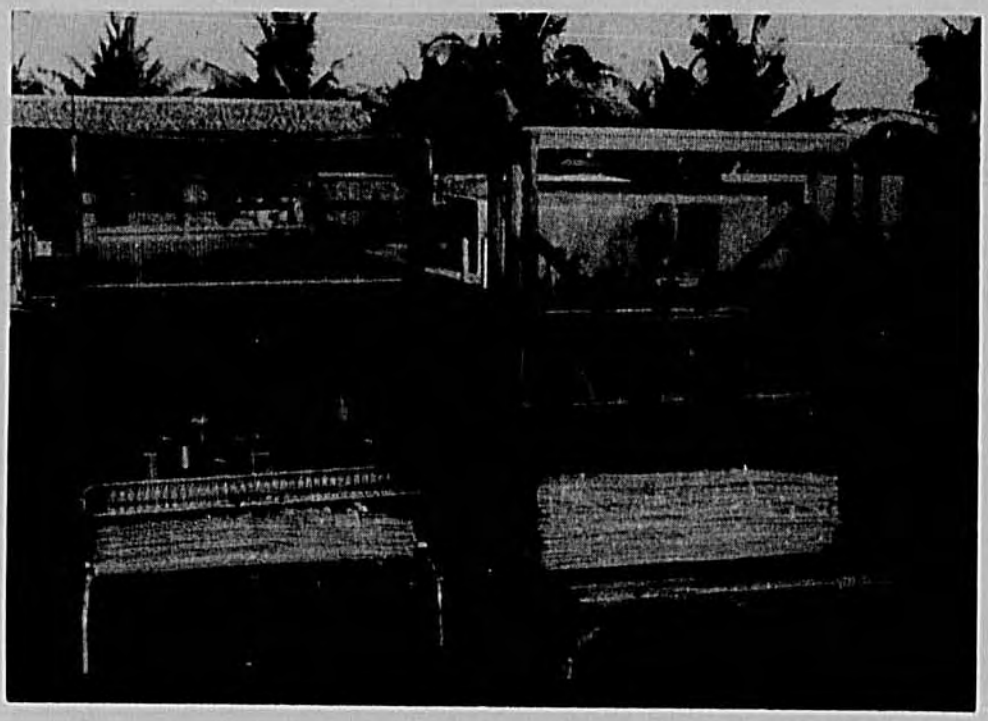
Rationale

A substitute material for mesh wire used in the drying trays comes in the form of bamboo slices or coconut midribs which is to be interwoven together with nylon strings to form the mat. The loom facilitates the weaving of the mat material.

Objective/target output

To provide a weaving device for use in the fabrication of mesh wire substitute for drying trays and of insulating mats.

Description of the device



Looms (Weaving Devices)

The device is made of steel or wood frame and can be operated by one or two persons depending on the width of mat being woven. The nylon strings hang in tension from the top and the other weave material is inserted in between as the weaving comb is positioned horizontally.

Accomplishment

The device was used in fabricating the tray mats used for the winged dryer.

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Future plan

- Introduce the device together with the drying technology.
- Other materials have to be tested to substitute for nylon strings.
- Use the device in weaving insulating mat from rice straw for use in the greenhouse dryer.

B. FUEL AND ENERGY CONVERSION SYSTEM RESEARCHES

In the development of different design capacities of dryers, the design of the heating system takes an important consideration. For example, building a small capacity dryer with heat exchanger will not be economically feasible because the heat exchanger alone takes 1/3 to 1/2 of the total cost of the dryer while the output capacity is low.

A component of the dryer project is the identification of heat sources and the design of heat energy conversion systems for the dryers. Thus, this activity aims to find ways to expand the utilization of rice hull and other solid fuels for drying and domestic purposes. Further, it is our object to match the heating system design with the dryer capacities.

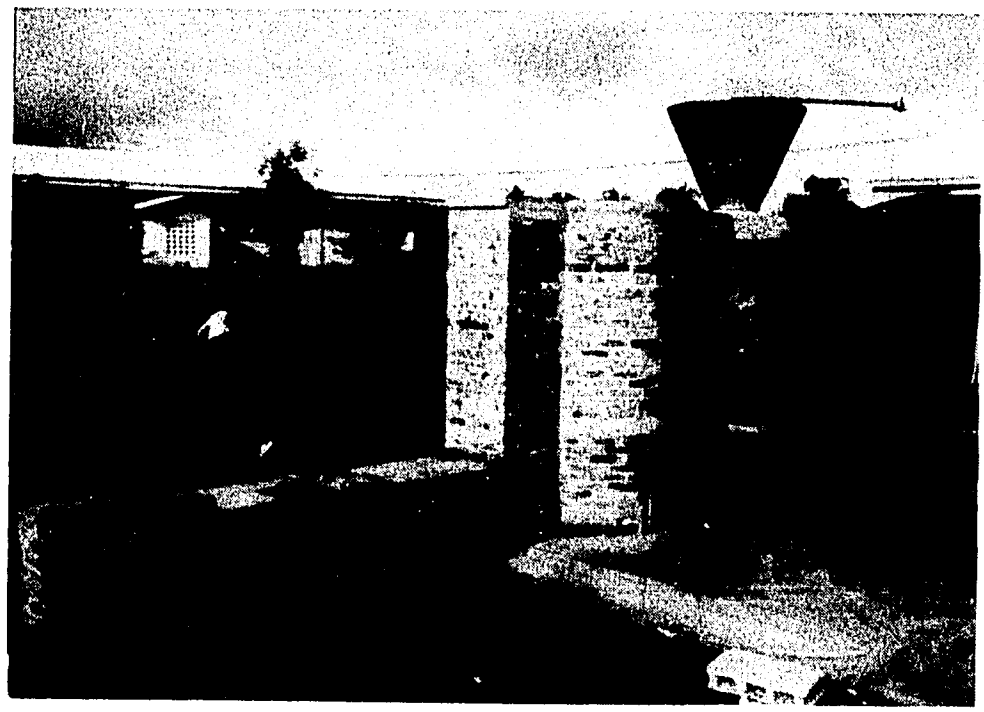
1. Rice hull carbonizer and center-tube furnace

The concept of a rice hull carbonizer-center tube furnace coupled with the dryers is aimed to improve a rice mill hull disposal while providing a heat recovery system for drying. The carbonizer produces rice hull charcoal which can be briquetted and used for different purposes. The volatile gases from carbonizing are further burned in the center tube furnace and the hot flue gas is used for drying.

Objective/target output

1. To provide a device for the carbonization of rice hull;
2. To provide a center-tube furnace for burning the volatile gases from carbonization and use this heat for drying;
3. To make recommendations for modifying a rice mill hull disposal system;
4. To develop a drying system for the rice mill.

Description of the carbonizer



Rice Hull Carbonizer and Center-tube Furnace

The device is also called a rice hull charcoal-making furnace. It is a cylindrical structure made of soil bricks provided with a feeding hopper. A hull spreader is suspended from the feed hopper to retard the fall of rice hull allowing it to burn initially during its downward movement. Chars are collected at the bottom and placed directly in water to stop further combustion.

The volatile gases from charring are burned in a center-tube furnace connected to the carbonizer. The

hot flue gas resulting from combustion is conducted to a dryer by a centrifugal fan.

Accomplishments

Two carbonizers were designed and constructed and were used for charring rice hull. The charcoal is used for briquetting. The second unit was connected to a center-tube furnace to recover hot volatile gases for use in drying.

Future plans

- Study the efficiency of heat recovery from the carbonizer by coupling it with a center-tube furnace and a suction fan. Recovered heat will be used for drying materials in bed, batch dryers.
- Study the economic feasibility of installing the carbonizer as component of a rice mill complex.
- Use the unit for the production of charcoal briquettes for drying and domestic uses.

2. Rice Hull Charcoal Briquettes, Briquetting Devices and Stoves for Charcoal

Rationale

Rice hull charcoal briquettes are becoming popularly used because of its clean flame. It is also easy to handle and has relatively high heating value.

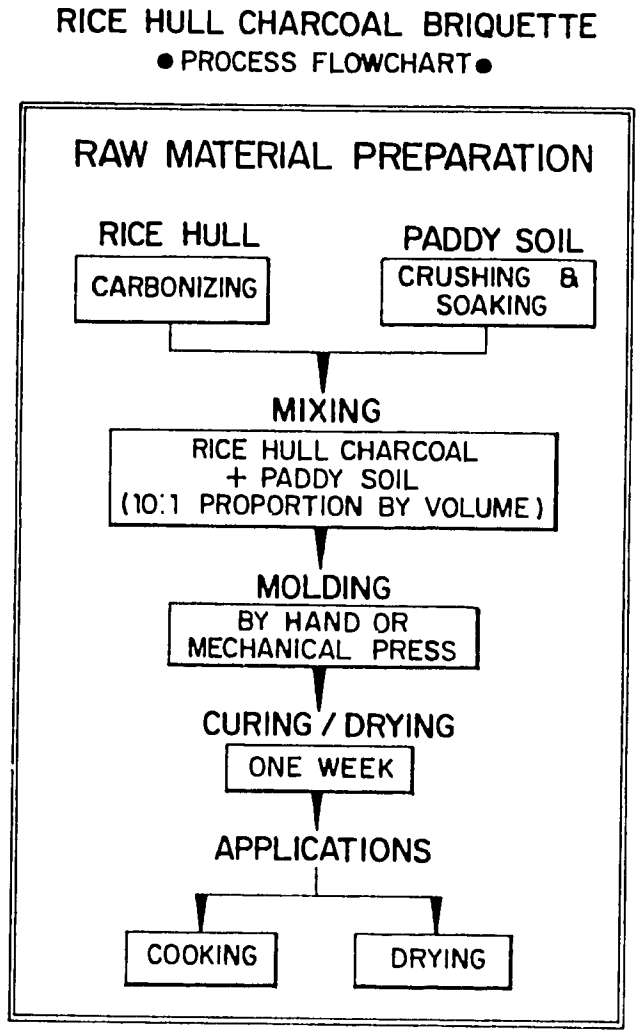
There are several available ways for briquetting the charcoal. Most of which uses cassava starch as binder and requires a special briquetting machine and process. It is the object of this work to develop an on-farm briquetting technique for the farmers using paddy soil as binder. A further object of the work is to design and develop simple tools and equipment for charcoal briquetting.

To ensure a complete burning of the charcoal briquettes, stoves has to be designed to fit its combustion requirements. Thus, simple stoves were designed and technique of burning briquettes was developed.

Objective/target output

1. To develop a simple technique for rice hull charcoal briquetting using locally available materials and simple tools;
2. To provide an alternative fuel for drying and domestic purposes;
3. To design stoves for burning the charcoal.

Description of the process



Flowchart for Rice Hull Charcoal Briquetting

Rice hull is carbonized and paddy soil of at least 50% clay content is soaked. A free flowing soil binder is added to the charcoal and mixed thoroughly. The

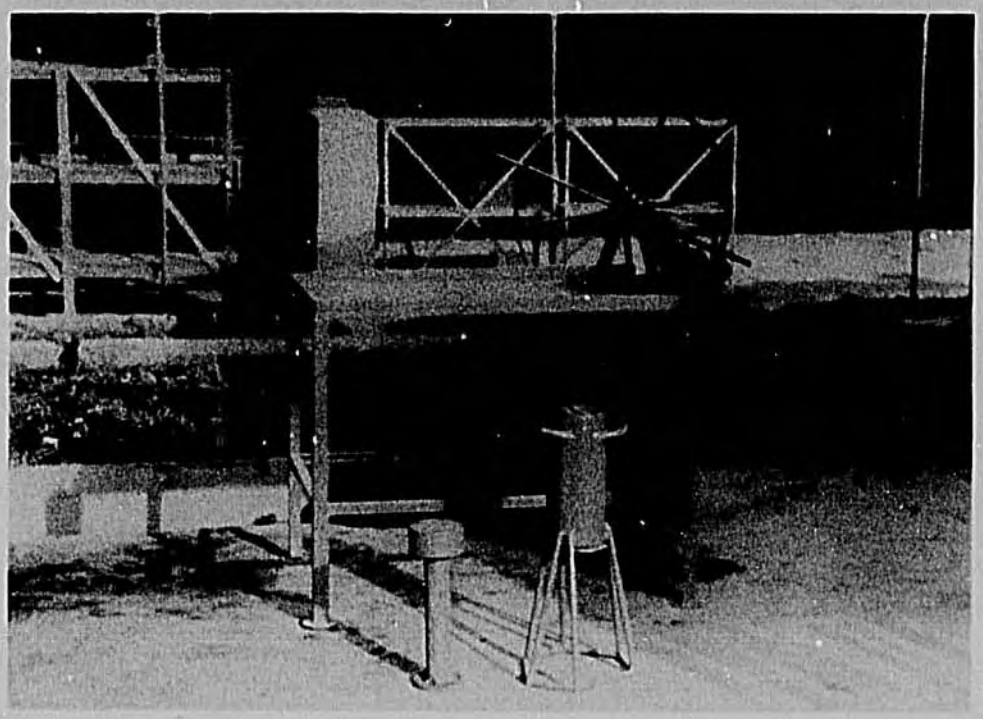
mixture is ready for molding into desired shape and size. The briquettes are dried and are ready for use.

Description of the stoves

The stoves are simple earthen pots provided with air inlet ports either at the sides or at the bottom for combustion air. Another construction is a drum stove fitted with cylindrical holes where charcoal is burned. The charcoal briquettes are burned either singly or in layers and are disposed in the same form. A tong is designed to handle hot briquettes.

Stoves for Charcoal

Description of the hand-operated briquetting devices



Charcoal Briquetting Devices

Two types of briquetting tools were designed and developed for the production of charcoal briquettes. Both devices are hand operated and simply compress the soil-rice hull charcoal mix to produce the compacted form.

Accomplishments

- Established a charcoal-soil binder ratio for charcoal briquetting.
- Developed a simple technique of rice hull charcoal briquetting using the hand or a hand-operated compactor.

- Tested briquette compressive strength and temperature generation efficiency.
- Fabricated and tested two hand-operated compactors.
- Designed and fabricated stoves for charcoal burning.
- Published a leaflet on rice hull charcoal briquetting as a component of the Prosperity Through Rice Project.

Future work

- Edit the rice hull charcoal briquetting leaflet and publish a more comprehensive guideline.
- Introduce the rice hull charcoal briquetting technology specially to rice mill owners.
- Further study on briquette transportability.

C. DESIGN, CONSTRUCTION AND DEVELOPMENT OF DRYERS

1. Pre-dryers for Grains and Other Materials

Rationale

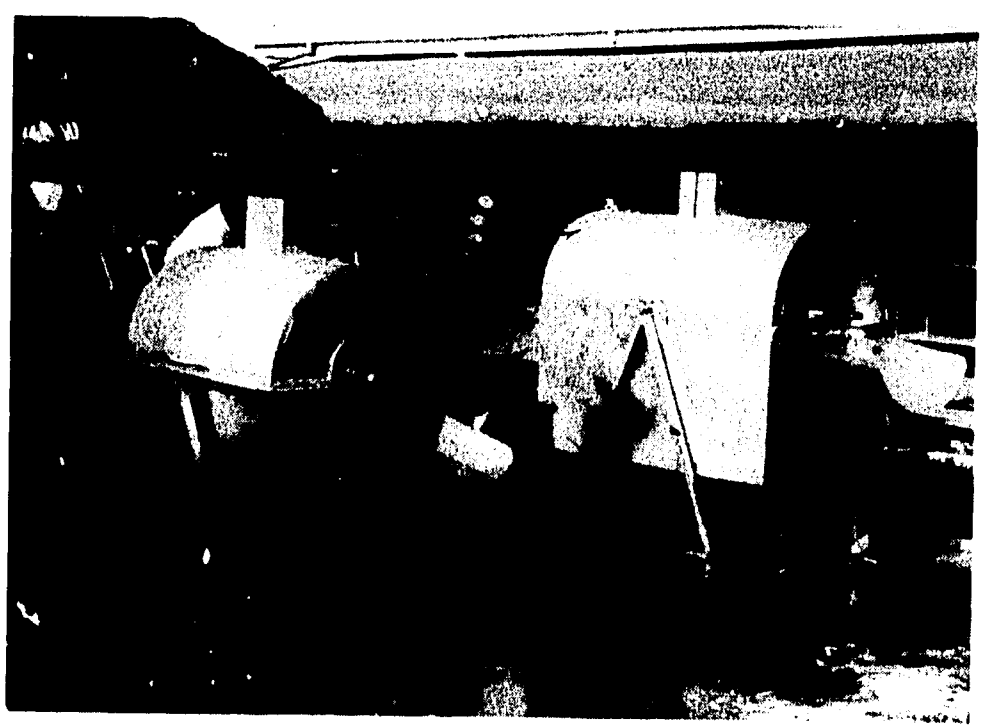
Often, harvesting very wet crops entails significant losses due to deterioration. To avoid this situation, the crop has to be dried immediately after threshing. This will also yield higher quality grain.

Drying high moistured grain in mechanical dryers however means higher operation costs. Therefore, this work is aimed to design a pre-dryer which is low-cost, portable and can be used to dry the crop right after threshing.

Objective/target output

To design, construct and develop a portable rotary type pre-dryer for grain and other crops to be used directly in the field after threshing particularly during the wet season harvest.

Description of the machine



Pre-dryers for Crops

Two types of small capacity rotary pre-dryers were designed based on the heating system. One direct-fired dryer is made from oil drum and equipped with a hand operated fan for faster drying. It is heated by burning agricultural wastes such as coconut husks, rice hull, corn cobs, etc.

A second type is a direct-fired unit which encloses the material in a perforated cylinder and is fueled by charcoal.

The material is loaded inside the drum which is heated up to 70°C and rotated. Drying takes place by conduction principle.

Each dryer capacity varies from 10 to 25 kg per batch reducing the moisture content from 28 to 20 percent in 10 to 60 minutes.

Accomplishments

- Designed and fabricated two small capacity pre-dryers described in the preceeding section.
- Tested the loading capacity, heat requirement and drying rate of paddy, corn and peanuts in the pre-dryer.
- Presented a paper on the preliminary evaluation of the dryer.

Future plans

- Modify the drum louvers.
- Increase size and capacity of the dryer with provisions for semi-mechanized operation.
- Test other crops.
- Make an economic analysis.

2. Warehouse Dryer for Individual Farmer (1 ton capacity)

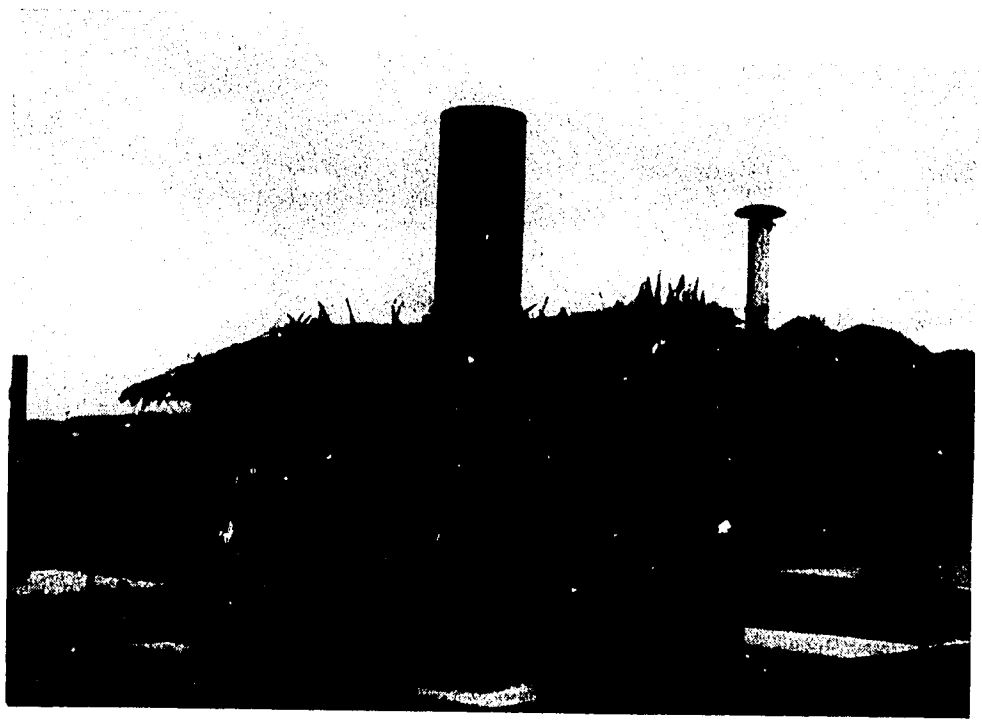
Rationale

Considering an individual farmer producing different kinds of crops and having an average yield of one ton, the design of the small warehouse dryer was undertaken. The dryer was designed for drying and storing different kinds of materials suited to the producing ability of a single farmer.

Objective/target output

To provide a small capacity (at most 1 ton) dryer for different kinds of crops suited for a single farmer.

Description of the dryer



Warehouse Dryer for Individual Farmer (1 Ton Capacity)

The dryer is a 3 x 3 x 2 m structure which houses a row of equally spaced vertical trays for holding the drying material. It has an indirect-fired heating system and provided with a smoke-stack for air exhaust. A work space is provided around the trays and can also serve to hold other drying materials.

Accomplishments and future plan

Drying tests are being carried out for paddy and cassava and sweet potato chips. Peanuts were also pre-

dried on the surface of the heat exchanger. Other crops are also planned to be dried.

Parts of the dryer will be modified based on analysis of the drying performance design parameters. Major modifications will be done on the heating system and the air exhaust stack.

3. Greenhouse-type Dryer

Rationale

The greenhouse type dryer was so named because it involves the 'greenhouse' effect for heating the structure. Since solar energy is available during certain times of the year, it is the object of this design to tap solar heat as heat source when available and to supplement heating with a furnace using agricultural wastes when the weather is bad. The dryer is also designed to make use of natural ventilation during fine weather. Further it is our purpose to provide a multi-commodity dryer which can be used for drying and storing throughout the year.

Objective/target output

To provide a warehouse dryer for different kinds of material which will utilize energy from the sun and the agricultural wastes as heat sources.

Description of the dryer

Greenhouse Dryer

The dryer is made of local construction materials and provided with a clear plastic sheet roofing which serves as solar heat collector. Natural ventilation is also possible during fine weather by opening the side doors. A center-tube furnace is provided to be operated during rainy days or when supplemental heat is needed.

Materials are loaded on vertical trays or stocked in bags for drying and/or storage.

Accomplishments and future plan

Modified the heating system and tested the unit for corn drying. Work is continuing to evaluate solar absorption efficiency and drying capacity.

A detailed analysis will be conducted on air suction rate using a smoke stack and a vortex wind machine of the same size.

4. Warehouse Dryer With Extended Walls (Winged Dryer)

Rationale

The warehouse dryer was built with extended corner walls which should serve as wind collectors. These will direct the wind blowing on either side into the warehouse and increase the suction capacity of the vortex wind machine. It is also the object of this design to provide an improved traditional drying system with an increased drying floor area and eaves for hanging drying materials.

Objective/target output

To design and construct a warehouse dryer with increased suction draft and drying capacity.

Description of the dryer

Warehouse Dryer with Extended Walls (Winged Dryer)

The dryer is essentially a warehouse equipped with drying trays, a direct fired stove and a chimney for air exhaust. It has an extended corner walls for increased air draft. In addition, a heat duct is provided under the floor which can be used if pre-drying is desired. It can hold different kinds of materials for drying in bulk or by hanging. The floor is heated for pre-drying materials before they are loaded for final drying or storing in the trays.

Accomplishment/future plan

Two types of the "winged" dryer were designed and constructed. One unit was a demonstration unit at the Prosperity Through Rice Project. It had been tested and evaluated and needs modification of the unloading system. A new modified unit for extensive testing and for extension is being prepared. This consists of a heated floor dryer in addition to the main heat source. Other dryers of different capacities is planned to be constructed based on this design.

5. Tent Dryer

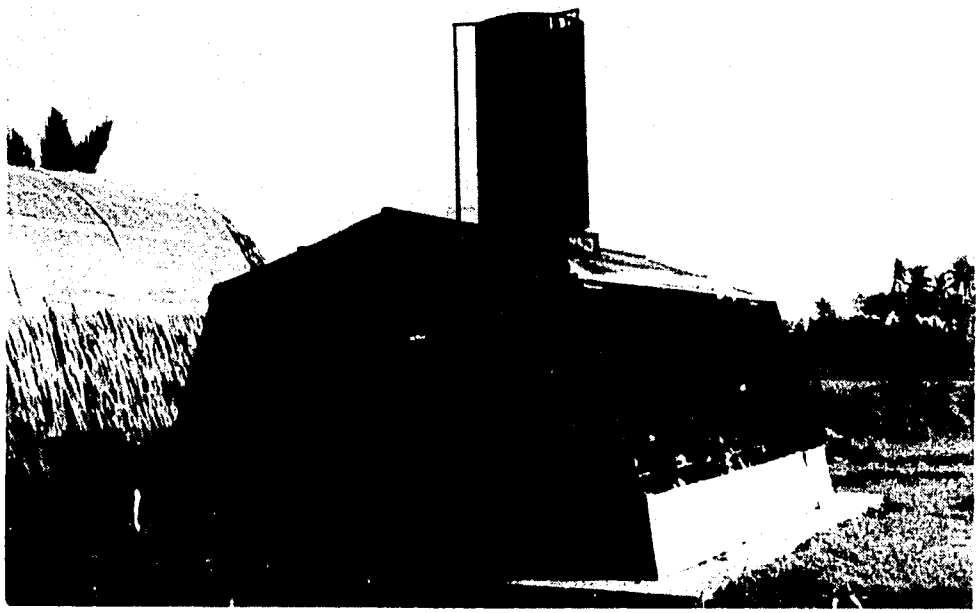
Rationale

The principle of combining natural and artificial drying is applied in this venture. It is the object of this work to design and construct a tent dryer easily adapted for multi-commodity drying using non-conventional energy sources.

Objective/target output

To provide a tent type warehouse dryer for different commodities.

Description of the dryer



Tent Dryer

The tent dryer has a skeletal fixed frame and covered with removable canvas on sides. It is painted black to serve as solar heat absorber for use in heating inside the tent. The canvas is provided with air inlet door flaps such that operation is possible with artificial heating. Drying air is exhausted by a vortex wind machine.

Racks and hangers can be used for holding materials inside the dryer.

Accomplishment/future plan

- The dryer was used for whole paddy crop drying and tested for air suction and air temperature distribution performance characteristics.
- Future plan includes modification of the drying racks to fit for fish drying and the like.
- Economic analysis will also be made.

D. MOISTURE VARIANCE DETERMINATION FOR DIFFERENT IR-RICE VARIETIES

Rationale

About 90% of the rices planted in the rice producing areas of South and Southeast Asia are high yielding varieties (HYV's). An important consideration in drying these varieties is the uniformity of moisture content during harvest. Most of these varieties do not usually mature at the same time and contains certain percentage of immature kernels at harvest. These quantity of green grains presents problems during drying.

This study was therefore initiated to determine the variation in moisture content of paddy within one variety and within harvested batches before and during harvest. Analysis will be referred in recommending the

proper time of harvest with optimum matured grain yield but minimum shattering losses. Design and development of dryers and milling devices will also be based on the results of the study.

Objective/target output

1. To determine the range of variation in moisture content of IR-rice varieties in relation to harvest date;
2. To provide basic information in the design of rice dryers, rice mill and other rice post-harvest equipment.

Methodology

Different IR-varieties planted at one time were used in the determination. One week before the expected harvest date, grain samples were drawn for moisture content determination. The amount of immature grains were also determined. The determination continued daily until one week after expected harvest date.

Accomplishment/future plan

Results of the determination are now being analyzed. Further experiments have to be designed based on this preliminary determination.

E. SOCIO-ECONOMIC STUDY

Rationale

A study on the economics of using the warehouse dryer and other alternative drying systems began since the start of the project. Socio-economic impact of the drying system on the small, medium and large farm levels and at the mill level has to be ascertained before any further implementation. The results of the study should provide information on the drying and storage requirements of different localities in order to design a drying system which is economically feasible for any given application.

Objective/target output

- To determine the feasibility of the warehouse dryer and to measure its socio-economic impact on the small, medium and large farm levels and at the mill level;
- To identify and document prevailing drying and storage practices in the study area;
- To identify the socio-economic and technical

drying system as a better alternative to alleviate these problems;

- To conduct a comparative economic and technical evaluation of different drying and storage systems in the area;
- To identify appropriate drying and storage systems compatible with the local needs.

Accomplishment/future plan

- Prepared a research proposal and two sets of interview schedules.
- Pre-tested interview schedules in the Bicol area.
- Conducted a case study on performance of selected dryer types in Mindanao.