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

ANNUAL PROGRESS REPORT
September 1, 1984

Cooperative Agreement AID 492-CA-1707
Project No. 498-0265

Annual Progress Report
September 1, 1984

Appendices

Cooperative Agreement AID 492-CA-1707
Project Number 498-0265

Annual Progress Report
September 1, 1984

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

Although the economies in the Southeast Asian countries had a serious impact upon agriculture, the small manufacturers with whom we work have continued to increase their production. Since currency devaluations have increased the cost of imported equipment, farmers are turning more to locally produced machinery. The table on page 25 of the MA-IRRI Annual Report (Philippines) illustrates how production has continued to be strong during 1983.

Notice was received in late 1983 that funding from the Asia Bureau will terminate on September 30, 1986 and that any continuation of the projects will be with support from the local missions. As a result, evaluations of country programs were requested for Indonesia and the Philippines. The evaluation for Indonesia was scheduled for February 1985: the one for the Philippines was completed in October, 1984. Both evaluations recommended continuation of the program. The specific recommendations are included in separate reports.

The program in India made good progress in 1983-84 although the adviser, Mr. Fred Nichols, did not arrive until September 1, 1984. We feel that much progress will be seen in 1985.

In general, the project continued to increase the number of machines being introduced to farmers and enlisted more manufacturers in the production of machines for the small farmers. The reception by manufacturers eager to find good designs to produce indicated that a need for such machines existed although the technical capabilities had not been developed. The IRRI Industrial Extension Program is designed to meet that need and develop the capabilities of local manufacturers.

v

Headquarters Activities

1. Staffing

The staffing of the Agricultural Engineering Department as of 1 September, 1984 was as follows:

Dr. C. W. Bockhop, Head of Department, and Project Leader of Industrial Extension.

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

Mr. Makoto Ariyoshi, Agricultural Engineer, with major responsibility in Test and Evaluation.

Mr. Bart Duff, Agricultural Economist, with major responsibility with the Economics Section.

Dr. Yong Woon Jeon was a consultant, Agricultural Engineering, with major responsibility in grain drying. He had been a Senior Research Fellow and was appointed a consultant pending approval of a project proposal submitted to the International Development Research Council (Canada). The approval was received on November 15 and the project will continue for three years.

Support staff included one assistant Agricultural Engineer, 22 Research Assistants, 6 secretaries and 32 shop personnel, draftsmen, field aides, and laborers.

Outreach Staff

Dr. Robert E. Stickney, Agricultural Engineer, Adviser to the Industrial Extension Program in the Philippines stationed in Manila.

Dr. Billy J. Cochran, Agricultural Engineer, Adviser to the Industrial Extension program in Indonesia stationed in Jakarta.

Mr. Fred Nichols, Agricultural Engineer, Adviser to the Industrial Extension program in India stationed in Coimbatore, Tamil Nadu state. Mr. Nichols' appointment began September 1, 1984.

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

Mr. S. Labro, Senior Research Assistant, the Agricultural Engineering Department, IRRI, was assigned to the Egypt Rice Project in October 1983. His appointment followed Mr. Marvin Parker who departed due to health reasons. This project is part of the University of California contract with USAID.

Mr. Malcolm Hammond is assigned to Burma as Agricultural Engineer and Project Leader. The project is supported by CIDA of Canada.

2. Training

The department had four post-doctoral fellows. Dr. Banshi D. Shukla had major responsibility in crop drying. His two year term was completed in August 1984 and he returned to India. He is now a research officer with the Central Institute of Agricultural Engineering in Bhopal.

Dr. Yong Woon Jeon was a Senior Post Doctoral Fellow until July 1, 1984 when he was appointed a consultant pending approval of a project by IDRC. This approval was granted and he was appointed to the Senior Staff on November 15, 1984. His principal responsibility is Crop Processing and Drying.

Dr. Thammanun Pongsrikul, An ex-ante evaluation of small farm mechanization policies in Thailand. (Post Doctoral Fellow). Adviser, Bart Duff.

Dr. Zenaida Toquero, Rice post production technology in the Philippines. (Post Doctoral Fellow). Adviser, Bart Duff.

The departmental staff supervised the research programs of the following scholars:

Mr. Zahid Mahmood, Pakistan, UPLB; thesis project -- Analysis of Augers for Metering Prilled Urea and Injecting it in Flooded Soils. Adviser, A. U. Khan. Graduated with a Master of Science Degree in October, 1984.

Mr. Md. Muzzammil Haq, Bangladesh, UPLB. Thesis project -- Performance Study of Three Types of Animal

Drawn Plows. Adviser, C. W. Bockhop. Graduated with a Master of Science Degree in May, 1984.

Mr. Mamerto Aban, Research Assistant, completed his studies leading to the Master of Science Degree and graduated from UPLB in October, 1984.

Mr. Alejandro Caballes, Research Assistant, completed his studies leading to the Master of Science degree and graduated from UPLB in October, 1983.

Mr. Luhong Zhang, China, began his studies in June 1984. Adviser, C. W. Bockhop.

Mr. Thanya Kiatiwat, Thailand, began his studies in July, 1984. Adviser, C. W. Bockhop.

Mr. Wenceslao Kilasara, Tanzania, started a research project, The PTO Driven Axial Flow Thresher, for a Master of Science program at University of Dar es Salaam. Adviser: C. W. Bockhop.

Mr. Francis Mwombeki, Tanzania, research project, Deep Placement of Fertilizer, for a Master of Science program at the University of Dar es Salaaam. Adviser, A. U. Khan.

Mr. Julius Kigalu, Tanzania, research project, Assessing the effects of selected levels of mechanization on small-scale rice production systems: Central Luzon, Philippines, a case study, for a Master of Science Degree at the University of Dar es Salaam. Adviser, Bart Duff.

Mr. Dermot Shields, Productivity and income effects of farm mechanization in Thailand and the Philippines (ODA fellow). Adviser, Bart Duff.

Mr. Ajay Markanday, The impact of mechanization on labor use in the Philippines, West Java and South Sulawesi. (ODA Fellow). Adviser, Bart Duff.

Mr. Somporn Saitan, The effect of tractor use on the structure of income and income distribution on small rice farms: a case study of Suphanburi Province. Thailand (Kasetsart University). Adviser, Bart Duff.

5

Mr. Inigo Camacho, Development of modified rice whitening techniques through an analysis of the rice huller efficiency in commercial sized rice mills. UPLB Dept. of Agricultural Engineering. Adviser, Bart Duff.

Ms. Leonarda Ebron, Changes in harvesting-threshing labor arrangements in Nueva Ecija. UPLB Dept. of Agricultural Education, Rural Sociology. Adviser, Bart Duff.

Ms. Fleurdeliz Juarez, Institutional and economic impact of mechanical rice threshing in Laguna and Iloilo, Philippines. UPLB Dept. of Rural Sociology. Adviser, Bart Duff.

The Department conducted two courses, each of three weeks duration, during 1983-84. A copy of the course schedule for the course May 8 to June 15, 1984 is attached as Appendix A. Attendance for the two courses is shown in Table 1.

Table 1. Attendance at Agricultural Engineering Course

Country	Nov 28-Dec 16 '83	May 28-June 15 '84
Bangladesh	2	
Bhutan	1	1
Burma	3	
China	2	
Ghana		1
India	4 (a)	3 (a)
Indonesia	1 (a)	1 (a)
Philippines	3 (a)	5 (a)
Sri Lanka	3	4
Thailand	2 (a)	2 (a)
Vietnam	1	1
Total	22	18

(a) Received support from Industrial Extension project. All others were supported by other projects.

3. Design and Development

Priorities for Design and Development are established by a Project Review Committee that includes senior staff from the departments of Agricultural Economics, Agronomy Entomology, Soil Physics, Multiple Cropping, and Training and Technology Transfer. Inputs to this committee come from Senior Staff and junior staff of the Agricultural Engineering Department, other departments, and from the Industrial Extension staff of the Outreach Program.

The work during 1983-84, in order of priority, was as follows:

a. Fertilizer Placement

Extensive research by Agronomists and Scientists from the International Fertilizer Development Center have shown that up to 60% of the nitrogen, applied as urea in the traditional way of spreading on the surface of a flooded field, can be lost through volatilization. To prevent this loss urea needs to be placed beneath the surface of the mud and immediately covered to prevent the introduction of water which dissolves the nitrogen.

The Agricultural Design Group has been investigating various designs of machines to place fertilizer under the surface and prevent the immediate dissolution of nitrogen. Three different designs have evolved and appear promising. The equipment has been tested in farmers fields and have demonstrated an increase in fertilizer efficiency.

Several machines have been fabricated by a manufacturer and the final product may be available to farmers in 1985. Five papers published during the past year are included in Appendix B.

b. Direct Seeding

Progress has been made in the development of machines for the direct seeding of rice. As labor becomes more expensive and in short supply farmers are practicing more direct seeding of rice. Proper land preparation and water control is critical and the proper cultural practices need to be developed. A ten row and a 14 row seeder have been developed and appear to be a practical answer to the farmers' need. Testing of the practice and the development

1

of the proper procedures are still needed. The machines are being tested in farmers' fields.

c. Crop Drying

Different versions of the warehouse type dryer continue to be developed to overcome problems which appeared in the early designs. Although the first designs were effective in drying of all crops, there were problems in loading and unloading while the warehouse was in the heated stage. Laborers objected to working in the high temperatures that prevailed. Also the cost of metal roofing has become exhorbitant. We are seeking ways of improving the handling and movement of the grain and to replace metal in the structure.

The research effort on crop drying is supported by a grant from IDRC.

d. Pumps

Testing of a two-stage axial flow pump has been completed. The research resulted in some excellent criteria for the design of a two-stage pump using the axial flow principle. The two stage pump is more economical at higher lifts and is able to maintain efficiency at a lift up to 5 1/2 meters and an output of 5000 liters per minute. A copy of a paper on the design is in Appendix C.

The designs for commercial production are not yet developed.

4. Industrial Extension Meeting

A meeting of Industrial Extension Engineers was held in Los Banos October 10-12. Each country representative discussed their problems and mutual concerns. This annual meeting is a useful and informative way to exchange ideas and present design ideas to the engineers at Los Banos.

Following the Industrial Extension Engineers meeting, the group went to China for a seminar with the Chinese Academy of Agricultural Mechanization Sciences. The group

9

were in China from October 13-24. We were guests of CAAMS and no USAID funds were expended for this exchange.

5. <u>Other activities</u>

In addition to the 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.

On September 2-6, 1984, Dr. Bockhop attended the meeting of the Congres Internationale du Genie Rurale in Budapest, Hungary. This is an International Congress for Agricultural Engineers that meets every 5 years. Personal funds were used for this meeting.

The Agricultural Engineering Department was evaluated by the Program Committee of the Board of Directors on October 1, 1984. The results of the evaluation was reassurance that the quality of the research and its outreach program were excellent. Recommendations of the Board were:

1. The Economics Section should be transferred to the Agricultural Economics Department.

2. The department is to be reorganized to accommodate the decrease in staff when Mr. Ariyoshi retires.

3. Priorities of research and development will include:

a. Complete the development of the fertilizer placement machines.

b. Develop the machines and cultural practice for the direct seeding of rice.

c. Develop seeders and planters for upland conditions.

d. Develop machines for the incorporation of azolla and organic materials and crops.

The reorganization was to be completed in April 1, 1985.

Outreach Programs

1. Philippines

During the 1983-84 year the MAF-IRRI project continued to expand cooperation with manufacturers. Several new firms and manufacturers who had not been associated with the program became cooperators.

The program assisted in organizing cooperating manufacturers on a regional basis. The groups met for the first time and began organizing to discuss their mutual problems and present their needs to the government with respect to financing, materials procurement, and distribution problems.

New machinery developments include the development of a corn sheller attachment for the TH8 thresher, the development of the tapak-tapak pump, and the design of a seed and fertilizer applicator for upland conditions.

The following are other activities of interest:

a. Arrangements were made with two inventors for the testing of a rice straw-fired steam engine as a portable power unit.

b. A floating power tiller, locally manufactured, has been tested. The results are being studied for possible applicability to the IRRI designed power tillers.

c. A carabao harness is being evaluated to see if improvements can be suggested to manufacturers.

The transplanter has created new interest and a training program for both farmers and manufacturers was developed. This training program was taken to Libmanan and conducted on the farmers fields. By getting the farmers involved at the local level, the training appeared to be more successful than when they are brought into a central location. Twenty-one units were sold as a result of the training program.

A detailed copy of the Annual Report for the Philippines is in Appendix D. A copy of the transplanter training program is in Appendix E.

2. Indonesia

The project staff in Indonesia conducted two training programs during the year; one in West Sumatra for fabricators of hand tractors, the second in West Java for carpenters to produce pedal threshers and pedal winnowers.

A 30-minute video tape, highlighting the project activities was prepared for distribution to the provinces.

A study on "Diffusion and Commercialization of Rice Post Harvest Equipment in West Sumatra", funded by ILO and conducted jointly by the Centre for Agro Economic Research and the IRRI-DITPROD staff was completed.

A detailed copy of the Annual Report for Indonesia is found in Appendix F. A draft copy of the study funded by the ILO is in Appendix G.

3. Thailand

Dr. B. J. Cochran began working as the Adviser to the program in Thailand on September 1, 1983.

Thirteen of the IRRI designed machines were introduced into Thailand during 1984. There was great interest shown in seeding equipment; and both the inclined plate planter and cyclone seeder were manufactured in large numbers. The improved buffalo plow, developed several years ago, is now being accepted and large numbers are being manufactured.

An economic study in Northeast Thailand to assess the potential of new and improved mechanization techniques was initiated in 1984. The results are being tabulated and the analyses should be completed in 1985. The results should provide insight into the needs of the area in improving resource use efficiencies and reducing production costs.

A detailed copy of the Annual Report for Thailand is in Appdendix H.

11

4. India

The project staff has made remarkable progress in the short time that they have been in place in Coimbatore. The workshop has been established on the grounds of Tamil Nadu University. An engineer, and some supporting staff were appointed; and a study of the area to provide base-line information was conducted.

The project adviser, Mr. Fred Nichols and the project engineer decided to concentrate on the introduction of the reaper, the thresher, and the transplanter. There was much interest in these machines by the manufacturers. Many demonstrations were held and there was much interest by the farmers.

Further demonstrations will be conducted during 1984 and manufacturers will be contacted for fabrication of first prototypes. Nineteen manufacturers are interested in cooperating with the project.

A detailed Annual Report is in Appendix I.

5. Burma

The project in Burma is supported by CIDA but is reported here to indicate the extent of activities in the Industrial Liaison Project.

The Burma project is establishing a workshop and research and testing capability for the Agricultural Research Institute at Yezin. The work is presently concentrating on the improvement of implements for animal power and on pumps for lifting water for irrigation.

A copy of the detailed Annual Report is in Appendix J.

12

6. Egypt

The project in Egypt is a sub-contract with the University of California at Davis and is part of a project in Rice Production. IRRI furnishes an engineer, an extension staff member, and a rice breeder to the program. Mr. S. Labro, an Assistant Engineer of the Agricultural Engineering Department of IRRI, is the Adviser for Mechanization.

The testing and introduction of the axial flow thresher, the reaper, the axial flow pump and the transplanter have been the principal activities during 1984.

There is much interest in an improved thresher for the small rice farmer in Egypt. However, the use of present native varieties with their long straw result in a low threshing output. The thresher may have to be modified to accommodate the longer straw. As the Egyptian farmers adopt the shorter stemmed varieties the problems of low thresher capacity may be overcome.

Labor is in short supply during the critical times of harvest and the rice farmers of Egypt need a low cost reaper. One manufacturer in Cairo has been engaged to fabricate 10 reapers for the project. He plans to fabricate 50 units for sale to farmers in 1985.

The planting or seeding of rice in Egypt needs to be mechanized to assist the farmer at this critical time of rice production. The IRRI engineer is testing the IRRI designed transplanter and plans to introduce a seeder. The transplanter will work well but the Egyptian farmer needs to be educated in the proper land preparation practices. A transplanter needs a level area in order to work properly. Present farmer practices leave the land in an uneven condition. A program of education by extension personnel is needed.

Budget and Expenditures

A summary of expenditures for 1983-84 and is included in Appendix K.

PROGRAM SCHEDULE

Three-Week Agricultural Engineering Training Course
November 19 - December 7, 1984

FIRST WEEK

November 19, 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"	Visitors' Bureau
9:15 - 9:30	Preparation for Introduction of Trainees	Move to Ag. Eng. Conf. Room
9:30 - 10:00	Introduction of Trainees and IRRI Staff	R. E. Stickney
10:30 - 10:45	Stipend, allowances and excess baggage coupon processing	A. Eleazar
10:45 - 11:00	Ticket confirmation and travel schedule	Jet Travel
11:00 - 12:00	Basic concepts in Agricultural Economics: Farm Planning and Budgeting	Z. F. Toquero
12:00 - 1:00	Lunch	
1:00 - 2:30	Farm Economics (Cont'd.)	
2:30 - 2:45	Coffee Break	
2:45 - 5:00	IRRI Engineering Drawing System	F. Jalotjot

November 20, 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	
1:00 - 5:00	Field Practice -- Transplanter, Reaper, Thresher, Axial Flow Pump and Power Tiller (with plow, rotavator and harrow)	A. Vasallo

November 21, 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 (Cont'd.)	I. Manalili
12:00 - 1:00	Lunch	
1:00 - 5:00	Shop Work: Power and Rotary Tillers	IM/E. Dungo

November 22, 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	
1:00 - 2:00	Transplanter: Economic Analysis (using PBP)	L. Ebron
2:00 - 3:00	Shop Tools and Plant Layout	H. Manaligod
3:00 - 3:15	Coffee Break	
3:15 - 5:00	Jigs and Fixtures	L. Kiamco

November 23, 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	
1:00 - 5:00	Threshers: Shop Work	MD/ED

SECOND WEEK

November 26, 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
11:45 - 12:00	Free Time	
12:00 - 1:00	Lunch	
1:00 - 2:00	Agricultural Machinery Testing and Evaluation	AC
2:00 - 5:00	Threshers: Field Test and Measurements	AC

November 27, 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	
1:00 - 5:00	Reaper: Shop Work	MD/ED

November 28, 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	Economics of Manufacturing	HM
12:00 - 1:00	Lunch	
1:00 - 2:00	Machinery Safety.	M. Ariyoshi
2:00 - 5:00	Reaper: Field Test and Measurements	AC

November 29, 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	
1:00 - 2:00	Seeder and Fertilizer Applicator: Economic Analysis (using IRR)	LE
2:00 - 5:00	Seeders and Fertilizer Applicators: Shop and Field Work	LK/ED

November 30, Friday Holiday -- No Training Class

December 1, Saturday

	Field Trip to Cooperating Manufacturers and Farmers	HM

THIRD WEEK

December 3, Monday

8:00 - 12:00	Small Engines for Farm Machinery	Briggs & Stratton Rep.
12:00 - 1:00	Lunch	
1:00 - 5:00	Small Engines: Shop Work	Briggs & Stratton

December 4, Tuesday

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	G. Salazar
12:00 - 1:00	Lunch	
1:00 - 5:00	Free Time	

16

December 5, Wednesday

8:00 - 10:00	Rice Drying	A. Belonio
10:00 - 10:15	Coffee Break	
10:15 - 12:00	Rice Milling	H. van Ruiten
12:00 - 1:00	Lunch	
1:00 - 2:30	Dring and Milling: Laboratory Work	AB
2:30 - 2:45	Coffee Break	
2:45 - 5:00	Axial Flow Pump: Shop Work	GS/ED

December 6, 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	
1:00 - 2:00	Extension Program: Overview	C. W. Bockhop
2:00 - 3:00	Individual Country Report	I. Manalili

December 7, Friday

8:00 - 10:00	Course Examination	IM
10:00 - 10:15	Coffee Break	
10:15 - 12:00	IRRI Tour	Visitors' Bureau
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/ecs

IRRI RESEARCH PAPER SERIES
NUMBER 96 OCTOBER 1983

FERTILIZER TRANSFER TO FLOODWATER DURING DEEP PLACEMENT

A. U. KHAN, L. KIAMCO, and V. TIANGCO

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

FERTILIZER TRANSFER TO FLOODWATER DURING DEEP PLACEMENT

A. U. Khan, L. Kiamco, and V. Tiangco[1]

ABSTRACT

This study indicates that presence of water during fertilizer placement plays a major role in reducing fertilizer use efficiency in flooded rice fields. Fertilizer applicators that have been developed in the past have transferred 40 to 70% of the fertilizer to the floodwater during the placement operation. Five possible ways of nitrogen transfer to floodwater are suggested. It was found that up to 40% of the placed fertilizer transfers to floodwater through dissolution during transit from the water surface to the furrow bottom. That was the major avenue for fertilizer transfer. The second major transfer is when the fertilizer solution and/or granules are pushed from the furrow bottom into the floodwater as the furrow closes. Transfers due to nitrogen diffusion through soil or through poorly closed furrows are not high. The authors argue that minimizing nitrogen transfer to floodwater during fertilizer placement is the key to improving fertilizer use efficiency in flooded rice fields. A deep placement applicator concept for minimum transfer to floodwater is proposed. The paper concludes that fertilizer dissolution and the dynamics of fertilizer solution in flooded rice fields have not been fully understood and need further research to improve fertilizer use efficiency.

[1]Agricultural engineer and research assistants, Agricultural Engineering Department, International Rice Research Institute, Los Baños, Laguna, Philippines.

FERTILIZER TRANSFER TO FLOODWATER DURING DEEP PLACEMENT

Asian farmers have not been able to effectively utilize fertilizer to boost their yields because of excessive nitrogen (N) losses in wetland paddy cultivation. As early as 1941 in Japan, Shioiri explained how surface-applied ammonia was lost in flooded soils and recommended deep placement of ammonium fertilizers. Several field experiments conducted in Japan from 1942 to 1952 indicated deep fertilizer placement increased rough rice yields by an average of 10% (Mitsui 1955). Despite more than 40 years of work, it has been impossible to implement these important findings at the farm level because suitable applicators have not been developed.

The Agricultural Engineering Department at the International Rice Research Institute (IRRI) has worked to develop deep placement applicators for almost a decade, and many interesting and innovative machines have been devised. Most of them can place fertilizer (Fertilizer in this paper refers to urea fertilizer.) 5 cm or deeper and can close the placement furrow. Many IRRI-developed machines have performed well in experiment station trials, but most have not performed consistently at farm locations. This poor field performance has been baffling, and site and soil differences quite often have been given as reasons for erratic performance.

However, the consistent poor field performance of IRRI machines that meet placement depth and furrow closing criteria suggests that we may have overlooked some important factors that determine applicator performance.

Our main emphasis in developing applicators has been the physical interactions of soil and fertilizer, and we have concentrated on placement at proper soil depth and thorough closing of furrows. Fertilizer-water interaction generally has not been recognized as a major factor affecting fertilizer loss, and engineers paid little attention to it in the design of deep placement applicators.

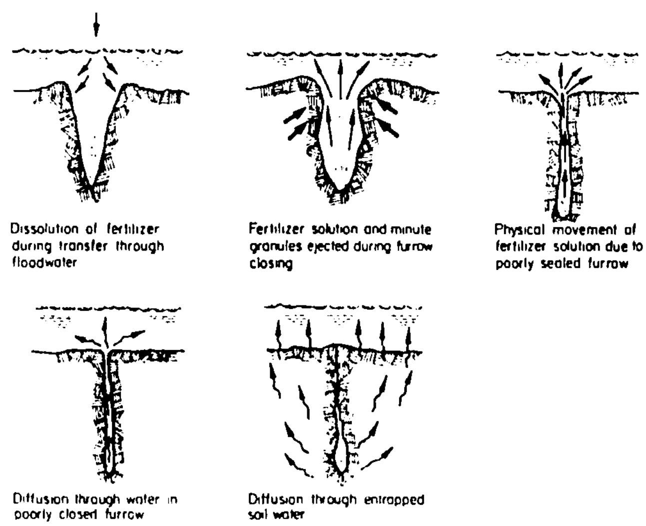
Fertilizer use efficiency on upland farms is 50 to 60% (Craswell and Vlek 1979). On flooded wetland farms, it is 30 to 50% (Prasad and De Datta 1979). In experiments in Pakistan (Ross 1980), dry fertilizer incorporation followed by flooding resulted in 60% applied N recovery by the rice crop, which indicated that flooding after fertilizer application does not reduce fertilizer use efficiency. However, presence of water during placement seems to reduce fertilizer efficiency. A literature review shows no published data on the role of water during placement in decreasing fertilizer use efficiencies in flooded fields.

Because fertilizer volatilization losses are directly affected by floodwater N levels, minimizing floodwater N might be an effective method of reducing fertilizer losses. Isolating the different ways fertilizer moves to floodwater would help to understand the mode and magnitude of such transfer. That, in turn, could help scientists improve applicator designs. A series of laboratory experiments were conducted by the Agricultural Engineering Department to define fertilizer-floodwater interactions.

There are five ways by which fertilizer can transfer (Fig. 1) to floodwater during or immediately after placement:

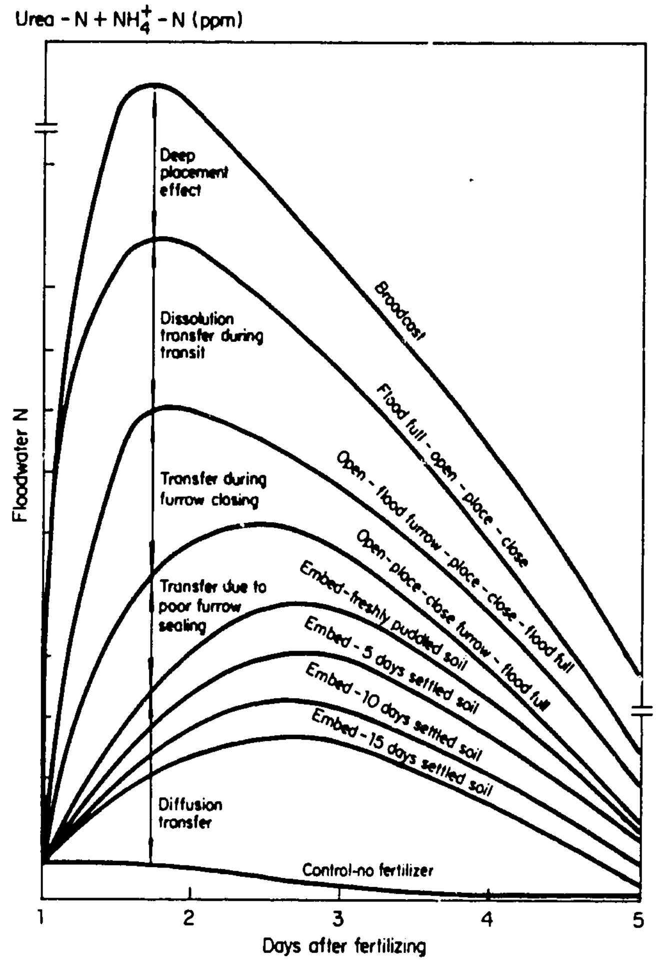
1. through the dissolution of fertilizer as it passes through standing floodwater to the furrow bottom:
2. by upward movement of fertilizer granules or solution caused by the displacement effect when the furrow is closed;
3. by convectional movement of the fertilizer solution through poorly closed furrows;
4. by diffusion through water trapped between poorly closed furrow walls; and
5. by diffusion through water trapped in puddled soil.

A set of hypothetical curves indicating the various ways of fertilizer transfer to floodwater and the experimental methods to isolate these effects are given in Figure 2.

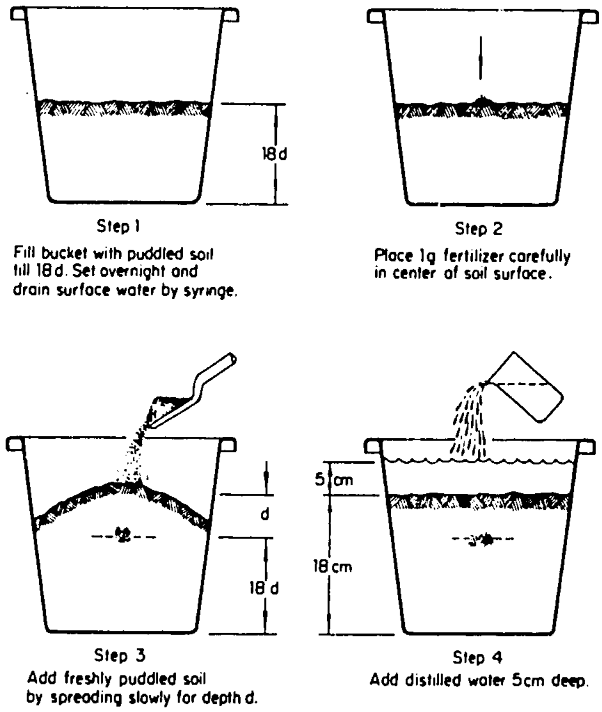


1. Avenues for fertilizer transfer to floodwater during deep placement.

10



2. Hypothetical curves showing possible avenues and experimental techniques for evaluating fertilizer transfer to floodwater during placement.



3. Fertilizer embedding experiments (freshly puddled soils). d = embedding depth.

The laboratory experiments were:

1. *Embedding* experiments (Fig. 3) for prilled, forestry-grade, and urea supergranules at 2.5 and 5 cm depths, to study diffusion of fertilizer through freshly puddled soil;
2. *Delayed-fertilizer-release* experiments (Fig. 4) in which embedded prilled, forestry-grade, and supergranule fertilizers were released, without disturbing the soil and after settling periods of 5, 10, and 15 days, to evaluate diffusion rates through settled soils; and
3. *Fertilizer placement* experiments (Fig. 5) with different furrow opening, closing, and flooding sequence, and with varying fertilizer-water contact time of 0, 5, and 10 seconds to understand N transfer rate due to contact with water during placement. (Only prilled fertilizer was used in this experiment because prilled urea is most susceptible to transfer to floodwater during placement and is the only fertilizer commercially available to rice farmers.)

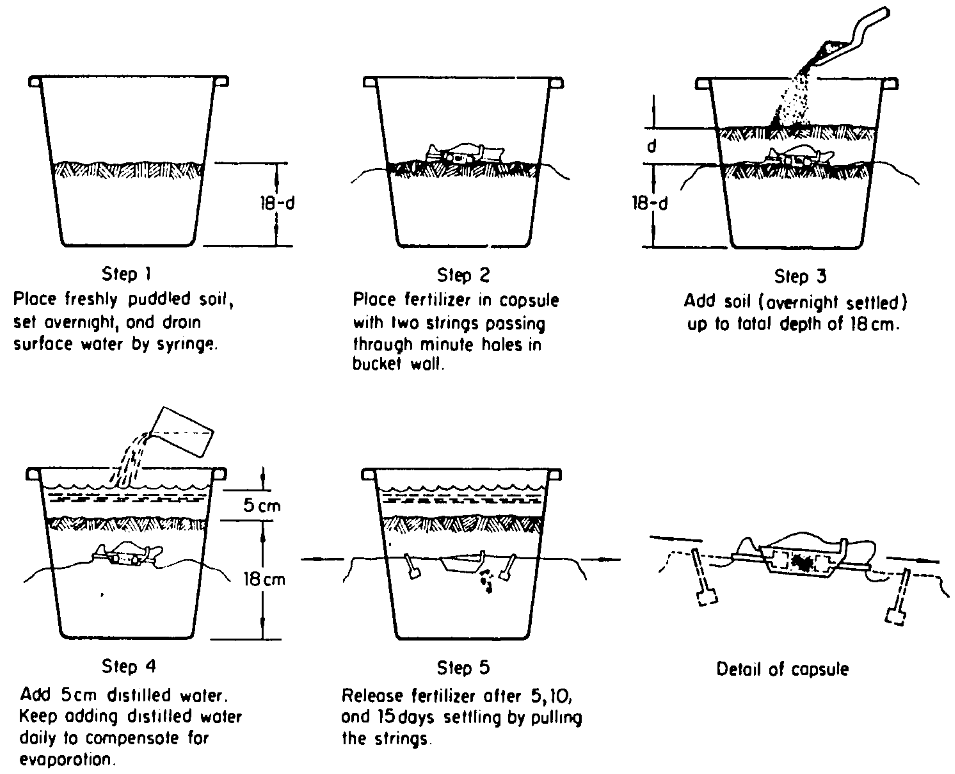
METHODOLOGY

Two preliminary experiments were conducted in 4,000-cc glass beakers: one to study fertilizer embedding and one to evaluate fertilizer-water placement sequence. A fairly high fertilizer rate (232 kg N/ha) was used in the tests. The embedding experiment (Fig. 6) indicated that larger granule size reduces N diffusion to floodwater during the first few days. To a limited extent, deeper placement also lowers N diffusion. The placement sequence experiment (Fig. 7) showed that presence of water during fertilizer placement and speed of furrow closing are important in increasing N diffusion to floodwater. The results of these experiments encouraged us to conduct three replicated experiments to confirm the findings.

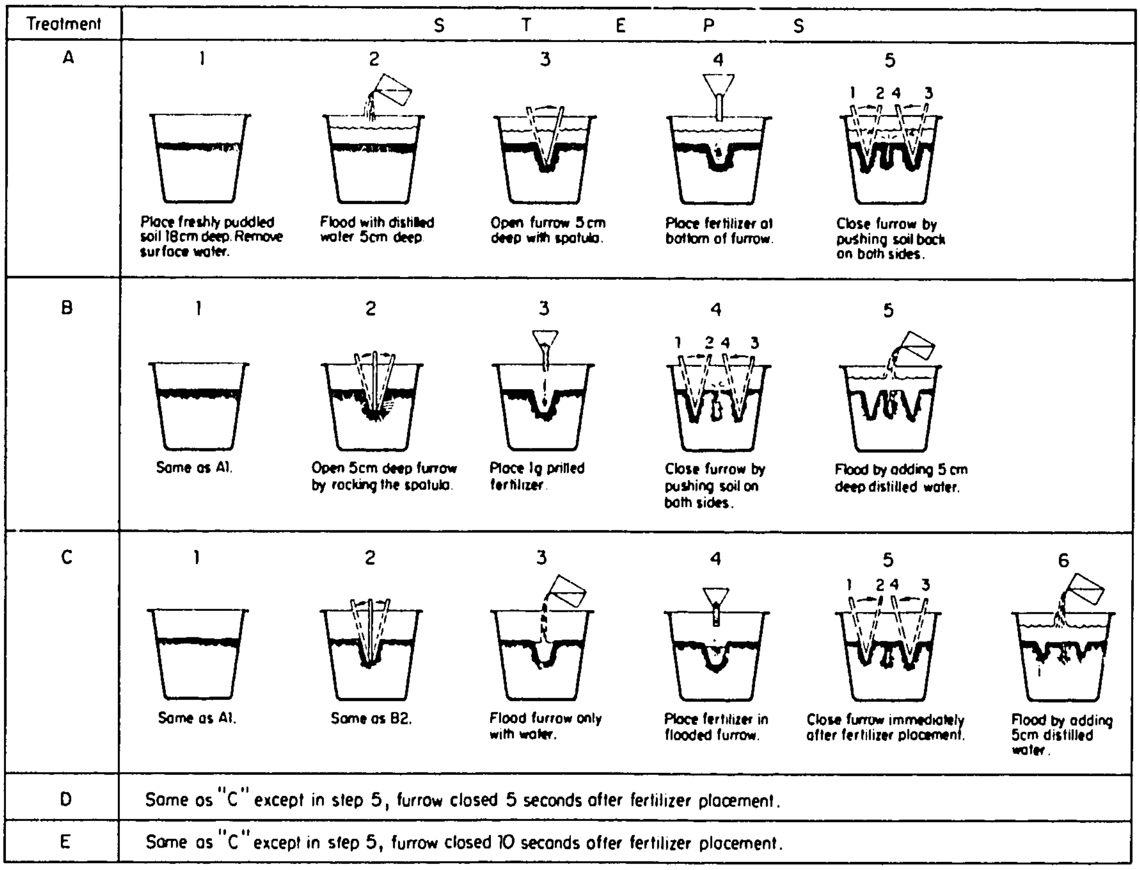
Experiments were conducted in 3-gallon plastic buckets under highly controlled laboratory conditions. Freshly puddled Maahas clay soil from the same fields was used, and 18-cm soil depth and 5-cm floodwater depth were maintained in all experiments. Buckets were kept indoors at about 24°C room temperature. Distilled water was used to avoid chemical contamination.

One gram of fertilizer (equivalent to 94 kg N/ha) was used throughout the tests. Floodwater samples were taken each day for 5 to 7 days after fertilizer placement in freshly puddled soil or after the delayed fertilizer release, and were analyzed for urea and ammonium N concentration.

In the first experiment (Fig. 3), fertilizer diffusion rates in freshly puddled soil for three fertilizer materials and two placement depths were studied. Buckets were filled with freshly puddled soil to 18-*d* cm depth, where *d* was the fertilizer placement depth, and fertilizer was carefully placed at the top of the soil in the center. Additional puddled soil was slowly deposited on top of the fertilizer to obtain the desired embedding depth. Care was taken that the total soil depth after fertilizer embedding was always 18



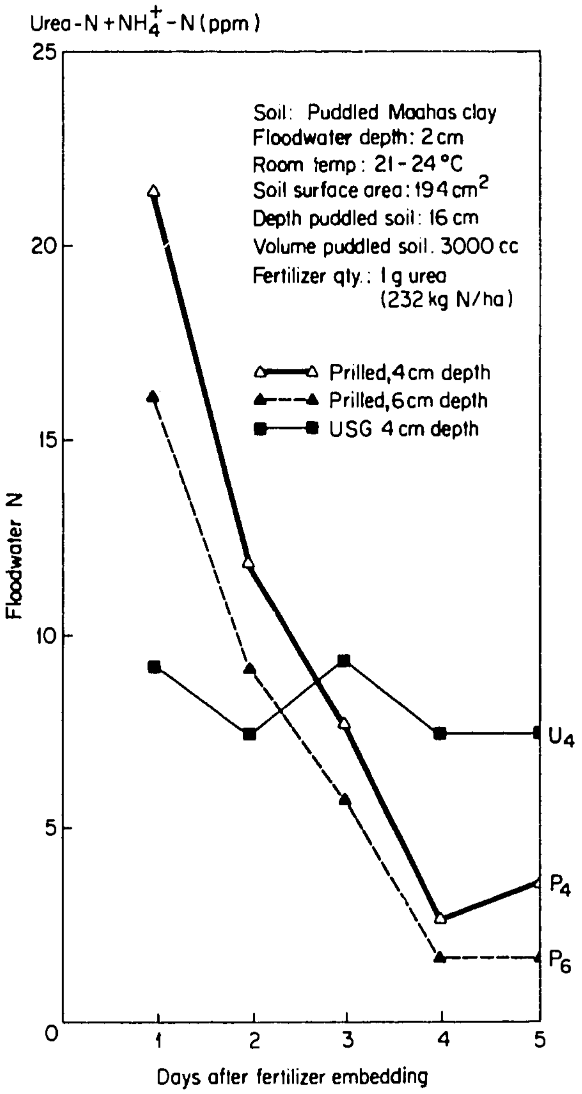
4. Delayed-fertilizer-release embedding experiments (5, 10, 15 days settled soil). d = embedding depth.



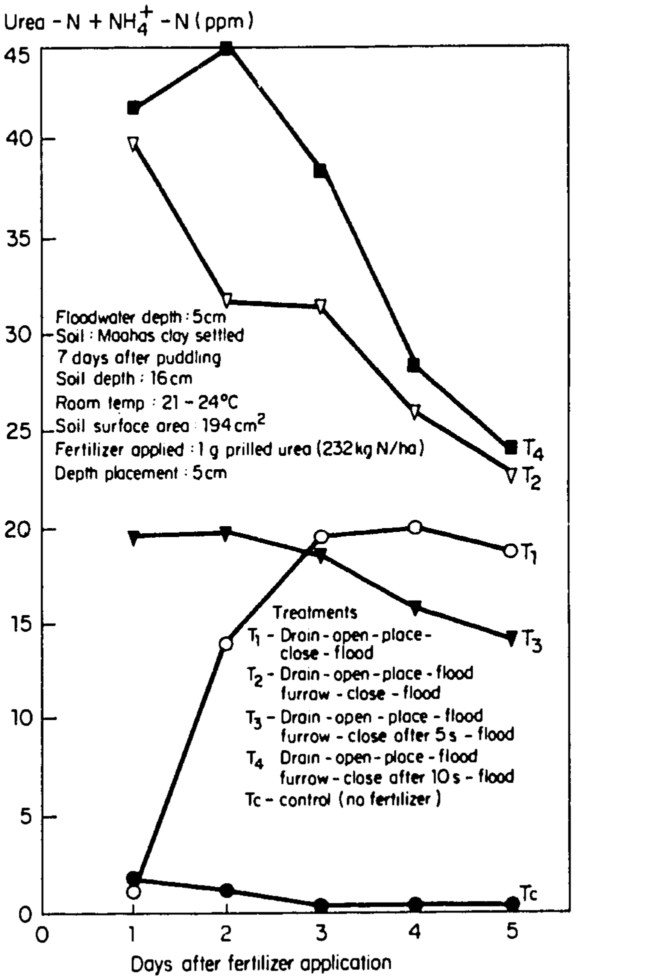
5. Fertilizer placement experiments with different placement sequence (freshly puddled soil).

cm. Distilled water was added to obtain the desired 5-cm water depth.

The second experiment (Fig. 4) studied fertilizer diffusion through water entrapped in soil that had settled 5, 10, and 15 days after puddling. A simple device was developed to release fertilizer in settled soil without disturbing the soil. It consisted of the sawed-off cylinder of a disposable plastic syringe that was fitted with two pistons, one on each end. Nylon thread was attached to the pistons so that pulling the ends of the string pulled the two pistons from the cylinder and released the fertilizer. This device with 1-g fertilizer was embedded in the soil, and the string ends



6. Effect of fertilizer embedding depth on urea and ammonium N concentration in floodwater. USG = urea supergranule.



7. Effect of fertilizer placement sequence on urea and ammonium N concentration in floodwater.

passed through two fine holes pierced on the bucket sidewalls. Fertilizer was released at 5, 10, or 15 days after puddling.

The third experiment (Fig. 5) evaluated the extent of fertilizer dissolution and transfer to floodwater during different fertilizer-water placement sequences. Different combinations of fertilizer placement and water flooding techniques were used to isolate the effect of water during placement (Fig. 5):

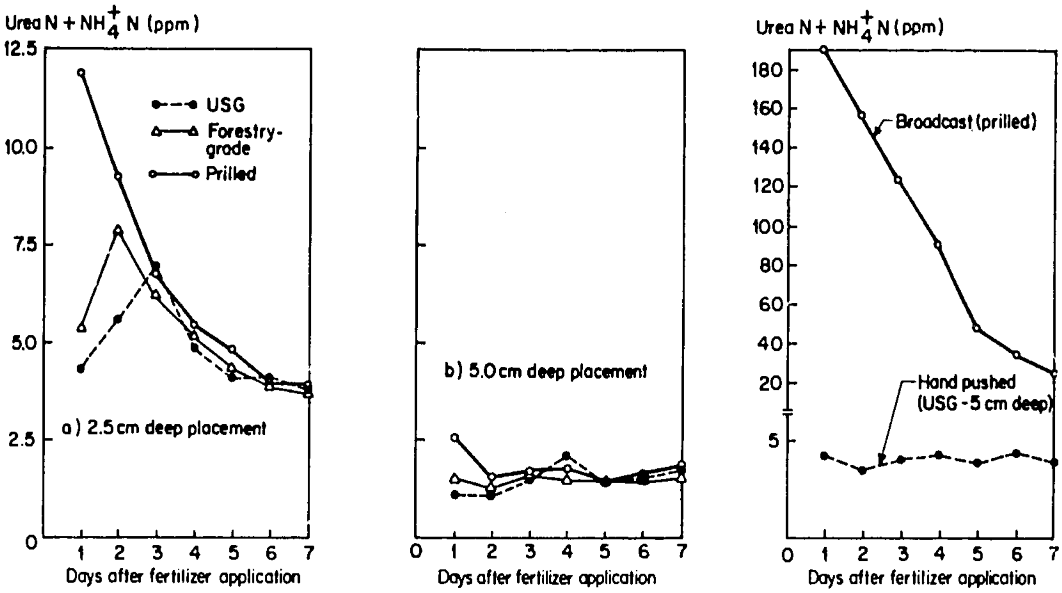
1. drain - open furrow - place fertilizer - close furrow - flood to 5 cm;
2. drain - open furrow - place fertilizer - flood furrow and close immediately - flood to 5 cm;
3. drain - open furrow - place fertilizer - flood furrow only - close furrow after 5 s - flood to 5 cm;
4. drain - open furrow - place fertilizer - flood furrow only - close furrow after 10 s - flood to 5 cm; and
5. drain - flood to 5 cm - open furrow - place fertilizer - close furrow.

Results of the three experiments are shown in Figures 8 to 14.

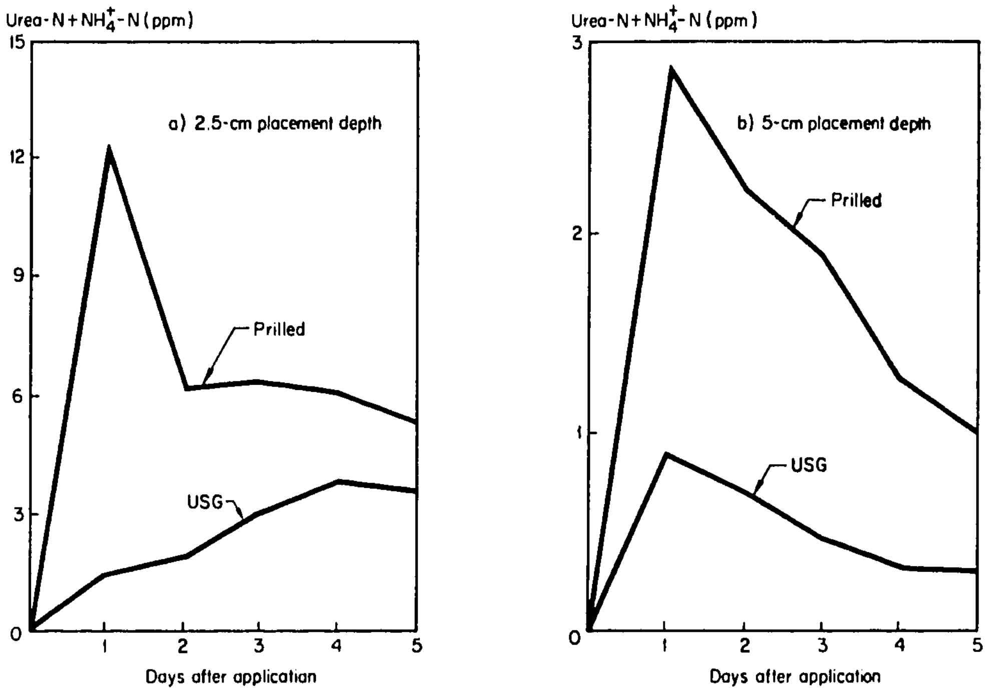
MAJOR FINDINGS AND SOME INTERPRETATIONS

1. At 5-cm water depth, N transfer to floodwater increases as fertilizer placement depth increases (Fig. 11). Nitrogen transfer to floodwater can be as high as 43%, 65%, and 76% of broadcast application for 2.5-, 5-, and 7-cm placement depths. The data indicate that conventional fertilizer applicators, which drop fertilizer by gravity into flooded furrows, transfer a large part of the fertilizer into floodwater, and are therefore inefficient for deep placement in flooded fields.
2. Fertilizer dissolution during transit to the furrow bottom at 5-cm depth causes the greatest fertilizer transfer to floodwater (Figs. 13, 14). At 5-cm placement, fertilizer transfer could be as high as 47% of the floodwater N level of broadcast application.
3. Physical movement of the fertilizer solution and fine granules from the furrow bottom to floodwater during furrow closing is the second major source of N transfer to floodwater during deep placement (Figs. 7, 12, 13, 14). With prilled urea, this N transfer at 5 cm placement depth could be as high as 29% of N transfer with surface-broadcast urea.
4. At 2.5-cm placement depth large urea granules showed less diffusion of N to floodwater during the

17



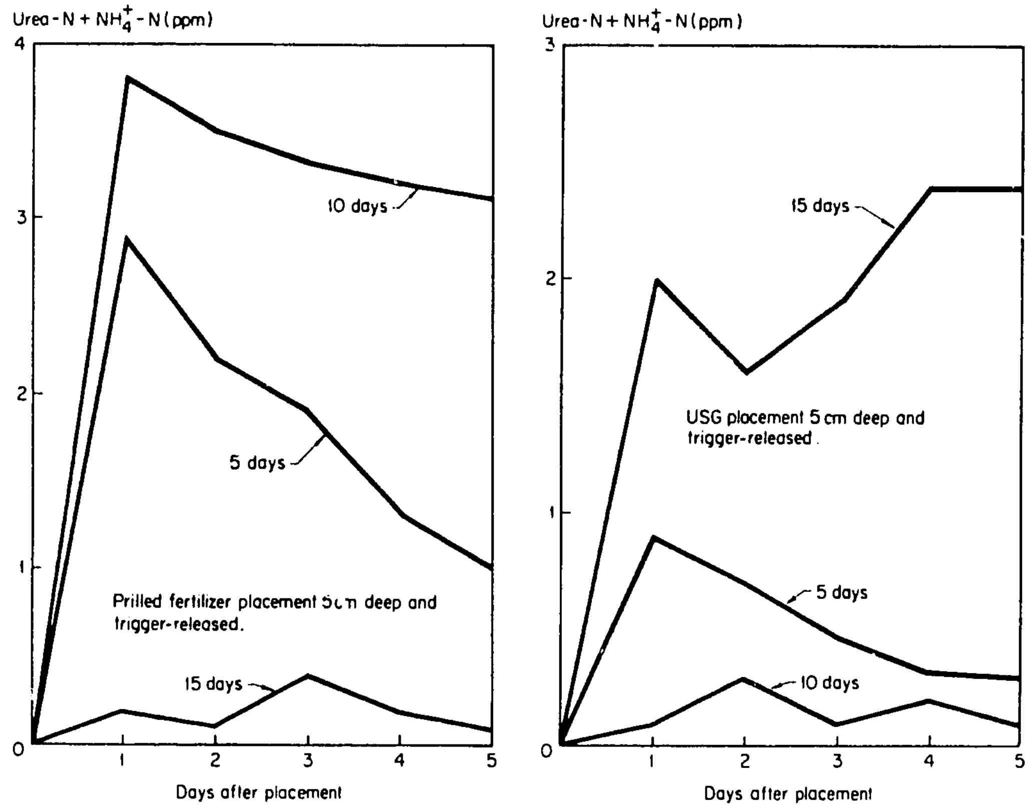
8. Fertilizer embedding experiment on freshly puddled Maahas clay. Floodwater depth, 5 cm; fertilizer rate, 94 kg N/ha. USG = urea supergranule.



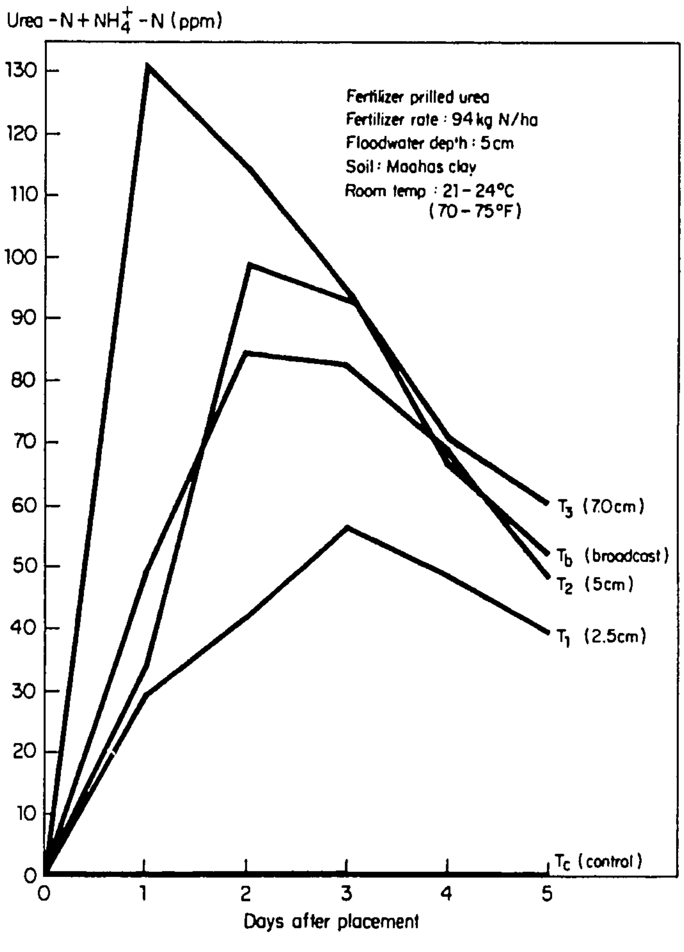
9. Diffusion of N to floodwater through Maahas clay that has settled for 5 days and fertilizer trigger released from 2.5- and 5-cm placement depths. USG = urea supergranule.

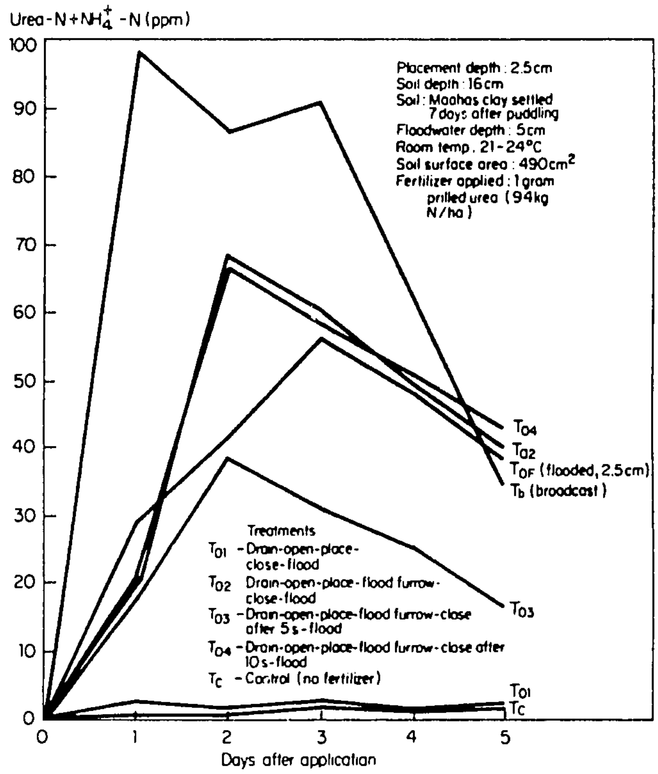
first 2 or 3 days than did prilled or forestry-grade urea. There is little difference in N transfer for the fertilizer materials after 3 days. Deeper embedding of prilled or forestry-grade urea also lowers N transfer (Figs. 6, 8). Finer granule fertilizer must be placed somewhat deeper than larger granules for equal N transfer up to 5 cm. Beyond 5 cm, however, the larger granule size (urea supergranule (USG) or forestry-grade) does not have any advantage over prilled fertilizer, indicating that all urea fertilizer could be placed at the same depth.

5. Quick closing of furrows after placement (+ 0 second) increases N transfer to floodwater as water rushing out of a rapidly closing furrow tends to push some fertilizer granules upward (Figs. 7, 12, 13). Experiments with slower (5 s) furrow closing exhibited lower N transfer than those with more rapid furrow closing. Most applicators developed at IRRI close the furrow quickly, and therefore encourage high N transfer.
6. Transfer through poorly joined furrow walls at 5-cm placement in Maahas clay is about 10% of the N transfer of broadcast application (Figs. 13, 14).
7. Nitrogen transfer to floodwater through diffusion in freshly settled soil after fertilizer has been properly deep placed and covered is not substantial (Figs. 8b, 9, 10).
8. Nitrogen diffusion through soil into floodwater, when prilled fertilizer was embedded at 2.5 cm, was quick and relatively high (Fig. 8a). Maximum N transfer was recorded the first day after placement. With forestry-grade and USG, however, N transfer



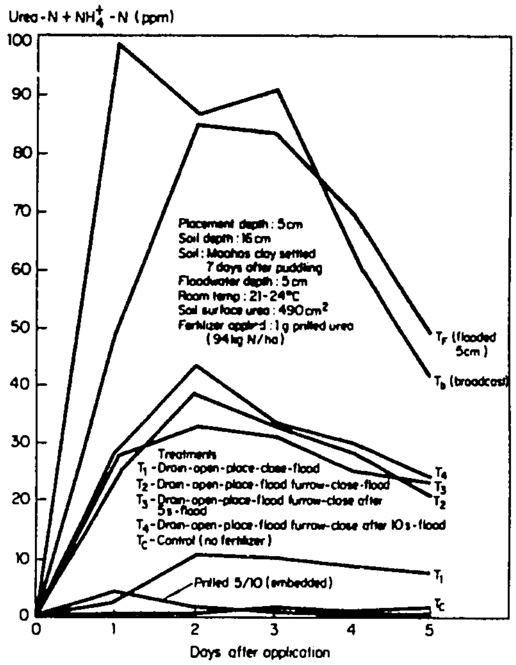
10. Diffusion of N to floodwater through Maahas clay that has settled for 5, 10, and 15 days. USG = urea supergranule.

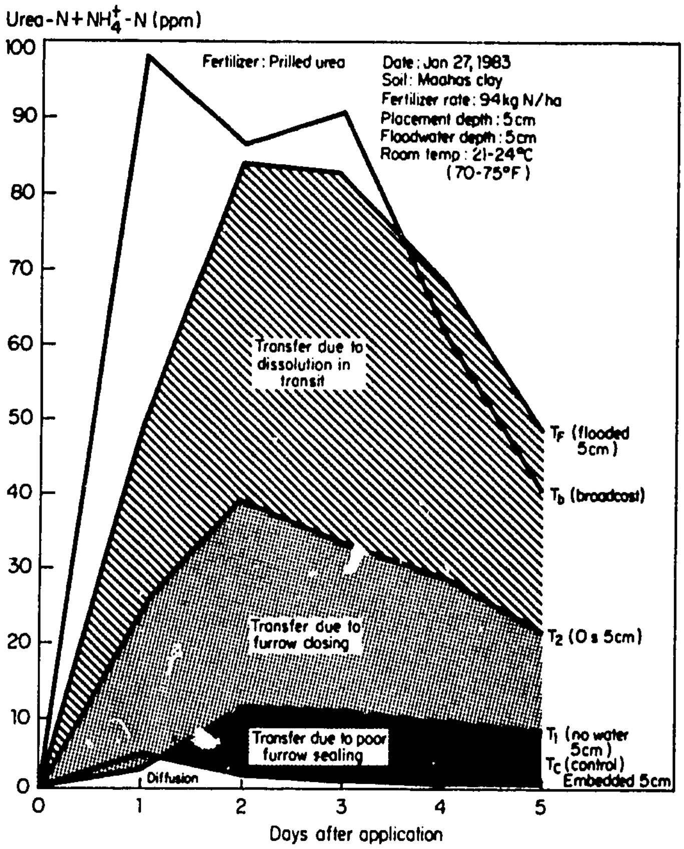




11. Effect of prilled fertilizer placement depth (2.5, 5, and 7 cm) in flooded soils on N transfer to floodwater.

12. Effect of placement sequence with prilled urea at 2.5 cm depth on urea and ammonium N transferred to floodwater.





▲
13. Effect of placement sequence of prilled fertilizer at 5 cm depth on urea and ammonium N transferred to floodwater.

►
14. Major avenues for N transfer to floodwater during prilled urea placement at 5 cm depth in flooded Maahas clay.

by diffusion 1 day after embedding was relatively small, but continued to increase slightly for 2 and 3 days.

9. Nitrogen diffusion through soil into floodwater, when fertilizer was embedded at 5 cm, was almost equal for all fertilizer materials (Figs. 8b, 9b), indicating that a 5-cm placement depth may be adequate in Maahas clay to minimize N transfer for all three materials.
10. Experiments on delayed fertilizer release of 5, 10, and 15 days were inconsistent (Fig. 10), perhaps because of experimental or analytical errors. It is obvious, however, that N diffusion through soil that had settled for 5, 10, and 15 days was quite small, because the maximum floodwater N level never exceeded a value of 4 ppm for USG or prilled fertilizer.
11. Minimizing fertilizer-water contact during all three phases of deep placement – transit, placement, and covering – would be highly effective for reducing fertilizer loss in flooded fields.
12. Dry fertilizer incorporation followed by flooding increases fertilizer use efficiencies because water dissolves the fertilizer and transfers it deep into the soil. This practice simulates a deep placement effect, thereby minimizing physical transfer of fertilizer granules or solution to the floodwater.
13. In sandy soils with high percolation rates, controlled irrigation techniques may be effective for deep placing fertilizer through irrigation water.
14. Use of low-cost prilled fertilizer coatings such as starch, clay, or oils, which could inhibit fertilizer dissolution in water during the placement and covering operation, may be an economic method for improving fertilizer use efficiencies in flooded fields.
15. Eliminating floodwater for 3 to 4 days prior to fertilizer application followed by flooding may result in a deep placement effect and improve fertilizer use efficiencies.
16. Major N transfer to floodwater occurs during the first 2 or 3 days after fertilizer application. Perhaps deep placement in unsaturated soil 1 or 2 days after draining, and delaying flooding for 2 to 3 days may improve fertilizer use efficiency.
17. Incorporation of fertilizer in a drained soil and delaying flooding till 2 or 3 days after incorporation may be more effective in improving fertilizer use efficiency than incorporating in fields with a substantial amount of water followed by immediate flooding.

IMPLICATIONS FOR APPLICATOR DESIGNS

Most applicators developed until now have not actually placed all the fertilizer deep in the soil because a large part entered the floodwater during the placement operation. This seems to be the main reason for the high degree of variability in field performance of applicators rather than the generally suspected site and soil differences.

Past efforts to develop deep placement applicators have focused on fertilizer-soil interactions. Findings of this study indicate that fertilizer dissolution and movement of fertilizer solution play a major role in increasing N transfer to floodwater in flooded fields. Thus, machines that cover the deposited fertilizer in the placement zone, or otherwise minimize movement of fertilizer and fertilizer water solution from the furrow bottom to the floodwater surface, would substantially improve fertilizer use efficiencies.

CONCLUSIONS

The major channels for fertilizer transfer to floodwater during placement are a) fertilizer dissolution during transit to furrow bottom and b) upward movement of fertilizer granules or solution to the floodwater during furrow closing. These two avenues are so important that in some cases N transfer to floodwater through them almost equals that of broadcast application. Transfer caused by poorly sealed furrows or diffusion in freshly puddled or settled soils is relatively small.

The high degree of variability in the field performance of the available deep placement applicators seems primarily due to excessive N transfer to floodwater during placement rather than to soil and site differences.

The findings of this study are important not only to the design of deep placement applicators but to the overall issue of fertilizer use efficiencies in wetland rice production. The key to improving urea fertilizer use efficiency may depend on keeping the floodwater N level low. Minimizing or blocking the various channels of N transfer through appropriate design of deep placement applicators is one approach to the problem. Research is also needed on fertilizer application and its interaction with different water management practices. Such research may lead to alternate solutions which would substantially improve urea fertilizer use efficiencies without resorting to the more labor-consuming operations of fertilizer incorporation or deep placement. The methodology developed in this study could be effectively utilized for developing such alternate fertilizer application techniques.

It seems that the physical interactions of urea fertilizer and water during deep placement are not fully understood. Further research is needed on fertilizer-soil-water interactions and on the dynamics of fertilizer solutions under different soil and water regimes.

Development of commercially viable deep placement applicators for prilled urea fertilizer is essential to increasing paddy production. It is a rare opportunity for agricultural engineers to play an important role in increasing rice production and in raising the living standards of Asian farmers.

REFERENCES CITED

Craswell, E. T., and P. L. G. Vlek. 1979. Fate of fertilizer nitrogen applied to wetland rice. Pages 175-192 *in* International Rice Research Institute. Nitrogen and rice. Laguna, Philippines.

Mitsui, S. 1955. Inorganic nutrition, fertilization and soil amelioration for lowland rice. 2d ed. Yokendo Press, Tokyo, Japan. 105 p.

Prasad, R., and S. K. De Datta. 1979. Increasing fertilizer nitrogen efficiency in wetland rice. Pages 465-484 *in* International Rice Research Institute. Nitrogen and rice. Laguna, Philippines.

Ross, V. E. 1980. Final report of the Collaborative Rice Research Project between PARC, Government of Pakistan, and IRRI-Philippines.

Shioiri, M. 1941. Denitrification in paddy soils [in Japanese]. Kagaku (Science in Japan) 16:104-116.

264

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

Stamp

Other papers in this series

FOR NUMBERS 1—40, TITLES ARE LISTED ON THE LAST PAGE OF NO. 41 AND PREVIOUS ISSUES

- No. 41 Weather and climate data for Philippine rice research
- No. 42 The effect of the new rice technology in family labor utilization in Laguna
- No. 43 The contribution of varietal tolerance for problem soils to yield stability in rice
- No. 44 IR42: a rice type for small farmers of South and Southeast Asia
- No. 45 Germplasm bank information retrieval system
- No. 46 A methodology for determining insect control recommendations
- No. 47 Biological nitrogen fixation by epiphytic microorganisms in rice fields
- No. 48 Quality characteristics of milled rice grown in different countries
- No. 49 Recent developments in research on nitrogen fertilizers for rice
- No. 50 Changes in community institutions and income distribution in a West Java village
- No. 51 The IRRI computerized mailing list system
- No. 52 Differential response of rice varieties to the brown planthopper in international screening tests
- No. 53 Resistance of Japanese and IRRI differential rice varieties to pathotypes of *Xanthomonas oryzae* in the Philippines and in Japan
- No. 54 Rice production in the Tarai of Kosi zone, Nepal
- No. 55 Technological progress and income distribution in a rice village in West Java
- No. 56 Rice grain properties and resistance to storage insects: a review
- No. 57 Improvement of native rices through induced mutation
- No. 58 Impact of a special high-yielding-rice program in Burma
- No. 59 Energy requirements for alternative rice production systems in the tropics
- No. 60 An illustrated description of a traditional deepwater rice variety of Bangladesh
- No. 61 Reactions of differential varieties to the rice gall midge, *Orseolia oryzae*, in Asia. Report of an international collaborative research project
- No. 62 A soil moisture-based yield model of wetland rainfed rice
- No. 63 Evaluation of double-cropped rainfed wetland rice
- No. 64 Trends and strategies for rice insect problems in tropical Asia
- No. 65 Landforms in the rice-growing areas of the Cagayan River Basin
- No. 66 Soil fertility, fertilizer management, tillage, and mulching effects on rainfed maize grown after rice
- No. 67 High-temperature stress in rice
- No. 68 Weed-fertilizer interactions in rice
- No. 69 The azolla-anabaena complex and its use in rice culture
- No. 70 An index to evaluate the effect of water shortage on the yield of wetland rice
- No. 71 The development and diffusion of rice varieties in Indonesia
- No. 72 Levels of resistance of rice varieties to biotypes of the BPH, *Nilaparvata lugens*, in South and Southeast Asia
- No. 73 Growing season analyses for rainfed wetland fields
- No. 74 San Bartolome: beyond the green revolution
- No. 75 Pathotypes of *Xanthomonas campestris* pv. *oryzae* in Asia
- No. 76 Focusing field research on future constraints to rice production
- No. 77 An international survey of methods used for evaluation of cooking and eating quality of milled rice
- No. 78 Research on algae, blue-green algae, and phototrophic nitrogen fixation at the International Rice Research Institute (1961-81), summarization, problems, and prospects
- No. 79 Seed-derived callus culture for selecting salt-tolerant rices
- No. 80 Economic limitations to increasing shallow rainfed rice productivity in Bicol, Philippines
- No. 81 Irrigation system management research and selected methodological issues
- No. 82 Interdisciplinary challenges and opportunities in international agricultural research
- No. 83 Comparative analysis of cropping systems: an exploratory study of 14 rainfed sites in the Philippines
- No. 84 Rapid generation advance of rice at IRRI
- No. 85 Physicochemical characterization of iron-toxic soils in some Asian countries
- No. 86 New rice technology, intrarural migration, and institutional innovation in the Philippines
- No. 87 RICEMOD: a physiologically based rice growth and yield model
- No 88 Sensitivity tests of the environmental variables in RICEMOD
- No. 89 Sensitivity tests of the crop variables in RICEMOD
- No. 90 New rice technology and labor absorption: comparative histories of two Philippine rice villages
- No. 91 Calculating the private benefits of farm machinery: a microcomputer application
- No. 92 Cropping systems research in the Pangasinan Project
- No. 93 Estimating risk of fertilizer use in rainfed rice production
- No. 94 Sensitivity tests of the environmental variables in IRRIMOD
- No. 95 Sensitivity tests of the crop and management variable in RICEMOD

27

Paper No. 83-17

CURRENT RESEARCH & DEVELOPMENT ON DEEP PLACEMENT TECHNIQUES AND THEIR POSSIBLE IMPACT ON FERTILIZER CONSUMPTION

By

Amir U. Khan
Agricultural Engineer

Paper presented at the Second International Fertilizer Industry Association ASEAN Regional Meeting, Manila Peninsula Hotel, Makati, Metro Manila, Philippines, November 10-11, 1983.

AGRICULTURAL ENGINEERING DEPARTMENT
THE INTERNATIONAL RICE RESEARCH INSTITUTE
P. O. BOX 933 MANILA PHILIPPINES

CURRENT RESEARCH & DEVELOPMENT ON DEEP PLACEMENT TECHNIQUES AND THEIR POSSIBLE IMPACT ON FERTILIZER CONSUMPTION

By

Amir U. Khan

A B S T R A C T

For over a decade, many attempts have been made to develop deep placement fertilizer applicators for improving fertilizer use efficiency in wetland paddy cultivation. The machines developed so far have not demonstrated consistent performance in the field. Laboratory studies reported here indicate that excessive N transfer to floodwater during deep placement was the main reason for the inconsistent field performance of the earlier applicators. The development of three new applicators, which place fertilizer deep in flooded soils with minimum contact with floodwater, is reported. The performance of these applicators, based on N transfer to floodwater and on yield experiments, are reported. The paper concludes that the three new applicators can satisfactorily place prilled and supergranular urea 5 cm deep in floodwater. Fertilizer savings of about 30 to 50% or substantial increases in paddy yields are possible with the use of these machines in Asia. The research strategy and key steps that led to the development of the three new applicators at IRRI in a relatively short period of nine months are briefly discussed.

***

CURRENT RESEARCH & DEVELOPMENT ON DEEP PLACEMENT TECHNIQUES AND THEIR POSSIBLE IMPACT ON FERTILIZER CONSUMPTION

By

Amir U. Khan*

INTRODUCTION

Paddy farmers in Asia have not been able to make full use of fertilizer to boost their yields due to poor fertilizer use efficiencies. As early as 1941, Shioiri in Japan explained the mechanics of loss of surface applied ammonia in flooded soils and recommended the deep placement of ammonium fertilizers. Many studies at IRRI and other institutions have consistently demonstrated that fertilizer use efficiency in wetland rice production could be almost doubled by placing fertilizer in the reduced soil layer at depths ranging from 5 to 15 cm. A lack of suitable deep placement applicators however, has not permitted the transfer of these findings to the farm level.

Prilled urea is the most popular fertilizer material used for rice production in Asia. Over the last decade on unusually large number of deep placement applicators have been developed (Kiamco, 1982) for prilled urea in Japan, China and at IRRI. Field performance of these machines however have been rather inconsistent. This has led to the belief that prilled urea is not a suitable fertilizer material for deep placement and consequently urea briquettes and urea super-granules have been experimentally developed.

---

*Agricultural Engineer, Agricultural Engineering Dept., IRRI, Los Baños, Laguna, Philippines.

The Institute is fully aware of the immense benefits that could accrue to rice farmers in Asia through deep placement of fertilizer and is placing a high priority on the development of such fertilizer applicators. In September 1982, the author was assigned to IRRI to concentrate on the development of deep placement applicators. A special engineering team* was organized by the author in the Agricultural Engineering Dept. to work on this critical problem.

As an initial step, a review of all deep placement applicator developments worldwide were undertaken to gain a better understanding of the deep placement problem. This led to the development of a set of criteria (Table 3) for technical and commercial acceptability of applicators (Khan, September 1982). In order to gain a better understanding of the deep placement phenomenon, a series of laboratory experiments were conducted, which led to the significant findings that under flooded conditions, placement of fertilizer in open furrows followed by furrow closing results in a large transfer of fertilizer to floodwater. The technical criteria for applicators were subsequently revised to reflect the new findings. Efforts were then made to separately optimize the designs of the three major components of applicators in the laboratory, i.e., the fertilizer metering, conveying and furrow closing mechanisms.

---

*The engineers who have been associated from time to time with this special task force are: Larry Kiamco, Val Tiangco, Gil Espiritu, Iñigo Camacho, Lito Diestro, Research Assistants, and Lito Bautista, Felipe Santos and Zahid Mahmood, Reseach Scholars of the Agricultural Engineering Department, IRRI, Los Baños, Laguna, Philippines.

Twenty new deep placement applicator concepts were then proposed (Khan, November 1982) out of which six were selected for intensive design and development efforts. This led to the eventual development of three new applicators. These applicators, two for prilled urea and one for USG were designed for minimum N transfer to floodwater. A brief discussion of the research study on N transfer to floodwater, which served as the basic foundation for the successful development of deep placement applicators, is included in this paper.

MECHANICS OF N TRANSFER TO FLOODWATER

Fertilizer use efficiencies in upland farming (unflooded conditions) have been reported to be 50 to 60% (Craswell & Velk, 1979) when those obtained under wetland farming conditions are generally 30 to 50% (Prasad & De Datta, 1979). The reasons of this wide difference in fertilizer use efficiencies have not been well understood. Experiments conducted in Pakistan (Ross, 1980) indicate a 60% recovery of applied nitrogen by rice crop when fertilizer was incorporated in dry condition and followed by flooding. More recently, Bhatti et al (1983) report that fertilizer incorporated in dry soil and followed by flooding increases paddy yields by 1 to 2 tons/ha over conventional broadcasting of fertilizer in flooded soils. One can conclude from the results of these two studies that flooding, after the fertilizer has been incorporated, is not the cause for reducing fertilizer use efficiencies in wetland farming, Since fertilizer use efficiencies under upland farming (unflooded) conditions are quiqe high, it was hypothesized that the low fertilizer use efficiencies in wetland farming were due to the presence of water during the time the fertilizer was being applied.

In flooded soils, there are four possible ways that fertilizer could be transferred to floodwater during or immediately after placement (Fig. 1a): 1) By dissolution while fertilizer transits through floodwater to the furrow bottom. 2) By upward movement of fertilizer granules or solution due to displacement effect of the furrow closing operation. 3) By convectional movement of fertilizer solution through poorly sealed furrow walls, and 4) By diffusion through water entrapped in puddled soils or between poorly closed furrows. A set of hypothetical curves indicating possible channels of fertilizer transfer to floodwater and the experimental methods which were used to isolate these effects are given in Fig. 1b.

The above considerations led to two laboratory studies in the IRRI Agricultural Engineering Department which permitted the assessment of the different avenues of N transfer to floodwater during deep fertilizer placement. Prilled urea was used in the first study (Khan et al, April 1983) as this material was considered to be most susceptible for N transfer to floodwater due to its small granule size. Similar experiments were later repeated with both prilled urea and urea supergranules (Mahmood et al, 1983). Fig. 1c summarizes the magnitude of N transfer to floodwater during placement when prilled urea is placed in 5 cm deep furrows.

The findings of these two studies indicated that the applicators developed in the past were not properly depositing fertilizer as most of it was transferred to floodwater during placement. The two major channels of fertilizer transfer to floodwater during deep placement were: a) Dissolution of fertilizer during transit from the water surface to the furrow bottom (43-76%); b) Upward movement of fertilizer granules or solution to the floodwater during furrow closing (up to 29%). If the furrow was properly closed, transfer through the closed furrow walls was generally less than 10%. Transfer due to diffusion through flooded soils was less than 5%.

On the basis of the N transfer studies, it was concluded that the key to improving fertilizer use efficiency in wetland cultivation was to minimize N transfer to floodwater during the fertilizer placement operation. Such a strategy would maximize retention of fertilizer in the soil where it would be less vulnerable to volatilization losses and would be available for plant use. It was thus concluded that minimizing fertilizer-water contact during the three phases of fertilizer application; transit, placement and covering, were the most critical steps in the development of deep placement applicators.

This general strategy was followed in the development of the following three new applicators (Khan et al, June 1983) at IRRI:

1) Straight Auger Applicator for prilled urea (Fig. 2).
2) Oscillating Plunger Applicator for prilled urea (Fig. 3).
3) Press-wedge Applicator for urea supergranules (USG) (Fig. 4).

COMPARATIVE PERFORMANCE OF APPLICATORS

During development, most machines must undergo a phase in which machines must be repeatedly evaluated and improved. In the past, performance of deep placement applicators were evaluated at IRRI through yield experiments. This required a five to six month cycle, between design improvement and performance evaluation, which seriously delayed the applicator development process. The level of urea and Ammonium N concentration in floodwater, after the fertilizer has been applied, is generally related to volatilization losses. It was felt that floodwater N level* could be used to obtain an approximate idea of the machine placement efficiency. This technique was used for quick preliminary evaluation of applicators which helped to accelerate the applicator development process at IRRI.

Last December, three deep placement applicators were evaluated in Maahas clay plots at IRRI by measuring the amount of N transfer to floodwater. The plots were settled for ten days after puddling. The results of this test, which are summarized below, indicated that the straight auger applicator for prilled urea was performing considerably better than the deep plunger (USG), and rolling press-wheel (forestry grade) applicators.

---

*Subsequent experience tells us that floodwater N level only gives an indication of the amount of N transferred to floodwater during the fertilizer application process. It fails to give direct indication of how the rest of the fertilizer will continue to be available to plants during the rest of the cropping season. Thus the floodwater N level at placement time may not necessarily relate to fertilizer use efficiencies during the crop production season which is more a function of how effectively fertilizer was sealed in the furrow during the placement operation.

Machine	Fertilizer material	Total N (ppm) in flood water - 24 hours after application	Machine performance rating
Straight auger	Prill	16.47	1
Deep plunger* (intermittent)	USG	34.37	2
Rolling presswheel	Forestry grade	38.63	3

*This machine was developed earlier and had given best performance in tests conducted during 1981-82. However it has some drawbacks which limit its commercial acceptability.

During the 1983 dry season, three of the new applicators, the Deep Plunger (USG) and hand placed (USG) methods were evaluated at the IRRI Research Farm in yield trials under a collaborative project between the Agronomy and Agricultural Engineering departments. The results of these tests were as follows:

PRELIMINARY YIELD TESTS, 1983 DRY SEASON, IRRI AGRONOMY DEPT.

Machine	Fertilizer material	Fertilizer Kg/N ha	Grain yield	Efficiency Kg rough rice / kg N
1) Straight auger 3/4"	Prill	78	5.9	28
2) Auger with transplanter	Prill	82	5.6	23
3) Rolling presswheel	Forestry grade	84	6.0	26
4) Deep plunger (intermittent)*	USG	84	5.5	21
5) Hand placed	USG	87	5.9	24

*This machine was developed earlier and had given promising performance in tests conducted in 1981-82. This machine, however, has some drawbacks which limit its commercial acceptability.

The performance of the three machines, Nos. 1, 2 & 3, in the above tests compared favorably with hand placement of USG, which had so far been considered to be the most efficient deep placement method at IRRI.

All the five new machines were again tested at the IRRI Research Farm in May 1983 by the Agricultural Engineering Dept. by evaluating the N transfer to floodwater. The results were as follows.

	Machine	Fertilizer material	Total N (ppm) in flood water - 24 hours after application	Machine performance rating
1)	Straight auger 3/4" surface closure	Prill	3.3	3
2)	Straight auger 3/4" with underground closure	Prill	2	1
3)	Rolling presswheel with underground closure	Forestry grade	11.6	7
4)	Rolling presswheel with underground closure	USG	6.7	5
5)	Inclined press-wedge	USG	14.8	8
6)	Oscillating plunger with underground closure	Prill	2.4	2
7)	Auger 3/4" on transplanter	Prill	8.7	6
8)	Deep plunger (Intermittent)*	USG	6.2	4
9)	Hand placement	USG	6.7	5

*This machine was developed earlier and had given promising performance in tests conducted in 1981-82. However, it has some drawbacks which limits commercial acceptability.

These tests indicate an encouraging performance of all five machines as the N transfer values were less than 25 ppm, a level that was agreed upon by scientists at IRRI to be acceptable. The two prilled urea applicators, the Straight Auger and the Oscillating Plunger, resulted in a lower N transfer to floodwater than hand placement of USG. This was a convincing proof that prilled urea can be as effectively deep placed as USG. The Inclined Press-wedge indicated a relatively high N transfer value and hence the wedge and opener was redesigned for a narrow profile and more effective sealing. The performance of the Rolling Presswheel was satisfactory however this machine was dropped from further development as it was felt to be too costly for successful commercial acceptance.

The three new machines, the Straight Auger (prill), the Oscillating Plunger (prill) and the modified Press-wedge (USG) were simple in design and offered excellent possibilities for commercial introduction. These three machines can be easily manufactured in most developing countries and could be marketed to farmers at a reasonable price of about US$50 to US$60. It was decided to further test and improve these machines through yield trials during the 1983 wet season in cooperation with the following groups:

a) The IRRI Agronomy Department at the IRRI Farm and at the Maligaya Research Station.

b) The IRRI Training & Technology Transfer Department at various research stations and farmers' fields in the Philippines.

c) The Ministry of Food & Agriculture, Govt. of the Philippines at various research sites.

d) The IRRI Agricultural Engineering Department in nine progressive farmers' fields in Laguna Province.

The three machines are now undergoing continuous improvements on the basis of feedback being received from field trials. As of this writing, yield data from the nine cooperating farmers in Laguna has been obtained by the IRRI Agricultural Engineering Dept. The results are presented in Tables 1 and 2.

The farmer trials indicate that in all nine cases, a single application by any of the three machines increased fertilizer use efficiency in every case when compared to farmer's traditional practice of split surface broadcast application. The average increase in fertilizer use efficiencies for the three machines on clayey soils at the nine farm locations in Laguna were as follows:

1) Straight Auger Applicator	Prill	49.82%
2) Oscillating Plunger Applicator	Prill	44.49%
3) Press-wedge Applicator	USG	51.29%

Each of the nine farmers were pleased with the wet season results and have requested to use these machines in the coming dry season.

Results from the other IRRI departments and outside agencies who are testing these applicators in different parts of the country are expected to be available by the end of this year. On the basis of the experience gaired so far, one can conservatively estimate that fertilizer savings of approximately 35% could be easily achieved through the use of these machines. Hopefully, by the end of this year, we will have additional results from other test sites and more precise estimates on fertilizer savings that could be achieved.

It is not clear at this moment whether farmers would prefer to save on fertilizer costs or go for maximization yields. The nine cooperating progressive farmers in Laguna were applying fairly high fertilizer rates. They expressed a preference for increased yields rather than fertilizer savings. Since fertilizer efficiencies generally show greater increases at low fertilizer rates, perhaps the majority of small, less progressive farmers would prefer to go for fertilizer savings rather than increased production. The rapidly increasing fertilizer prices in the Philippines and farmers' capital constraints may automatically force an input saving rather than a yield maximizing strategy for the immediate future.

At this stage, it is rather appropriate to compare the three new applicators with the original target specifications that were developed in consultation with concerned IRRI scientists at the start of this crash program to develop deep placement applicators. Table 3 lists the Essential, Desirable and Undesirable Target Specifications along with an assessment of how the new machines have met the original objectives. The table includes a fourth machine, the Deep Plunger Applicator (USG) which was the best performing applicator in 1982. It is interesting to note that the three new machines have not only met all the essential specifications but exceeded three of these beyond their desired limits.

It is hoped that by the end of 1983, the three machines would have been sufficiently tested and improved for different soil and water conditions so these could be released for limited commercial

40

production in the Philippines and for extensive farm trials in other countries of Asia. If these trials prove conclusive, the designs of these applicators will be released by late 1984 to selected manufacturers in Asia for regular commercial production.

CONCLUSIONS

The machines reported here have demonstrated a rather encouraging performance in the various tests and field trials that have been conducted so far. We are confident that with the development of these three applicators, the primary hurdle of deep placement of prilled and supergranular urea has essentially been overcome. What remains now, is the extensive evaluation and adaptation of these applicators to suit farmer preferences, varying site, soil and cultural differences in the major rice growing countries of Asia.

Introduction of these machines to farmers through normal manufacturing and commercial channels will require a major agricultural and industrial extension effort from IRRI, the national agricultural agencies and fertilizer manufacturers in the rice growing countries. While the introduction of deep placement applicators seems to be the solution for improving fertilizer use efficiencies, there is little doubt in my mind that these machines will be mostly used by the more affluent farmers. Majority of the small subsistent farmers will not have the resources to purchase machine. Such farmers will either have to rent these machines or alternate non-mechanical methods must be developed to improve their fertilizer use efficiencies. Use of irrigation water to dissolve and deep place

41

fertilizer and low cost fertilizer coatings such as clay, starch, oil, etc. to momentarily arrest fertilizer dissolution, offer some interesting possibilities for improving fertilizer use efficiencies without resorting to special machines.

The progress achieved during the last one year at IRRI on the development of deep placement applicators, specially for prilled urea, has been most challenging and satisfying to those of us who have been associated with this project. There are a number of strategic steps which led to the rapid development of the deep placement applicators that are reported in this paper. These steps included, the precise definition of the deep placement applicator problem; the prioretization of the technical and market criteria for applicators; the better understanding of the N transfer to floodwater during deep placement; the separate optimization in the laboratory of the individual components of applicators, the shortening of the applicator evaluation process through floodwater N measurements; the development of a large number of the applicator concepts which led to the design of the three promising machines and finally the dedicated efforts of the Design engineers and staff of the IRRI Agricultural Engineering Department who helped in the development of these applicators.

The assistance provided by the IRRI Agronomy Dept., the Training and Technology Transfer Dept. and the Test Section of the Agricultural Engineering Dept. in testing and evaluation of the applicators, the IRRI Analytical Service Laboratory in analyzing floodwater samples and some of my IRRI colleagues who gave informal suggestions which helped in many ways is gratefully acknowledged.

REFERENCES

BHATTI, A., H. REHMAN & A.H. GURMANI. 1983. "Efficiency of urea applied to rice by various methods." International Rice Research Newsletter, Vol. 8 No. 3. June.

CRASWELL, E.T. & P.L.G. VELK. 1979. "Fate of fertilizer nitrogen applied to wetland rice." Nitrogen & Rice, IRRI, Los Baños, Laguna, Philippines.

KHAN, A.U. 1983. "New deep placement applicators for minimum N transfer to floodwater." IRRI Thursday Seminar. June 23.

KHAN, A.U., L.C. KIAMCO & V.M. TIANGCO. 1983. "Mechanics of fertilizer transfer to floodwater during deep placement." Paper presented during the International Rice Research Conference, IRRI, April 18-22.

KHAN, A.U. 1982. "Alternative concepts for deep placement fertilizer applicators." IRRI Saturday Seminar. November 18.

KHAN, A.U. 1982. "Some concepts and issues for deep placement fertilizer applicators." Paper for internal circulation at IRRI. September.

KIAMCO, L.C., I.R. CAMACHO, G.C. SALAZAR & B.J. COCHRAN. 1982. "Development of deep placement fertilizer applicators at IRRI." Paper presented at the International Workshop/Training on Nitrogen Management held in Fuzchou, China, April 25-May 4/14.

MAHMOOD, Z., L.C. KIAMCO & A.U. KHAN. 1983. "Further studies on mechanics of fertilizer transfer to floodwater during deep placement." Special Problems in Agricultural Engineering, University of the Philippines at Los Baños, Summer.

PRASAD, R. & S.K. DE DATTA. 1979. "Increasing fertilizer nitrogen efficiency in wetland rice." Nitrogen & Rice, IRRI, Los Baños, Laguna, Philippines.

ROSS, V.E. 1980. Final Report of the Collaborative Rice Research Project between PARC, Govt. of Pakistan and IRRI-Philippines.

SHIOIRI, M. 1941. "Denitrification in paddy soils." (Japanese) Kagaku (Science in Japan) 16:104-116.

***

Table 1

DEEP PLACEMENT FERTILIZER APPLICATOR TRIALS[1] IN FARMERS' FIELDS
CALAMBA & CALAUAN, LAGUNA - 1983 WET SEASON
IRRI AGRICULTURAL ENGINEERING DEPT.
NOVEMBER 1983

No.	Farmer-Cooperator Name & Address	Variety	Application Method[2]	Fertilizer		Projected Yield[3] Tons/ha	Fertilizer Efficiency	
				Material	Rate Kg N/ha		Kg Rough Rice/kg N	% Change Over Control
1	Mr. V. Oruga Bo. Mabacan Calauan, Laguna	Sinang-Domeng (HYV)	Farmer Practice (no machine - control)	Prill	90	4.87	54.11	-
			Spring Auger	Prill	47	4.42	94.04	+ 73.79
			Oscillating Plunger	Prill	48	3.95	68.10	+ 25.85
			Press-wedge	USG	48	3.82	79.58	+ 47.07
2	Mr. P. Macatangay Bo. Mabacan Calauan, Laguna	Sinang-Domeng (HYV)	Farmer Practice (no machine - control)	Prill	78	4.98	63.85	-
			Spring Auger	Prill	55	5.03	91.45	+ 43.22
			Oscillating Plunger	Prill	58	5.17	89.14	+ 39.61
			Press-wedge	USG	48	5.03	109.79	+ 64.12
3	Mr. J. Espinili Bo. Mabacan Calauan, Laguna	Sinang-Domeng (HYV)	Farmer Practice (no machine - control)	Prill	78	6.87	88.08	-
			Spring Auger	Prill	42	5.46	130	+ 47.59
			Oscillating Plunger	Prill	41	5.01	122.20	+ 38.74
			Press-wedge	USG	42	5.01	119.28	+ 35.42
4	Mr. S. Ilagan Bo. Mabacan Calauan, Laguna	IR-42	Farmer Practice (no machine - control)	Prill	78	4.76	61.02	-
		C-4	Spring Auger	Prill	52	3.42	65.77	+ 7.98
		IR-42	Oscillating Plunger	Prill	39	4.42	113.33	+ 85.73
		IR-42	Press-wedge	USG	41	4.30	104.88	+ 71.88
5	Mr. C. Pabro Bo. Mabacan Calauan, Laguna	IR-42	Farmer Practice (no machine - control)	Prill	80	4.28	53.5	-
			Spring Auger	Prill	66	4.92	75.54	+ 39.33
			Oscillating Plunger	Prill	58	4.03	69.48	+ 29.87
			Press-wedge	USG	45	4.06	90.22	+ 68.64
6	Mr. R. Vergara Bo. Mabacan Calauan, Laguna	IR-42	Farmer Practice (no machine - control)	Prill	78	4.66	59.74	-
			Spring Auger	Prill	47	4.28	91.06	+ 52.43
			Oscillating Plunger	Prill	50	4.20	84.00	+ 40.61
			Press-wedge	USG	44	4.38	99.54	+ 66.62
7	Mr. L. Casubha Bo. Parian Calamba, Laguna	IR-42	Farmer Practice (no machine - control)	Prill	67	5.47	81.64	-
			Spring Auger	Prill	40	5.19	129.75	+ 58.93
			Oscillating Plunger	Prill	53	5.03	94.91	+ 16.25
			Press-wedge	USG	51	4.58	89.80	+ 10.00
8	Mr. R. Isip Bo. Parian Calamba, Laguna	IR-42	Farmer Practice (no machine - control)	Prill	78	5.74	73.59	-
			Spring Auger	Prill	40	5.25	131.25	+ 78.35
			Oscillating plunger	Prill	46	5.21	113.26	+ 53.91
			Press-wedge	USG	47	5.37	114.26	+ 55.26
9	Mr. C. Oleta Bo. Parian Calamba, Laguna	IR-42	Farmer Practice (no machine - control)	Prill	68	5.71	69.26	-
			Spring Auger	Prill	45	4.58	101.78	+ 46.95
			Oscillating Plunger	Prill	47	5.53	117.66	+ 69.88
			Press-wedge	USG	48	4.74	98.75	+ 42.58

[1] Except for application methods & fertilizer rates each farmer applied his own traditional cultural practices on all of 4 treatments.

[2] With machine applications, all fertilizer was applied as a single dose at 10 to 18 days after transplanting. Farmer practice varied but generally included 2 to 3 split broadcast applications.

[3] Based on 4 sampling sites (projected value at 14% m.c.).

Table 2

SUMMARY RESULTS OF INCREASES IN FERTILIZER USE EFFICIENCIES[1/] WITH DEEP PLACMENT APPLICATORS ON NINE COOPERATING FARMERS IN LAGUNA, PHILIPPINES

IRRI Agricultural Engineering Department
November 1983

		Percent Increase Over Farmer Split Broadcast Practice		
		Straight Auger Applicator Prill	Oscillating Plunger Applicator Prill	Press-Wedge Applicator USG
1	Mr. V. Oruga Bo. Mabacan Calauan, Laguna	73.79[2/]	25.85[2/]	47.07[2/]
2	Mr. P. Macatangay Bo. Mabacan Calauan, Laguna	43.22	39.61	64.12
3	Mr. J. Espinili Bo. Mabacan Calauan, Laguna	47.59	38.74	35.42
4	Mr. S. Ilagan Bo. Mabacan Calauan, Laguna	7.98[3/]	85.73	71.88
5	Mr. C. Pabro Bo. Mabacan Calauan, Laguna	39.33[4/]	29.87[4/]	68.64
6	Mr. R. Vergara Bo. Mabacan Calauan, Laguna	52.43[4/]	40.61[4/]	66.62[4/]
7	Mr. L. Casubha Bo. Parian Calamba, Laguna	59.93[4/]	16.25	10.00
8	Mr. R. Isip Bo. Parian Calamba, Laguna	78.35	53.91	55.26
9	Mr. C. Oleta Bo. Parian Calamba, Laguna	46.95	69.88	42.58
	Average Increase	49.82	44.49	51.29

[1/] Due to lack of better methods for comparative assessment, efficiencies at different fertilizer rates have been compared.

[2/] Plots were affected by stemborer infestation.

[3/] C-4 variety was used with this machine only & the crop lodged.

[4/] Deep-placed plots recovered from field submergence of 2 to 3 days during typhoon.

Table 3

COMPARATIVE DESIGN FEATURES OF IRRI DEVELOPED DEEP PLACEMENT FERTILIZER APPLICATORS

TARGET SPECIFICATIONS 1/	STRAIGHT AUGER (PRILL) COMPARATIVE ASSESSMENT 2/				OSC. PLUNGER (PRILL) COMPARATIVE ASSESSMENT 2/				PRESS WEDGE (USG) COMPARATIVE ASSESSMENT 2/				DEEP PLUNGER (USG) COMPARATIVE ASSESSMENT 2/			
	EX.	W.M.	P.M.	N.M.	EX.	W.M.	P.M.	N.M.	EX.	W.M.	P.M.	N.M.	EX.	W.M.	P.M.	N.M.
ESSENTIAL																
• MUST APPLY PRILLED FERTILIZER, 5 to 10 CM. DEEP.		✓				✓				✓				✓		
• CONTINUOUS (NON-INTERMITTENT) OPERATION.		✓				✓				✓						✓
• MUST APPLY COMM'L GRADE FERTILIZER W/O GRADING.		✓				✓				✓						✓
• RATE 45 & 75 KG. N/HA. (2 to 3 BAGS).		✓				✓			✓	✓					✓	
• MUST FUNCTION IN UP TO 5 CM. DEEP STANDING WATER		✓				✓				✓				✓		
• MUST APPLY 5 to 20 DAYS AFTER TRANSPLANTING.		✓				✓				✓					✓	
• LABOR INPUT 8-12 HRS/HA. PER APPLICATION.			✓				✓				✓					✓
• LIGHT (10-18 KG.) FOR LIFTING AT END OF ROWS.	✓				✓				✓						✓	
• APPROXIMATE SELLING PRICE - US $ 50-100.	✓				✓				✓							✓
• MUST ADEQUATELY SEAL PLACEMENT OPENING.	✓				✓					✓				✓		
• STURDY TO LAST AT LEAST 4-6 SEASONS		✓				✓				✓				✓		
• PULLING OR PUSHING FORCE OF 7 to 10 KG		✓				✓				✓				✓		
• SMOOTH UNIDIRECTIONAL MOVEMENT.		✓				✓				✓						✓
DESIRABLE																
• COULD BE USED FOR BOTH PRILLED/USG OR FG/USG				✓				✓			✓					✓
• ROTARY RATHER THAN OSCILLATING MECHANISM.		✓				✓				✓						✓
• ROLLING ON WHEELS RATHER THAN ON SKIDS.				✓				✓				✓				✓
• PUSH-TYPE FOR POST-TRANSPLANT OPERATION.		✓				✓				✓				✓		
• MULTI-ROW OPERATION - 2 to 4 ROWS.			✓				✓				✓				✓	
• NON-FURROW OPENER TYPE.				✓				✓				✓		✓		
• MECHANICAL INJECTOR TYPE.		✓				✓						✓		✓		
• EASY TO MANUFACTURE BY SMALL SHOPS.		✓				✓				✓				✓		
• NOT NEED HIGH PRECISION IN PRODUCTION.		✓				✓			✓					✓		
• PULL TYPE FOR PRE-TRANSPLANT OPERATION.				✓				✓				✓				✓
• CAN ALSO BE USED FOR RANDOM SEEDED CROP.				✓				✓				✓				✓
UNDESIRABLE																
• INTERMITTENT OPERATION.		✓				✓				✓						✓
• MULTI-DIRECTION ACTION DURING OPERATION.		✓				✓				✓						✓
• USED OF LIQUID CONVEYING MECHANISM.		✓				✓				✓				✓		
• COMPLEX MECHANISMS.		✓				✓				✓				✓		
• DELICATE MECHANISMS.		✓				✓				✓				✓		

1/ THE TARGET SPECIFICATIONS WERE DEVELOPED IN NOV. 1982 AFTER CONSULTATION WITH CONCERNED IRRI SCIENTISTS.

2/ EX. = EXCEEDED; W.M. = WELL MET; P.M. = PARTIALLY MET; N.M. = NOT MET

DATE: NOV. 10, 1983

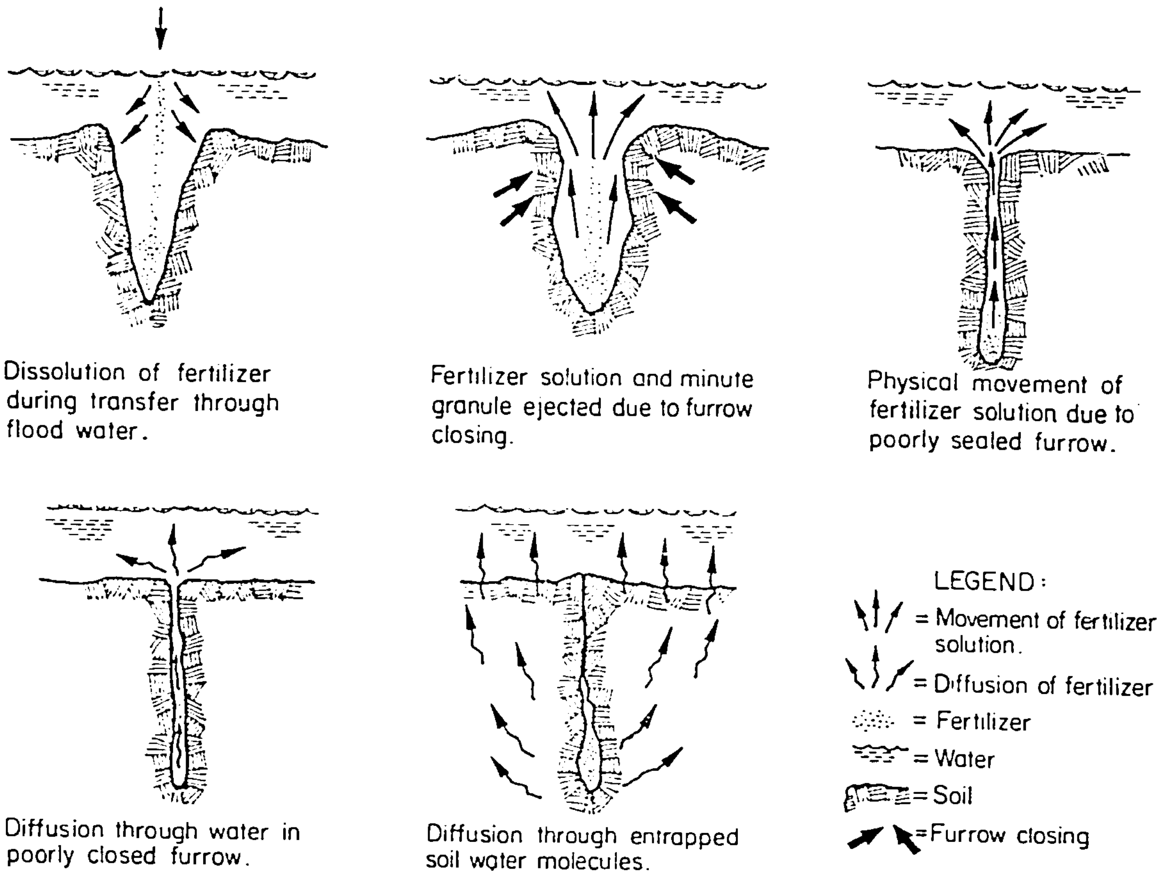


Fig. 1a. Avenues for fertilizer transfer to floodwater during deep placement

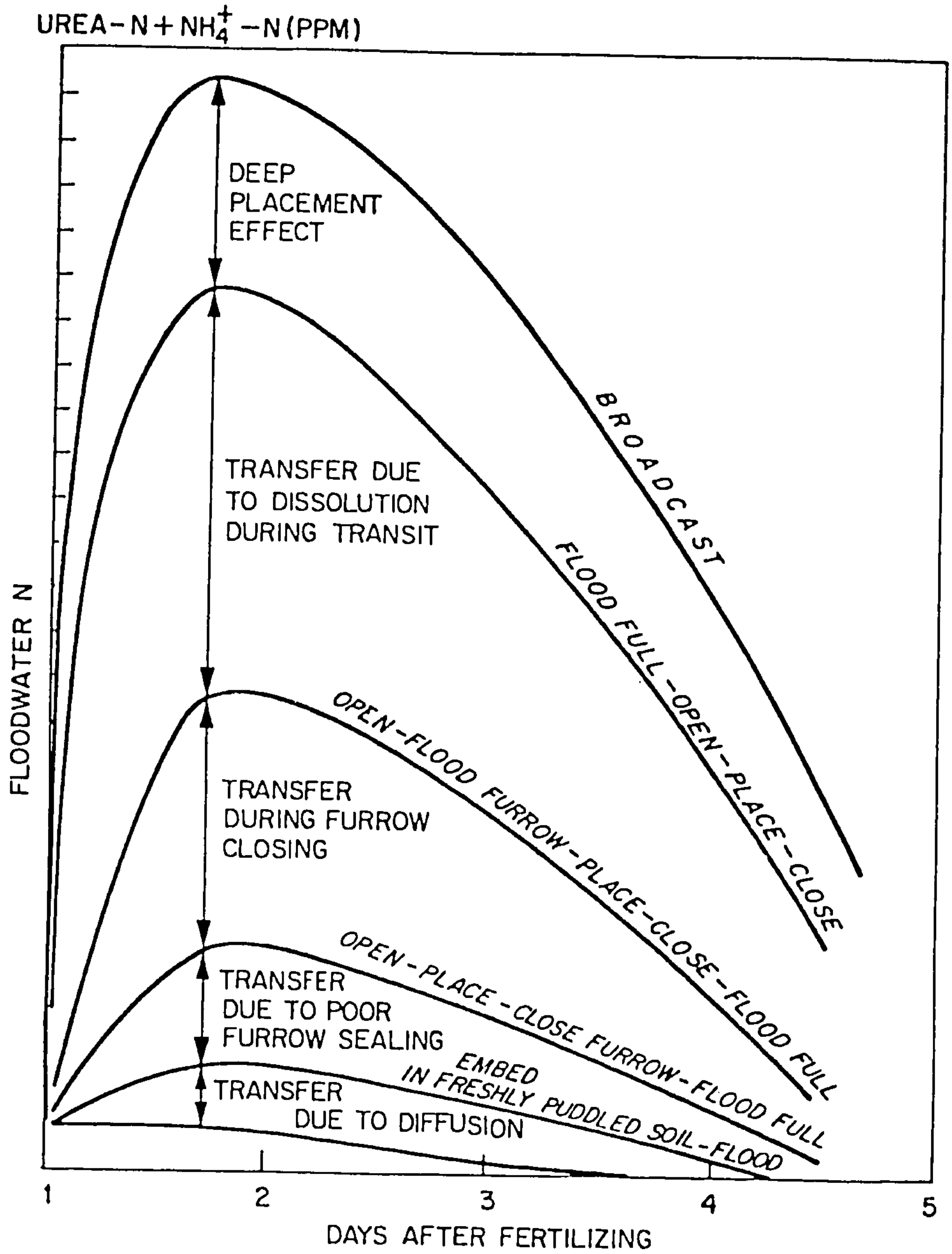


Fig. 1b. HYPOTHETICAL CURVES SHOWING POSSIBLE AVENUES AND EXPERIMENTAL TECHNIQUES FOR EVALUATING FERTILIZER TRANSFER TO FLOODWATER DURING PLACEMENT.

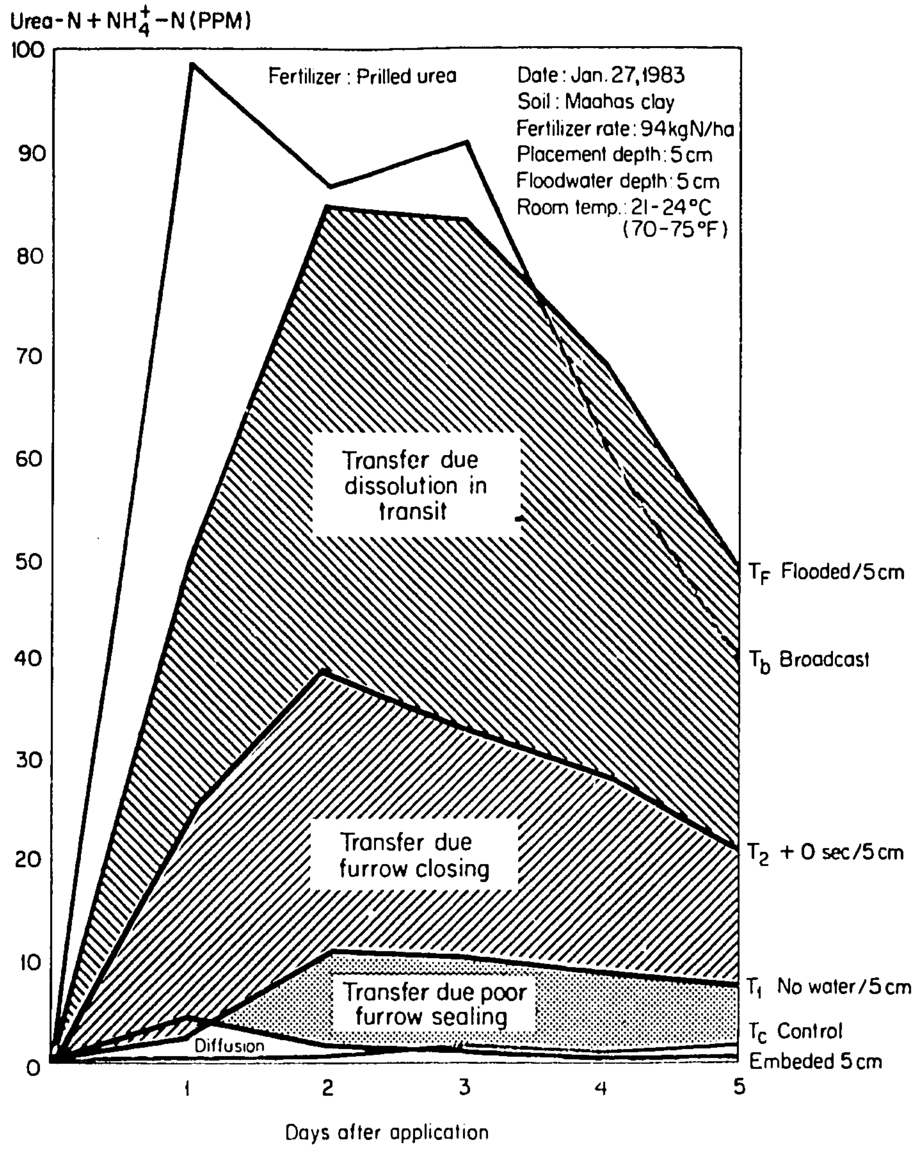


Fig. 1c. Major avenues for N transfer to floodwater during prilled urea placement at 5 cm depth in flooded Maahas clay. (Ag. Eng'g.)

49

Fig. 2 Straight auger applicator for prilled urea.

Fig. 3 Oscillating plunger applicator for prilled urea.

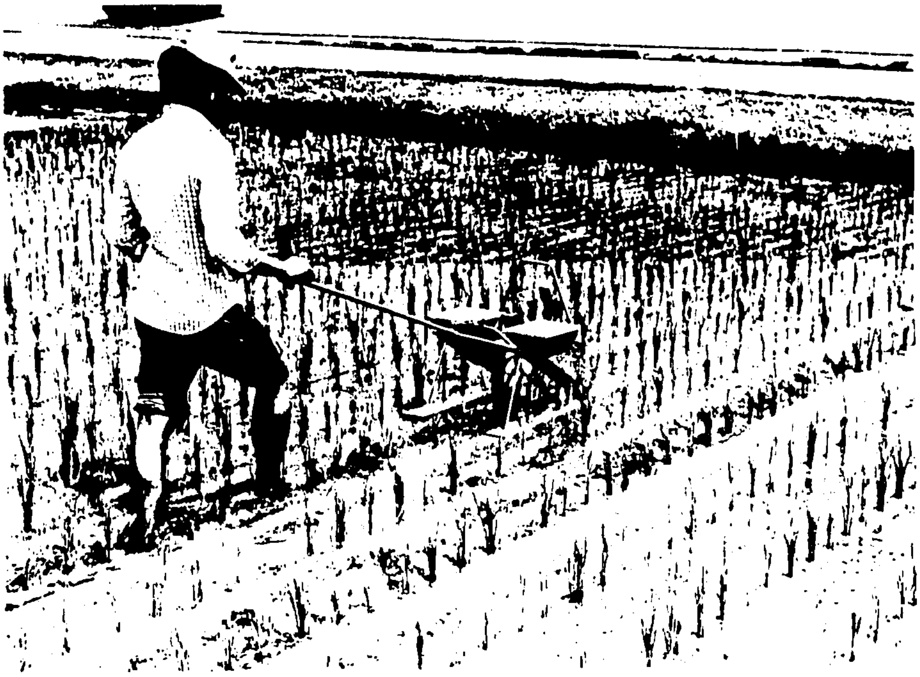


Fig. 4 Press-wedge applicator for urea supergranules (USG).

51

PAPER NO. 83-5540

DEEP PLACEMENT FERTILIZER APPLICATORS FOR WET PADDIES

by

AMIR U. KHAN
Agricultural Engineer
Agricultural Engineering Department
International Rice Research Institute
P.O. Box 933, Manila, Philippines

For Presentation at the 1983 WINTER MEETING
AMERICAN SOCIETY OF AGRICULTURAL ENGINEERS

Hyatt Regency Illinois Center
Chicago, Illinois
December 13-16, 1983

SUMMARY:

Fertilizer use efficiencies in wetland paddy production are about half that of dryland crops. Deep placement of fertilizer has been recognized as a method to increase fertilizer use efficiency. Inspite of numerous efforts worldwide, it had not been possible to place fertilizer deep in flooded paddies because of the problems of rapid transfer of N to floodwater during placement. This paper reports the development of three new applicators which can successfully deep place fertilizer in flooded paddies and offer possibilities for substantial yield increases in Asian paddy production.

American Society of Agricultural Engineers

St. Joseph, Michigan 49085

58

DEEP PLACEMENT FERTILIZER APPLICATORS FOR WET PADDIES

By

*Amir U. Khan**

INTRODUCTION

Paddy farmers in Asia have not been able to make full use of fertilizer to boost their yields due to poor fertilizer use efficiencies. As early as 1941, Shioiri in Japan explained the mechanics of loss of surface applied ammonia in flooded soils and recommended the deep placement of ammonium fertilizers. Many studies at IRRI and other institutions have consistently demonstrated that fertilizer use efficiency in wetland rice production could be almost doubled by placing fertilizer in the reduced soil layer at depths ranging from 5 to 15 cm. A lack of suitable deep placement applicators however, has not permitted the transfer of these findings to the farm level.

Prilled urea is the most popular fertilizer material used for rice production in Asia. Over the last decade an unusually large number of deep placement applicators have been developed (Kiamco, 1982 & Liu Chung-chu, 1982) for prilled urea in Japan, China and at IRRI. Field performance of these machines however have been rather inconsistent. This has led to the belief that prilled urea is not a suitable fertilizer material for deep placement and consequently briquettes and urea supergranules** have been experimentally developed.

The Institute is fully aware of the immense benefits that could accrue to rice farmers in Asia through deep placement of fertilizer and is placing a high priority on the development of such fertilizer applicators. In September 1982, the author was assigned to IRRI to concentrate on the development of deep placement applicators. A special engineering team*** was organized by the author in the Agricultural Engineering Department to work on this critical problem.

Agricultural Engineer, Agricultural Engineering Department, IRRI, Los Baños, Laguna, Philippines.

****Urea Briquettes & Urea Supergranules are essentially large size granules of 1 gram weight that were developed to facilitate deep placement in flooded soils.*

****The engineers who have been associated from time to time with this special task force are: Larry Kiamco, Val Tiangco, Gil Espiritu, Iñigo Camacho, Lito Diestro, Research Assistants, & Lito Bautista, Felipe Santos & Zahid Mahmood, Research Scholars of the Agricultural Engineering Department, IRRI, Los Baños, Laguna, Philippines.*

As an initial step, a review of the deep placement applicator development worldwide were undertaken to gain a better understanding of the deep placement problem. This led to the development of a set of criteria (Table 3) for technical and commercial acceptability of applicators (Khan, September 1982). In order to gain a better understanding of the deep placement phenomenon, a series of laboratory experiments were conducted, which led to the significant findings that under flooded conditions, placement of fertilizer in open furrows followed by furrow closing results in a large transfer of fertilizer to floodwater. The technical criteria for applicators were subsequently revised to reflect the new findings. Efforts were then made to separately optimize the designs of the three major components of applicators in the laboratory, i.e., the fertilizer metering, conveying and furrow closing mechanisms.

Twenty new deep placement applicator concepts were then proposed (Khan, November 1982) out of which six were selected for intensive design and development efforts. This led to the eventual development of three new applicators. These applicators, two for prilled urea and one for USG were designed for minimum N transfer to floodwater. A brief discussion of the research study on N transfer to floodwater, which served as the basic foundation for the successful development of deep placement applicators, is included in this paper.

MECHANICS OF N TRANSFER TO FLOODWATER

Fertilizer use efficiencies in upland farming (unflooded conditions) have been reported to be 50 to 60% (Craswell & Vlek, 1979) when those obtained under wetland farming conditions are generally 30 to 50% (Prasad & De Datta, 1979). The reasons of this wide difference in fertilizer use efficiencies have not been well understood. Experiments conducted in Pakistan (Ross, 1980) indicate a 60% recovery of applied nitrogen by rice crop when fertilizer was incorporated in dry condition and followed by flooding. More recently, Bhatti et al (1983) report that fertilizer incorporated in dry soil and followed by flooding increases paddy yields by 1 to 2 tons/ha over conventional broadcasting of fertilizer in flooded soils. One can conclude from the results of these two studies that flooding, after the fertilizer has been incorporated, is not the cause for reducing fertilizer use efficiencies in wetland farming. Since fertilizer use efficiencies under upland farming (unflooded) conditions are quite high, it was hypothesized that the low fertilizer use efficiencies in wetland farming had something to do with the presence of water during the time the fertilizer was being applied. It was suspected that some fertilizer was being transferred to floodwater during application. Since ammonia volatilization losses are related to floodwater N levels, minimizing floodwater N level seemed a logical approach for reducing fertilizer losses.

In flooded soils, there are four possible ways that fertilizer could be transferred to floodwater during or immediately after placement (Fig. 1a): 1) By dissolution while fertilizer transits through floodwater to the furrow bottom. 2) By upward movement of fertilizer granules or solution due to displacement effect of the furrow closing operation. 3) By convectional movement of fertilizer solution through poorly sealed furrow walls, and 4) By diffusion through water entrapped in puddled soils or between poorly closed furrows. A set of hypothetical curves indicating possible channels of fertilizer transfer to floodwater and the experimental methods which were used to isolate these effects are given in Fig. 1b.

The above considerations led to two laboratory studies in the IRRI Agricultural Engineering Department which permitted the assessment of the different avenues of N transfer to floodwater during deep fertilizer placement. Prilled urea was used in the first study (Khan et al, April 1983) as this material was considered to be most susceptible for N transfer to floodwater due to its small granule size. Similar experiments were later repeated with both prilled urea and urea supergranules (Mahmood et al, 1983). Fig. 1c summarizes the magnitude of N transfer to floodwater during placement when prilled urea is placed in 5 cm deep furrows.

The findings of these two studies confirmed that the applicators developed in the past were not properly depositing fertilizer as most of it was transferred to floodwater during placement. The two major channels of fertilizer transfer to floodwater during deep placement were: a) Dissolution of fertilizer during transit from the water surface to the furrow bottom (43-76%); b) Upward movement of fertilizer granules or solution to the floodwater during furrow closing (up to 29%). If the furrow was properly closed, transfer through the closed furrow walls was generally less than 10%. Transfer due to diffusion through flooded soils was less than 5%.

On the basis of the N transfer studies, it was concluded that the key to improving fertilizer use efficiency in wetland cultivation was to minimize N transfer to floodwater during the fertilizer placement operation. Such a strategy would maximize retention of fertilizer in the soil where it would be less vulnerable to volatilization losses and would be available for plant use. It was thus concluded that minimizing fertilizer-water contact during the three phases of fertilizer application; transit, placement and covering, were the most critical considerations in the development of deep placement applicators.

This general stragegy was followed in the development of the following three new applicators (Khan et al, June 1983) at IRRI:

1) Straight auger applicator for prilled urea (Fig. 2).
2) Oscillating plunger applicator for prilled urea (Fig. 3).
3) Press-wedge applicator for urea supergranules (USG) (Fig. 4).

55

COMPARATIVE PERFORMANCE OF APPLICATORS

During development, most machines must undergo a phase in which machines are repeatedly evaluated and improved. In the past, performance of deep placement applicators were evaluated at IRRI through yield experiments. This required a five to six month cycle, between design improvement and performance evaluation, which seriously delayed the applicator development process. The level of urea and Ammonium N concentration in floodwater, after the fertilizer has been applied, is generally related to volatilization losses. It was felt that floodwater N level* could be used to obtain an approximate idea of the machine placement efficiency. This technique was used for quick preliminary evaluation of applicators which helped to accelerate the applicator development process at IRRI.

Last December, three deep placement applicators were evaluated in Maahas clay plots at IRRI by measuring the amount of N transfer to floodwater. The plots were settled for ten days after puddling. The results of this test, which are summarized below, indicated that the straight auger applicator for prilled urea was performing considerably better than the deep plunger (USG), and rolling presswheel (forestry grade) applicators.

Machine	Fertilizer material	Total N (ppm) in flood water - 24 hours after application	Machine performance rating
Straight auger	Prill	16.47	1
Deep plunger* (intermittent)	USG	34.37	2
Rolling presswheel	Forestry grade	38.63	3

*This machine was developed earlier and had given best performance in tests conducted during 1981-82. However it has some drawbacks which limit its commercial acceptability.

---

*Subsequent experience tells us that floodwater N level only gives an indication of the amount of N transferred to floodwater during the process of fertilizer application. It fails to give any indication of how the rest of the fertilizer will be available to plants during the rest of the cropping season. Thus the floodwater N level, at placement time, may not necessarily give an indication of fertilizer use efficiencies which is more a function among others of how effectively fertilizer was sealed in the furrow at the time of placement.

During the 1983 dry season, three of the new applicators, the Deep Plunger (USG) and hand placed (USG) methods were evaluated at the IRRI Research Farm in yield trials under a collaborative project between the IRRI Agronomy and Agricultural Engineering departments. The results of these tests were as follows:

PRELIMINARY YIELD TESTS, 1983 DRY SEASON, IRRI AGRONOMY DEPT.

Machine	Fertilizer material	Fertilizer Kg/N ha	Grain yield	Efficiency Kg rough rice / kg N
1) Straight auger 3/4"	Prill	78	5.9	28
2) Auger with transplanter	Prill	82	5.6	23
3) Rolling presswheel	Forestry grade	84	6.0	26
4) Deep plunger (intermittent)*	USG	84	5.5	21
5) Hand placed	USG	87	5.9	24

*This machine was developed earlier and had given promising performance in tests conducted in 1981-82. This machine, however, has some drawbacks which limit its commercial acceptability.

The performance of the three machines, Nos. 1, 2 & 3, in the above tests compared favorably with hand placement of USG, which had so far been considered to be the most efficient deep placement method at IRRI.

All the five new machines were again tested at the IRRI Research Farm in May 1983 by the Agricultural Engineering Dept. by evaluating the N transfer to floodwater. The results were as follows:

	Machine	Fertilizer material	Total N (ppm) in floodwater - 24 hours after application	Machine performance rating	Fertilizer rate kg N/ha
1)	Straight auger 3/4" surface closure	Prill	3.3	3	58
2)	Straight auger 3/4" with underground closure	Prill	2	1	58
3)	Rolling presswheel with underground closure	Forestry grade	11.6	7	58
4)	Rollimg presswheel with underground closure	USG	6.7	5	58
5)	Inclined press-wedge	USG	14.8	8	57
6)	Oscillating plunger with underground closure	Prill	2.4	2	58
7)	Auger 3/4" on transplahter	Prill	8.7	6	58
8)	Deep plunger (intermittent)*	USG	6.2	4	58
9)	Hand placement	USG	6.7	5	58

*This machine was developed earlier and had given promising performance in tests conducted in 1981-82. However, it has some drawbacks which limits commercial acceptability.

These tests indicate an encouraging performance of all five machines as the N transfer values were less than 25 ppm, a level that was agreed upon by scientists at IRRI to be acceptable. The two prilled urea applicators, the Straight Auger and the Oscillating Plunger, resulted in a lower N transfer to floodwater than hand placement of USG. This was convincing proof that prilled urea could be as effectively deep placed as USG. The performance of the Rolling Presswheel was satisfactory however this machine was dropped from further development as it was felt to be too costly for commercial introduction. The Inclined Press-wedge indicated a relatively high N transfer value and hence the wedge and opener was redesigned with a narrow profile for more effective sealing and reduced pushing force.

The three new machines, the Straight Auger (prill), the Oscillating Plunger (prill) and the modified Press-wedge (USG) were simple in design and offered excellent possibilities for commercial introduction. These three machines can be easily manufactured in most developing countries and could be marketed to farmers at a reasonable price of about US$50 to US$60. It was decided to further test and improve these machines through yield trials during the 1983 wet season in cooperation with the following groups:

a) The IRRI Agronomy Department at the IRRI Farm and at the Maligaya Research Station.

b) The IRRI Training & Technology Transfer Department at various research stations and farmers' fields in the Philippines.

c) The Ministry of Food & Agriculture, Govt. of the Philippines at various research sites.

d) The IRRI Agricultural Engineering Department in nine progressive farmers' fields in Laguna Province.

The three machines are now undergoing continuous improvements on the basis of feedback being received from field trials. As of this writing, yield data from the nine cooperating farmers in Laguna has been obtained by the IRRI Agricultural Engineering Department. The results are presented in Tables 1 and 2.

The farmer trials indicate that in all nine cases, a single application by any of the three machines increased fertilizer use efficiency in every case when compared to farmers' traditional practice of split surface broadcast application. The average increase in fertilizer use efficiencies for the three machines on clayey soils at the nine farm locations in Laguna were as follows:

1)	Straight Auger Applicator	Prill	49.82%
2)	Oscillating Plunger Applicator	Prill	44.49%
3)	Press-wedge Applicator	USG	51.29%

Each of the nine farmers were pleased with the wet season results and have requested to use these machines in the coming dry season.

Results from the other IRRI departments and outside agencies who are testing these applicators in different parts of the country are expected to be available by the end of this year. On the basis of the experience gained so far, one can conservatively estimate that fertilizer savings of approximately 35% could be easily achieved through the use of these machines. Hopefully, by the end of this year, we will have additional results from other test sites and more precise estimates on fertilizer savings that could be achieved.

It is not clear at this moment whether farmers would prefer to save on fertilizer costs or go for maximization of yields. The nine cooperating progressive farmers in Laguna were used to applying fairly high fertilizer rates. They expressed a preference for increased yields rather than fertilizer savings. Since fertilizer efficiencies generally show greater increases at low fertilizer rates, perhaps the less progressive farmers would prefer to save fertilizer rather than increase yields. The rapidly increasing prices of fertilizer in the Philippines and farmers capital constraints may automatically force an input saving rather than a yield maximizing strategy for the near future.

At this stage, it would be appropriate to compare the three new applicators with the original target specifications that were developed in consultation with concerned IRRI scientist at the start of this crash program to develop deep placement applicators. Table 3 lists the Essential, Desirable and Undesirable Target Specifications along with an assessment of how the new machines have been able to meet the original objectives. The table includes a fourth machine, the Deep Plunger Applicator (USG), which was the best performing applicator in 1982. It is interesting to note that the three new machines have not only met all the essential specifications but exceeded three of these beyond their desired limits.

It is hoped that by the end of 1983, the three machines would have been sufficinetly tested and improved under different soil and water conditions for limited commercial production release in the Philippines and for extensive farm trials in other Asian countries. If these trials prove conclusive, the designs of these applicators will be released by late 1984 to selected manufacturers in Asia for regular commercial production.

CONCLUSIONS

The machine reported here have demonstrated a rather encouraging performance in the various tests and field trials that have been conducted so far. We are confident that with the development of these three applicators, the primary hurdle of deep placement of prilled and supergranular urea has essentially been overcome. What remains now, is the extensive evaluation and adaptation of these applicators to suit farmer preferences, varying site, soil and cultural differences in the major rice growing countries of Asia.

Introduction of these machines to farmers through normal manufacturing and commercial channels will require substantial agricultural and industrial extension efforts from IRRI, National Agricultural Agencies and Fertilizer Manufacturers in the rice growing countries. While the introduction of deep placement applicators seems to be the solution for improving fertilizer use efficiencies, there is little doubt in my mind that these machines will be used mostly by the more affluent farmers. Majority of the small subsistent farmers will not have the resources to purchase machines. Such farmers will either have to rent these machines or alternate non-mechanical methods must be developed to improve their fertilizer use efficiencies. Use of irrigation water to deep place fertilizer and low cost fertilizer coatings such as clay, starch, oil, etc. to momentarily arrest fertilizer dissolution, offer some interesting possibilities for improving fertilizer use efficiencies without resorting to special machines.

The progress achieved during the last one year at IRRI on the development of deep placement applicators, specially for prilled urea, has been most challenging and satisfying to those of us who have been associated with this project. There are a number of strategic steps which led to the rapid development of the deep placement applicators that are reported in this paper. These steps included, the precise definition of the deep placement applicator problem; the prioretization of the technical and market criteria for applicators; the better understanding of the N transfer to floodwater during deep placement; the separate optimization in the laboratory of the individual components of applicators, the shortening of the applicator evaluation process through floodwater N measurement; the development of a large number of the applicator concepts which led to the design of the three promising machines and finally the dedicated efforts of the Design engineers and staff of the IRRI Agricultural Engineering Department who helped in the development of these applicators.

The assistance provided by the IRRI Agronomy Department, the Training & Technology Transfer Department and the Test Section of the Agricultural Engineering Department in testing and evaluation of the applicators, the IRRI Analytical Service Laboratory in analyzing floodwater samples and informal suggestions of some of my IRRI colleagues which helped in many ways is gratefully acknowledged.

61

REFERENCES

BHATTI, A., H. REHMAN & A.H. GURMANI. 1983. "Efficiency of urea applied to rice by various methods." International Rice Research Newsletter, Vol. 8 No. 3. June.

CRASWELL, E.T. & P.L.G. VELK. 1979. "Fate of fertilizer nitrogen applied to wetland rice." Nitrogen & Rice, IRRI, Los Baños, Laguna, Philippines.

KHAN, A.U. 1983. "New deep placement applicators for minimum N transfer to floodwater." IRRI Thursday Seminar. June 23.

KHAN, A.U., L.C. KIAMCO & V.M. TIANGCO. 1983. "Mechanics of fertilizer transfer to floodwater during deep placement." Paper presented during the International Rice Research Conference, IRRI, April 18-22.

KHAN, A.U. 1982. "Alternative concepts for deep placement fertilizer applicators." IRRI Saturday Seminar. November 18.

KHAN, A.U. 1982. "Some concepts and issues for deep placement fertilizer applicators." Paper for internal circulation at IRRI. September.

KIAMCO, L.C., I.R. CAMACHO, G.C. SALAZAR & B.J. COCHRAN. 1982. "Development of deep placement fertilizer applicators at IRRI." Paper presented at the International Workshop/Training on Nitrogen Management held in Fuzchou, China, April 25-May 4/14.

LIU CHUNG-CHU. 1982. "The development of ball fertilizer deep placement technique in China." Paper presented at the International Workshop/Training Course for Nitrogen Management sponsored by FAAS/IFDC/IRRI IN Fuzchou, China, April 26-May 4.

MAHMOOD, Z., L.C. KIAMCO & A.U. KHAN. 1983. "Further studies on mechanics of fertilizer transfer to floodwater during deep placement." Special Problems in Agricultural Engineering, University of the Philippines at Los Baños, Summer.

PRASAD, R. & S.K. DE DATTA. 1979. "Increasing fertilizer nitrogen efficiency in wetland rice." Nitrogen & Rice, IRRI, Los Baños, Laguna, Philippines.

ROSS, V.E. 1980. Final Report of the Collaborative Rice Research Project between PARC, Govt. of Pakistan and IRRI-Philippines.

SHIOIRI, M. 1941. "Denitrification in paddy soils." (Japanese) Kagaku (Science in Japan) 16:104-116.

***

Table 1

DEEP PLACEMENT FERTILIZER APPLICATOR TRIALS[1] IN FARMERS' FIELDS
CALAMBA & CALAUAN, LAGUNA - 1983 WET SEASON
IRRI AGRICULTURAL ENGINEERING DEPT.
NOVEMBER 1983

No.	Farmer-Cooperator Name & Address	Variety	Application Method[2]	Fertilizer		Projected Yield[3] Tons/ha	Fertilizer Efficiency[4]	
				Material	Rate Kg N/ha		Kg Rough Rice/kg N	% Change Over Control
1	Mr. V. Oruga Bo. Mabacan Calauan, Laguna	Sinang-Domeng (HYV)	Farmer Practice (no machine - control)	Prill	90	4.87	54.11	-
			Spring Auger	Prill	47	4.42	94.04	+ 73.79
			Oscillating Plunger	Prill	48	3.95	68.10	+ 25.85
			Press-wedge	USG	48	3.82	79.58	+ 47.07
2	Mr. P. Macatangay Bo. Mabacan Calauan, Laguna	Sinang-Domeng (HYV)	Farmer Practice (no machine - control)	Prill	78	4.98	63.85	-
			Spring Auger	Prill	55	5.03	91.45	+ 43.22
			Oscillating Plunger	Prill	58	5.17	89.14	+ 39.61
			Press-wedge	USG	48	5.03	109.79	+ 64.12
3	Mr. J. Espinili Bo. Mabacan Calauan, Laguna	Sinang-Domeng (HYV)	Farmer Practice (no machine - control)	Prill	78	6.87	88.08	-
			Spring Auger	Prill	42	5.46	130	+ 47.59
			Oscillating Plunger	Prill	41	5.01	122.20	+ 38.74
			Press-wedge	USG	42	5.01	119.28	+ 35.42
4	Mr. S. Ilagan Bo. Mabacan Calauan, Laguna	IR-42	Farmer Practice (no machine - control)	Prill	78	4.76	61.02	-
		C-4	Spring Auger	Prill	52	3.42	65.77	+ 7.98
		IR-42	Oscillating Plunger	Prill	39	4.42	113.33	+ 85.73
		IR-42	Press-wedge	USG	41	4.30	104.88	+ 71.88
5	Mr. C. Pabro Bo. Mabacan Calauan, Laguna	IR-42	Farmer Practice (no machine - control)	Prill	80	4.28	53.5	-
			Spring Auger	Prill	66	4.92	75.54	+ 39.33
			Oscillating Plunger	Prill	58	4.03	69.48	+ 29.87
			Press-wedge	USG	45	4.06	90.22	+ 68.64
6	Mr. R. Vergara Bo. Mabacan Calauan, Laguna	IR-42	Farmer Practice (no machine - control)	Prill	78	4.66	59.74	-
			Spring Auger	Prill	47	4.28	91.06	+ 52.43
			Oscillating Plunger	Prill	50	4.20	84.00	+ 40.61
			Press-wedge	USG	44	4.38	99.54	+ 66.62
7	Mr. L. Casubha Bo. Parian Calamba, Laguna	IR-42	Farmer Practice (no machine - control)	Prill	67	5.47	81.64	-
			Spring Auger	Prill	40	5.19	129.75	+ 58.93
			Oscillating Plunger	Prill	53	5.03	94.91	+ 16.25
			Press-wedge	USG	51	4.58	89.80	+ 10.00
8	Mr. R. Isip Bo. Parian Calamba, Laguna	IR-42	Farmer Practice (no machine - control)	Prill	78	5.74	73.59	-
			Spring Auger	Prill	40	5.25	131.25	+ 78.35
			Oscillating plunger	Prill	46	5.21	113.26	+ 53.91
			Press-wedge	USG	47	5.37	114.26	+ 55.26
9	Mr. C. Oleta Bo. Parian Calamba, Laguna	IR-42	Farmer Practice (no machine - control)	Prill	68	5.71	69.26	-
			Spring Auger	Prill	45	4.58	101.78	+ 46.95
			Oscillating Plunger	Prill	47	5.53	117.66	+ 69.88
			Press-wedge	USG	48	4.74	98.75	+ 42.58

[1] Except for application methods & fertilizer rates each farmer applied his own traditional cultural practices on all of 4 treatments.

[2] With machine applications, all fertilizer was applied as a single dose at 10 to 18 days after transplanting. Farmer practice varied but generally included 2 to 3 split broadcast applications.

[3] Based on 4 sampling sites (projected value at 14% m.c.).

[4] For lack of better methods of assessment, fertilizer efficiencies at different fertilizer rates have been compared.

62

Table 2

SUMMARY RESULTS OF INCREASES IN FERTILIZER USE EFFICIENCIES[1/] WITH DEEP PLACMENT APPLICATORS ON NINE COOPERATING FARMERS IN LAGUNA, PHILIPPINES

IRRI Agricultural Engineering Department
November 1983

		Percent Increase Over Farmer Split Broadcast Practice		
		Straight Auger Applicator Prill	Oscillating Plunger Applicator Prill	Press-Wedge Applicator USG
1	Mr. V. Oruga Bo. Mabacan Calauan, Laguna	73.79[2/]	25.85[2/]	47.07[2/]
2	Mr. P. Macatangay Bo. Mabacan Calauan, Laguna	43.22	39.61	64.12
3	Mr. J. Espinili Bo. Mabacan Calauan, Laguna	47.59	38.74	35.42
4	Mr. S. Ilagar Bo. Mabacan Calauan, Laguna	7.98[3/]	85.73	71.88
5	Mr. C. Pabro Bo. Mabacan Calauan, Laguna	39.33[4/]	29.87[4/]	68.64
6	Mr. R. Vergara Bo. Mabacan Calauan, Laguna	52.43[4/]	40.61[4/]	66.62[4/]
7	Mr. L. Casubha Bo. Parian Calamba, Laguna	59.93[4/]	16.25	10.00
8	Mr. R. Isip Bo. Parian Calamba, Laguna	78.35	53.91	55.26
9	Mr. C. Oleta Bo. Parian Calamba, Laguna	46.95	69.88	42.58
	Average Increase	49.82	44.49	51.29

[1/] Due to lack of better methods for comparative assessment, efficiencies at different fertilizer rates have been compared.

[2/] Plots were affected by stemborer infestation.

[3/] C-4 variety was used with this machine only & the crop lodged.

[4/] Deep-placed plots recovered from field submergence of 2 to 3 days during typhoon.

Table 3

**COMPARATIVE DESIGN FEATURES
OF
IRRI DEVELOPED
DEEP PLACEMENT FERTILIZER APPLICATORS**

TARGET SPECIFICATIONS 1/	STRAIGHT AUGER (PRILL) COMPARATIVE ASSESSMENT 2/				OSC. PLUNGER (PRILL) COMPARATIVE ASSESSMENT 2/				PRESS WEDGE (USG) COMPARATIVE ASSESSMENT 2/				DEEP PLUNGER (USG) COMPARATIVE ASSESSMENT 2/			
	EX.	W.M.	P.M.	N.M.	EX.	W.M.	P.M.	N.M	EX.	W.M.	P.M.	N.M.	EX.	W.M.	P.M.	N.M.
ESSENTIAL																
• MUST APPLY PRILLED FERTILIZER 5 to 10 CM DEEP		✓				✓				✓				✓		
• CONTINUOUS (NON-INTERMITTENT) OPERATION		✓				✓				✓						✓
• MUST APPLY COMM'L GRADE FERTILIZER W/O GRADING		✓				✓				✓						✓
• RATE 45 & 75 KG N/HA (2 to 3 BAGS)		✓				✓			✓	✓					✓	
• MUST FUNCTION IN UP TO 5 CM DEEP STANDING WATER		✓				✓				✓				✓		
• MUST APPLY 5 to 20 DAYS AFTER TRANSPLANTING		✓				✓				✓					✓	
• LABOR INPUT 8-12 HRS/HA PER APPLICATION			✓				✓				✓					✓
• LIGHT (10-18 KG) FOR LIFTING AT END OF ROWS	✓				✓				✓						✓	
• APPROXIMATE SELLING PRICE - US $ 50-100.	✓				✓				✓							✓
• MUST ADEQUATELY SEAL PLACEMENT OPENING	✓				✓					✓				✓		
• STURDY TO LAST AT LEAST 4-6 SEASONS		✓				✓				✓				✓		
• PULLING OR PUSHING FORCE OF 7 to 10 KG		✓				✓				✓				✓		
• SMOOTH UNIDIRECTIONAL MOVEMENT		✓				✓				✓						✓
DESIRABLE																
• COULD BE USED FOR BOTH PRILLED/USG OR FG/USG				✓				✓			✓					✓
• ROTARY RATHER THAN OSCILLATING MECHANISM		✓				✓				✓						✓
• ROLLING ON WHEELS RATHER THAN ON SKIDS				✓				✓				✓				✓
• PUSH-TYPE FOR POST-TRANSPLANT OPERATION		✓				✓				✓				✓		
• MULTI-ROW OPERATION - 2 to 4 ROWS			✓				✓				✓				✓	
• NON-FURROW OPENER TYPE.				✓				✓				✓		✓		
• MECHANICAL INJECTOR TYPE		✓				✓						✓		✓		
• EASY TO MANUFACTURE BY SMALL SHOPS		✓				✓				✓				✓		
• NOT NEED HIGH PRECISION IN PRODUCTION		✓				✓			✓					✓		
• PULL TYPE FOR PRE-TRANSPLANT OPERATION				✓				✓				✓				✓
• CAN ALSO BE USED FOR RANDOM SEEDED CROP				✓				✓				✓				✓
UNDESIRABLE																
• INTERMITTENT OPERATION.		✓				✓				✓						✓
• MULTI-DIRECTION ACTION DURING OPERATION		✓				✓				✓						✓
• USED OF LIQUID CONVEYING MECHANISM		✓				✓				✓				✓		
• COMPLEX MECHANISMS		✓				✓				✓				✓		
• DELICATE MECHANISMS		✓				✓				✓				✓		

1/ THE TARGET SPECIFICATIONS WERE DEVELOPED IN NOV 1982 AFTER CONSULTATION WITH CONCERNED IRRI SCIENTISTS.

2/ EX. = EXCEEDED; W.M. = WELL MET; P.M. = PARTIALLY MET; N.M. = NOT MET

DATE: NOV. 10, 1983

6

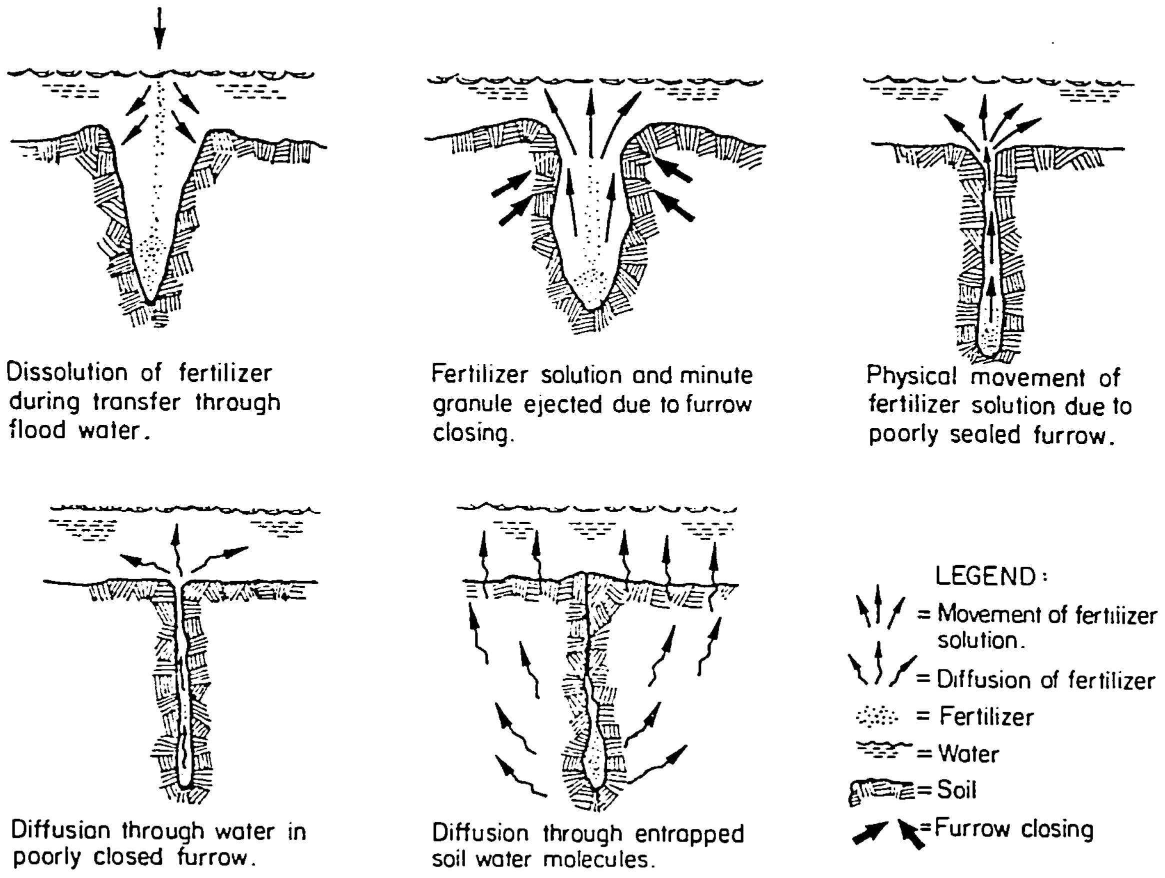


Fig. 1a. Avenues for fertilizer transfer to floodwater during deep placement

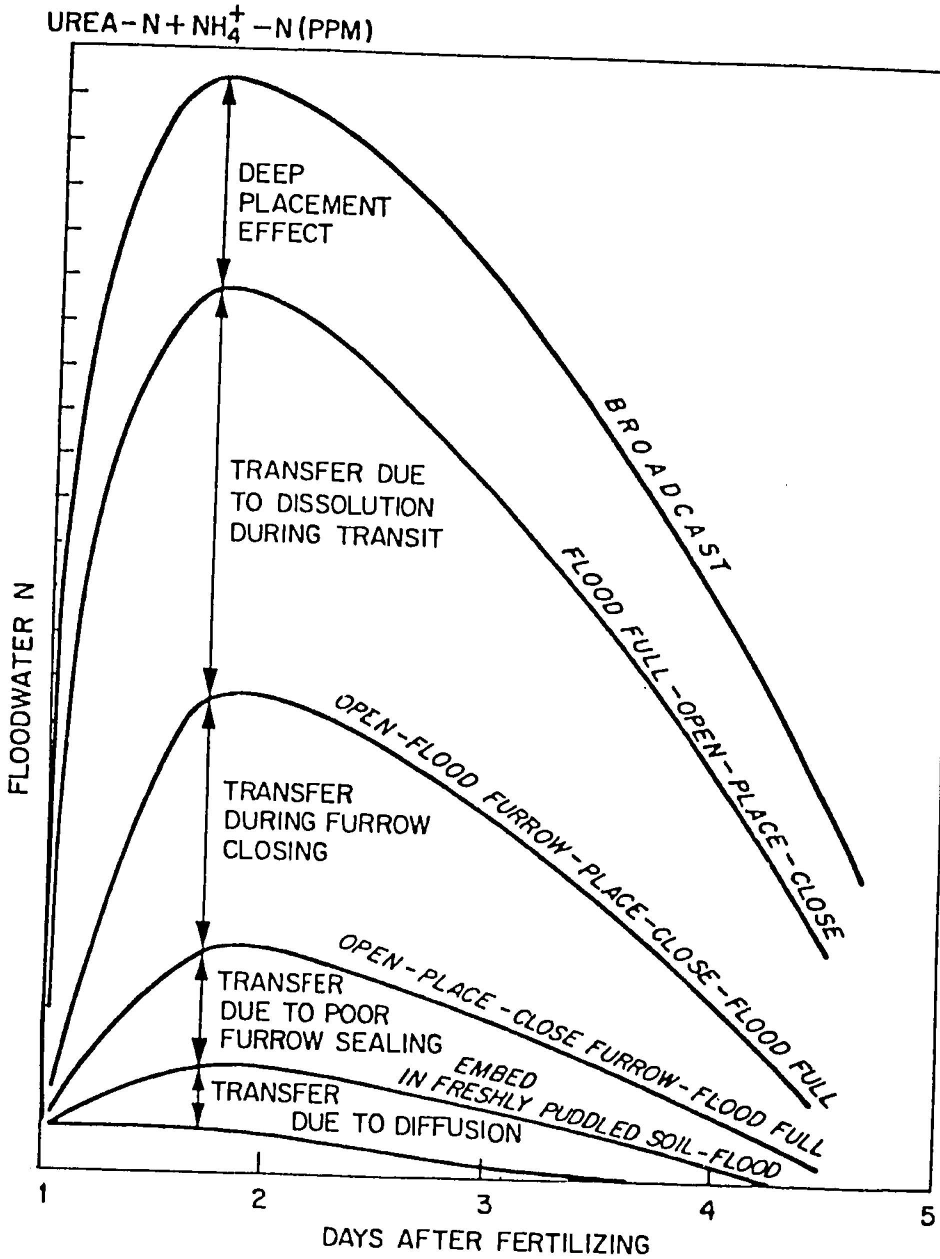


Fig. 1b. HYPOTHETICAL CURVES SHOWING POSSIBLE AVENUES AND EXPERIMENTAL TECHNIQUES FOR EVALUATING FERTILIZER TRANSFER TO FLOODWATER DURING PLACEMENT.

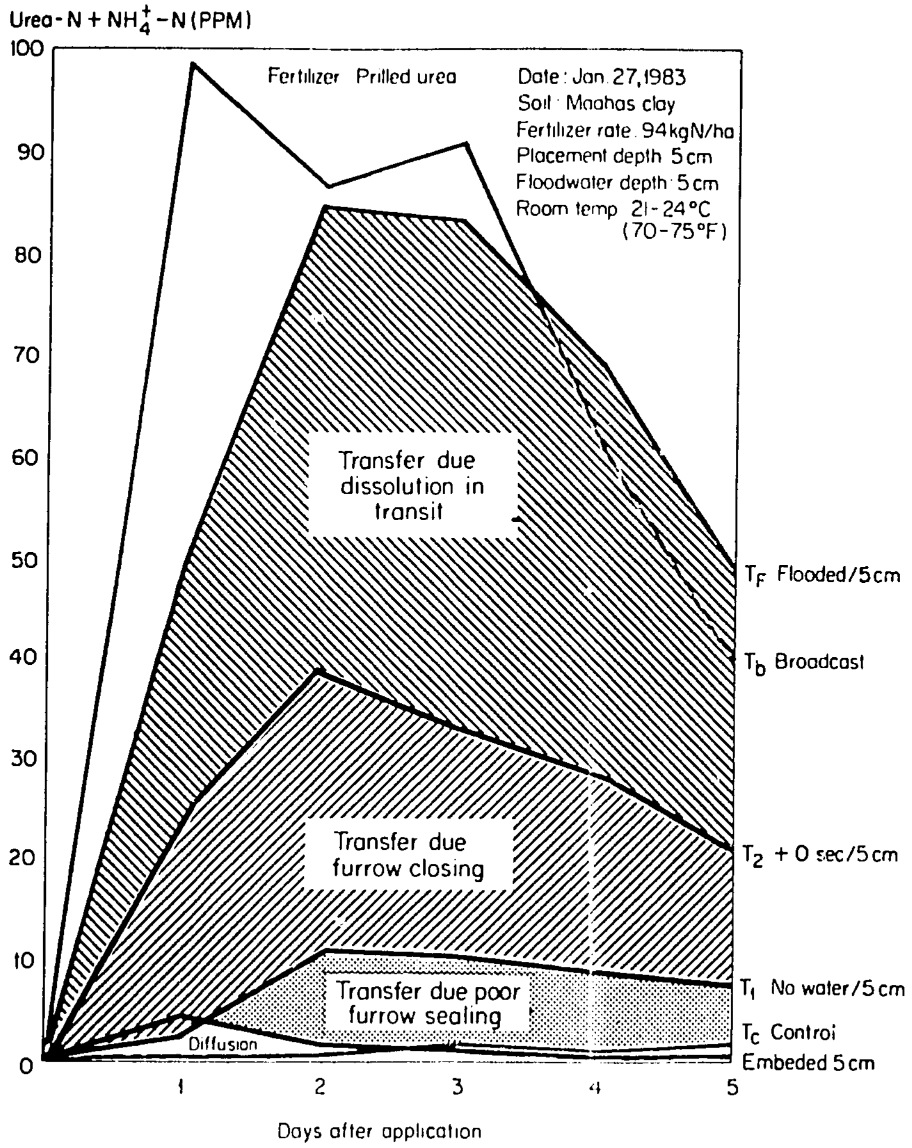


Fig. 1c. Major avenues for N transfer to floodwater during prilled urea placement at 5 cm depth in flooded Maahas clay. (Ag. Eng'g.)

Fig. 2 Straight auger applicator for prilled urea.

Fig. 3 Oscillating plunger applicator for prilled urea.

Fig. 4 Press-wedge applicator for urea supergranules (USG).

Paper No. AE-84-07

APPLICATORS FOR IMPROVED FERTILIZER USE EFFICIENCIES IN WETLAND PADDIES

By

A.U. Khan, L.C. Kiamco, V.M. Tiangco, I.R. Camacho
M.S. Diestro & E.U. Bautista

Paper for presentation at the Crop Science Society of the Philippines (CSSP) 15th Annual Scientific Convention to be held in Batac, Ilocos Norte, May 16-18, 1984.

• AGRICULTURAL ENGINEERING DEPARTMENT •
THE INTERNATIONAL RICE RESEARCH INSTITUTE
P.O. BOX 933 ◦ MANILA ◦ PHILIPPINES

APPLICATORS FOR IMPROVED FERTILIZER USE EFFICIENCIES IN WETLAND PADDIES

By

A.U. Khan, L.C. Kiamco, V.M. Tiangco, I.R. Camacho, M.S. Diestro & E.U. Bautista

ABSTRACT

Many research studies have demonstrated that fertilizer use efficiencies in rice production can be almost doubled by placing fertilizer 5 to 15 cm deep in flooded soils. Over the last forty years, numerous attempts have been made in Japan, China and at the International Rice Research Institute to develop deep placement fertilizer applicators for wetland paddy. Field performance of the applicators developed in the past however was always inconsistent and consequently farmers were not able to benefit from this important research findings.

On the basis of research conducted in the IRRI Agricultural Engineering Dept., it was concluded that excessive N transfer to floodwater, during the deep placement operation, was the main reason for poor field performance of the earlier applicators. Past applicators were not able to deep place fertilizer in the soil as most of the fertilizer was transferred to the floodwater during placement where it was subject to volatilizationa losses. It was also concluded that maintaining a 3-5 cm soil barrier, between floodwater and the deposited fertilizer, is adequate to minimize N transfer and improve fertilizer use efficiencies rather than placement at greater depths, as has been generally advocated.

The development of three new applicators, which inject and seal fertilizer below the soil surface, without contacting the floodwater, is described. Performance of these machines, based on yield experiments at research stations and on farmers' fields in the Philippines, are reported. Average increase in fertilizer use efficiency of 50% is reported in tests conducted in nine farmer fields in the Laguna Province of the Philippines. These machines are now being further evaluated by the International Rice Research Institute in the Philippines and other Asian rice producing countries. The authors conclude that these applicators, have opened possibilities for substantial savings of fertilizer and increases in rice yields in Asia.

APPLICATORS FOR IMPROVED FERTILIZER USE EFFICIENCIES IN WETLAND PADDIES

By

A.U. Khan, L.C. Kiamco, V.M. Tiangco, I.R. Camacho*
M.S. Diestro & E.U. Bautista

INTRODUCTION

Because of the excessive loss of nitrogen, farmers in Asia have not been able to make more effective use of fertilizer to boost their rice yields. As early as 1941, Shioiri in Japan explained the mechanics of loss of surface applied ammonia in flooded soils and recommended the deep placement of ammonium fertilizers. A number of field experiments were conducted in Japan from 1941 to 1952 which indicated that deep placement of fertilizer increase rough rice yields by an average of 10% (Mitsui, 1955).

Many studies at IRRI and other institutions have consistently demonstrated that fertilizer use efficiencies in wetland rice production could be almost doubled by placing fertilizer in the reduced soil layer at depths ranging from 5 to 15 cm. In spite of over forty years of efforts however, it has not been possible to transfer these important research findings to the farm level.

**Agricultural Engineer and Research Assistants respectively, Agricultural Engineering Dept., The International Rice Research Institute, Los Baños, Laguna, Philippines.*

Prilled urea is the most popular fertilizer material used for rice production in Asia. Over the last few decades, an unusually large number of deep placement applicators have been developed for prilled urea in Japan, China and at IRRI. The performance of these machines have not been consistent at the field level. This had led to the belief that prilled urea was not a suitable fertilizer material for deep placement. Consequently, urea briquettes and urea supergranules (USG) have been specially developed for deep placement, however these materials are more expensive and still difficult to deep place.

During the later part of 1982, a special engineering team was organized at IRRI, with the primary focus on the development of deep placement applicators for prilled urea and urea supergranules. As an initial step, a review of deep placement applicator developments worldwide was undertaken. A series of laboratory experiments were conducted to gain a better understanding of the reasons for the lack of success of the numerous deep placement applicators that were developed earlier. This led to the significant conclusions that the earlier applicators were not properly placing fertilizer in the soil as a large part of the fertilizer was being transferred to the floodwater during the placement operation. A systematic effort was then made to define precisely the specifications of the kind of deep placement applicators that would be acceptable to small farmers in Asia. This led to the development of a set of prioretized criteria for technical and commercial acceptability of applicators (Khan, September 1982). Efforts were then made to separately optimize the designs of the three major applicator components; the fertilizer metering, conveying and furrow closing mechanisms in the IRRI Agricultural Engineering laboratory.

Twenty new deep placement applicator concepts were then developed (Khan, November 1982) out of which six were finally chosen for intensive design and development. These concepts led to the eventual development of three injector type applicators which have shown good performance during the 1983 wet season. These applicators, two for prilled urea and one for USG, were designed with the objective of minimizing N transfer to floodwater. A brief discussion of the research on N transfer to floodwater during placement, which served as the basic foundation for the successful development of the three applicators, is given below.

Mechanics of N Transfer to Floodwater

Fertilizer use efficiencies in upland farming have been reported to be 50 to 60% (Craswell & Velk, 1979) when those obtained under wetland farming conditions are generally 30 to 50% (Prasad & De Datta, 1979). The reasons of this wide difference in fertilizer use efficiencies have not been well understood. Experiments conducted in Pakistan (Ross, 1980) report a 60% recovery of applied nitrogen by rice crop when fertilizer was incorporated in a dry condition and followed by flooding. On the basis of this study it was concluded that flooding, after the fertilizer has been incorporated, was not the cause for reducing fertilizer use efficiencies in wetland farming.

Since fertilizer use efficiencies under unflooded upland farming conditions are quite high, it was hypothesized that the low fertilizer use efficiencies under wetland farming were perhaps due to the presence of water at the time the fertilizer was being applied. This hypothesis led to a laboratory study (Khan et al, 1983) in the IRRI Agricultural Engineering Department to evaluate the four different avenues (Fig. 1) of N transfer to floodwater during deep placement. The methodology used to isolate the different channels of N transfer to floodwater during deep placement is illustrated in Fig. 2 a&b. The main findings of this study were:

a) Dissolution of fertilizer during transit from the water surface to the furrow bottom was the major channel for N transfer to floodwater (Fig. 3 - 53-75%); b) Fertilizer placement in deeper furrows results in much higher N transfer to floodwater than placement at shallower depths (Fig. 4). This can be explained by the high degree of N transfer due to longer transit through floodwater at deeper placement depths; c) The second most important channel for N transfer to floodwater was the upward movement of fertilizer solution and granules from the furrow bottom to the floodwater during the furrow closing operation (up to 20%); d) N transfer due to poorly sealed furrows or due to diffusion through puddled soils was relatively small; e) The first two transfer avenues were found to

77

be so significant that in some cases N transfer to floodwater during deep placement was almost equal to that of broadcast surfac application in flooded fields.

Experiments with embedding of prilled, forestry grade and supergranular urea fertilizer in Maahas clay at 2.5 cm and 5 cm depth (Fig. 5) indicated that a placement depth of 4-5 cm was more than adequate to minimize N transfer to floodwater with all the three fertilizer materials. It has been generally believed that placement at greater depth was necessary for improving fertilizer use efficiencies in wetland cultivation and hence 5-20 cm placement depths have often been recommended. These experiments however indicated that maintaining a 4-5 cm thick soil barrier, between the deposited fertilizer and floodwater, is sufficiently effective for minimizing N transfer to floodwater rather than placement at greater depths.

It was concluded from these studies that a) Floodwater plays a major role in reducing fertilizer use efficiencies in wetland paddy cultivation; b) The practice of depositing fertilizer in open flooded furrows followed by furrow closing was not a suitable method for deep placement as almost 80 to 90% of the fertilizer was not deposited in the soil but was transferred to floodwater.
c) Minimizing fertilizer-water-contact, during all the three phases of fertilizer application (transit, placement and covering), and maintenance of an adequate soil barrier between the deposited fertilizer and floodwater would be an effective approach for minimizing fertilizer loss in flooded paddies.

These conclusions led to the development of a fertilizer injecting concept (Fig. 6) in which fertilizer is placed in flooded soils without contacting the floodwater and is subsequently sealed with a soil layer to minimize subsequent N transfer to floodwater. This general concept of minimizing N transfer to floodwater was followed in the development of the three following applicators:

1) Spring Auger Applicator for prilled urea (Fig. 7)
2) Oscillating Plunger Applicator for prilled urea (Fig. 8)
3) Press-wedge Applicator for USG (Fig. 9)

The three machines can inject prilled urea or USG fertilizer in between paddy rows under flooded field conditions without permitting any contact between floodwater and fertilizer. All the three machines have demonstrated consistent good performance during the last cropping season at IRRI and in farmer fields in the Philippines (Khan et al, June 1983). A brief description of each machine follows:

1) <u>Spring Auger Applicator for Prilled Urea</u>

This machine (Figs. 10 & 11) has been designed as a lightweight unit to minimize pushing force and to facilitate operation. The machine is a two-row, push-type, band placement machine which can be used for deep placement of prilled urea at 4-5 cm depth. Metering and placement are performed by spring augers housed in fertilizer delivery tubes. The fertilizer delivery tubes are connected to fertilizer hoppers at their upper end and extend below the skid for delivering fertilizer 4-5 cm deep in soil without contacting the floodwater.

Wire agitators are installed in each hopper to permit smooth flow of fertilizer into the delivery tube. A V-shaped furrow opener is installed under the skid and ahead of the auger tube to open a small furrow for deposition of fertilizer. A single soil deflecting blade and press plate is installed at the rear of the fertilizer delivery opening under the skid to close the furrow and seal the fertilizer in the soil.

2) Oscillating Plunger Applicator for Prilled Urea

This two-row band placement applicator (Figs. 12 & 13) has been designed as a lightweight machine to minimize operational pushing force. The machine has two ground driven oscillating stainless steel plungers which pick prilled urea fertilizer from hoppers and feed it through narrow 16mm diameter steel tubes into the soil for placement at 4 to 5 cm depth. The machine can be used for applying prilled fertilizer in fields with up to 5 cm floodwater.

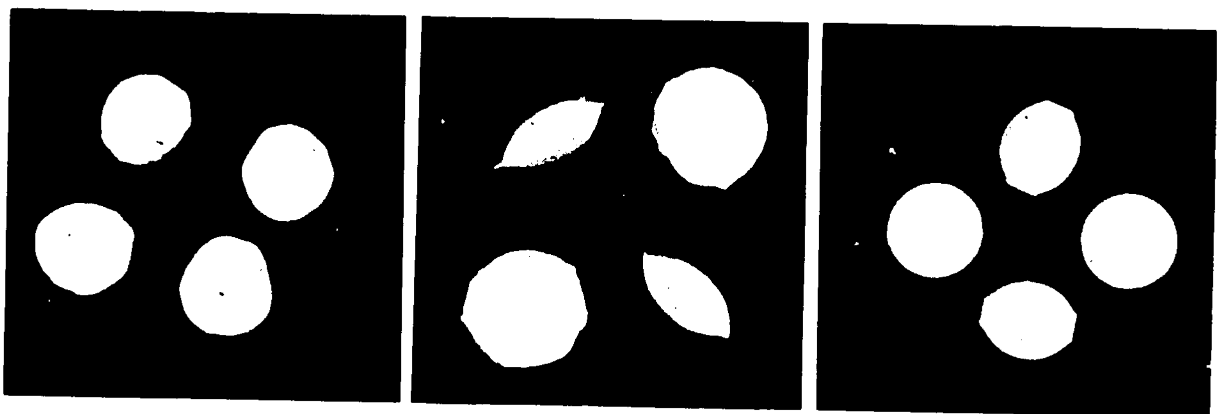
Conveying of fertilizer through narrow tubes of less than 20mm diameter with a plunger is difficult as prilled fertilizer has low crushing strength. With ordinary plungers, prilled urea crushes and forms a pellet which plugs the tubes. This machine uses a special plunger design which provides agitation in the full length of the fertilizer tubes thus eliminating any pressure points in the tube. With the oscillating plunger, fertilizer is conveyed in an agitated state in the full length of the tube.

Agitation in the hopper is provided with a wire agitator which ensures smooth flow of fertilizer to feed the plunger intake opening.

As the machine moves on the soil surface, the skids push floodwater away from the soil surface. Narrow V-shaped furrow openers are installed under the skid to open small furrows in which fertilizer is deposited from the plunger tube and is then instantly closed and sealed in the soils by the two staggered furrow closures. The smooth trailing end of the skids further compresses the soil surface and help to seal the fertilizer.

3) Press-wedge Applicator for USG

Because of the past problems of deep placing prilled urea under flooded field conditions, urea supergranules (USG) and briquettes (shown below) have been developed by fertilizer companies. Briquettes and USG are generally spherical in shape and weigh about 1 gram each. This two-row machine is designed for application of such granules or briquettes under flooded field conditions.



a) Urea supergranules (USG) b) Briquettes (China) c) Briquettes (India)

This machine has two hoppers with cup-type mechanisms (Fig. 14 & 15) to meter USG or briquettes. It has 76mm wide skids with fertilizer delivery holes. Two 4 cm deep furrow openers are mounted under the skids just ahead of the fertilizer holes. Two inclined press-wedges, are installed under the skids, on the trailing side of the holes. The press-wedges are inclined 10° with the horizontal skid such that the upper ends of the wedges start next to the trailing end of the holes. Metered granules are delivered through the holes to the furrows. As the machine moves forward, the wedges push the granules further into the furrow to the desired 4-5 cm depth. Two staggered furrow closures are installed at the trailing end of each wedge, to push some soil back into the furrow for covering the deposited fertilizer. The trailing smooth undersides of the skids further compresses and smoothens the soil which helps to better seal the placement openings.

Comparative Performance of Applicators

During the design and development phase, all machines must undergo repeated design improvements and evaluation. In the past, performance of deep placement applicators have been generally evaluated through yield experiments. This required a five to six months cycle time, between design improvements and evaluation, thereby seriously slowing the applicator development process. The level of total nitrogen concentration in floodwater, after the fertilizer has been applied, is generally related to fertilizer volatilization losses. It was felt that measurement of floodwater N level, after placement of fertilizer, could be used to assess a machine's performance. This technique was successfully used for preliminary evaluation of all applicator improvements at IRRI which substantially accelerated the applicator development process.

During the last cropping season, these machines were extensively tested by various IRRI departments in the Philippines. In yield tests conducted by the IRRI Agronomy Department in the 1983 wet season all the three machines demonstrated highly satisfactory performance (Table 1). It is interesting to note that the two prilled urea machines gave somewhat better performance than manual and machine placement of USG. The performance of all the three machines were comparable or better than research's and farmers' split.

The results of ten farmer trials conducted by the IRRI Training and Technology Transfer Dept. in Cagayan Province of the Philippines are given in Table 2. These trials were conducted on plots of 500 sq.m size. The applicators performed well with yields ranging from 4.17 to 5.778 tons/ha.

In all nine farmer trials conducted by the Agricultural Engineering Department (Tables 3a & 3b), a single application by any of the three machines substantially increased fertilizer use efficiencies when compared to farmers' traditional practice of split application. The average increase in fertilizer use efficiencies for the three machines on clayey soils at the nine farm locations in Laguna were as follows:

1)	Straight Auger Applicator	Prill	49.82%
2)	Oscillating Plunger Applicator	Prill	44.49%
3)	Press-wedge Applicator	USG	51.29%

The three new machines are simple in design and offer good possibilities for commercial introduction in Asia. These machines require simple production facilities and can be marketed in most developing countries at a price of about US$50 to $60. Two manufacturers have initiated limited production run of these applicators on specific orders from IRRI and the Government of the Philippines.

Extensive evaluation of these applicators in the Philippines and other Asian rice-producing countries is now continuing during the current dry season. It is hoped that by mid-1984, the three applicators would have been sufficiently evaluated under different soil and water conditions. If these machines are found to be satisfactory, these would be released to manufacturers for commercial production in the Philippines and other Asian rice producing countries.

CONCLUSION

The study concludes that the two main channels for N transfer to floodwater during fertilizer placement are a) Fertilizer dissolution during transit through floodwater (53-75%); b) Transfer due to movement of fertilizer solution from the furrow to floodwater during the closing operation (up to 20%).

It seems that the role of floodwater in reducing fertilizer use efficiencies has not been fully recognized in the past. This issue was probably not well looked into, as deeper placement was generally believed to be the effective approach for improving fertilizer use efficiencies. While deep placement in close proximity to rootzone has been widely recognized as a good approach for improving fertilizer use efficiencies in upland crops. This practice may not be as effective for flooded condition as N transfer to floodwater plays a major role in reducing fertilizer use efficiencies. Conveying of fertilizer without permitting dissolution in floodwater and covering of the deposited fertilizer with an adequate soil barrier (3-5 cm in Maahas Clay) seems a more effective approach than deeper placement.

The development of three new applicators which can continuously inject fertilizer in flooded soil is reported. These applicators minimize fertilizer-water-contact during the three phases of fertilizer application, (transit, placement and closing) and effectively seal the deposited fertilizer below a 4-5 cm soil barrier for improving fertilizer use efficiencies in wetland farming. These applicators have exhibited promising performance during the last paddy season and are now being further evaluated in the Philippines and other Asian countries.

REFERENCES

CRASWELL, E.T. & P.L.G VELK. 1979. "Fate of fertilizer nitrogen applied to wetland rice." Nitrogen & Rice, IRRI, Los Baños Laguna, Philippines

KHAN, A.U. 1983. "New deep placement applicators for minimum N transfer to floodwater." IRRI Thursday Seminar. June 23.

KHAN, A.U., L.C. KIAMCO & V.M. TIANGCO. 1983. "Fertilizer transfer to floodwater during deep placement." IRRI Research Paper Series No. 96. October.

KHAN, A.U. 1982. "Some concepts and issues for deep placement fertilizer applicators." Paper for internal circulation at IRRI. September.

MAHMOOD, Z., L.C. KIAMCO & A.U. KHAN. 1983. "Further studies on mechanics of fertilizer transfer to floodwater during deep placement." Special Problems in Agricultural Engineering, University of the Philippines at Los Baños, Summer.

PRASAD, R. & S.K. DE DATTA. 1979. "Increasing fertilizer nitrogen efficiency in wetland rice." Nitrogen & Rice, IRRI, Los Baños, Laguna, Philippines.

ROSS, V.E. 1980. Final Report of the Collaborative Rice Research Project between PARC, Govt. of Pakistan and IRRI-Philippines.

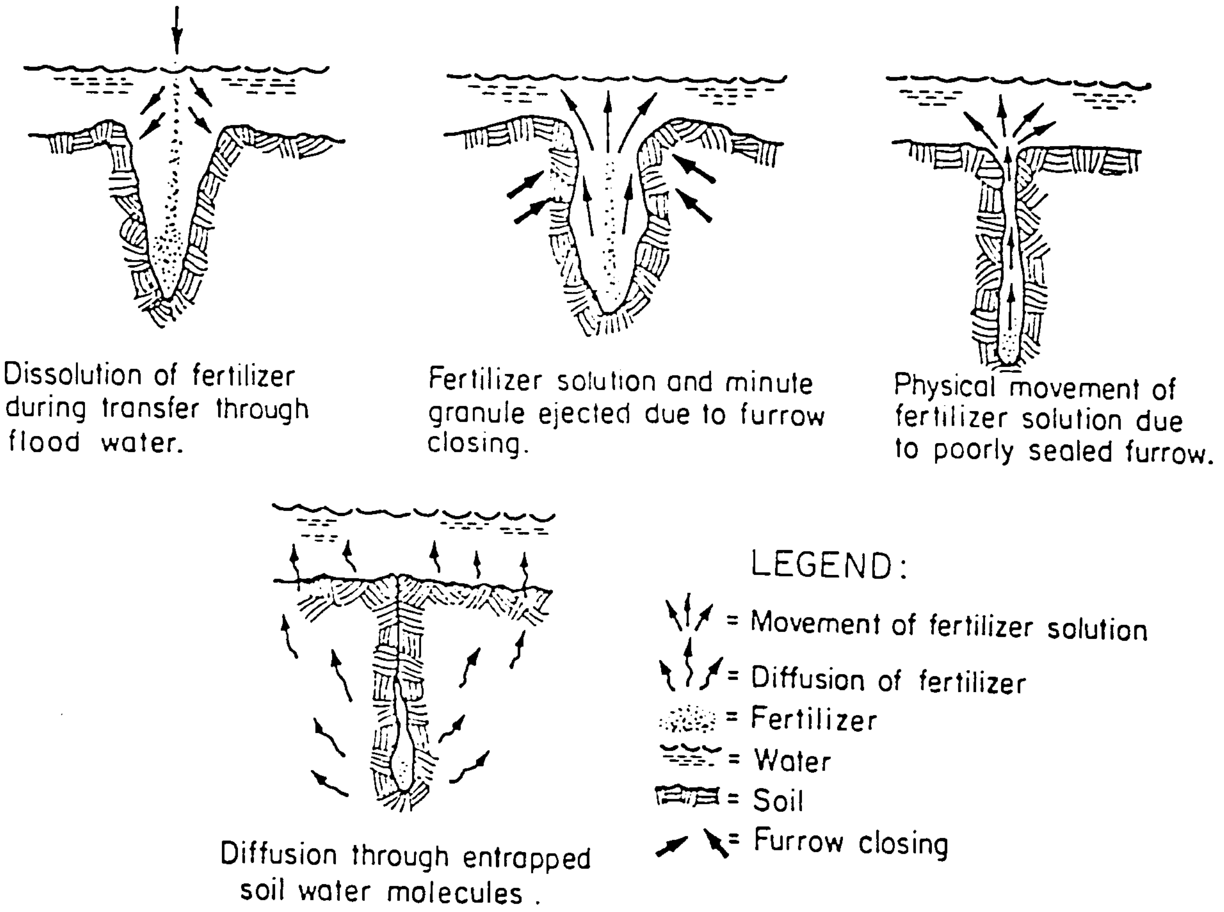
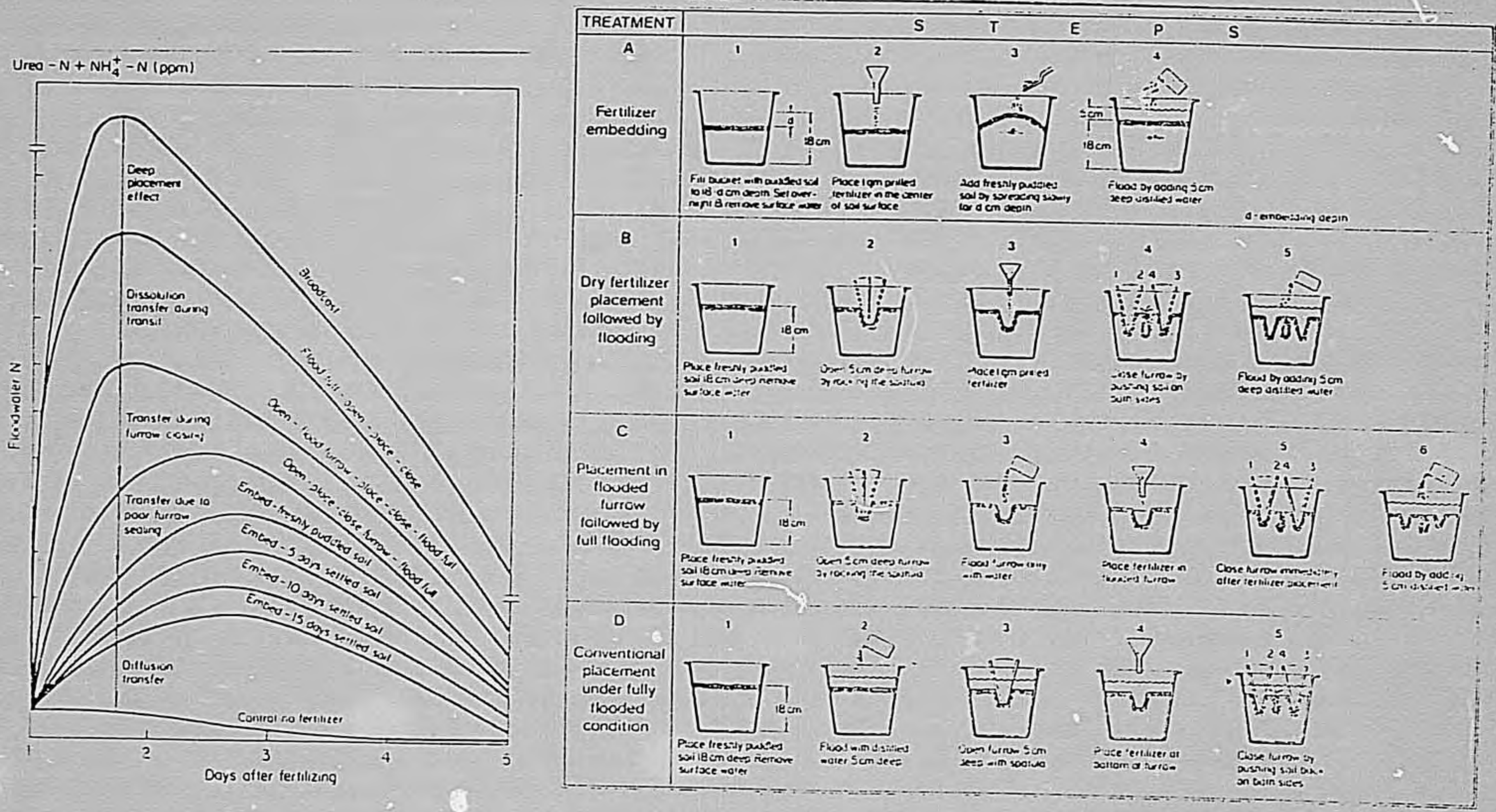


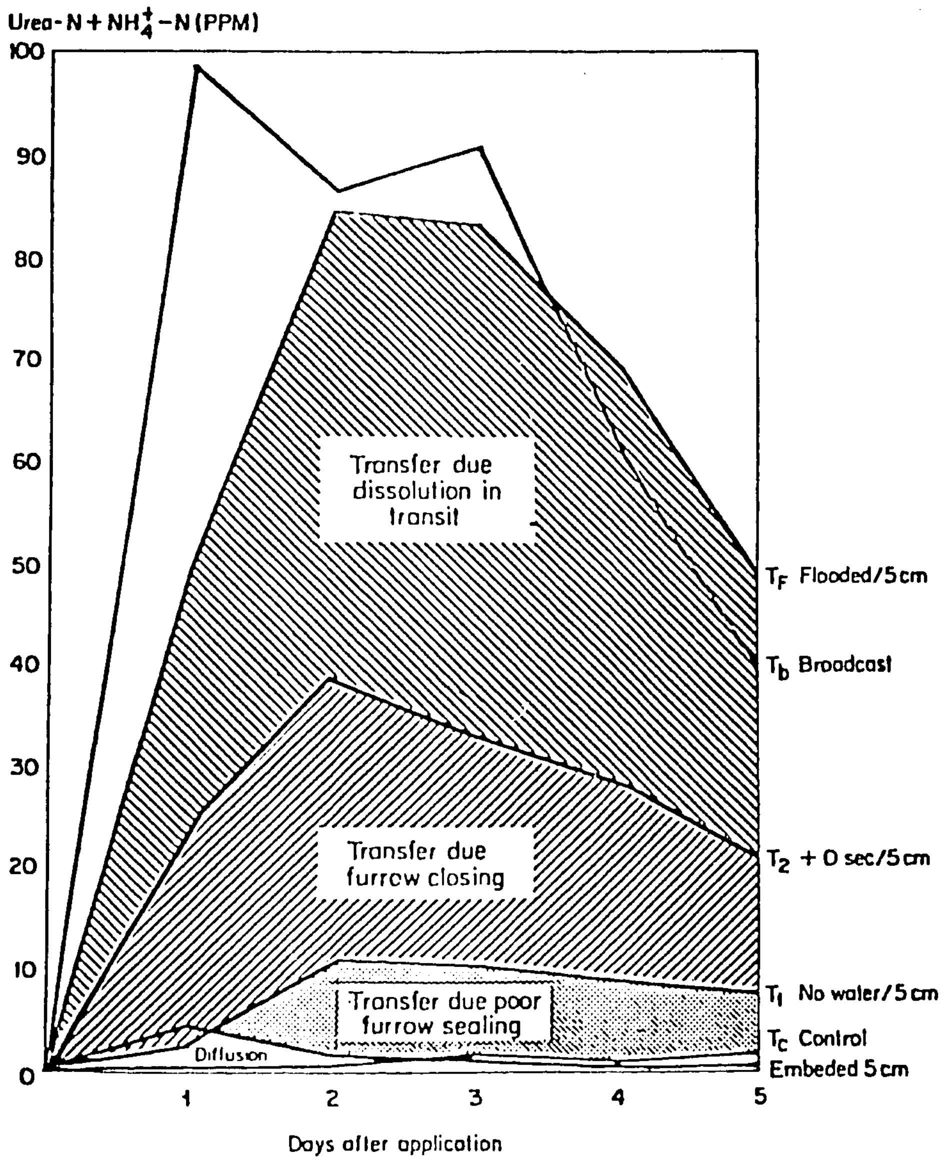
Fig 1. Avenues for fertilizer transfer to floodwater during deep placement .



(a)

(b)

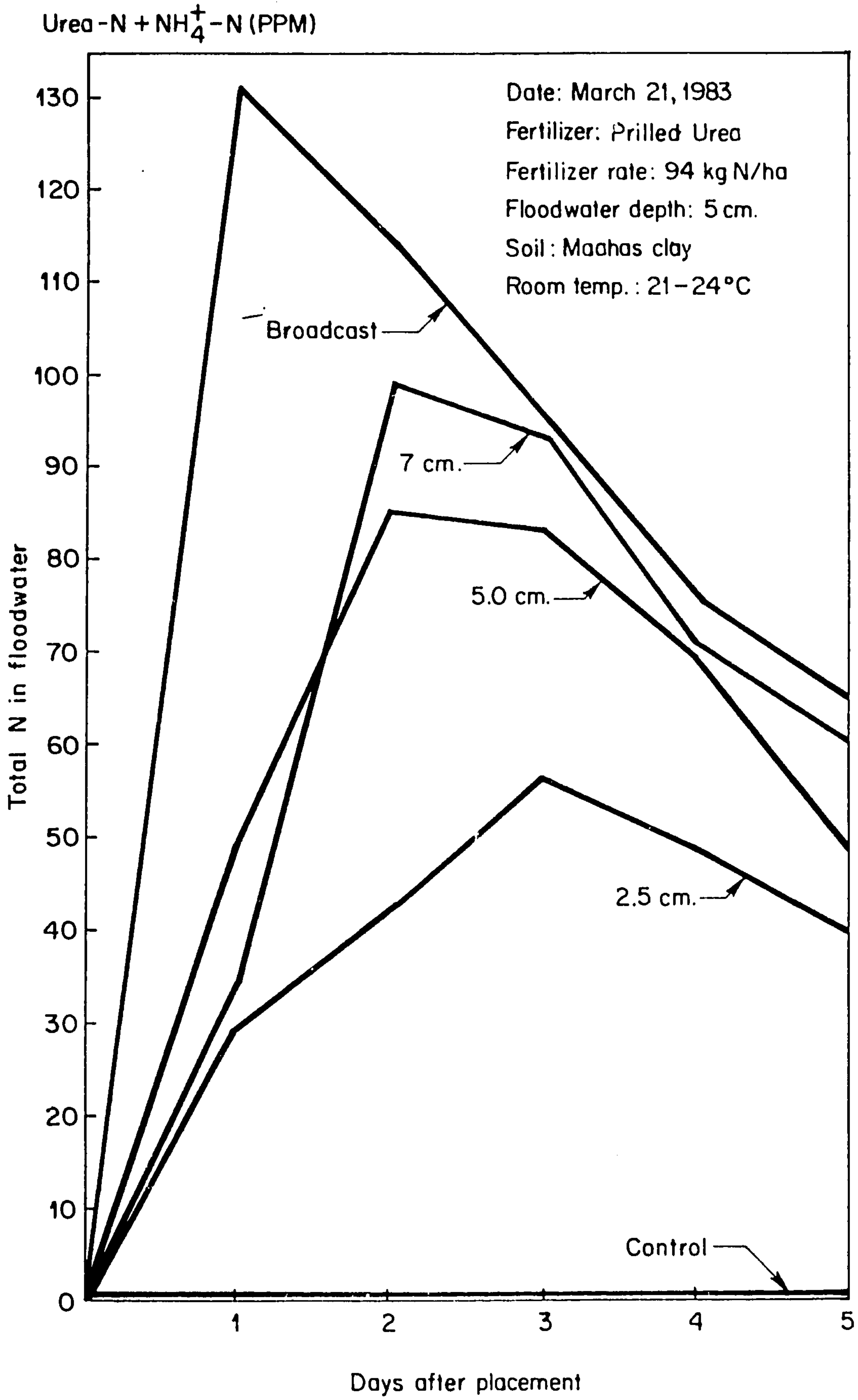
Fig. 2 a) Hypothetical curves showing possible avenues; b) Experimental techniques for evaluating fertilizer transfer to floodwater during placement.



Major avenues for N transfer to floodwater during prilled fertilizer placement at 5 cm depth in flooded Maahas clay.

Fig. 3

98



N transfer to floodwater with prilled urea fertilizer placement at 2.5, 5, and 7 cm. depths in flooded open furrows followed by furrow closing.

Fig. 4

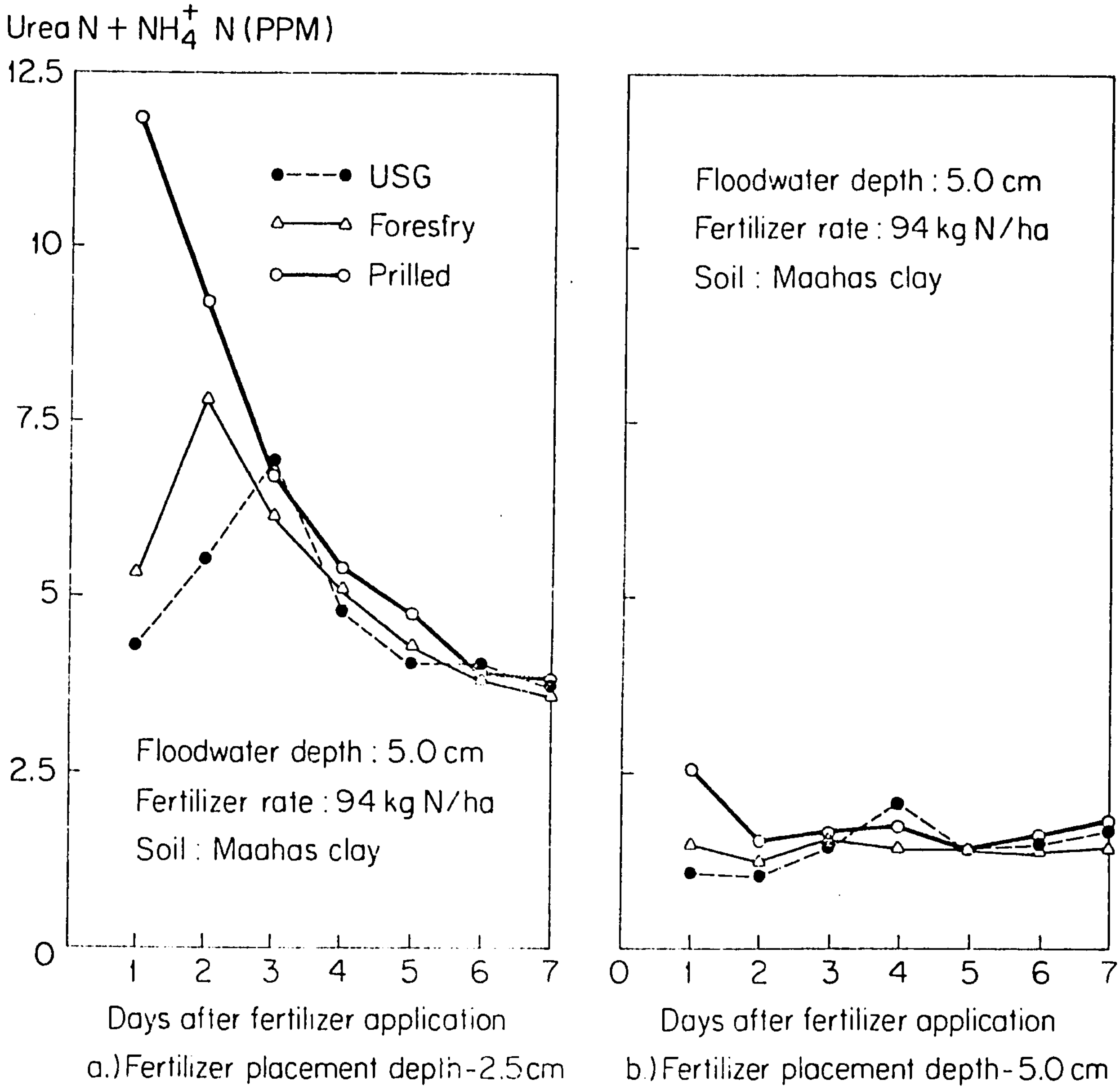
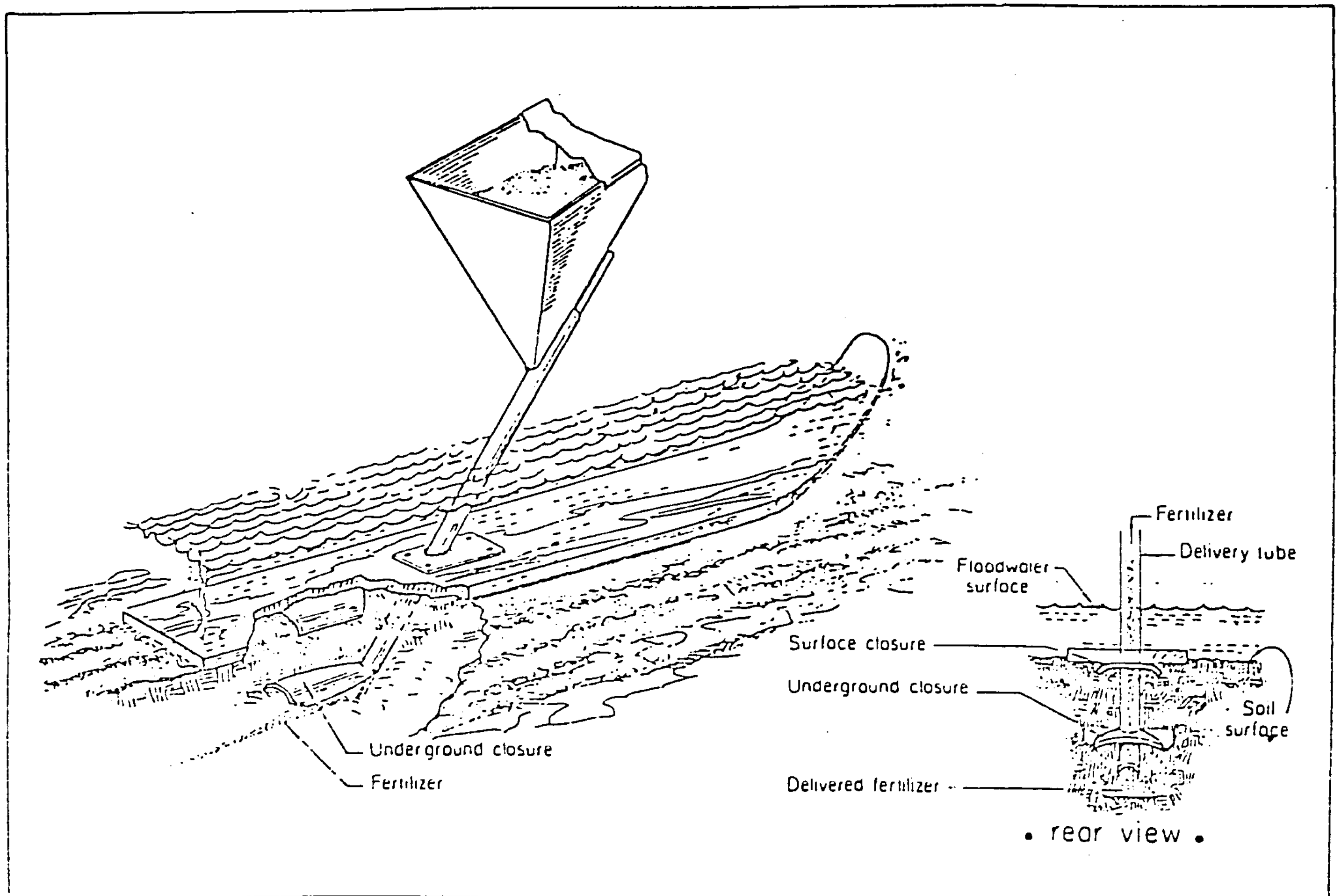


Fig. 5. N transfer to floodwater when urea fertilizer is embedded at 2.5 and 5.0 cm depth in freshly puddled Maahas clay.



CONTINUOUS FERTILIZER INJECTION WITH UNDERGROUND CLOSURE FOR MINIMIZING 'N' TRANSFER TO FLOODWATER DURING DEEP PLACEMENT.	Design Concept .... AUK Drawn by : .... FCJ Date .... 5 APRIL 1983

Fig. 6

Fig. 7 Straight auger applicator for prilled urea.

Fig. 8 Oscillating plunger applicator for prilled urea.

Fig. 9 Press-wedge applicator for urea supergranules (USG).

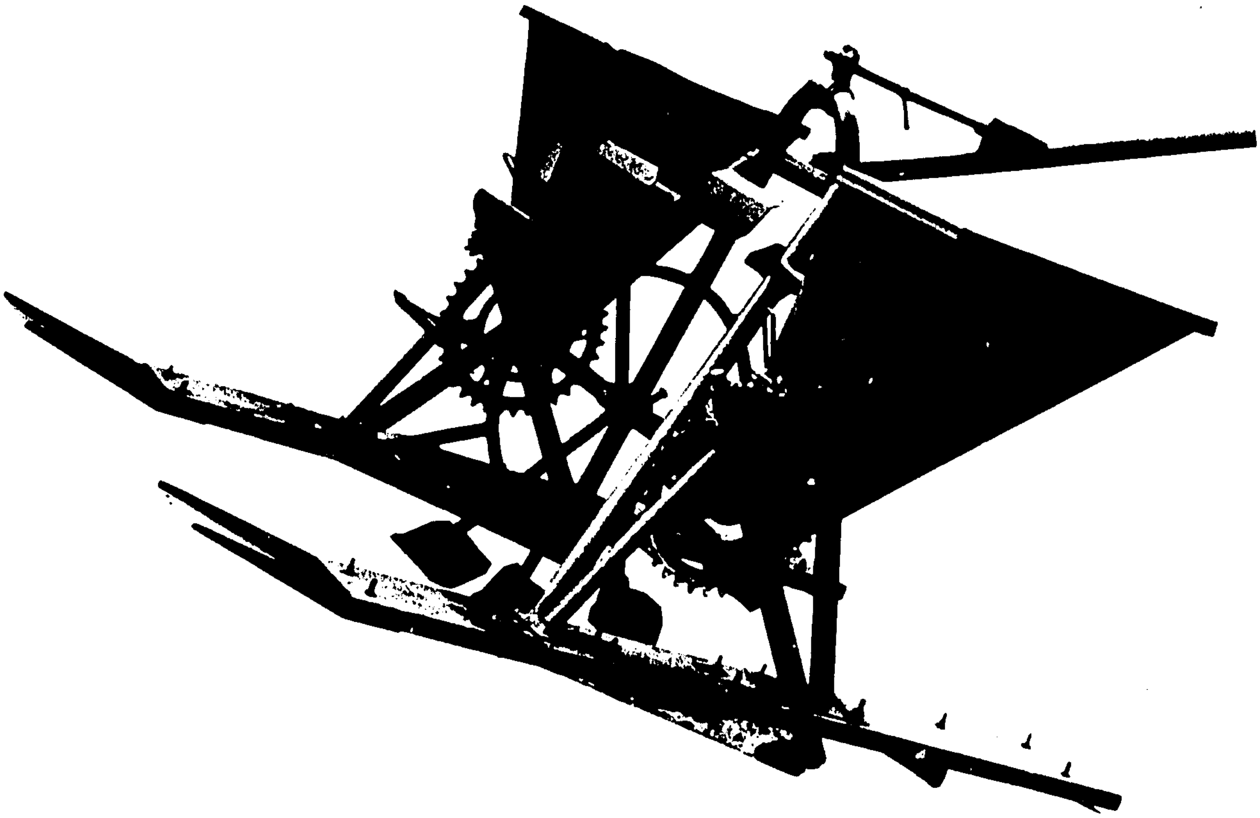


Fig. 10

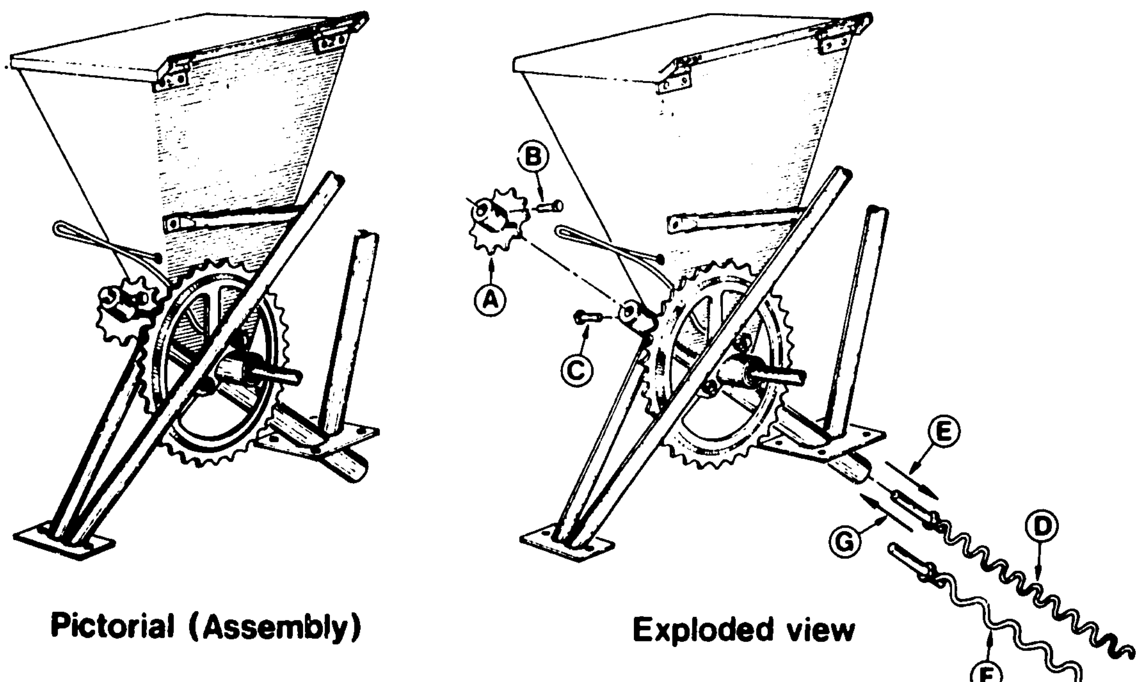


Fig. 11

95

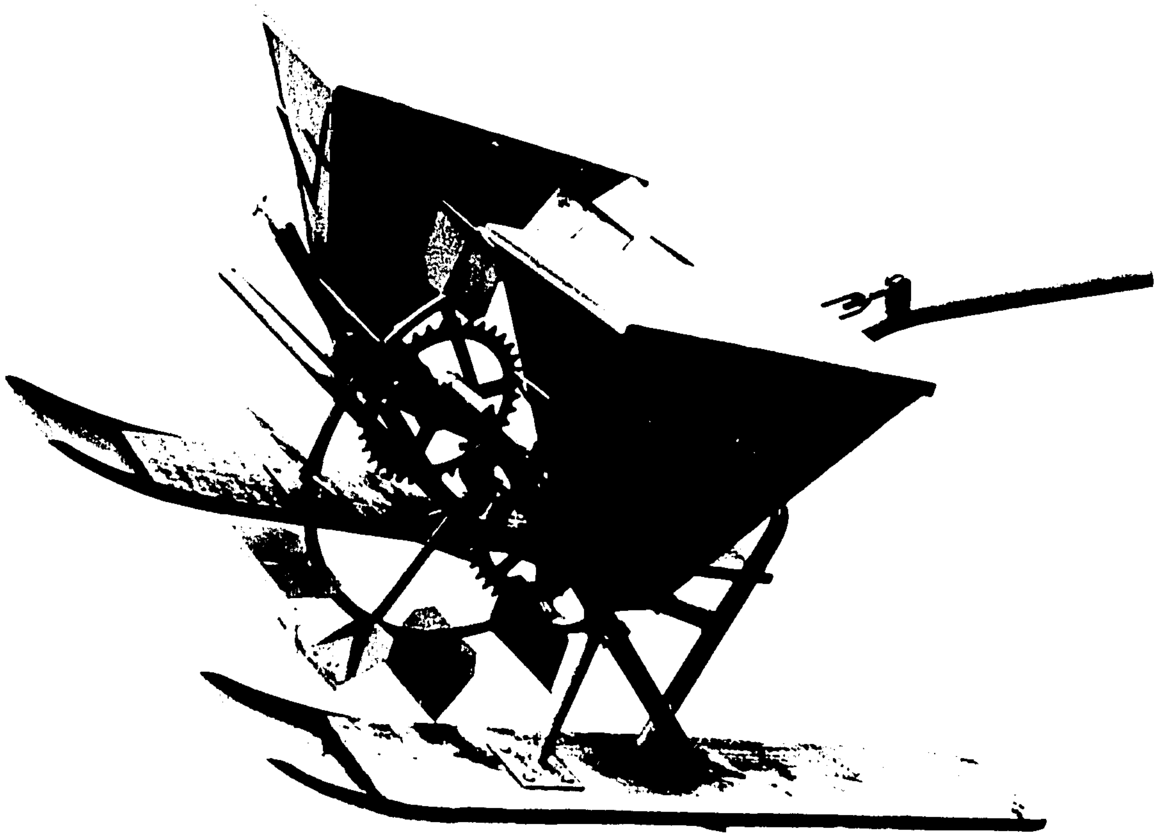


Fig. 12

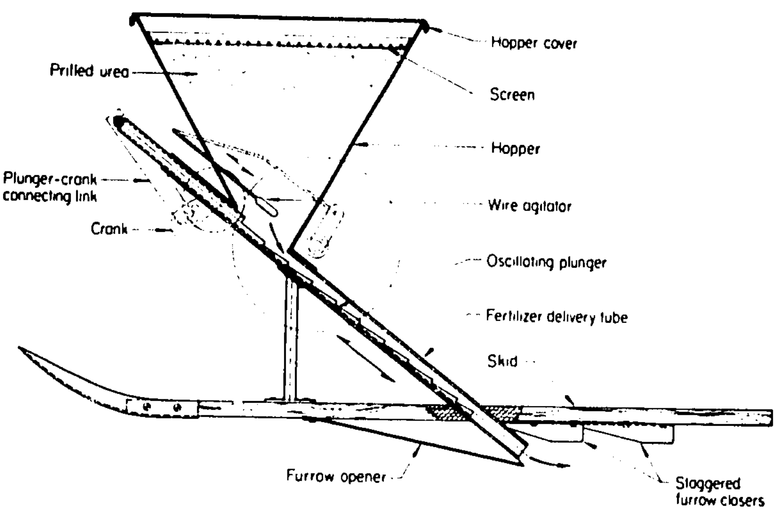


Fig 2 Schematic diagram of oscillating plunger prilled urea applicator

Fig. 13

96

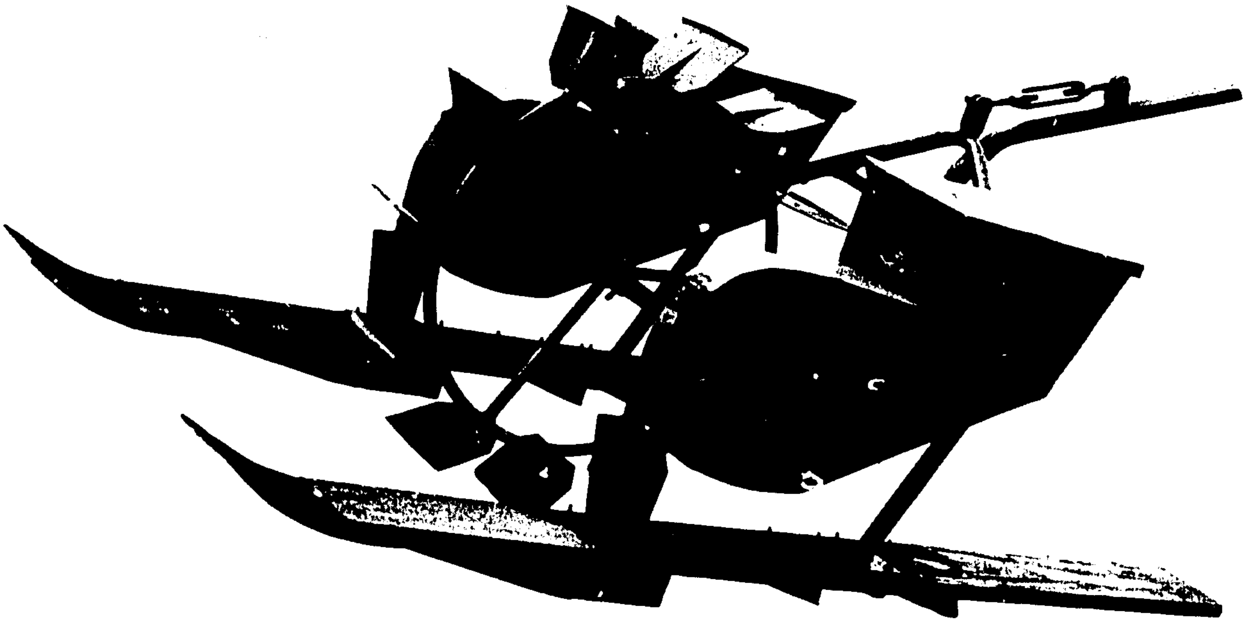


Fig. 14

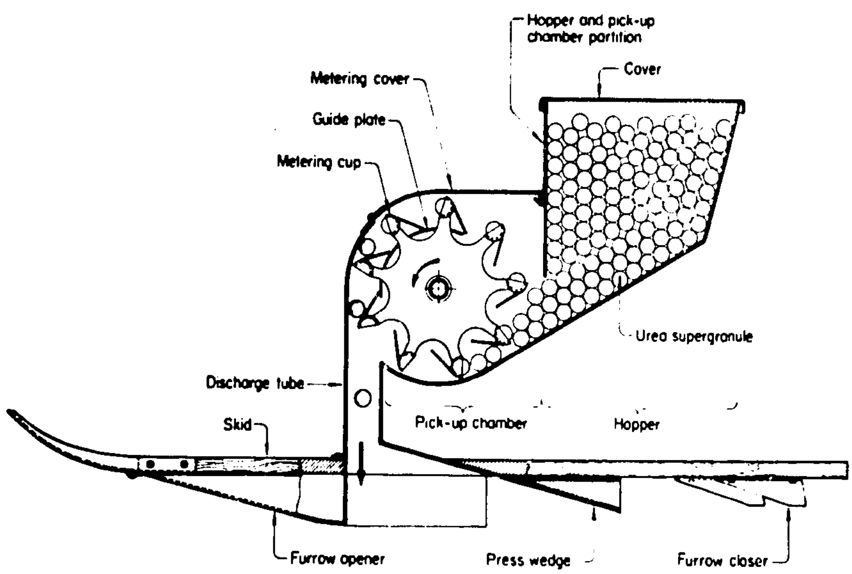


Fig. 3. Schematic diagram of the press wedge applicator.

Fig. 15

1983 Wet Season

Cooperators Test, IRRI Agronomy and Ag. Engineering Depts.

Urea source	Application method	Nitrogen applied (kg N/ha)	Water depth during basal fert. appln. (cm)	Grain yield (t/ha)
	No fertilizer nitrogen	0	-	2.9 c
Prilled	Band placement by spring auger	56	4.6	4.7 ab
Prilled	Band placement by oscillating plunger	58	4.8	5.1 a
Supergranule	Point placement by deep plunger	58	4.9	4.4 ab
Supergranule	Point placement by press wedge	46	5.1	4.3 b
Supergranule	Point placement by hand	58	5.3	4.6 ab
Prilled	Researchers' split	58	5.0	4.2 b
Prilled	Farmers'	58	5.0	4.3 b

[a] 10 DT and 10 days after PI

Effect of nitrogen on IR58 grain yields with different manual and machine placement techniques.

Table 1

1983 Wet Season

Cooperative Farmer Trials, IRRI Training & Technology Transfer and Ag. Engineering Depts.

TREATMENT	COOPERATING FARMER #1 kg N/ha	#1 t/ha	#2 kg N/ha	#2 t/ha	#3 kg N/ha	#3 t/ha	#4 kg N/ha	#4 t/ha	#5 kg N/ha	#5 t/ha	Mean
Prilled urea											
Spring auger	108	4.33	109	4.48	89	4.60	86	4.17	101	5.42	4.60 a
Oscillating plunger	59	4.85	85	4.33	68	4.34	82	4.56	74	5.65	4.75 a
	# 6		# 7		# 8		# 9		# 10		
USG											
Press wedge	52	4.15	57	4.51	54	5.44	58	4.60	57	5.50	4.84 a
Deep plunger	71	4.64	66	4.09	69	5.12	73	5.54	65	5.78	5.03 a
CV (%)											7.9

[a] Means followed by the same letter are not significantly different at 5% level by Duncan's Multiple Range Test.

Effect of nitrogen on IR36 grain yields with four deep placement machines in farmers field trials, Cagayan.

Table 2

1983 WET SEASON

IRRI AG. ENG'G DEPARTMENT

DEEP PLACEMENT FERTILIZER APPLICATOR TRIALS[1] IN FARMERS' FIELDS
CALAMBA & CALAUAN, LAGUNA - 1983 WET SEASON
IRRI AGRICULTURAL ENGINEERING DEPT.
NOVEMBER 1983

No.	Farmer-Cooperator Name & Address	Variety	Application Method[2]	Fertilizer		Projected Yield[3] Tons/ha	Fertilizer Efficiency[4]	
				Material	Rate Kg N/ha		Kg Rough Rice/kg N	% Change Over Control
1	Mr. V. Oruga, Bo. Mabacan, Calauan, Laguna	Sinang-Uomeng (HYV)	Farmer Practice (no machine - control)	Prill	90	4.87	54.11	-
			Spring Auger	Prill	47	4.42	94.04	+ 73.79
			Oscillating Plunger	Prill	48	3.95	68.10	+ 25.85
			Press-wedge	USG	48	3.82	79.58	+ 47.07
2	Mr. P. Macatangay, Bo. Mabacan, Calauan, Laguna	Sinang-Domeng (HYV)	Farmer Practice (no machine - control)	Prill	78	4.98	63.85	-
			Spring Auger	Prill	55	5.03	91.45	+ 43.22
			Oscillating Plunger	Prill	58	5.17	89.14	+ 39.61
			Press-wedge	USG	48	5.03	109.79	+ 64.12
3	Mr. J. Espinili, Bo. Mabacan, Calauan, Laguna	Sinang-Domeng (HYV)	Farmer Practice (no machine - control)	Prill	78	6.87	88.08	-
			Spring Auger	Prill	42	5.46	130	+ 47.59
			Oscillating Plunger	Prill	41	5.01	122.20	+ 38.74
			Press-wedge	USG	42	5.01	119.28	+ 35.42
4	Mr. S. Ilagan, Bo. Mabacan, Calauan, Laguna	IR-42	Farmer Practice (no machine - control)	Prill	78	4.76	61.02	-
		C-4	Spring Auger	Prill	52	3.42	65.77	+ 7.98
		IR-42	Oscillating Plunger	Prill	39	4.42	113.33	+ 85.73
		IR-42	Press-wedge	USG	41	4.30	104.88	+ 71.88
5	Mr. C. Pabro, Bo. Mabacan, Calauan, Laguna	IR-42	Farmer Practice (no machine - control)	Prill	80	4.28	53.5	-
			Spring Auger	Prill	66	4.92	75.54	+ 39.33
			Oscillating Plunger	Prill	58	4.03	69.48	+ 29.87
			Press-wedge	USG	45	4.06	90.22	+ 68.64
6	Mr. R. Vergara, Bo. Mabacan, Calauan, Laguna	IR-42	Farmer Practice (no machine - control)	Prill	78	4.66	59.74	-
			Spring Auger	Prill	47	4.28	91.06	+ 52.43
			Oscillating Plunger	Prill	50	4.20	84.00	+ 40.61
			Press-wedge	USG	44	4.38	99.54	+ 66.62
7	Mr. L. Casubha, Bo. Parian, Calamba, Laguna	IR-42	Farmer Practice (no machine - control)	Prill	67	5.47	81.64	-
			Spring Auger	Prill	40	5.19	129.75	+ 58.93
			Oscillating Plunger	Prill	53	5.03	94.91	+ 16.25
			Press-wedge	USG	51	4.58	89.80	+ 10.00
8	Mr. R. Isip, Bo. Parian, Calamba, Laguna	IR-42	Farmer Practice (no machine - control)	Prill	78	5.74	73.59	-
			Spring Auger	Prill	40	5.25	131.25	+ 78.35
			Oscillating plunger	Prill	46	5.21	113.26	+ 53.91
			Press-wedge	USG	47	5.37	114.26	+ 55.26
9	Mr. C. Oleta, Bo. Parian, Calamba, Laguna	IR-42	Farmer Practice (no machine - control)	Prill	68	5.71	69.26	-
			Spring Auger	Prill	45	4.58	101.78	+ 46.95
			Oscillating Plunger	Prill	47	5.53	117.66	+ 69.88
			Press-wedge	USG	48	4.74	98.75	+ 42.58

[1] Except for application methods & fertilizer rates each farmer applied his own traditional cultural practices on all of 4 treatments.

[2] With machine applications, all fertilizer was applied as a single dose at 10 to 18 days after transplanting. Farmer practice varied but generally included 2 to 3 split broadcast applications.

[3] Based on 4 sampling sites (projected value at 14% m.c.).

[4] For lack of better methods of assessment, fertilizer efficiencies at different fertilizer rates have been compared.

Table 3a

100

1983 WET SEASON

FARM TRIAL IRRI AG. ENG'G DEPT.

SUMMARY RESULTS OF INCREASES IN FERTILIZER USE EFFICIENCIES[1/] WITH DEEP PLACMENT APPLICATORS ON NINE COOPERATING FARMERS IN LAGUNA, PHILIPPINES

IRRI Agricultural Engineering Department
November 1983

		Percent Increase Over Farmer Split Broadcast Practice		
		Straight Auger Applicator Prill	Oscillating Plunger Applicator Prill	Press-Wedge Applicator USG
1	Mr. V. Oruga Bo. Mabacan Calauan, Laguna	73.79[2/]	25.85[2/]	47.07[2/]
2	Mr. P. Macatangay Bo. Mabacan Calauan, Laguna	43.22	39.61	64.12
3	Mr. J. Espinili Bo. Mabacan Calauan, Laguna	47.59	38.74	35.42
4	Mr. S. Ilagan Bo. Mabacan Calauan, Laguna	7.98[3/]	85.73	71.88
5	Mr. C. Pabro Bo. Mabacan Calauan, Laguna	39.33[4/]	29.87[4/]	68.64
6	Mr. R. Vergara Bo. Mabacan Calauan, Laguna	52.43[4/]	40.61[4/]	66.62[4/]
7	Mr. L. Casubha Bo. Parian Calamba, Laguna	59.93[4/]	16.25	10.00
8	Mr. R. Isip Bo. Parian Calamba, Laguna	78.35	53.91	55.26
9	Mr. C. Oleta Bo. Parian Calamba, Laguna	46.95	69.88	42.58
Average Increase		49.82	44.49	51.29

[1/] Due to lack of better methods for comparative assessment, efficiencies at different fertilizer rates have been compared.

[2/] Plots were affected by stemborer infestation.

[3/] C-4 variety was used with this machine only & the crop lodged.

[4/] Deep-placed plots recovered from field submergence of 2 to 3 days during typhoon.

Table 3b

Deep Placement Fertilizer Applicators for Improved Fertilizer Use Efficiency

by
Amir U. Khan
Agricultural Engineer
Agricultural Engineering Department
IRRI, Los Banos, Laguna
Philippines

Abstract

For over two decades, numerous attempts have been made in Japan, China and at the International Rice Research Institute to develop deep placement fertilizer applicators for wetland paddy. Field performance of the many applicators developed in the past, however, have been inconsistent. This study concludes that excessive N transfer to floodwater during the deep placement operation was the main reason for poor field performance of these applicators. It also concludes that maintaining an adequate soil barrier between the deposited fertilizer and floodwater is a critical factor for improving fertilizer use efficiencies rather than deeper placement, as has been generally believed.

The development of three new applicators, which can positively place and cover fertilizer in the soil-subsurface without contacting floodwater, is reported. Performance of these machines, based both on the level of N transfer to floodwater and on yield experiments, are discussed. The paper concludes that the development of these applicators have opened new possibilities for increasing rice yields in Asia. The key steps that led to the development of the three applicators, at the International Rice Research Institute are briefly described.

Introduction

Due to the excessive loss of nitrogen, farmers in Asia have not been able to make more effective use of fertilizer to boost their rice yields. As early as 1941, Shioiri in Japan explained the mechanics of loss of surface applied ammonia in flooded soils and recommended the deep placement of ammonium fertilizers. A number of field experiments were conducted in Japan from 1942 to 1952 which indicated that deep placement of fertilizer increase paddy yields by an average of 10% (Mitsui, 1955).

Many studies at IRRI and other institutions have consistently demonstrated that fertilizer use efficiencies in wetland rice production could be almost doubled by placing fertilizer in the reduced soil layer at depths ranging from 5 to 15 cm. In spite of over 40 years of efforts, it has not been possible to transfer these important research findings to farm level.

Prilled urea is the most popular fertilizer material used for rice production in Asia. Over the last decade an unusually large number of deep placement applicators have been developed for prilled urea in Japan, China and at IRRI. The performance of these machines have not been consistent at the field level. This has led to the belief that prilled urea is not a suitable fertilizer material for deep placement. Consequently, urea briquettes and urea supergranules (USG) have been specially developed for deep placement.

During 1983, a major effort was placed on the development of deep placement applicators for prilled urea in the IRRI Agricultural Engineering Dept. As an initial step a review of deep placement applicator developments worldwide was undertaken by the author and his collegues in order to gain a better understanding of the deep placement applicator problem. A systematic effort was then made to precisely define the deep placement problem. This led to the development of a set of criteria for

Note: The author was assisted by Engineers Larry Kiamco, Val Tiangco, Iñigo Camacho, Miguelito Diestro and Eulito Bautista of the Agricultural Engineering Dept, IRRI, in the development of the deep placement applicators reported in this paper.

The assistance provided by the IRRI Agronomy Department, the Training and Technology Transfer Department and the Test Section of the Agricultural Engineering Department in the testing of the applicators, the IRRI Analytical Service Laboratory in analyzing floodwater samples and the informal suggestions of some of our colleagues which helped in many ways in the development of the three applicators.

technical and commercial acceptability of applicators (Khan, September 1982). In order to gain a better understanding of the deep placement phenomenon, a series of laboratory experiments were conducted during 1983 which led to the significant findings that conventional methods of fertilizer placement result in a large transfer of nitrogen to floodwater. The technical criteria for applicators were subsequently revised to reflect the new findings. Efforts were then made in the laboratory to separately optimize the designs of the three major components of applicators; the fertilizer metering, conveying and furrow closing mechanisms.

Twenty new deep placement applicator concepts were developed out of which six were selected for intensive design and development work. This led to the eventual development of three new applicators which have shown good performance during the 1983 wet season. These applicators, two for prilled urea and one for USG were designed with the objective of minimizing N transfer to floodwater. A brief discussion of the research study on N transfer to floodwater, which served as the basic foundation for the development of the three applicators, is given below.

Mechanics of N Transfer to Floodwater

Fertilizer use efficiencies in upland farming have been reported to be 50 to 60% (Craswell and Velk 1979) when those obtained under wetland farming conditions are generally 30 to 50% (Prasad and De Datta, 1979). The reasons of this wide difference in fertilizer use efficiencies have not been well understood. Experiments conducted in Pakistan (Ross, 1980) report a 60% recovery of applied nitrogen by rice crop when fertilizer was incorporated in dry condition and followed by flooding. We concluded from the result of this study that flooding, after the fertilizer has been incorporated, was not the cause for reducing fertilizer use efficiencies in wetland farming. Since fertilizer use efficiencies under unflooded upland farming conditions are quite high, it was hypothesized that the low fertilizer use efficiencies in wetland farming were perhaps due to the presence of water during the time the fertilizer was being applied.

This hypothesis led to two laboratory studies in the IRRI Agricultural Engineering Department to evaluate the different avenues of N transfer to floodwater (**Fig. 1**) during deep placement of fertilizer. Prilled urea was used in the first study (Khan et al, 1983) as this material was considered to be most susceptible to N transfer to floodwater due to its small- sized granules. Similar experiments were later conducted on both prilled urea and urea supergranules (Mahmood et al, 1983).

The findings of these two studies indicated that depositing fertilizer in open flooded furrows followed by furrow closing was not a suitable method for deep placement as most of the fertilizer was not deposited in the soil but was rather transferred to floodwater (**Fig. 2**). The two main channels for fertilizer transfer to floodwater during deep placement were: a) Dissolution of fertilizer during transit from the water surface to the furrow bottom (43-75%); and b) Upward movement of fertilizer granules or solution to the floodwater during furrow closing (up to 20%). These two transfer avenues were so significant that in some cases N transfer to floodwater during deep placement was almost equal to that of broadcast application. Transfer due to poorly sealed furrows or due to diffusion through puddled soil was relatively small.

Experiments with embedding prilled, forestry grade and supergranular urea fertilizer in Maahas clay at 2.5 cm and 5 cm depth indicated that a placement depth of 4-5 cm was adequate to minimize N transfer to floodwater (**Fig. 3**). It was concluded from these experiments that maintaining an adequate soil barrier, between the deposited fertilizer and floodwater, was a critical factor for improving fertilizer use efficiencies rather than placement at greater depths as has been generally believed earlier.

Minimizing fertilizer-water contact, during all the three phases of fertilizer placement; (transit, place-

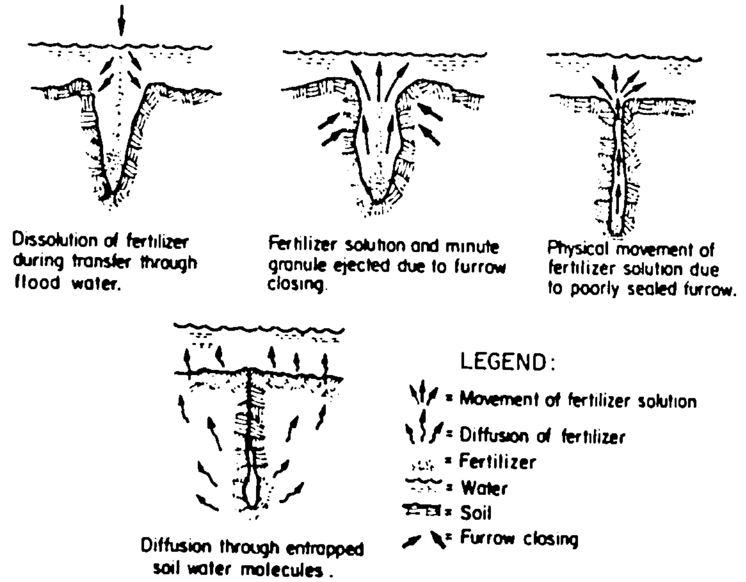


Fig. 1 Avenues for fertilizer transfer to floodwater during placement.

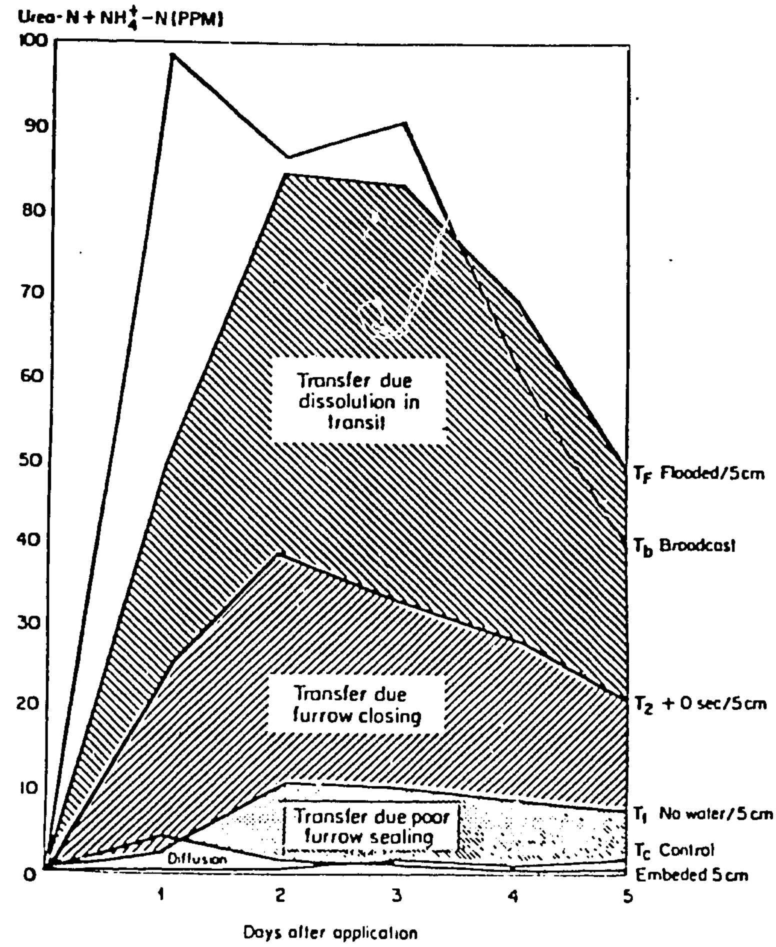


Fig. 2 Major avenues for N transfer to floodwater during prilled fertilizer placement at 5 cm depth in flooded Maahas clay.

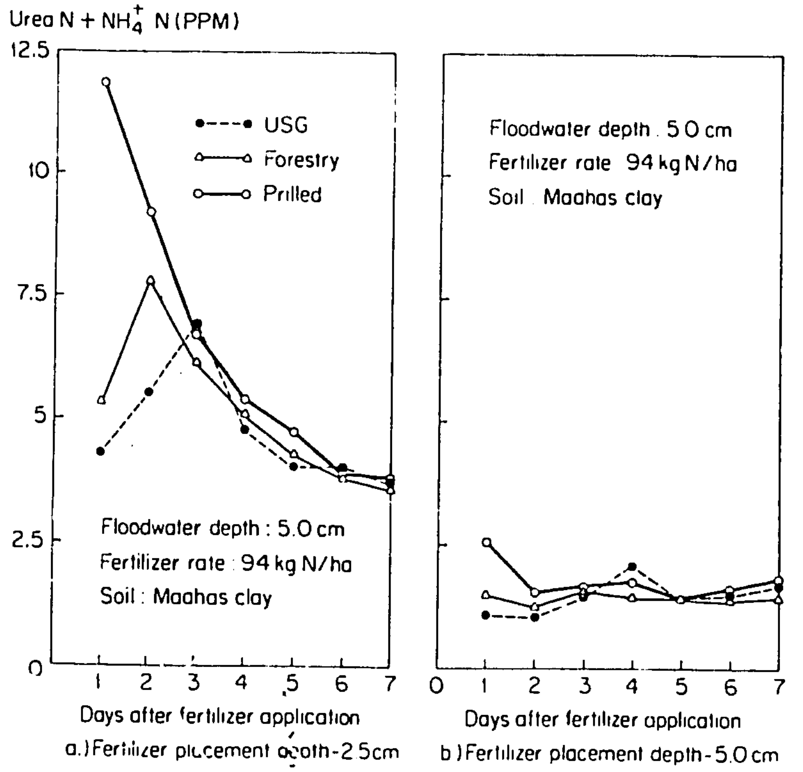


Fig. 3 N transfer to floodwater when urea fertilizer is embedded at 2.5 and 5.0 cm depth in freshly puddled maahas clay.

Fig. 4 Straight auger applicator for prilled urea.

Fig. 5 Oscillating plunger applicator for prilled urea.

Fig. 6 Press-wedge applicator for urea supergranules (USG).

ment and covering), and maintenance of an adequate soil barrier between the deposited fertilizer and floodwater would be an effective strategy for minimizing fertilizer loss in flooded paddies. This would permit better retention of deposited fertilizer in the soil where it would be less vulnerable to volatilization losses. The above general approach of minimizing N transfer to floodwater was followed at IRRI in the development of the following three new applicators which have demonstrated consistent good performance during the last cropping season (Khan et al, June 1983):

1) Spring auger applicator
   –Prilled urea **(Fig. 4)**
2) Oscillating plunger applicator

– Prilled urea (Fig. 5)
3) Press-wedge applicator
– USG (Fig. 6)

Comparative Performance of Applicators

During the design and development phase, machines must undergo repeated design improvements and evaluation. In the past, performance of deep placement applicators were evaluated at IRRI through yield experiments. This required a 5- to 6- month cycle time between design improvements and evaluation thereby seriously hampering the applicator development process. The level of urea and ammonium N concentration in floodwater, after the fertilizer has been applied, is generally related to volatilization losses. It was felt that floodwater N level could be measured to obtain an approximate idea of the machine's capability to deep place fertilizer. This technique was successfully used for preliminary evaluation of applicator improvements which accelerated the applicator development process at IRRI.

The three new machines are simple in design and offer encouraging possibilities for commercial introduction in Asia. These machines can be manufactured and marketed in most developing countries at a price of about US$50 to US$60. During the last cropping season, these machines were extensively tested in cooperation with the following groups at IRRI: a) the Agronomy Department at the IRRI Farm and at the Maligaya Research Station in Central Luzon; b) the Training and Technology Transfer Department at various research stations and farmers' fields in the Philippines; and c) the Agricultural Engineering Department at nine progressive farmers' fields in Laguna Province.

In yield tests conducted by the IRRI Agronomy Department in the 1983 wet season all the three machines demonstrated a good performance (Table 1). It is interesting to note that the two prilled urea machines gave somewhat better performance than manual and machine placement of USG. The performance of all the three machines were comparable or better than the research's and farmers' split.

The results of 10 farmer trials conducted by the IRRI Training and Technology Transfer Dept. in Cagayan are given in Table 2. These trials were conducted on plots of 500 m². Yields in these tests ranged from 4.17 to 5.778 t/ha. It is interesting to note that trials with higher dosage of fertilizer generally did not produce any higher yields than those at the lower fertilizer rates.

Table 1 Effect of Nitrogen on IR58 Grain Yields with Different Manual and Machine Placement Techniques (1983 Wet Season).

Urea source	Application method	Nitrogen applied (kg N/ha)	Water depth during basal fert. appln. (cm)	Grain yield (t/ha)
	No fertilizer nitrogen	0	–	2.9 c
Prilled	Band placement by spring auger	56	4.6	4.7 ab
Prilled	Band placement by oscillating plunger	58	4.8	5.1 a
Supergranule	Point placement by deep plunger	58	4.9	4.4 ab
Supergranule	Point placement by press wedge	46	5.1	4.3 b
Supergranule	Point placement by hand	58	5.3	4.6 ab
Prilled	Researchers' split	58	5.0	4.2 b
Prilled	Farmers' split	58	5.0	4.3 b

[a] 10 DT and 10 days ofter PI

Table 2 Effect of Nitorogen on IR36 Grain Yields with four Deep Placement Machines in Farmers Field Trials, Cagayan (1983 Wet Season).

Treatment	Cooperating Farmer										Mean
	#1		#2		#3		#4		#5		
	kg N/ha	t/ha	kg N/ha	t/ha	kg N/ha	t/ha	kg N/ha	t/ha	kg N/ha	t/ha	
Prilled urea:											
Spring auger	108	4.33	109	4.48	89	4.60	86	4.17	101	5.42	4.60 a
Oscillating plunger	59	4.85	85	4.33	68	4.34	82	4.56	74	5.65	4.75 a
	#6		#7		#8		#9		#10		
USG:											
Press wedge	52	4.15	57	4.51	54	5.44	58	4.60	57	5.50	4.84 a
Deep plunger	71	4.64	66	4.09	69	5.12	73	5.54	65	5.78	5.03 a
CV (%)											7.9

[a] Means followed by the same letter are not significantly different at 5% level by Duncan's Multiple Range Test.

Table 3a Deep Placement Fertilizer Applicator Trials[1)] in Farmers' Fields, Calamba and Calauan, Laguna - 1983 Wet Season

Farmer cooperator	Variety	Application method[2)]	Fertilizer		Projected yield[3)] t/ha	Fertilizer efficiency[4)]	
			Material	Rate kg N/ha		kg Rough rice/kg N	% Change over control
No.1	Sinang-Domeng (HYV)	Farmer practice (no machine - control)	Prill	90	4.87	54.11	–
		Spring auger	Prill	47	4.42	94.04	+ 73.79
		Oscillating plunger	Prill	48	3.95	68.10	+ 25.85
		Press-wedge	USG	48	3.82	79.58	+ 47.07
No.2	Sinang-Domeng (HYV)	Farmer practice (no machine - control)	Prill	78	4.98	63.85	–
		Spril Auger	Prill	55	5.03	91.45	+ 43.22
		Oscillating plunger	Prill	58	5.17	89.14	+ 39.61
		Press-wedge	USG	48	5.03	109.79	+ 64.12
No.3	Sinang-Domeng (HYV)	Farmer practice (no machine - control)	Prill	78	6.87	88.08	–
		Spring auger	Prill	42	5.46	130	+ 47.59
		Oscillating plunger	Prill	41	5.01	122.20	+ 38.74
		Press-wedge	USG	42	5.01	119.28	+ 35.42
No.4	IR-42	Farmer practice (no machine - control)	Prill	78	4.76	61.02	–
	C-4	Spring auger	Prill	52	3.42	65.77	+ 7.98
	IR-42	Oscillating plunger	Prill	39	4.42	113.33	+ 85.73
	IR-42	Press-wedge	USG	41	4.30	104.88	+ 71.88
No.5	IR-42	Farmer practice (no machine - control)	Prill	80	4.28	53.5	–
		Spring auger	Prill	66	4.92	75.54	+ 39.33
		Oscillating plunger	Prill	58	4.03	69.48	+ 29.87
		Press-wedge	USG	45	4.06	90.22	+ 68.64
No.6	IR-42	Farmer practice (no machine - control)	Prill	78	4.66	59.74	–
		Spring auger	Prill	47	4.28	91.06	+ 52.43
		Oscillating plunger	Prill	50	4.20	84.00	+ 40.61
		Press-wedge	USG	44	4.38	99.54	+ 66.62
No.7	IR-42	Farmer practice (no machine - control)	Prill	67	5.47	81.64	–
		Spring auger	Prill	40	5.19	129.75	+ 58.93
		Oscillating plunger	Prill	53	5.03	94.91	+ 16.25
		Press-wedge	USG	51	4.58	89.80	+ 10.00
No.8	IR-42	Farmer practice (no machine - control)	Prill	78	5.74	73.59	–
		Spring auger	Prill	40	5.25	131.25	+ 78.35
		Oscillating plunger	Prill	46	5.21	113.26	+ 53.91
		Press-wedge	USG	47	5.37	114.26	+ 55.26
No.9	IR-42	Farmer practice (no machine - control)	Prill	68	5.71	69.26	–
		Spring auger	Prill	45	4.58	101.78	+ 46.95
		Oscillating plunger	Prill	47	5.53	117.66	+ 69.88
		Press-wedge	USG	48	4.74	98.75	+ 42.58

1) Except for application methods and fertilizer rates each farmer applied his own traditional cultural practices on all of 4 treatments.

2) With machine applications, all fertilizer was applied as a single dose at 10 to 18 days after transplanting. Farmer practice varied but generally included 2 to 3 split broadcast applications.

3) Based on 4 sampling sites (projected value at 14% m.c.).

4) For lack of better methods of assessment, fertilizer efficiencies at different fertilizer rates have been compared.

Table 3b Summary Results of Increases in Fertilizer Use Efficiencies[1] with Deep Placement Applicators on Nine Cooperating Farmers in Laguna, Philippines, (1983 Wet Season).

Farmer-cooperator	Percent Increase over Farmer Split Broadcast Practice		
	Straight auger applicator prill	Oscillating plunger applicator prill	Press-wedge applicator USG
No.1	73.79[2]	25.85[2]	47.07[2]
No.2	43.22	39.61	64.12
No.3	47.59	38.74	35.42
No.4	7.98[3]	85.73	71.88
No.5	39.33[4]	29.87[4]	68.64
No.6	52.43[4]	40.61[4]	66.62[4]
No.7	59.93[4]	16.25	10.00
No.8	78.35	53.91	55.26
No.9	46.95	69.80	42.58
Average Increase	49.82	44.49	51.29

1) Due to lack of better methods for comparative assessment, efficiencies at different fertilizer rates have been compared. 2) Plots were affected by stemborer infestation. 3) C-4 variety was used with this machine only & the crop lodged. 4) Deep-placed plots recovered from field submergence of 2 to 3 days during typhoon.

Nine farmer trials conducted by the Agricultural Engineering Department (**Tables 3a and 3b**) indicate that in all cases, a single deep placement application by any of the three machines increased fertilizer use efficiencies as compared to farmers' traditional practice of split application. The average increase in fertilizer use efficiencies for the three machines on clayey soils at the nine farm locations in Laguna were as follows:

1) Straight auger applicator
Prill 49.82%
Prill 44.49%
USG 51.29%

Further evaluation of the applicators in the Philippines and other

Table 4 Comparative Design Features of IRRI-Developed Deep Placement Fertilizer Applicators

Target specifications[1]	Straight Auger (Prill) Comparative assessment[2]				Osc. Plunger (Prill) Comparative assessment[2]				Press Wedge (USG) Comparative assessment[2]			
Essential:	EX	WM	PM	NM	EX	WM	PM	NM	EX	WM	PM	NM
Must apply prilled fertilizer 5 to 10 cm, deep.		X				X				X		
Continuous (non-intermittent) operation.		X				X				X		
Must apply commercial grade fertilizer without grading.		X				X				X		
Rate 45 and 75 kg N/ha (2 to 3 bags).		X				X			X	X		
Must function in up to 5 cm deep standing water		X				X				X		
Must apply 5 to 20 days after transplanting		X				X				X		
Labor input 8-12 hrs/ha per application			X				X				X	
Light (10-18 kg) for lifting at end of rows	X				X				X			
Approximate selling price – US$50-100	X				X				X			
Must adequately seal placement opening	X				X					X		
Sturdy to last at least 4-6 seasons		X				X				X		
Pulling or pushing force of 7 to 10 kg		X				X				X		
Smooth unidirectional movement		X				X				X		
Desirable:												
Could be used for both prilled/USG or FG/USG				X				X			X	
Rotary rather than oscillating mechanism		X				X				X		
Rolling on wheels rather than on skids				X				X				X
Push-type for post-transplant operation		X				X				X		
Multi-row operation – 2 to 4 rows			X				X				X	
Non-furrow opener type				X				X				X
Mechanical injector type		X				X						X
Easy to manufacture by small shops		X				X				X		
Not need high precision in production		X				X			X			
Pull type for pre-transplant operation				X				X				X
Can also be used for random seeded crop				X				X				X
Undesirable:												
Intermittent operation		X				X				X		
Multi-direction action during operation		X				X				X		
Used of liquid conveying mechanism		X				X				X		
Complex mechanisms		X				X				X		
Delicate mechanisms		X				X				X		

1) The target specifications were developed in nov. 1982 after consultation with IRRI scientists. 2) EX = Exceeded; WM = Well met; PM = Partially met; NM = Not met date: Nov. 10, 1983

Asian rice-producing countries is continuing during the current dry season. It is hoped that by the end of the 1984 dry season, the three IRRI machines would have been sufficiently tested under different soil and water conditions and designs finalized for their commercial release in the Philippines and for extensive trials in other Asian countries.

At this stage it would be appropriate to compare the three new applicators with the original target specifications that were developed in consultation with concerned IRRI scientists at the start of this crash program. Table 4 lists the Essential, Desirable and Undesirable Target Specifications along with the assessment of how the three new machines have met the original objectives. It is interesting to note that the three new machines have not only met all the essential specifications but have exceeded three beyond the desired limits.

On the basis of the results obtained so far, it seems that the N response curves of conventionally applied and deep placed fertilizer in wetland cultivation follow somewhat different patterns. **Fig. 7a** shows a typical N response curve of conventionally applied fertilizer along with a theoretical gross N response curve. The theoretical curve is an extension of the slope line of the N response curve at the point of maximum fertilizer use efficiency. It seems that a typical N response curve has two distinct zones: Zone I in which nutrition availability plays a significant part in increasing yields; Zone II in which non-nutritional yield decreasing factors become increasingly dominant thereby lowering yields from the theoretical maximum. Since deep placement can only provide increased nutrition by reducing fertilizer losses, it seems that this technique can influence yields mostly in Zone I.

There are sufficient indications that at low fertilizer rates yield increases due to deep placement are substantial. As fertilizer rates increase, yield advantages of deep placement are gradually decreased. At very high fertilizer rates, yields with deep placement are often less than those of conventional fertilizer application. The above observations are graphically illustrated in **Fig. 7b** which shows a set of hypothetical curves for conventional and deep place fertilizer. From this, one could conclude that deep placement is a technique for increasing yields at the lower fertilizer rates rather than for maximizing yields at high fertilizer input levels.

Fig. 7c shows three hypothetical N response curves of soil N, deep placed N and conventionally applied N. Since soil N is not subject to as high losses as applied N, plants make more efficient use of soil N. This is represented by the high degree of slope of the soil N curve. The soil N response curve in a way indicates the maximum efficiency that could be achieved with applied N, if most of the losses could be effectively

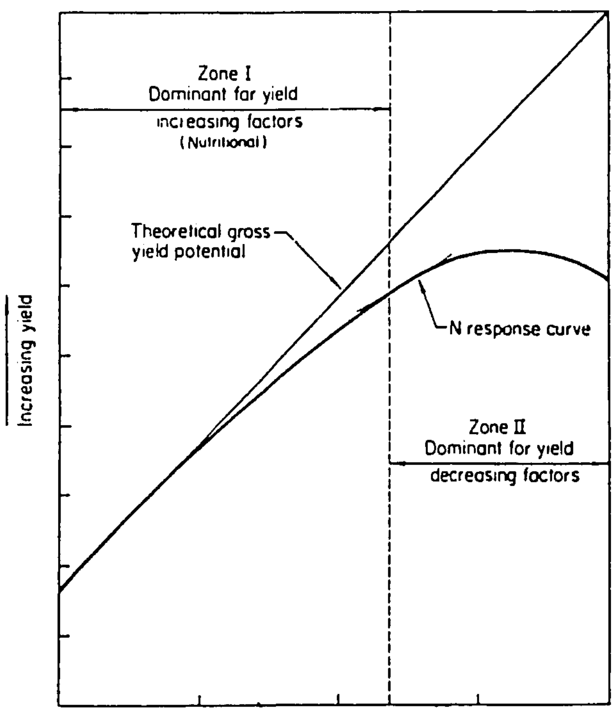


Fig. 7a Dominant zones of yield increasing and decreasing factors on N response curve (AUK Ag Eng'g Jan, 1984).

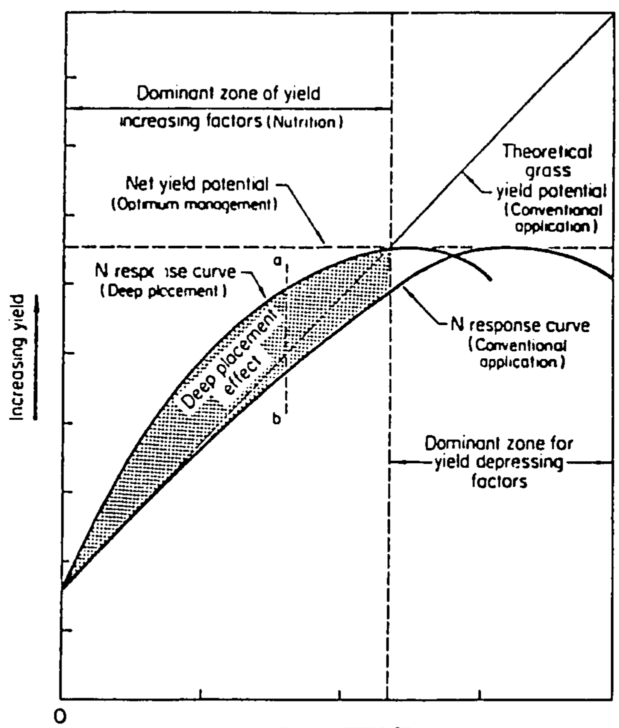


Fig. 7b Hypothetical N response curves for conventional and deplacement fertilizer application (AUK Ag Eng'g Jan, 1984).

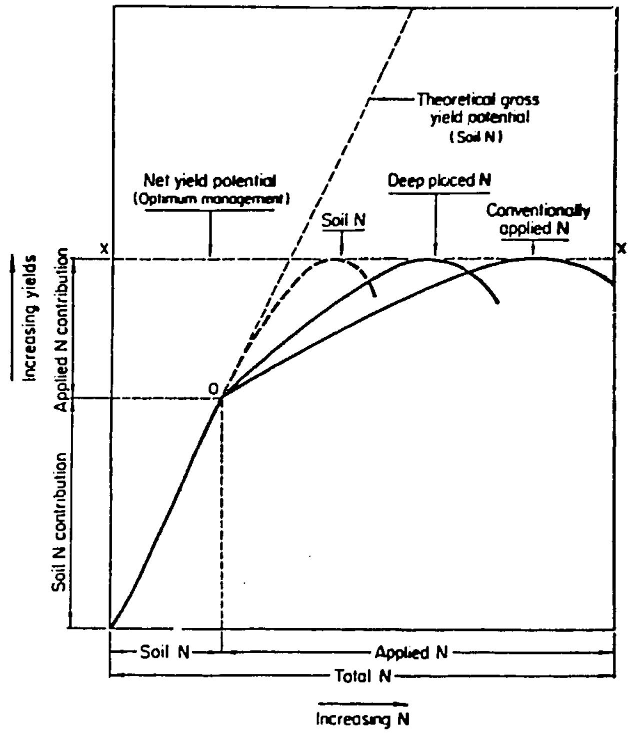


Fig. 7c Hypothetical N response on yield: soil N, deep placed N and conventionally applied N (AUK Ag Eng'g Jan 23, 1984).

minimized. It is important, therefore, that the exact slope and shape of the soil N response curve is experimentally determined. Such a knowledge will provide a good understanding of the potential efficiencies that could be achieved through deep placement and other improved fertilizer application techniques.

The progress achieved at IRRI during the last year on the development of deep placement applicators, specially for prilled urea, has been most challenging and satisfying to those of us who have been associated with this project. There are a number of strategic steps which lead to the development of the deep placement applicators that are reported here. These steps include the precise definitions of the deep placement applicator problem; priory setting of the technical and market criteria for applicators; better understanding of N transfer to floodwater during deep placement; separate optimization in the laboratory of the designs of the components of applicators; shortening of the applicator evaluation process through floodwater N measurements; development of a large number of the applicator concepts which eventually led to the design of the three promising machines; and the dedicated efforts of the Design Engineering Team in the IRRI Agricultural Engineering Department which developed these applicators.

REFERENCES

Craswell. E.T. and P.L.G Velk. 1979. "Fate of fertilizer nitrogen applied to wetland rice." Nitrogen & Rice, IRRI, Los Baños Laguna, Philippines

Khan, A.U. 1983. "New deep placement applicators for minimum N transfer to floodwater." IRRI Thursday Seminar. June 23.

Khan, A.U., L.C. Kiamco and V.M. Tiangco. 1983. "Fertilizer transfer to floodwater during deep placement." IRRI Research Paper Series No. 96. October.

Khan, A.U. 1982. "Some concepts and issues for deep placement fertilizer applicators." Paper for internal circulation at IRRI. September.

Mahmood, Z., L.C. Kiamco and A.U. Khan. 1983. "Further studies on mechanics of fertilizer transfer to floodwater during deep placement." Special Problems in Agricultural Engineering, University of the Philippines at Los Baños, Summer.

Prasad, R. and S.K. Datta. 1979. "Increasing fertilizer nitrogen efficiency in wetland rice." Nitrogen & Rice, IRRI, Los Baños, Laguna, Philippines.

Ross, V.E. 1980. Final Report of the Collaborative Rice Research Project between PARC, Govt. of Pakistan and IRRI-Philippines.

IRRI Saturday Seminar
Agricultural Engineering Department
02 February 1985

For internal use only, not for quotation or publication

DESIGN PARAMETERS AFFECTING THE PERFORMANCE OF THE IRRI-DESIGNED AXIAL FLOW PUMP

Mamerto M. Aban*

INTRODUCTION

Finding the optimum flow condition is the objective of every pump designer. The design of an axial flow pump as cited by several authors is highly dependent on experimental data. Hence, the prediction of the characteristics of the axial flow impeller would require detailed information of the impeller and other pump parts. Karassik and Carter (1970) mentioned that no simplified guide can be offered for general use of this type of pump.

As a fine-tuning activity on the design of the IRRI axial flow pump, IRRI engineers realized that finding the optimum flow conditions before and after the impeller are as important as the correct impeller design. Improving the efficiency or operating characteristics of the pump requires consideration of a number of variables. Each design parameter can affect the pump's output and several performance curves can be developed from each combination of these parameters. Among the more important design parameters that need further study are the shape of inlet approach, the impeller vane discharge angle or pitch, the diffusion vane angle and the clearance between the impeller and the stator casing. Knowing the effects of these parameters would provide pump designers the necessary data for designing at the optimum hydraulic performance.

---

*Research Assistant, Agricultural Engineering Department, The International Rice Research Institute, Los Banos, Laguna, Philippines.

The axial flow pump operates at a greatly reduced capacity when the operating head is above the design point and may overload the prime mover. To overcome overloading, Linsley and Franzini (1964) suggested that the head may be distributed among a number of pumps in series or a multi-stage unit may be used. Along this line, a two-stage pump would provide a higher pumping lift.

A study was undertaken to determine the effects of the aforementioned parameters on the performance of the IRRI-designed axial flow pump. A two-stage unit was designed and compared with the single-stage pump. Cost comparison between the two pumps was made to determine which pump is more economical to use at different pumping lift applications.

DESIGN AND DEVELOPMENT OF THE IRRI AXIAL FLOW PUMP

In 1978, the IRRI Agricultural Engineering Department initiated a project to develop an efficient, low-cost and portable axial flow pump that can lift water 1-4 meters from lakes, rivers or irrigation canals and can be driven by an internal combustion engine or electric motor. The project started with the effort to improve the efficiency and to simplify the design of a Thai-designed axial flow pump in a manner that would reduce cost and enable fabrication by workshops in rural areas (Salazar and Calilung, 1982). The Thailand axial flow pump was made of a boat propeller and shaft encased in a long tube and coupled with an engine. The propeller was made to turn in a direction in which water is sucked in from the propeller end and driven out at the other end.

The first prototype consisted of a bamboo discharge tube, 4.2 m long and 12 cm in diameter, fabricated steel impeller coupled to a lineshaft of 1.9 cm (0.75 in. nominal) pipe, a bamboo stator casing, and a 180 steel elbow. The lineshaft is supported by wooden bearing holders to the bamboo tube. The pump was driven by a 5 hp (3.73 kw) gasoline engine through a flexible coupling. The preliminary test results showed that the pump was capable of pumping up to 1350 liters per minute of water at 1.5 m lift.

The pump performed satisfactorily during a 100-hour test but cracking and deflection of the bamboo tube and excessive wear of bearings were observed. This led to the development of a second prototype using a steel discharge tube and redesigned wooden bearings. Inlet guide vanes and diffusion vanes were incorporated to increase the efficiency and an oblique entrance was added to reduce inlet head loss. The highest efficiency obtained from tests was 40 percent at an output of 1900 liters per minute, a speed of 2330 rpm and total head of 1.8 meters.

After the performance test was conducted on the second prototype, a value analysis team was formed to reduce the cost of the pump and improve its versatility. The major changes included the elimination of the inlet guide vanes, a new engine stand that doubles as a handle during transport, and through a belt-drive attachment that permits the use of a power tiller to power the pump.

More performance tests were conducted to determine the effects of the removal of the inlet guide vanes. The absence of inlet guide vanes induced liquid prerotation in the direction of the impeller rotation which caused unloading of the impeller and subsequent reduction of the capacity and brake horsepower. There was no appreciable change in the pump efficiency.

To increase the capacity and efficiency, the impeller vane pitch was changed from 15° to 20° and a 10 percent increase in efficiency was obtained. Performance and life tests were conducted in the field and test results showed that a 5 hp (3.73 kw) gasoline engine was sufficient to drive the 15 cm diameter axial flow pump. The drawings of this pump was then released and made available to interested manufacturers in late 1979.

The final design of the 15 cm axial flow pump (Fig. 1) consists of a especially designed axial flow impeller which is secured to a pump shaft and encased inside a 15 cm diameter steel discharge tube. The pump is supported by an engine stand at the discharge end, and a support near the pump outlet. A flexible coupling connects the engine and the pump shaft (alternatively, the pump may be driven by a separate engine such as power tiller engine through V-belts and pulleys). The pump inlet area is widened to reduce suction losses and vortex formation through a 30° cut across the tube axis. A wire mesh inlet strainer is incorporated to prevent the entry of foreign materials. Behind the axial flow impeller is a set of diffusion vanes which serve to straighten the spiral flow from the impeller for improved efficiency and to hold the primary rubber bearings. To simplify replacement of the intermediate bearing, there is a bend on the discharge tube at approximately 70 cm from the inlet end. This allows the pump shaft to exit from the discharge tube so the bearing can be located outside the tube.

REVIEW OF DESIGN PARAMETERS

In hydraulic design, the whole machine is to be handled as a unit. Kovats (1964) stated that the most important basic principle is that the interaction of the individual elements should be considered. Stepanoff (1957) mentioned that selection of design parameters depend upon experience and it depends upon the skill of the designer to discern the effects of these several variables leading to the optimum performance of the pump. A literature review was made on the following design parameters:

1. Inlet approach. Kovats (1964) mentioned that the emphasis of previous researches on pump design was always on "exact" calculations of impeller blade angles and the approach conditions were often overlooked or little attention was given to the parts downstreams of the impeller. It is evident that "correct" blade angles are not of much use, if the flow enters the impeller from the side at a very narrow angle or the flow is restricted.

2. Impeller vane curvature. Stepanoff (1957) stated that the head of the pump is produced by the impeller alone. The head produced is essentially the same for all vane setting and this is a function of vane curvature alone. This means that although the tangential component at the impeller discharge is higher at higher values of vane discharge angle the tangential component at inlet is increased by approximately the same amount, the peripheral velocity being the same at inlet and outlet, thus no change in head results. Capacity varies approximately directly as the inlet pitch.

3. <u>Diffusion vane curvature</u>. Shepherd (1956) stated that the efficiency obtained with diffusion vanes is very much dependent on the actual setting of the vanes and the flow area. The diffusion vane angle or curvature is selected so that the liquid enters the diffusion vanes with a minimum loss and leaves the casing axially. Because of uncertain knowledge of the actual flow conditions, it is very necessary to test several arrangements and obtain the optimum results empirically. A reduction of efficiency beyond the optimum point is caused by the fact that high velocities through the pump parts, as found at high speeds, require a greater degree of refinement in hydraulic design than is found in normal good designs based on moderate speeds and head per stage. In general, a great degree of streamlining is required at higher speeds.

4. <u>Clearance between the impeller and the stator casing</u>. Losses in pump capacity and efficiency of the axial flow pump is a function of clearance. These losses are known as leakage. Leakage losses take place primarily through clearance setting between the impeller and the stator casing. The capacity available at the pump discharge is smaller than that passes through the impeller by the amount of leakage. From IRRI test results, a Thai axial flow pump which had a clearance of 6 mm had a lower capacity than the IRRI axial flow pump with a 3 mm clearance.

MATERIALS AND METHODS

In general, dimensional analysis applied to the general flow problem is important for the detailed examination of blades and rotors of turbomachines. Dimensional analysis was used to determine the relationships of several design parameters which were used as basis of experiments designed to obtain some empirical relationship that can be used for design purposes. The effects of the parameters on the pump capacity and power input (bhp) were determined by varying one variable at a time and holding all other variables constant.

Two shapes of inlet approach, the original oblique-shaped and a fishtail-shaped approach were compared using the same pump. The optimum design of each shape was first determined by varying the degree of cut across the tube axis from 30° to 90° for the oblique-shaped approach and the radius of curvature of the flared sides for the fishtail-shaped approach (Fig. 2). The efficiencies obtained from the optimum design of each shape were compared.

The impeller vane discharge angle or pitch was varied from 15° to 30° at 5° intervals (Fig. 3). The 35° pitch was never tested because of the limited available power of the prime mover used to drive the pump. The prime mover used throughout the experiment was a calibrated 15 hp (11.19 kw) electric induction motor. The diffusion vane angles were set at 40°, 50°, 60°, and 90° (Fig. 4). The 90° vane angle was of particular interest because it was easier to fabricate. The clearance between the impeller and the stator casing was varied from 2 mm to 10 mm at 2 mm intervals.

The two-stage pump design was basically the same as the single-stage with additional parts consisting of a 152 mm long flanged series case with the diffusion vanes and main bearing holder welded inside it, an impeller, a rubber bearing, and an additional shaft and coupling (Fig. 5). The performance curves of the two-stage pump were developed from test data and compared with the performance of the single-stage pump. Further tests were conducted by setting the spacings between the two impellers at 125 mm, 150 mm, 175 mm and 1250 mm to determine the effect of impeller spacing.

Cost analysis was made using the technique of discounting to express the costs over the life of the machine in present worth. The lower present worth of cost was used as the selection criterion.

RESULTS AND DISCUSSION

Effect of Shape of Inlet Approach on the Efficiency of the Axial Flow Pump

The optimum designs of the two shapes of inlet approach were based on the maximum efficiencies obtained from the independent variables. Maximum efficiency was obtained from

115

the fishtail-shaped approach with 40 cm radius of curvature of the flared sides. The 60° angle of cut across the cylindrical column was found the most efficient design for the oblique-shaped approach. Both approaches were attached close to the impeller.

The effect of shape of inlet approach on the efficiency of the pump is shown in Fig. 6. The fishtail-shaped approach has higher peak efficiency at a much higher capacity (7500 l/min) than the oblique-shaped approach with a peak efficiency obtained at 6250 l/min capacity. The better performance of the fishtail-shaped approach could be attributed to the more uniform velocity distribution attained as water approached the pump suction as compared to the sharp turn in the case of the oblique-shaped approach.

Effects of Impeller Vane Discharge Angle, Diffusion Vane Angle and Clearance Between the Impeller and Stator Casing on the Capacity and Bhp of the Pump

1. Impeller vane discharge angle or pitch β_2. The capacity Q and brake horsepower (bhp) input of the pump varied directly with pitch. The variation in capacity with β_2 was due to the change in the net area swept by the impeller vane. Consequently, the brake horsepower of the pump increased with the increase in Q. Such relationship as represented in dimensionless terms, π_4 on π_1, is shown in Fig. 7. The corresponding increase in bhp with β_2 was significantly different. A steeper slope of the curve was observed starting at approximately 22.5° pitch or $\pi_4 = 0.39$. This meant that at pitch greater than 22.5° greater increase in Q could be obtained but the corresponding increase in bhp was also greater.

2. Diffusion vane angle, α_v. From Fig. 8 slight variation in capacity was observed as the diffusion vane angle was varied from 40° to 60° but a drop in capacity as shown by the negative slope of the curve was obtained using a straight vane or 90° vane angle. The observed drop in Q showed a corresponding decrease in bhp but not significantly different from the bhp of the other diffusion vane angles.

The result indicates that α_v is not a critical design parameter and variations from 40° to 60° vane angle have hardly any noticeable effect on the pump performance. The simplicity and ease of fabrication of a straight diffusion vane (90°) was not justified by its low performance. A diffusion vane angle of 47° was found optimum.

3. Clearance between impeller and stator casing. The capacity increased significantly from 2 mm to 4 mm clearance and Q began to drop as clearance was further increased up to 10 mm. This relationship is shown in Fig. 9. The unexpected increase in Q from 2 mm to 4 mm clearance could be attributed to the observed rubbing between the impeller vanes tips and the stator casing due to greater deflection of the long pump shaft than the required 2 mm clearance. The long shaft was mainly supported by two rubber bushings at the diffuser hub and the middle-bearing housing. The observed variation of Q from 4 to 10 mm clearance can be explained by the loss of Q due to leakage losses which took place through each clearance setting between the impeller and the stator casing. Leakage losses increased as the clearance increases. This relationship is presented in Fig. 10 excluding the sample point gathered from the 2 mm clearance because the result was affected by factors other than clearance. The optimum clearance for the 20 cm diameter impeller is approximately 4 mm. There was corresponding decrease in bhp as the Q decreases as a result of the increase in clearance.

Effects of Spacing Between Impellers on the Performance of Two-stage Pump

The spacing between impellers was found to have no significant effect on the capacity of the two-stage pump but the bhp requirement was significantly different at spacing greater than 150 mm (Table 1) where the highest pump efficiency was obtained (Fig. 11). The increase in bhp was due to the difference in stage pressures where the interstage leakages played a very important role. The interstage leakage became greater as the spacing between stages increases as these leakages just circulated between the high pressure and the low pressure casings.

117

Comparison of Performances Between the Two-stage and Single-stage Axial Flow Pump

The performance of the two-stage pump was compared with the single-stage pump in terms of their capacity Q, brake horsepower and efficiency. The performance curves at 1800 and 1500 rpm of both pumps are shown in Figs. 12 and 13, respectively. At 1800 rpm, the capacity of both pumps at best efficiency point was approximately the same (5400 l/min). At this capacity, the total static head and the bhp of the two-stage pump was more than twice that of the single-stage pump. The greater percentage increase in head than in bhp resulted to a slightly higher peak efficiency of the two-stage pump. Similar observations were made at 1500 rpm. However, the efficiency of the two-stage pump at this speed decreased. The average efficiencies of both pumps, therefore, tended to be approximately equal.

Cost Comparison of Two-stage versus Single-stage Axial Flow Pumps

At pumping lift of up to 2.5 meters, the single-stage pump can be driven by a 5-hp (3.73 kw) engine and the two-stage pump by an 8-hp (5.97 kw) engine. Above 2.5 meters, lift, the prime mover of the single-stage would be 8-hp (5.97 kw) engine while that of the two-stage pump would be 10-hp (7.46 kw) engine. Table 2 shows the pump capacity Q, pumping hours required per hectare-season and area capacity per year at different lifts of both pumps. The two-stage pump has greater Q and consequently lesser pumping hours required per hectare and greater area capacity per year than the single-stage pump at the same static head or lift.

The initial cost of the two-stage pump is greater than the single-stage pump due to the added series case assembly and a bigger engine requirement (Tables 3 and 4). The same tables show that the two-stage pump has greater total fixed cost per year and the variable cost per hour. However, the total variable cost per hectare is lower because the total pumping hours per hectare is shorter.

Cost comparisons based on present worths were made at 2.0 m, 2.5 m and 3.0 m lifts and the calculations are summarized in Table 5. At 2.0 m lift, the single-stage pump has a lower present worth of cost than the two-stage pump for all the three discount rates used. This indicates that at 2.0 meter pumping level and below, it is cheaper to use a single-stage pump. At 2.5 m lift, the cost of two-stage pump is lower or cheaper to use up to 30 percent discount rate. At 40 percent rate, however, the cost of the single-stage is lower. The two stage-pump continues to have lower cost at 3.0 meter lift, and hence cheaper to use for lifting water at 3.0 meter or higher level. This is due to the greater decrease in capacity of the single-stage pump as the head or lift increases which entails longer pumping hours per hectare and additional operating cost. It can be seen from Fig. 12, a performance comparison of both pumps, that at 2.0 m lift the single-stage pump has already reached its peak and the efficiency starts to drop as the head increases. On the other hand, the two-stage pump is only starting to increase its efficiency at 2.0 m lift and reaches its peak at a lift approximately twice the optimum head of the single-stage pump. At this pumping level, the efficiency of the single-stage pump has dropped by almost 10 percent.

From Table 5, the costs at 2.5 m lift have different shapes. The two-stage pump has a lower cost up to 30 percent and the single-stage pump at 40 percent discount rate. In this case, the choice would depend upon the opportunity cost of capital. A point where the two pumps has the same present worth known as the crossover or equalizing discount rate is calculated in Table 6. Fig. 14 shows that the crossover discount rate is 39.17 percent. At 39.17 percent opportunity cost of capital, the choice would be indifferent between the single-stage and the two-stage pumps.

CONCLUSIONS AND RECOMMENDATIONS

The following are conclusions and recommendations based from the findings of this study:

1. The optimum flow conditions approaching the impeller of the pump is very much affected by the shape of inlet approach. A fishtail-shaped approach gives higher pump performance than the oblique-shaped approach.

2. The impeller vane discharge angle β_2 as a single design parameter affects the head-capacity characteristics of the axial flow pump. The head-capacity curve varies directly with β_2. Therefore, the value of β_2 depends upon the desired head-capacity characteristics of the designers. If there is no limitation on the power available, β_2 may be increased up to 30°, otherwise the power input must be considered.

3. The diffusion vane angle α_v is not a critical parameter on the design of the axial flow pump. Variations as great as ±5° from the optimum value of 47° can be used without any considerable effect on the performance.

4. The optimum clearance between the impeller and the stator casing is affected by the deflection of the pump shaft. The clearance must be kept minimum if the deflection of the shaft is negligible.

5. The optimum spacing between impellers of the two-stage pump is 150 mm. Greater spacing requires greater power input due to interstage leakage.

6. A two-stage pump is basically two units of single-stage pumps in terms of performance. At constant capacity at the best efficiency point, the head and bhp requirement is doubled with approximately the same efficiency as that of a single-stage pump.

7. The single-stage pump is cheaper to use up to two-meter lift and at 2.5 m lift if the opportunity cost of capital is 40 percent. However, the two-stage pump is more economical at 2.5 m lift if the opportunity cost of capital is up to 30 percent and at higher levels.

REFERENCES

AGRICULTURAL ENGINEERING DEPARTMENT. 1978. Rice machinery development and industrial extension. Semi-annual Progress Report Nos. 26-27. IRRI. January to December.

__________________________________. 1979. Semi-annual Progress Report Nos. 28-29. IRRI. January to December.

GEREMIA, J. O. 1979. Screen tests for product designs. Machine Design, Vol. 51, No. 9. April 26. 177 p.

____________. 1977. Test less, learn more. Machine Design, Vol. 49, No. 20. September 8. 110-115 pp.

HYDRAULIC INSTITUTE. 1955. Standards, 10th ed. New York 17, N. Y.

KARASSIK, I. J. and ROY CARTER. 1960. Centrifugal pumps. New York, San Francisco, Toronto, London and Sydney: McGraw-Hill Book Company, 204 p.

KOVATS, A. 1964. Design and performance of centrifugal and axial flow pumps and compressors. New York: A Pergamon Press Book, The McMillan Company.

LANGHAAR, H. L. 1951. Dimensional analysis and theory of models. New York, London and Sydney: John Wiley and Sons, Inc. 39-40 pp.

LINSLEY, R. K. and J. B. FRANZINI. 1964. Water-resources engineering. New York, San Francisco, Toronto, and London: McGraw-Hill Book Company, 348-349 pp.

MURPHY, GLENN. 1950. Similitutde in engineering. New York: The Ronald Press Company.

SALAZAR, G. S. and E. J. CALILUNG. 1982. IRRI axial flow pumps. Handout Sheet. Agricultural Engineeering Training Program, IRRI. June.

SHEPHERD, D. G. 1956. Principles of turbomachinery. New York: The McMillan Company, 30-31 pp.

STEPANOFF, A. J. 1957. Centrifugal and axial flow pumps. 2nd ed. New York: John Wiley and Sons, Inc.

Table 1. Pump capacity and brake horsepower input at best efficiency point of two-stage axial flow pump as affected by different impeller spacings at 1500 rpm.

IMPELLER SPACING (mm)	CAPACITY MEAN[1] (l/min)	BHP INPUT MEAN[1] (kw)
125	4375 a	4.42 a
150	4375 a	4.30 a
175	4470 a	4.66 b
1250	4690 a	4.90 c

[1]Average of three readings. Any two means having common letter are not significantly different at the 5% level by DMRT.

Table 2. Command area capacity of the 20 cm diameter single-stage and two-stage axial flow pumps operating at 1500 rpm.

	SINGLE-STAGE	TWO-STAGE
A. Pump capacity at different lifts	(m^3/hr)	
2.0 m total static head	219.00	316.50
2.5 m total static head	186.00	297.60
3.0 m total static head	157.80	277.50
3.5 m total static head	133.50	253.50
4.0 m total static head	111.00	240.00
B. Average water requirement per ha-season = 12,000 m^3		
C. Pumping hour requirement per hectare-season	(hrs/ha-season)	
2.0 m total static head	54.79	37.91
2.5 m total static head	64.52	40.32
3.0 m total static head	76.05	43.24
3.5 m total static head	89.89	47.34
4.0 m total static head	109.11	50.00
D. Area capacity of pump per year assuming 8 ha per day of operation, 6 days per week, 4 week per month, 4 months per season, and 2 seasons per year or 1536 hrs per year	(ha/yr)	
2.0 m total static head	28.03	40.52
2.5 m total static head	23.81	38.10
3.0 m total static head	20.20	35.52
3.5 m total static head	17.09	32.45
4.0 m total static head	14.08	30.72

Table 3. Comparative cost analysis of the IRRI 20-cm diameter single-stage and two-stage axial flow pumps operating at 2.0 m, 2.5 m lifts and 1500 rpm.

	SINGLE-STAGE	TWO-STAGE
CAPITAL OUTLAY		
Pump	₱3500	₱4600
Engine	5950	8500
Total Capital Outlay	9450	13100
FIXED COST PER YEAR		
Depreciation - pump and engine	1701	2358
Interest on average capital investment, 30%	1559.25	2161.50
Repair and maintenance, 10% of IC	945	1310
Insurance, 2% of IC	189	262
Total Fixed Cost Per Year	4394.25	6091.50
VARIABLE COST PER HOUR		
Gasoline, oil and grease	12.28	18.42
Labor	2.50	2.50
Total Variable Cost Per Hour	14.78	20.92
Total Variable Cost Per Hectare at 2.0 m lift	809.80	793.08
2.5 m lift	953.61	843.49

Table 4. Comparative cost analysis of the IRRI 20 cm diameter single-stage and two-stage axial flow pumps operating at 3.0 m lift at 1500 rpm.

	SINGLE-STAGE	TWO-STAGE
CAPITAL OUTLAY		
Pump	₱ 3,500.00	₱ 4,600.00
Engine	8,500.00	11,950.00
Total Capital Outlay	12,000.00	16,550.00
FIXED COST PER YEAR		
Depreciation - pump and engine	2,160.00	2,979.00
Interest on average capital investment, 30%	1,980.00	2,730.75
Repair and maintenance, 10% of IC	1,200.00	1,655.00
Insurance, 2% of IC	240.00	331.00
Total Fixed Cost Per Year	5,580.00	7,695.75
VARIABLE COST PER HOUR		
Gasoline, oil and grease	18.42	22.98
Labor	2.50	2.50
Total Variable Cost Per Hour	20.92	25.48
Total Variable Cost Per Hectare at 3.0 m lift	1,590.76	1,102.01

125

Table 5. Comparison of total present worth of costs between the single-stage and the two-stage pumps using 20%, 30% and 40% discount rates for 2.0 m, 2.5 m and 3.0 m pumping lifts at 1500 rpm.

PUMPING LIFT, (m)	DISCOUNT RATES					
	20%		30%		40%	
	Single-stage	Two-stage	Single-stage	Two-stage	Single-stage	Two-stage
2.0 [a]	₱ 61,267	₱ 65,327	₱ 51,649	₱ 55,561	₱ 44,719	₱ 48,580
2.5 [b]	₱ 69,879	₱ 68,253	₱ 58,664	₱ 58,017	₱ 50,574	₱ 50,632
3.0 [c]	₱111,493	₱ 88,388	₱ 93,025	₱ 75,054	₱ 79,720	₱ 65,447

Assumptions:

1. Estimated useful life of the pumps and components is 5 years with 10% salvage value.
2. Total area that could be served by both pumps per year at 3 meters or below is 20 hectares.

Computed costs per year using the single-stage (A) or the two-stage (B) pumps are:

a A: IC (₱ 9,450); FC/Year = R&M (₱ 945) + Insurance (₱189); Annual VC (₱ 16,196).
B: IC (₱13,100); FC/Year = R&M (₱1,310) + Insurance (₱262); Annual VC (₱ 15,861).

b A: IC (₱ 9,450); FC/Year = R&M (₱ 945) + Insurance (₱189); Annual VC (₱ 19,072).
B: IC (₱13,100); FC/Year = R&M (₱1,310) + Insurance (₱262); Annual VC (₱ 16,870).

c A: IC (₱12,000); FC/Year = R&M (₱1,200) + Insurance (₱240); Annual VC (₱ 31,815).
B: IC (₱16,550); FC/Year = R&M (₱1,655) + Insurance (₱331); Annual VC (₱ 22,040).

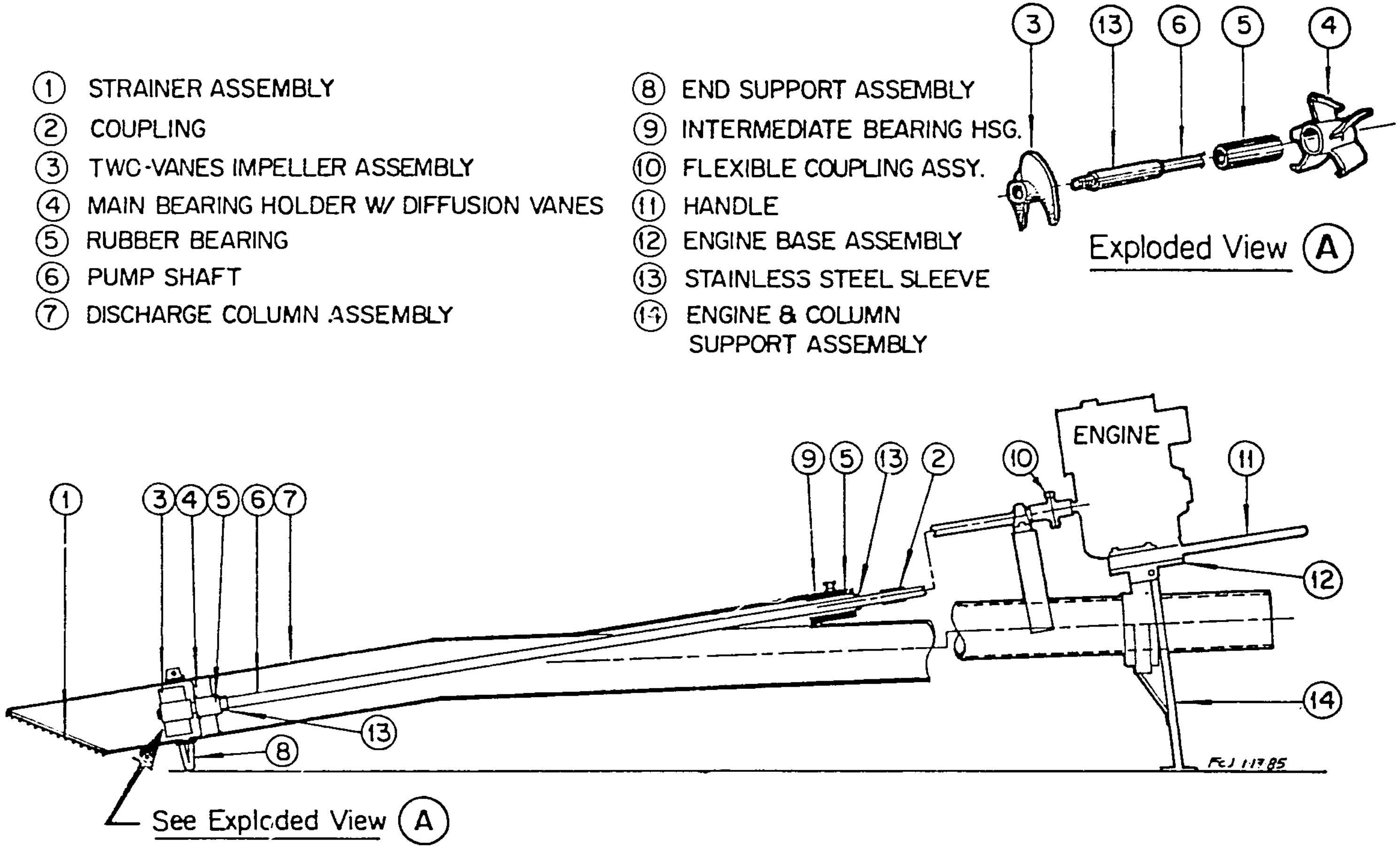
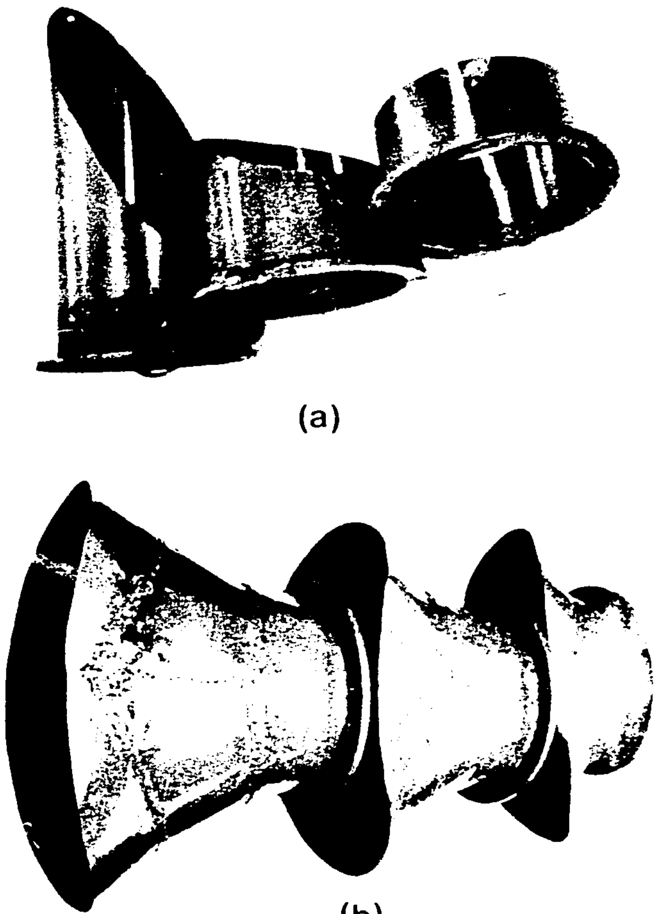


Fig. 1. Schematic drawing of axial-flow propeller pump, 1979.



(a)

(b)

Fig. 2. Two shapes of inlet approach of different designs, (a) oblique-shaped, (b) fishtail-shaped.

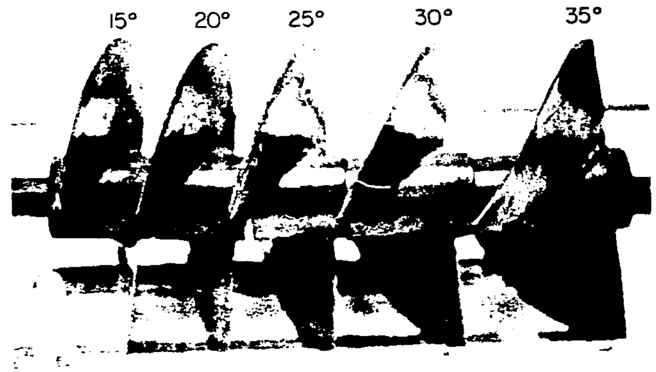


Fig. 3. Axial-flow pump impellers (20 cm diameter) of different vane discharge angles, β_2.

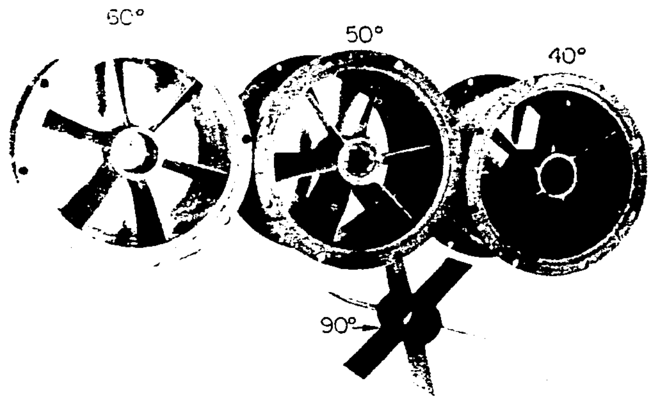


Fig. 4. Axial-flow pump diffusers of different vane angles, α_V.

128

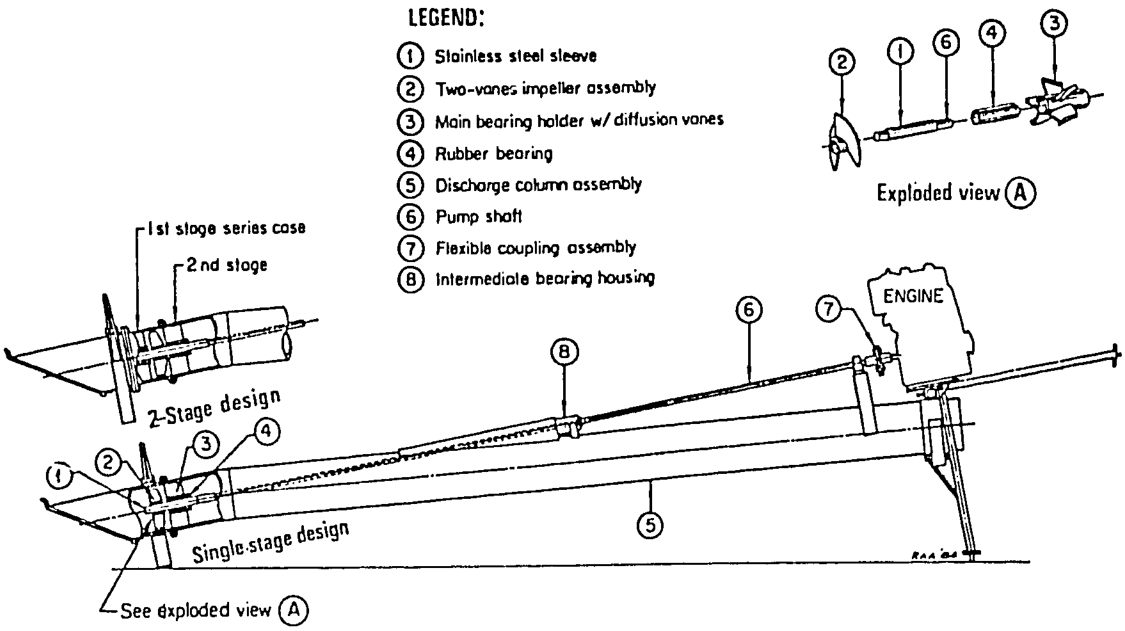


Figure 5 . The single-stage axial flow pump design can be converted into a two-stage unit by attaching a series case assembly consisting of a flanged casing of 152 mm long with the diffusion vanes and main bearing holder welded inside it, a rubber bearing, an additional shaft and another impeller.

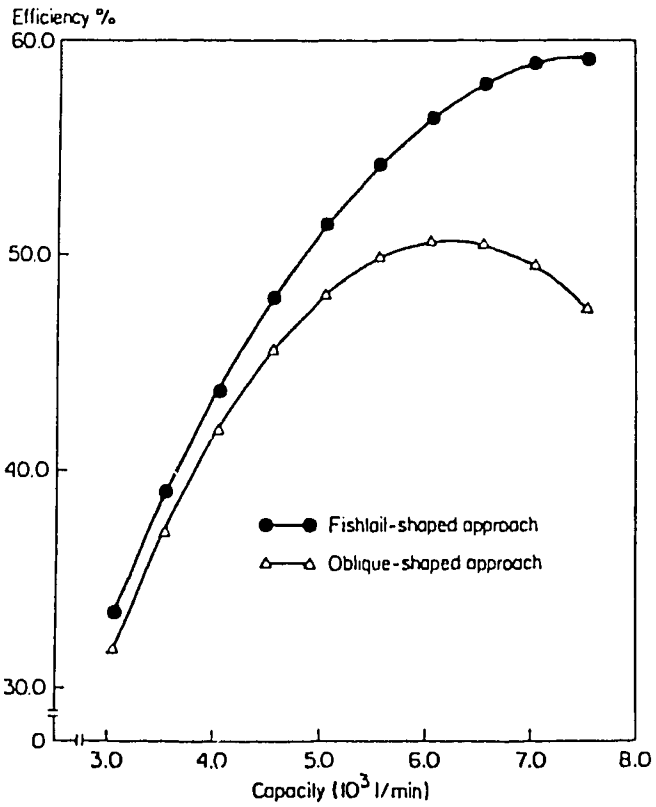


Fig. 6 .Effect of shape of inlet approach on the efficiency of IRRI-designed axial flow pump.

129

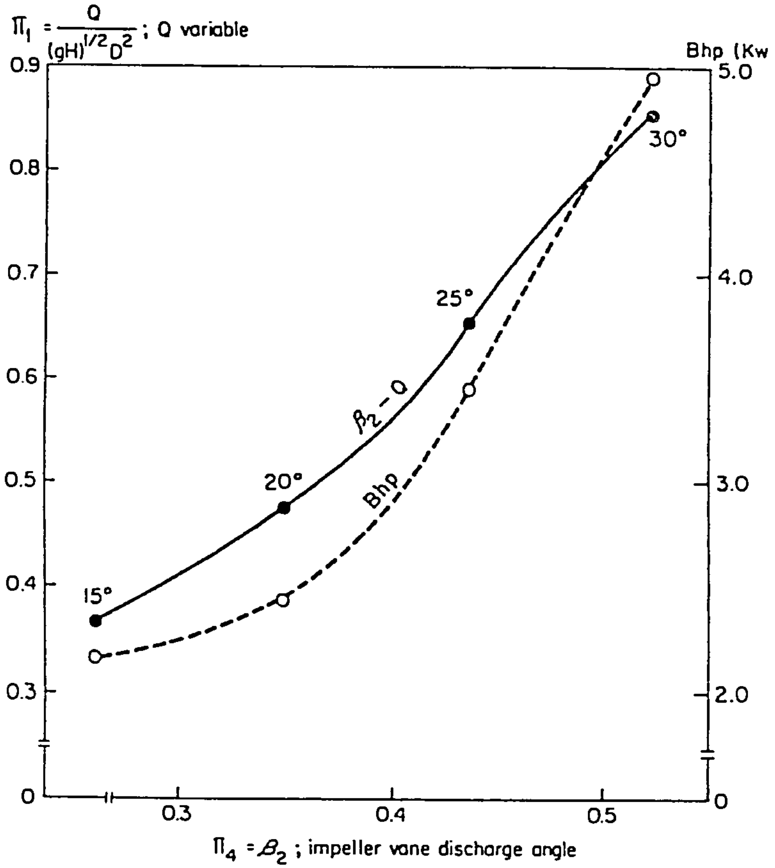


Fig. 7. Effect of impeller vane discharge angle on capacity Q and break-horsepower of axial-flow pump.

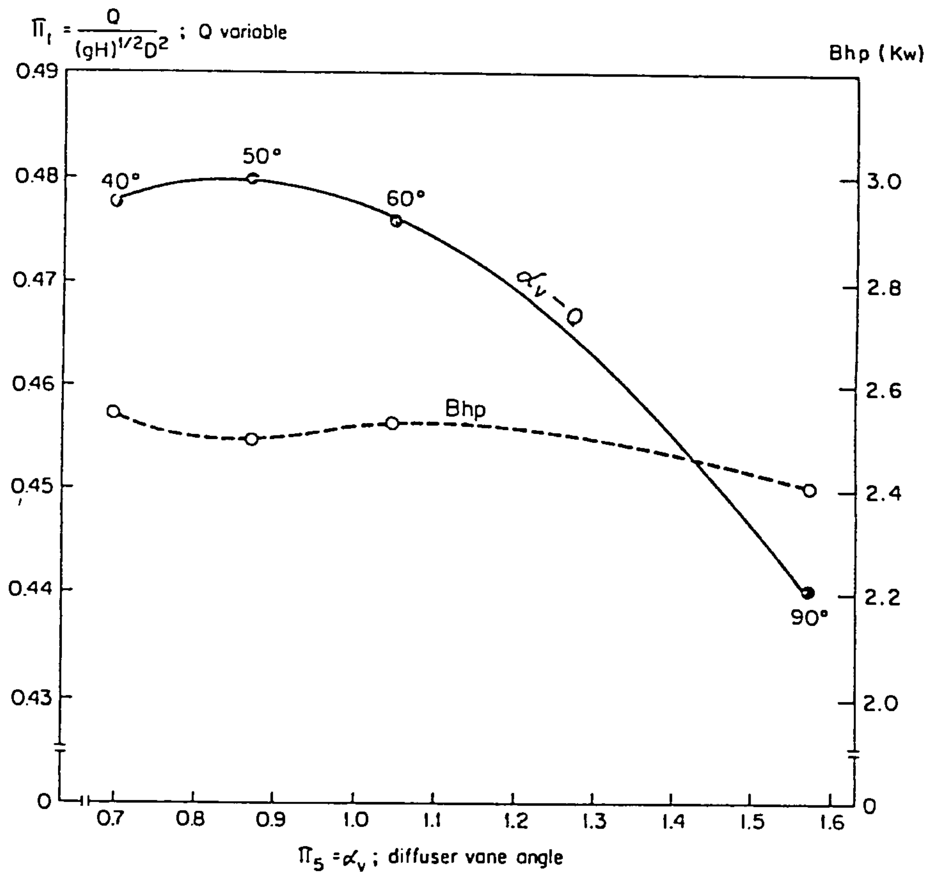


Fig. 8 . Effect of diffuser vane angle α_v on capacity Q and brakehorsepower of axial-flow pump.

130

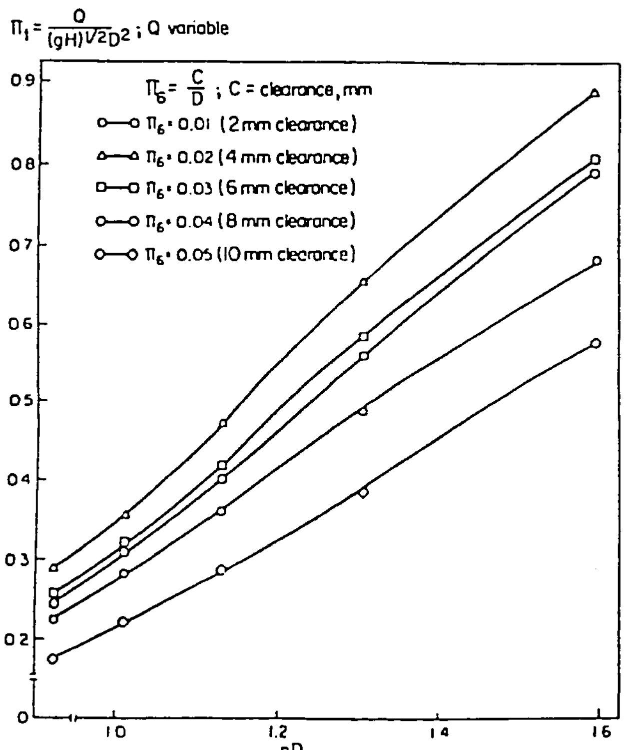


Fig. 9. Relationship between Π_1 and Π_2 at different levels of Π_6 used in determining equation 5

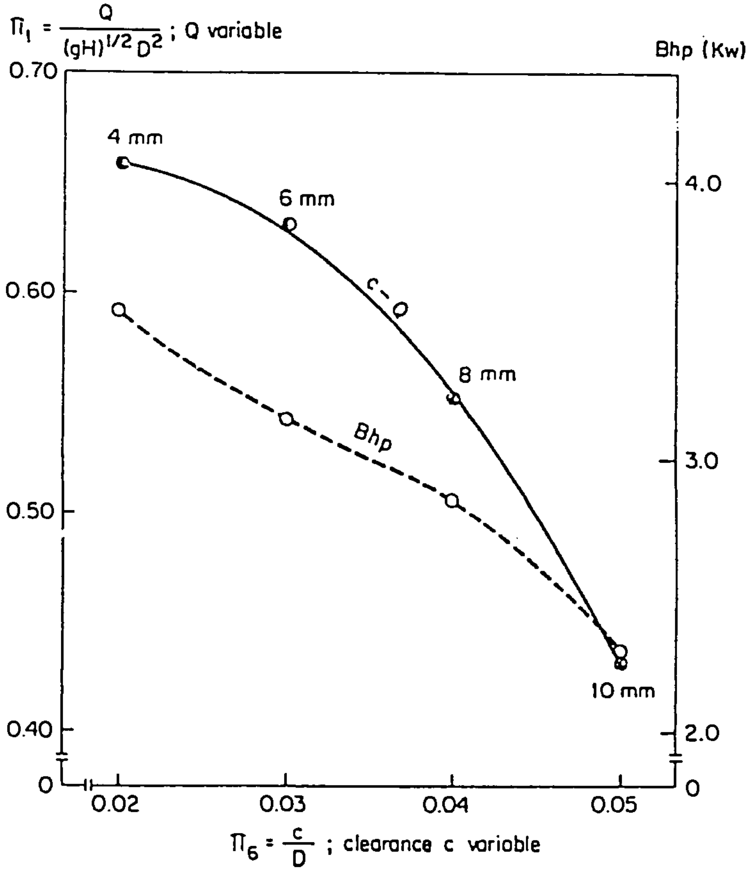


Fig. 10. Effect of clearance on capacity Q and Break-horsepower of axial-flow pump.

131

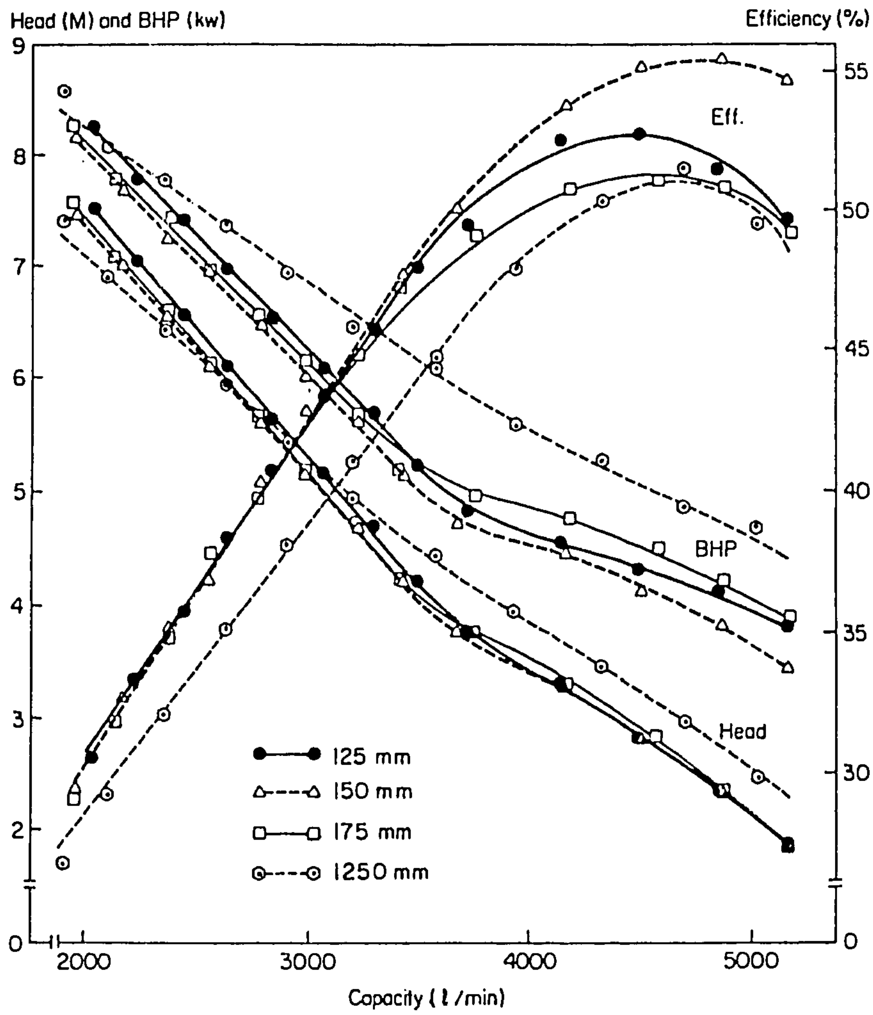


Fig.11 . Effect of spacing between impellers on the performance of two-stage axial flow pump.

\32

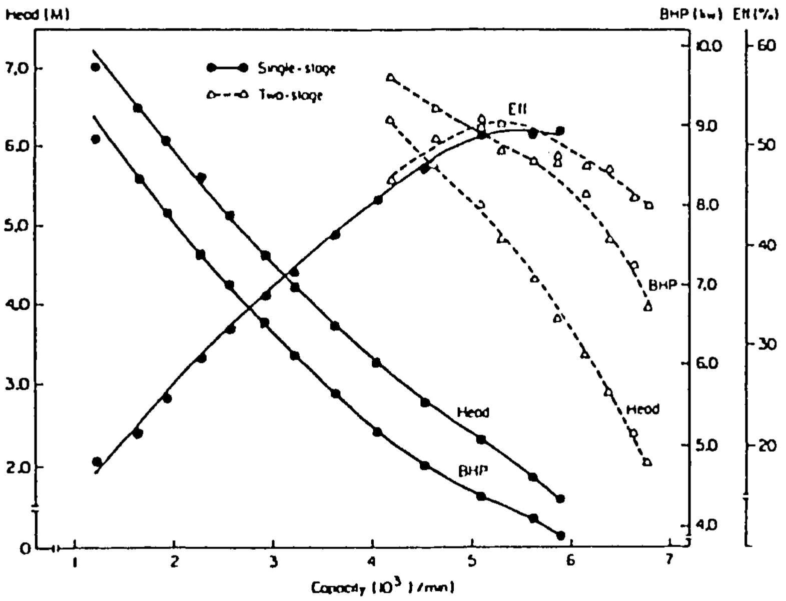


Fig.12 . Performance of single-stage and two-stage IRRI axial-flow pumps at 1800 rpm

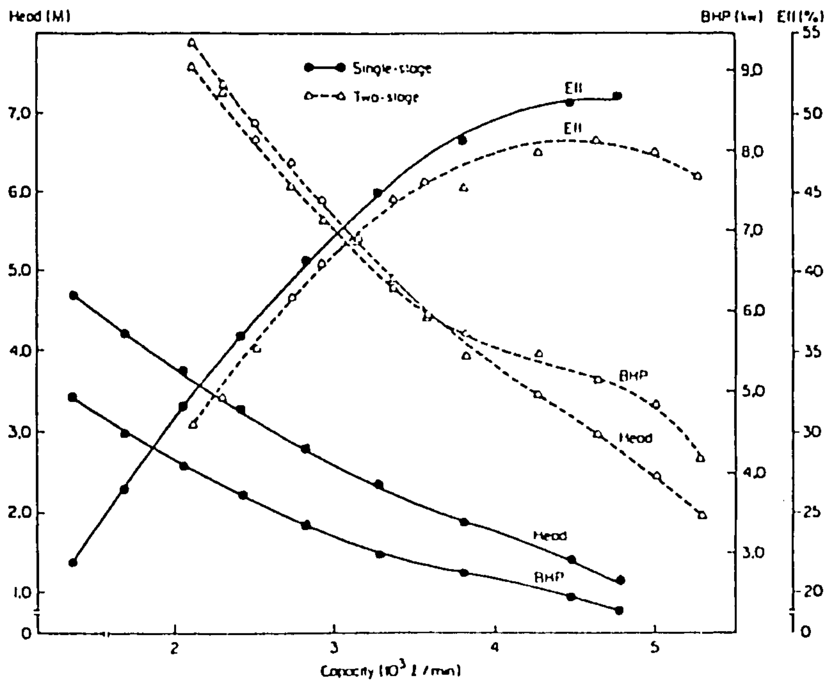


Fig. 13. Performance of single-stage and two-stage IRRI axial-flow pumps at 1500 rpm

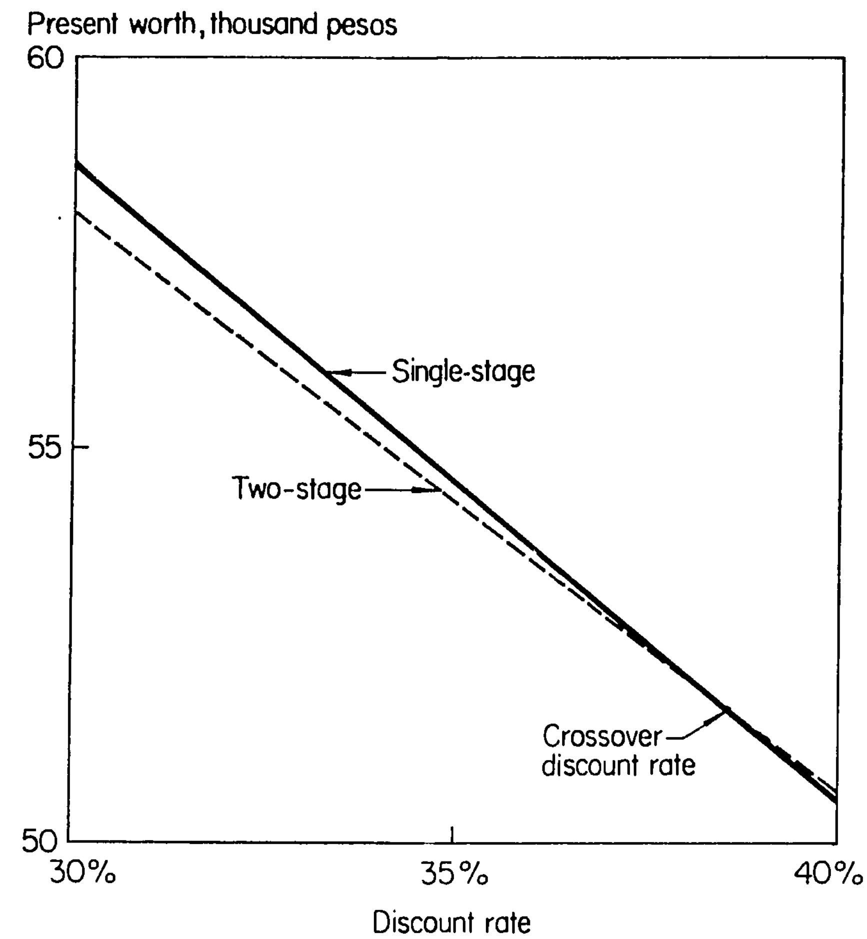


Fig. 14. Crossover discount rate between single-stage and two-stage pump.

MA-IRRI INDUSTRIAL EXTENSION PROGRAM FOR SMALL FARM EQUIPMENT

ANNUAL REPORT
(September 1983 - September 1984)

and

PROPOSED WORKPLAN
(September 1984 - September 1985)

Prepared by:

BENITO C. GONZALO
BPI Co-Leader

ROBERT E. STICKNEY
IRRI Co-Leader

MA-IRRI INDUSTRIAL EXTENSION PROGRAM FOR SMALL FARM EQUIPMENT
Agricultural Engineering Division
Bureau of Plant Industry
Ministry of Agriculture
San Andres Street, Malate
Metro Manila

1. INTRODUCTION

In 1980 the International Rice Research Institute (IRRI) received a grant from the US Agency for International Development (USAID) to establish agricultural equipment extension projects in four countries: Indonesia, India, Thailand, and the Philippines. This report covers the project carried out in the Philippines under the name "MA-IRRI Industrial Extension Program for Small Farm Equipment".

The MA-IRRI Program was initiated in September 1981 when the IRRI Co-Leader reported for work at the Bureau of Plant Industry (BPI), Manila, after completing orientation at IRRI. The present report summarizes the Program's progress from September 1981 through September 1984, with emphasis on the last twelve months of this period.

The report has three objectives:

1. It fulfills the requirement of submitting an annual report to the Program's Advisory Committee and to USAID/Washington.
2. It provides the basic document for an evaluation of the Program to be carried out in October 1984 under the direction of USAID/Manila.
3. It serves as the prototype for the final report which will be submitted upon termination of the project on September 30, 1985.

The general objectives and conceptual framework of the MA-IRRI Program are described in Section 2. A major objective is to establish an institutional structure (described in Sections 3 and 4) capable of sustaining the Program after termination of the present project in 1985. Section 5 presents a description of the specific objectives and activities of the MA-IRRI Program, indicating the degree of progress achieved to date. The current status of the Program is evaluated in Section 6 for the purpose of identifying the principal obstacles and/or problems which are limiting progress and must be overcome, to the degree possible, during the final year. The report's annexes provide reference information, including a detailed progress report on equipment development and extension.

2. GENERAL OBJECTIVES AND PRIORITIES

In broad terms, the ultimate objective of this Program is to increase the profitability and output of small farms* in the Philippines through the utilization of appropriate agricultural equipment, ranging from hand tools and animal-drawn implements to small engine-powered machines.

It is proposed that this objective may best be achieved by means of an extension program directed primarily towards small manufacturing shops** located in agricultural areas. The principal advantage of such shops is that their business requires them to provide equipment which is highly attractive to farmers with respect to price, performance, durability, and service. Since the reputation of a local shop is communicated rapidly among neighboring farmers, shop owners are very responsive to the desires, suggestions, and complaints of their customers. This factor, together with keen competition between shops, promotes rapid innovations to improve equipment performance and reduce production costs. Small rural shops now found in the country generally utilize labor-intensive methods to minimize capital investments, and this facilitates the proliferation of competing shops and contributes to rural employment. Furthermore, such shops can survive the present economic depression better than large urban firms because they can respond more easily to market changes, - e.g., farmers deciding to request shops to repair their existing equipment rather than to fabricate new (replacement) units.

---

*The size of a "small farm" is difficult to define because productivity is highly dependent upon water availability and other factors. In areas having irrigation throughout the year, a 2-ha. farm may be above the subsistence level, while in rainfed areas the equivalent size may be 3 to 5 ha.

**In this discussion the term "small shop" denotes one with a low level of capital investment; the number of employees need not be small.

Although the Program concentrates primarily on small rural shops, assistance will also be provided to larger, urban-based manufacturers in the case of equipment or components which require costly or complex fabrication techniques, mass production, or other factors beyond the capabilities of small shops.

The Program's activities are directed towards assisting shops to be largely self-sufficient with respect to financial backing, marketing, and technical innovations relating to new and/or modified equipment designs and fabrication methods. The reason for this emphasis is to prevent the shops from being weakened by over-dependence upon heavily subsidized credit, sales generated primarily by government programs, and/or excessive technical assistance. R&D institutions will be encouraged to concentrate on those tasks which generally are beyond the capabilities of small shops, such as: searching for innovative designs developed in other countries; developing and testing prototypes based on advanced scientific and/or technological concepts or on high-risk ideas; developing special materials or processes, when necessary (e.g., hardened steel cutter blades).

From the outset, the Program will be implemented in close collaboration with the shop owners and technicians themselves in a manner that both encourages and benefits from their ideas derived from practical experience and familiarity with local conditions, as well as from their pragmatic approach based more on "learning-by-doing" than on scientific knowledge or project planning methodologies. A principal responsibility of the Program staff will be to identify and facilitate the cooperation of institutions which may assist the shops in ways that are consistent with these objectives. For example, these may be private or public institutions associated with developing small-scale industry, promoting innovations and inventions, providing credit to small farmers, developing agricultural equipment, etc. The form of institutional cooperation will vary markedly from one type of implement to another, thereby precluding the possibility of establishing a single inter-institutional structure which could serve for all activities and phases of the Program. On the contrary, rigid structures should be avoided in order to encourage the adoption of flexible arrangements tailored to fit the particular characteristics of a given type of equipment.

Although agricultural equipment often relates to the problem of reducing the peak (or seasonal) demands for labor, the Program will not limit its focus solely to labor-saving implements. High priority will be given to equipment which increase cropping intensity (e.g., small pumps for irrigation), reduce losses (e.g., dryers), and improve the effectiveness of agricultural inputs (e.g., implements for proper placement of fertilizer and/or seeds). At present, however, equipment of this type is extremely limited or still in the R&D stage. Consequently, the Program attempts to identify and stimulate the development of implements which may be suitable for extension in subsequent years. This includes efforts to increase local production of equipment now being imported, thereby hopefully reducing prices to farmers, creating employment opportunities, simplifying maintenance and repair, and improving the balance of trade.

3. ORGANIZATIONAL STRUCTURE

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. When the MA-IRRI-USAID agreement terminates in September 1985, an institutional structure similar to that shown in Figure 1 should be functioning in an effective and sustained manner.

Athough Figure 1 presents a highly simplified picture of the institutional relationships affecting the Program, it helps us to describe several of the principal factors. The main component is the FARMERS*, who in this case are primarily rice and corn farmers with small land holdings (see Section 2). The objective is to enable

---

*The components of Figure 1 are typed in capital letters for emphasis.

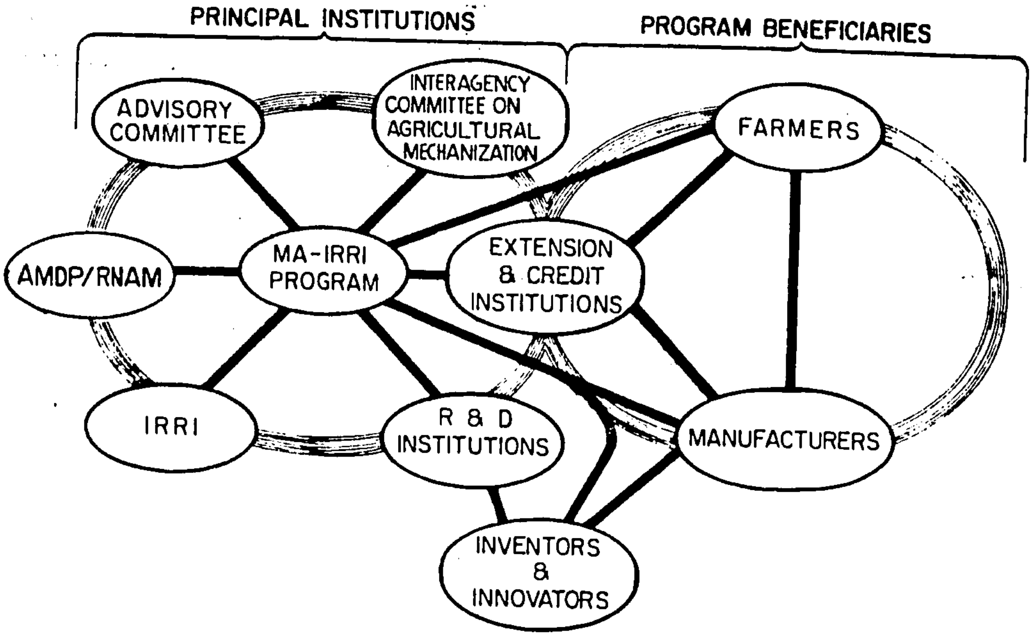


Figure 1. Organizational Structure of MA-IRRI Program

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, on-farm trials, 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 MANUFACTURERS. 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 Banos, 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),

141

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 efforts of 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 Banos), 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 (AMMDA). 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) joined together with the Ministry of Agriculture and IRRI to sponsor a workshop on agricultural mechanization in 1983. However, it appears that neither NEDA nor PICAM has yet been able to initiate substantive activities relating to smal-farm equipment.

4. PERSONNEL AND FACILITIES OF MA-IRRI PROGRAM

The central office of the Program is located in the Agricultural Engineering Division of the Bureau of Plant Industry (BPI) of the Ministry of Agriculture (MA) in Malate, Manila. The two co-leaders of the Program are Benito C. Gonzalo, Chief of the BPI Agricultural Engineering Division, and Robert E. Stickney, IRRI extension engineer.

The BPI Agricultural Engineering Division has a staff of 15 engineers, of which 10 have regular appointments and 5 are contracted as casual (temporary) employees. Seven of the 15 engineers are devoting at least 50% of their time to the Program, for which they receive an honorarium of ₱450/month (based on Government-approved PCARRD regulations) if their level of activity has been adequate during the month.

The program also utilizes the part-time services of "Regional Project Engineers" who are regular employees of the Ministry's experiment stations or regional offices located in the agricultural regions of the country. Eight Regional Project Engineers have been devoting an average of 25% of their time to the Program, thereby contributing approximately two man-years of effort per year. Their participation is essential to the Program because they live in the regions and therefore are familiar with the local conditions, practices, and dialects -- and can provide frequent assistance to local manufacturers. They submit monthly reports to the central office and are given an honorarium of ₱450/month if their level of activity has been adequate.

All of the abovementioned engineers who are participating in the MA-IRRI Program have received training at IRRI. Most have attended the basic two or three week course on IRRI agricultural machinery, and many have also participated in individualized on-the-job training at IRRI and/or field sites on specific equipment (e.g., transplanter, hand tractor, reaper, pump and thresher/sheller) and on specific skills (e.g., drafting). Three of the regional project engineers

147

have undergone three-month training periods at IRRI and BPI, thereby helping to familiarize them with the Program and its staff, as well as strengthening their technical skills and knowledge.

A primary goal is to have more of the equipment development work be carried out at the regional level rather than at the central office in Manila. This is consistent with the general decentralization movement in the Ministry of Agriculture, and it would strengthen the Regional Project Engineers' roles in the Program and benefit from their proximity to farmers and cooperating manufacturers. Moreover, an increasing portion of the work at the regional level is being done through direct collaboration with some of the outstanding cooperating manufacturers, thereby benefitting from their practical experience with farm equipment and farmer preferences, their ability to innovate, and the availability of their shop facilities. This approach is described in more detail in Annex E.

The MA-IRRI Program provides the central office with a Program Co-Leader and a secretary/bookkeeper. The Program has also hired two engineers on a temporary basis to carry out specific tasks relating to the seed and fertilizer applicator and the tapak-tapak pump. Both have skills that are essential to the Program but unavailable among BPI engineers, and it is unfortunate that BPI cannot hire them due to a freeze on staff employment.

The Program has one vehicle available on a full-time basis (1976 Ford Granada donated by IRRI to BPI) and it occasionally utilizes BPI vehicles (a jeep and a pickup). It may be necessary to obtain a pickup truck on a full-time basis if the availability of the BPI pickup is not improved. We are exploring the possibility of borrowing a pickup from the Bureau of Agricultural Extension.

In general, the Regional Project Engineers are able to use vehicles available at their experiment stations or regional offices, with BPI providing funds to some regions for fuel. However, travel has been limited recently because these funds from BPI have been reduced and delayed.

Progress has been hampered by the inadequate facilities and personnel of the BPI machine shop with regards to fabricating prototype equipment. The MA-IRRI Program has provided the shop with some essential equipment (e.g., sheet metal bender and roller, oxy-acetylene torch, and hand tools), and BPI has taken actions to improve supervision of shop personnel. A basic problem is that the BPI wages for shop technicians are too low (e.g., ₱20 to ₱25 per day) to attract qualified workers. The Advisory Committee has been asked to help resolve these problems.

The Industrial Extension Section located at IRRI has provided the MA-IRRI Program with approximately two man-years of engineering effort during the past year, plus one secretary. The MA-IRRI staff agrees that the participation of these IRRI engineers is essential but their role should be that of assisting BPI engineers rather than leading them, especially with respect to visits to cooperating manufacturers when the visible program should be MA-IRRI, not IRRI.

5. PROGRAM ACTIVITIES

The principal activities of the MA-IRRI Program may be described in terms of six steps:

1. Define Priorities
2. Develop Equipment
3. Test and Evaluate Equipment
4. Promote Equipment to Manufacturers
5. Technical Assistance to Manufacturers
6. Monitor and Evaluate

These steps, which are described below, are the basic elements of the on-going process of the Program, - with feedback occurring between steps as a result of learning gained through implementation. For example, experience gained in steps 3 and 6 provide useful information for sharpening the definition of the Program's priorities in step 1.

Step 1: Define Priorities

One of the first tasks of the MA-IRRI Program was to determine:

- Who are the principal target groups of the Program?
- What types of agricultural equipment would be most appropriate for these target groups?

It was decided that the target groups should be small farmers (say 1-5 ha) who grow either rice or corn as primary crops. Rice is the main food crop of the Philippines and it was the highest priority of the Ministry of Agriculture during the 1970s. Corn is now a high priority because the Government wishes to reduce importation of yellow corn needed for animal feed. We also chose to consider mungbean, cowpea, and vegetables which are frequently grown by rice and corn farmers as secondary crops.

The Program staff visited all of the major rice and corn areas of the Philippines. Figure 2 presents a map showing the major rice-producing areas. It is recognized that different areas have different needs with respect to small farm equipment. The more recently settled areas, such as the Cagayan Valley and Mindanao, generally have larger farm sizes and lower availability of labor and, therefore, may benefit from labor-saving equipment (e.g., reapers) which would not be appropriate in the densely-populated areas, such as Bicol, where farm sizes are small and labor is in greater supply. The latter areas would benefit from equipment which increase the opportunities for labor through, for example, increased cropping intensity (e.g., manually powered pumps and planters to enable dry-season crops). Areas with intense rainfall during harvest periods would benefit from post-harvest equipment (e.g., threshers and dryers) to reduce crop losses. We have kept these considerations in mind when planning area-specific extension activities, as will be subsequently illustrated.

148

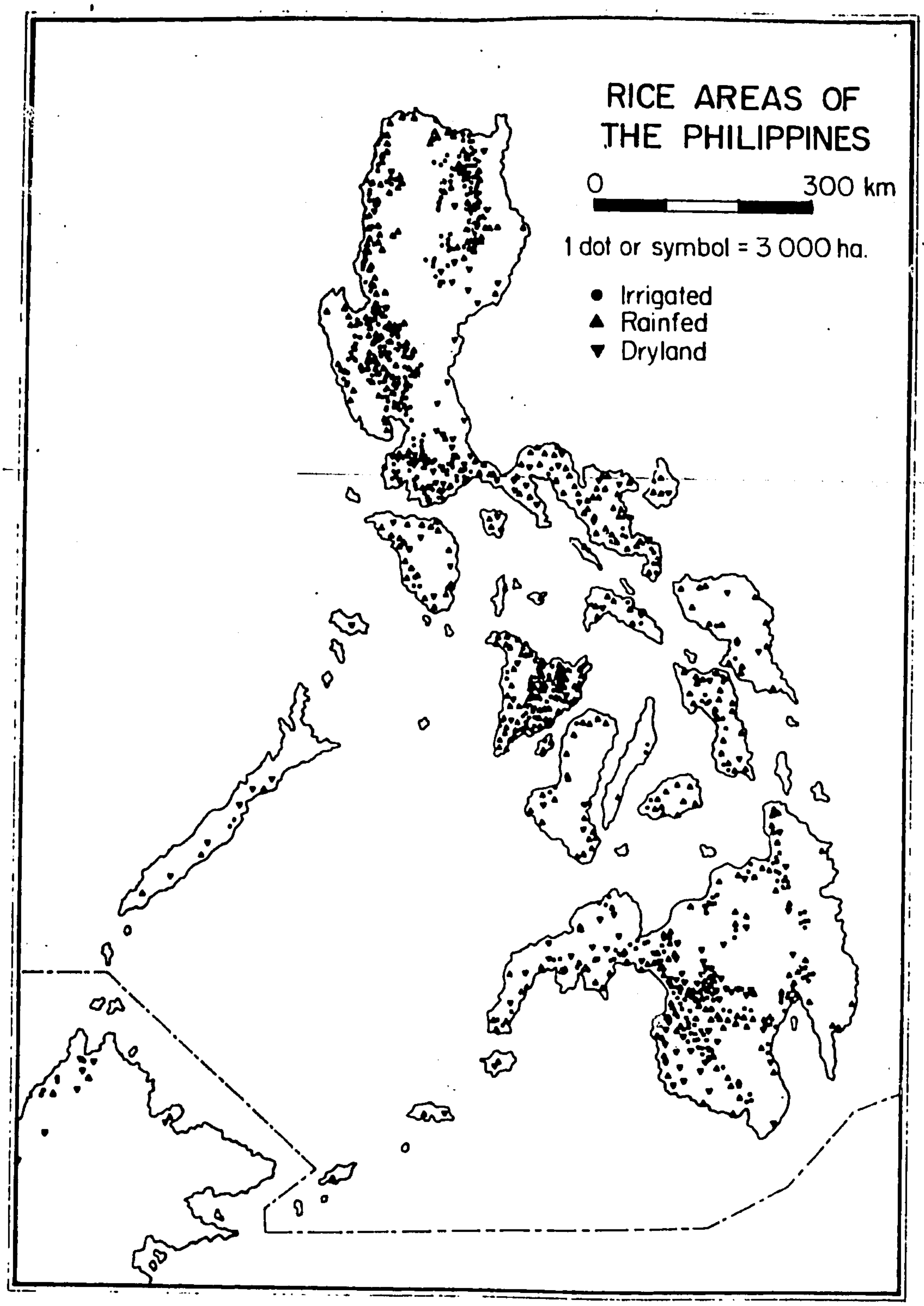


Figure 2. Rice Areas of the Philippines.

Our first task was to study available information provided by past surveys of agricultural equipment in the Philippines, and then to visit the main agricultural areas to carry out informal surveys to provide missing details. We then organized two workshops for the purpose of determining the types of small farm equipment which should be considered as priorities for the MA-IRRI Program. One workshop was held in Central Luzon and the other in Mindanao, and the participants included farmer leaders, agricultural extension technicians, R&D workers, and outstanding manufacturers. The principal output of these workshops is the list of priority equipment shown in Table 1. Although we consider this list to be imperfect and incomplete, it has served as a useful guide in our efforts to identify and develop appropriate equipment for the MA-IRRI Program, as described below.

Table 1. Priority Equipment for MA-IRRI Program.*

RICE FARMS	CORN FARMS
Reaper	Planter-fertilizer
Dryer	Weeder-cultivator
Rotary weeder	Sprayer
Broadcaster	Sheller
Transplanter	Dryer

*See Annex A for detailed discussion.

Step 2. Develop Equipment

The Program's effort to develop equipment may be divided into a short-term and a long-term effort. The objective of the short-term effort was to identify promising designs of priority equipment for immediate use in the Program. The search for designs began at IRRI

148

and UPLB, and then extended to other universities and R&D institutions within the country, as well as to talk with farmers and manufacturers about existing innovations. It also included a review of international publications on agricultural equipment suitable for small farms.

The objective of the long-term effort was to establish contacts with Philippine institutions which may help provide the Program with new equipment designs in the future. This is an institution building activity which focuses on strengthening the national capability for R&D on small farm equipment. It included contacts with organizations such as PCARRD and ARO which provide funds to government and private institutions for R&D on agricultural equipment. A related activity was to promote the development of inventors and innovators of small farm equipment through national contests, such as the Philippine Inventors Fair and the National Science Fair. (See Annex B).

Table 2 provides a list of the equipment which has been considered by the Program during the past three years. (See Annex E for detailed report). Notice that equipment designs have come from a variety of sources. As indicated, we have discontinued work on some designs which did not appear to have sufficient promise.

Step 3. Test and Evaluate Equipment

We have carried out two types of tests or evaluations:

1. Intensive on-farm tests of prototype equipment to determine its durability and technical and economic performance under a wide variety of conditions (e.g., soil composition, rainfall, crops, etc.). An example is the intensive test of the reaper and transplanter carried out at the PPC Rice Farm in Mindanao.
2. On-farm demonstrations and tests to obtain farmers' evaluations of prototype equipment, including their suggestions regarding possible improvements.

Table 2. Equipment Considered by MA-IRRI Program*

Equipment	Source of Design	Regions where evaluated	Current Status
1. Axial-flow thresher	IRRI design	2, 5, 8-12	MA-IRRI continuation; of IRRI extension initiated in 1981
2. Reaper	Chinese design adapted by IRRI	2, 4, 5, 8-12	Extension initiated in 1982
3. Hand tractor	IRRI modification of existing designs	2, 4, 5, 8-12	Extension initiated in 1982
4. Axial-flow pump	Thailand and Vietnam designs modified by IRRI	2-6, 8-12	Extension initiated in 1982
5. Seed and fertilizer applicator	MA-IRRI modification of existing designs	2-4, 6-12	Extension initiated in 1983
6. Transplanter	IRRI design with improvements through MA-IRRI feedback	2-6, 10, 12	Preliminary extension initiated in 1984
7. Rolling injection planter	IITA design modified by IRRI	2, 4, 6, 11, 12	Undergoing on-farm evaluation
8. One-wheel hand tractor	USA-manufactured unit purchased by MA-IRRI for evaluation	4	Discuounted work on basis of evaluation
9. Heated floor dryer	MA-IRRI and IRRI design	10	Discounted work on basis of evaluation
10. Root-crop chipping machine	BPI adaptation of existing designs	4, 8	Extension initiated in 1984
11. Corn harvesting hook	USA design via San Miguel R&D Center	2, 4	Discounted work on basis of evaluation
12. Low-volume sprayer	Sri Lankan design	4	Evaluation shelved due to inadequate personnel
13. Manual corn sheller	USA design modified by MA-IRRI	4	Discounted work on basis of evaluation
14. Thresher/sheller	MA-IRRI adaptation of IRRI thresher design	2-4, 10-12	Extension initiated in 1984
15. Tapak-Tapak pump	Bangladesh design adapted by MA-IRRI	3, 4, 12	Extension will be initiated in late 1984
16. Disk plow for hand tractor	Filipino manufacturer adaptation	4, 11, 12	Evaluation in progress
17. Vertical-bin dryer	Modification of IRRI design	4	Discontinued work on basis of evaluation
18. Floating power tiller	Filipino manufacturer design	5	Evaluation in progress
19. Rice hull furnace	Japanese design; unit purchased by MA-IRRI for evaluation	4	Evaluation in progress
20. Corn dryer	UPLB design	4	Evaluation in progress
21. Harness for draft animals	Designs from international publications	-	Preliminary study initiated in 1984

*See Annex E for detailed report.

150

Equipment tests and evaluations were carried out in various regions during the past three years, as indicated in Table 2. These were time consuming and relatively costly undertakings, but we consider them as essential steps to be taken before making a decision to promote (or not to promote) a particular type of equipment.

Step 4. Promote Equipment to Manufacturers

A major effort of the Program was to establish close working relationships with a number of manufacturers throughout the country, especially in farming areas (Section 2). This was done by visiting the main agricultural areas and asking leading farmers and agricultural extension technicians to identify the best equipment manufacturers and repair shops in the vicinity. We then visited these manufacturers to inform them of the Program and to invite them to become "cooperators". A manufacturer becomes a cooperator in the MA-IRRI Program by signing a Memorandum of Agreement covering two major points. First, the 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.

At present, the Program has over 200 cooperators located in the main rice-producing areas of the country. The geographical location of these cooperators is illustrated in Figure 3, and a detailed list of the names and locations of cooperators is included in Annex C.

The cooperators range in size from small blacksmith and metalcraft shops to large-scale industries. The data presented in Table 3 indicate that the majority of the cooperators are small with respect to capital assets and number of employees. However, a few of the cooperators are large-scale manufacturers located in or near Metro Manila.

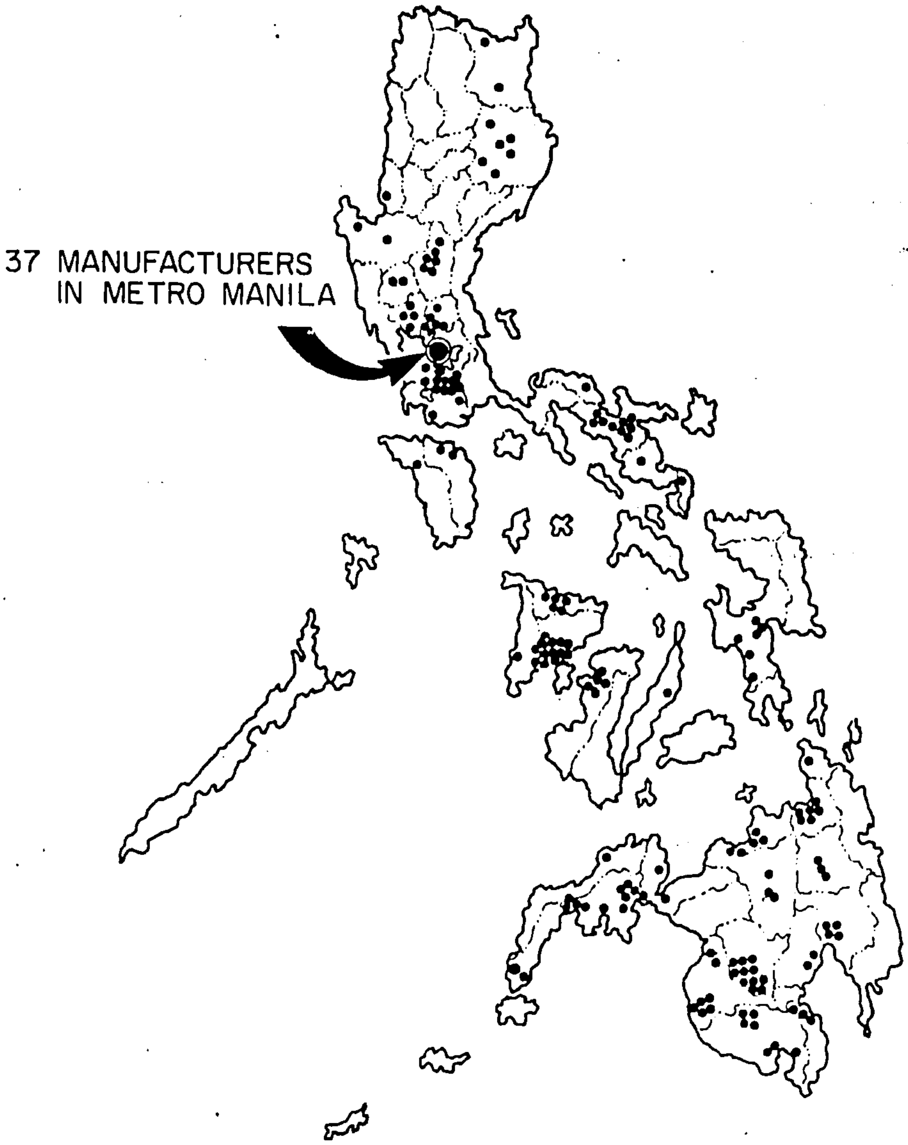


Fig. 3. Geographical location of cooperating manufacturers of the MA-IRRI Industrial Extension Program for Small Farm Equipment.

Table 3. Profile of MA-IRRI Cooperating Manufacturers accoding to Capital Assets and Labor.[a]

Ranges		Cooperators (%)
CAPITAL ASSETS[b]		
Cottage Industry	: Below US$10,000	43
Small Industry	: $10,000 to $100,000	43
Medium Industry	: $100,000 to $400,000	10
Large Industry	: Above $400,000	4
LABOR (Number of employees)		
	Below 6	29
	6 to 15	44
	16 to 50	21
	above 50	6

[a]Data as of March 1983.

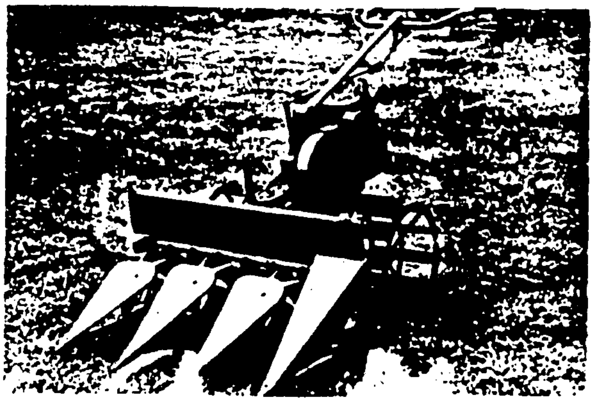
[b]Converted from Pesos using ₱10 per US dollar (March 1983).

Figure 4 illustrates the types of equipment promoted by the Program. New cooperators are allowed to request a set of engineering drawings ("blueprints") for only two types of equipment until they have proven their capability. Table 4 summarizes the number of blueprints requested by cooperators during the past three years, and the popularity of the reaper and PT5 hand tractor is evident. The table also indicates the number of cooperators who have borrowed a unit of prototype equipment from the Program to facilitate fabrication of their first unit. Most small shops are not capable of fabricating equipment solely from the blueprints, and they are helped by loaning them a unit to serve as a model.

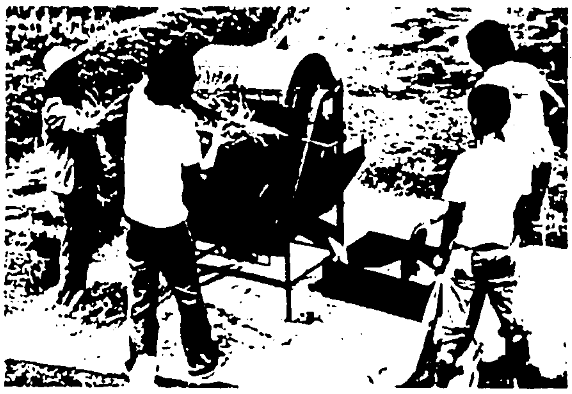
Table 4. Numbers of cooperating manufacturers who requested blueprints and/or borrowed demo units of MA-IRRI equipment (1982-84).

Equipment	Number who requested blueprints	Number who borrowed unit
Thresher (TH6, 7 and 8)	65	6
Reaper (RE2)	126	26
Hand Tractor (PT5)	132	27
Axial Flow Pump (PU)	18	5
Transplanter (TR3 and 4)	58	9
Seed and Fertilizer Applicator (SFA)	24	15
Rolling Injection Planter (RIP)	14	9
Totals	437	97

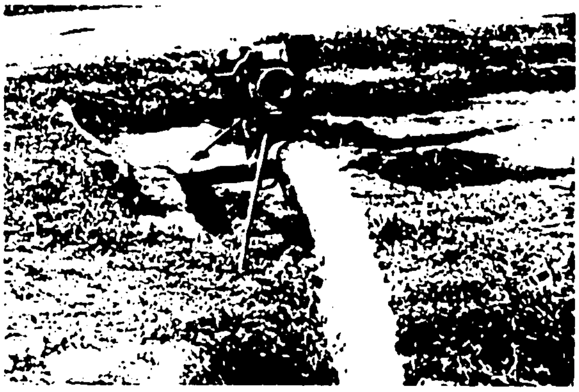
Lightweight Hand Tractor



One-meter Reaper



Axial-flow Thresher



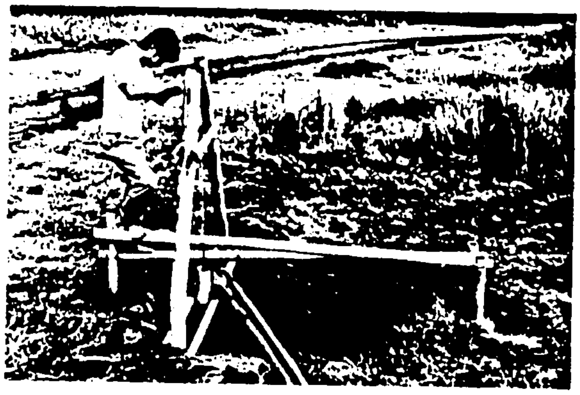
Axial-flow Pump

Seed and Fertilizer Applicator

Figure 4. Equipment being promoted by the MA-IRRI Industrial Extension Program.

Rice Seedling Transplanter

Rootcrop
Chipping Machine



Foot-powered Pump

(Continuation of Fig. 4)

156

Step 5. Technical Assistance to Manufacturers

The Program provided the following types of technical assistance to manufacturers:

a. Assist manufacturers to understand the blueprints for the type of MA-IRRI equipment selected by them.
b. Loan prototype units of equipment to small manufacturers who are not capable of fabricating equipment solely from blueprints. In some cases, the most important jigs and fixtures were also loaned.
c. Advise manufacturers on where they may purchase materials and parts that either are not available in their vicinity or may be purchased elsewhere at much lower prices.
d. Assist manufacturers with the most difficult and/or critical steps of fabrication, assembly, and adjustments. In the case of the reaper and PT5 hand tractor, the Program carried out two training courses for interested manufacturers. (A total of 56 manufacturers attended at their own expense.)
e. Collaborate with manufacturers in pre-tests of the first ("prototype") units produced by them, indicating how to operate the equipment properly in the field, as well as correcting fabrication defects and demonstrating critical adjustments and maintenance procedures.
f. Conduct detailed tests of the prototype units produced by manufacturers, both in their shops and in the field, indicating any necessary modifications. If the prototype passes this test, the MA-IRRI Program provides a written approval informing the manufacturer that he may commence commercial production.
g. Assist manufacturers with initial sales efforts, including field demonstrations to farmer groups, using equipment for custom (contract) work, and arranging loans from local banks.

Our technical assistance efforts were most intensive in Regions 2, 6, 9, 10, 11, and 12, followed by Regions 3, 4, 5, and 8. We expect to initiate efforts in Regions 1 and 7 before the end of this Project.

The most tangible indicator of the effectiveness of the Program's technical assistance efforts is the number of manufacturers who have successfully fabricated at least one unit of equipment promoted by the Program. As may be seen in Table 5, the reaper and PT5 hand tractor were fabricated successfully by 39 manufacturers. Seven other types of equipment were fabricated by a small number of manufacturers.

Table 5. Number of manufacturers who have fabricated at least one unit of MA-IRRI equipment.

Equipment	Number of Manufacturers
Reaper (RE2)	39
Hand Tractor (PT5)	39
Axial Flow Pump (PU)	9
Transplanter (TR3 and 4)	9
Seed and Fertilizer Applicator (SFA)	8
Rolling Injection Planter (RIP)	4
Thresher/sheller	2
Tapak-Tapak Pump	1
Chipping Machine	1

Step 6. Monitor and Evaluate

An on-going effort was made to monitor and evaluate the Program's performance with respect to the time-phased implementation plan (see Annex G), thereby identifying problems and deciding upon corrective measures. The most tangible measure or indicator of the overall performance of the MA-IRRI Program is the number of units of MA-IRRI equipment manufactured and sold by cooperating manufacturers. These data are presented in Table 6, where the reader may observe that the reaper and PT5 hand tractor achieved reasonable levels of production. (As described in Annex E, reaper sales have dropped off markedly in 1984 due to both technical and economic problems.) The data in Table 7 show that other types of MA-IRRI equipment have achieved only low levels of production, perhaps because of the newness of the equipment and the depressed economy. Consequently, it is too early to judge these equipment with respect to degree of acceptance by farmers.

The most important output of the Program is the impact (positive or negative) of MA-IRRI equipment on the productivity and income of small farmers and landless farm laborers. Because of the low level of sales of MA-IRRI equipment, it is too early to carry out a detailed impact study of this nature. We have, however, undertaken preliminary studies of the reaper (in collaboration with IRRI economists), the rolling injection planter (in collaboration with IRRI's Training and Technology Transfer Department), and the axial flow pump. The need for impact studies is discussed in Section 6.

Table 6. PRODUCTION STATISTICS FOR MA-IRRI COOPERATING MANUFACTURERS

PHILIPPINES 1975-1983

EQUIPMENT	YEAR									TOTALS
	1975	1976	1977	1978	1979	1980	1981	1982	1983	
1. Hand Tractor (PT5 and variations of PT3)	2178	2586	856	795	1337	978	1107	2310 1/	2268	14415
2. Axial Flow Thresher (TH7 & 8)	275	552	494	689	1850	1059	1417	1689	1162	9187
3. Portable Thresher (TH6)	-	-	827 2/	1746	2290	1218	1275	1113	1129	9598
4. Batch Dryer: BD1, horizontal bin	33	93	64	34	47	66	102	41	12	492
BD2, vertical bin	-	-	-	-	-	16 3/	16	6	14	52
5. Axial Flow Pump (PU4)	-	-	-	-	13 4/	55	66	38	86	258
6. Transplanter (TR1 & 4)	-	-	-	-	-	17 5/	82	73	31	203
7. 1.0 m Reaper (RE2)	-	-	-	-	-	-	-	37 1/	363	400
8. Seed and Fertilizer Applicator (SFA)	-	-	-	-	-	-	-	50 6/	67	117
TOTALS	2486	3231	2241	3264	5537	3409	4065	5357	5132	34722
No. of manufacturers reporting	14	19	17	20	21	31	33	55	75	

1/ PT5 hand tractor and 1.0 m reaper were introduced in early 1982.
2/ Portable thresher was released during later part of 1976.
3/ BD2 vertical bin batch dryer was released during later part of 1979.
4/ Axial flow pump was released during 1979.
5/ Transplanter was first released during later part of 1979; modified version released in 1983.
6/ Seed and fertilizer applicator was introduced in 1983; data include existing designs.

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 MA-IRRI cooperating manufacturers; and b) the number of cooperators has increased markedly over the past four years.

6. SUMMARY OF ACHIEVEMENTS AND SHORTCOMINGS

The purpose of this section is to summarize the results of our self-evaluation of the current status of the MA-IRRI Program. The evaluation attempts to measure the degree to which the principal objectives of the Program have been achieved. This required us to select an indicator of achievement for each objective, as shown in Table 7. Based on these indicators we have evaluated the Program's current status and summarized the conclusions in the third column of the table. The reader should study Table 8 before proceeding to the following discussion of the main conclusions.

We believe that the most critical weakness of the Program is that the BPI staff and budget are inadequate to sustain the basic activities. Although specialized training at IRRI and elsewhere has strengthened many of the skills of BPI engineers, the Program continues to suffer from the lack of: (a) a person who can conceptualize and innovate new designs of small-farm equipment; (b) a machine design engineer/draftsman; and (c) a person capable of performing economic evaluations. Unfortunately, a freeze on hiring prevents BPI from adding persons with these skills.

The BPI budget for the MA-IRRI Program was adequate until 1984 when it was markedly reduced. Funds are now insufficient for travel and transportation expenses associated with technical assistance visits, field trials, and demonstrations. Furthermore, vehicles are often unavailable to MA-IRRI engineers (both at the central and regional levels) even though both BPI and MA Regional offices have idle vehicles.

We request that the Advisory Committee and the Evaluation Team attempt to resolve these staff and budgetary problems. Possible solutions to be considered are: (a) unification of the AMDP and MA-IRRI Programs; and (b) request budgetary support from existing Government programs (e.g., World Bank and USAID supported projects on agricultural extension and research, or on small-scale industry development) or through the establishment of a new project specifically on small-farm equipment.

TABLE 7. EVALUATION OF THE MA-IRRI PROGRAM

OBJECTIVES	KEY QUESTIONS TO BE CONSIDERED	EVALUATION OF CURRENT STATUS
General Objective: To establish a self-sustaining Program for assisting local manufacturers to produce agricultural equipment that will increase small-farm production and income.	1. Are the staff, facilities, and budget of Program's central office (Ag. Eng. Division, BPI) adequate to sustain work after termination of USAID support?	1. This is critical weakness of Program. Staff and budget are inadequate to sustain work. Advisory Committee and Evaluation Team should recommend actions to alleviate problem.
	2. Are working relationships adequate between the Program's central office and other institutions (see Fig. 1) which are essential to development and extension of agricultural equipment, including institutions responsible for national policies affecting agriculture equipment?	2. Working relationships with MA central and regional offices must be strengthened, and a unified effort should be established with AMDP. Also need to strengthen relationships with other extension and R&D efforts described in Section 3.
	3. Do manufacturers have organizations which enable them to: (a) communicate their common needs to the Government; and (b) collaborate in reducing the costs and increasing the quality of their products - but without undermining constructive competition?	3. Initial efforts have been made but with little success except in Region 12 where collaboration with SBAC has been established. Program needs professional advice and assistance on this point.
Specific Objectives: To establish an on-going process consisting of the following activities:		
Define Priorities	4. Is there a suitable document defining priorities of Program with respect to types of equipment to be developed and promoted?	4. A document listing priority equipment has been published (Table 1). This effort must be repeated and refined.
Develop Equipment	5. How many promising designs of priority equipment have been developed by the Program and/or collaborating institutions?	5. Through collaboration with various institutions the Program has come up with a significant number of designs for priority equipment (Table 2).
Test and Demonstrate Equipment	6. How many equipment designs have passed tests and demonstrations to determine technical and economic performance and farmer acceptance?	6. Only a few equipment designs have passed the tests and demonstrations (Table 2). This indicates the need to accelerate the search for new designs.
Promote Equipment to Manufacturers	7. How many manufacturers joined the Program and requested blueprints of equipment promoted by Program?	7. Two of the most successful aspects of the Program are the number and geographical distribution of cooperating manufacturers (Fig. 3) and the distribution of blueprints (Table 4).
Technical Assistance to Manufacturers	8. How many manufacturers have successfully fabricated at least one unit of equipmment promoted by the Program?	8. A moderate number of manufacturers have successfully fabricated MA-IRRI equipment (Table 5).
Monitor and Evaluate	9. (a) How many units of equipment have been manufactured and sold as a consequence of Program's effort? (b) What is the impact of these equipment on small-farm productivity and on the income of farm owners and laborers?	9. (a) Total production of MA-IRRI equipment has been quite low except for the reaper and hand tractor (Table 6). (b) Impact evaluations of MA-IRRI equipment have been initiated but the results are not yet available. Additional evaluations need to be carried out in collaboration with IRRI economists.

162

Another critical problem affecting the MA-IRRI Program is the depressed economic condition of both farmers and manufacturers. We have discussed this problem and possible solutions with private and public institutions (see Annex F), and little progress has been made except in Region 12 where an association of manufacturers is being organized in collaboration with the Small Business Advisory Center (SBAC) of the Ministry of Trade and Industry. We request the Advisory Committee and Evaluation Team to review the situation and recommend possible actions.

With respect to the Program's activities, we feel that progress has been generally satisfactory except for an insufficient number of new equipment designs capable of achieving rapid and well-spread acceptance by farmers. Perhaps it is premature to evaluate acceptance at only three years after the Program's birth. However, we are concerned by the fact that an extension program cannot succeed without new designs which are accepted by significant numbers of farmers. We suggest that the Advisory Committee and Evaluation Team attempt to devise mechanisms to increase the development of appropriate small-farm equipment, perhaps by improving collaboration between IRRI, MA-IRRI, AMDP, and other national institutions which either carry out or provide funds for R&D on agricultural equipment.

We believe that significant progress has been made during the past 12 months with regards to forming collaborative efforts with innovative cooperating manufacturers for the purpose of developing new and/or improved equipment designs. At present, these efforts involve 8 manufacturers on 5 types of equipment, i.e., thresher/sheller, manual pump, dryer, floating tiller, and steam-powered pump. (See Annex E for details). We will place high priority of these productive relationships during the next year.

ANNEXES

A. Proposed Priorities for R&D on Small Farm Equipment

B. MA-IRRI Design Contest - A Challenge to Aggie Engineers and Agricultural Engineering Students

C. List of Cooperating Manufacturers of the MA-IRRI Program

D. Leaflets on Equipment Promoted

E. Progress Report on Equipment Development and Extension Activities

F. Letters to Governor Federico V. Borromeo (Ministry of Trade and Industry) and Mr. Ernesto Garilao (Philippine Business for Social Progress)

G. MA-IRRI Industrial Extension Program for Small Farm Equipment - Schedule of Activities: September 1983 - September 1984.

ANNEX A

MA-IRRI INDUSTRIAL EXTENSION PROGRAM
FOR SMALL FARM EQUIPMENT

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

PROPOSED PRIORITIES FOR R&D ON SMALL FARM EQUIPMENT

Two workshops involving farmers, extension technicians, and researchers have been held for the purpose of:

- Identifying priorities regarding the types of agricultural equipment which would be most useful on small farms in the Philippines;

- Formulating R&D activities for each of the identified equipment priorities.

These considerations concentrated primarily on rice and corn, together with other crops (e.g., legumes, sorghum) which are also planted on rice or corn farms.

The recommendations of the two workshops are described in detail in published reports.* After studying these recommendations, the MA-IRRI Program has come up with the proposal presented in the attached table. The first column lists the ten equipment priorities identified by the workshops. The current status of each of these equipment priorities is summarized in the second column, and the actions proposed for each are described in the third column. Since the actions are for the immediate future, it will be necessary to revise them each year or so.

This proposal is tentative and open for discussion. The MA-IRRI Program would appreciate receiving suggestions on how the proposal may be improved.

---

*1. Report on the Workshop on Small Farm Equipment R&D, held at Maligaya Rice Research and Training Center, Muñoz, Nueva Ecija, December 3-4, 1981 (Report No. IEP-1, July 16, 1982, MA-IRRI Industrial Extension Program for Small Farm Equipment).

2. Report on the Workshop on Small Farm Equipment for Corn Production and Processing, held at Regional Health Training Center, Cagayan de Oro City, June 2-3, 1982 (Report No. IEP-2, July 16, 1982, MA-IRRI Industrial Extension Program for Small Farm Equipment).

PROPOSED ACTIONS ON EQUIPMENT PRIORITIES IDENTIFIED BY TWO WORKSHOPS

EQUIPMENT	CURRENT STATUS	PROPOSED ACTIONS
A. Rice Equipment		
1. Reaper	MA-IRRI Program is promoting the CAAMS-IRRI reaper and providing technical assistance to manufacturers. IRRI Ag. Eng. will modify reaper design according to feedback from the field.	The efforts of the MA-IRRI Program and of the IRRI Ag. Eng. Department should be sufficient for the immediate future. Additional R&D on reapers is not considered to be a high priority at present.
2. Dryer	Many institutions, including the MA-IRRI Program, are carrying out R&D on dryers. However, a dryer acceptable to small farmers has not been demonstrated. A special contest on dryers has been initiated by the MA-IRRI Program.	The MA-IRRI Program should undertake dryer R&D as a high priority. It should also help promote dryer R&D by other institutions, perhaps by organizing a meeting of PCARR, UPLB, IRRI, SEARCA, NAPHIRE, etc. to stimulate and coordinate efforts.
3. Rotary Weeder	UPLB is developing improved designs of two-row rotary weeders. The MA-IRRI Program arranged for a test of the UPLB weeder at the PPC Rice Farm, and one of the wooden weeders used at PPC has been brought to UPLB for evaluation.	Since the potential market for weeders has been reduced markedly by the increasing adoption of direct seeding and herbicides, it is believed that a multi-institutional effort on weeder R&D is not needed. The UPLB project should be sufficient, and the MA-IRRI Program will continue to collaborate in testing prototypes.
4. Broadcaster (of seed, fertilizer, and pesticides)	There is insufficient information for assessing the potential demand and benefits of broadcasters. It appears that R&D on broadcasters is not being performed in any national institutions.	The MA-IRRI Program should meet with PCARR to discuss the possibility of that organization financing a study of the potential market and benefits of broadcasters. The results would provide the basis for planning future R&D on broadcasters.

(continued)

EQUIPMENT	CURRENT STATUS	PROPOSED ACTIONS
5. Transplanter	The MA-IRRI Program has demonstrated the IRRI transplanter at field days, and the farmers have expressed only moderate interest because: (a) the seedling preparation differs from the most common practice (e.g., washed-root or wet bed method) and appears to them to be more costly; (b) there is an increasingly wide-spread trend towards direct seeding in order to avoid the high labor cost of transplanting. The MA-IRRI Program has collaborated with IRRI Ag. Eng. and the PPC Rice Farm to develop a modified transplanter and seedling preparation method which have been adopted by that farm. A simplified method for seedling preparation has also been developed recently in Burma.	It is believed that the transplanter will not be accepted unless the seedling preparation method is simplified to reduce cost. Consequently, the seedling preparation methods of PPC and Burma should be tested and adapted to local conditions. It is suggested that a fertilizer applicator be added to the transplanter to increase its utility. IRRI Ag. Eng. is working on these tasks, and the MA-IRRI Program will collaborate in promoting tests and feedback. It is suggested that no efforts other than these are needed at this time.
B. Corn Equipment		
6. Planter-fertilizer	Several manufacturers have fabricated planter-fertilizers for sorghum and corn, but sales have been very limited. The MA-IRRI Program has designed an experimental unit which combines the best features of existing models and adds several new modifications. This unit will be tested, improved, and then disseminated through the Program.	The planter-fertilizer development by the MA-IRRI Program should continue to receive high priority. Testing and promotion should be planned with NFAC and its collaborating institutions in the Maisagana Program. Similar efforts should be encouraged in agricultural colleges, perhaps through funding by PCARR, ARO, or others.

(continued)

EQUIPMENT	CURRENT STATUS	PROPOSED ACTION
7. Weeder-cultivator	A wide variety of designs of weeder-cultivators exists in the technical literature and many have been tested in the Philippines. However, the majority of the corn farmers continue to use the traditional plow which has limited effectiveness and often damages the roots.	The Ma-IRRI Program should collaborate with PCARR to promote R&D on weeder-cultivators by agricultural colleges. The Program will also initiate its own effort if personnel becomes available.
8. Sprayer	The MA-IRRI Program has begun a study to determine: what types of sprayers are available; are these imported or locally made; what design characteristics are most important; would it be technically and economically feasible to promote local manufacture of an appropriate sprayer?	A definite proposal will be made after having the results and recommendations of the study now being carried out by the MA-IRRI Program.
9. Sheller	A wide variety of corn shellers are fabricated by small shops in many areas of the country. To our knowledge, no study has been made to compare the advantages and disadvantages of these shellers.	It is recommended that the MA-IRRI Program and PCARR collaborate in promoting a comparative study of shellers in order to determine: which designs are most appropriate for small farmers; is there a need to improve these designs for dissemination through the MA-IRRI Program and/or other programs?
10. Dryer	Many institutions, including the MA-IRRI Program, are carrying out R&D on dryers for palay and, less frequently, for corn. However, a dryer acceptable to small farms has not yet been demonstrated.	The MA-IRRI Program should undertake R&D on dryers for corn as well as rice. It should also attempt to promote dryer R&D by other institutions (see above discussion under item #2).

168

Philippine Agricultural Engineering Journal
Vol. XIV No. 1, 1983

ANNEX B

MA-IRRI Design Contest – A Challenge to Aggie Engineers and Agricultural Engineering Students

By
Teresita C. Silva

The Ministry of Agriculture (MA) and the International Rice Research Institute (IRRI) have recently initiated a collaborative extension program on agricultural equipment for small farms producing rice plus other food crops. In general terms, the program's objective is to promote the development, production, and utilization of equipment that will increase the profitability and productivity of small farms in the Philippines. A wide range of equipment such as hand tools, animal-drawn implements, and small machinery will be considered, for operations ranging from land preparation to post-harvest processing. The extension effort will involve the collaboration of existing public and private institutions which are now providing technical and/or financial assistance to small equipment manufacturers or the farmers.

One of the objectives of this program is to strengthen the national capability to develop farm equipment which is: (1) appropriate for local agricultural conditions and needs; (2) produced by small manufacturing shops in rural areas; (3) low cost; (4) designed to minimize the use of imported parts, materials, and fuels. To achieve this objective, the program collaborated with the Science Promotion Institute (SPI) formerly the Science Foundation of the Philippines and the Philippine Invention Development Institute (PIDI), formerly the Philippine Inventors Commission, in giving MA-IRRI Special Awards to participants to the National Science Fair and the Inventors Week, respectively, who have entries related to the program's theme every year.

For two consecutive years, i.e. 1982-'3 and 1983-84, the theme has been "Search for Improved Technology on Palay Drying." The drying equipment should have the following characteristics:

- Appropriate for use on small farms (or groups of small farms)
- Simple in design and acceptable to farmers with respect to cost, operations, etc.
- Locally available materials and fabrication techniques
- Renewable energy sources (e.g. sun, wind, straw, hulls, etc.

MA-IRRI Project Co-leader Benito C. Gonzalo awarding the P5,000 cash award to Messrs. Dennis Arboleda and Mark Arboleda during the Inventors Week.

During the National Science Fair, sponsored by the Science Promotion Institute and held in Tacloban City last January 24-28, 1983, two special prizes of P1,000 each were given to outstanding participants with entries on palay dryer. Mr. Noel Laylo, a senior college student of Marawi State University (MSU), Iligan Institute of Technology (IIT), won the cash award of P1,000 with his entry "Palay Dryer." The other P1,000 cash award went to Mr. Joselito Bacolor, a high school student of Jose Panganiban High School, Camarines Norte for his entry "Reinforced Solar Grain Dryer."

In the recently concluded 1983 Inventors Week sponsored by the Philippine Invention Development Institute (PIDI) and held last February 20-26 at the Philippine Trade Exhibits (PHILTRADE), Roxas Blvd., Manila, three special prizes were given by the MA-IRRI Extension Program. The first prize cash award of P5,000 donated by Planters Products Inc. went to Messrs. Dennis Arboleda and Mark Dondi Arboleda, both third year high school students for their entry "High Speed Drying of Palay." The second prize cash award of P3,000 went to Mr. Edgar S. Virina, a commerce graduate for his entry "Combination Solar and Dendrothermal Dryer" and the third prize cash award of P1,000 went to Mr. Ruperto Elnacin, a farmer, for his entry "Elnacin Universal Grain Dryer."

The panels of judges of both contests composed of selected grain specialists from among the members of the Philippine Society of Agricultural Engineers were as follows:

SPI's National Science Fair:

1. Engr. Felix V. Quero, Jr.
   Project Director

(over)

Farming Systems Development
Project-Eastern Visayas
Tacloban City
Chairman of the Board of Judges

2. Engr. Benito C. Gonzalo
Chief, Agricultural Engineering Division
BPI, Manila

3. Engr. Teresita C. Silva
Supervising Agricultural Engineer
BPI, Manila

4. Engr. Carlito P. Fernandez
Agricultural Engineer
BPI, Manila

5. Engr. Carlos Macabenta
Agricultural Engineer
Gandara Seed Farm
Gandara, Samar

PIDI's Inventors Week:

1. Engr. Pedro N. Laudencia
Consultant
University of Life
Chairman of the Board of Judges

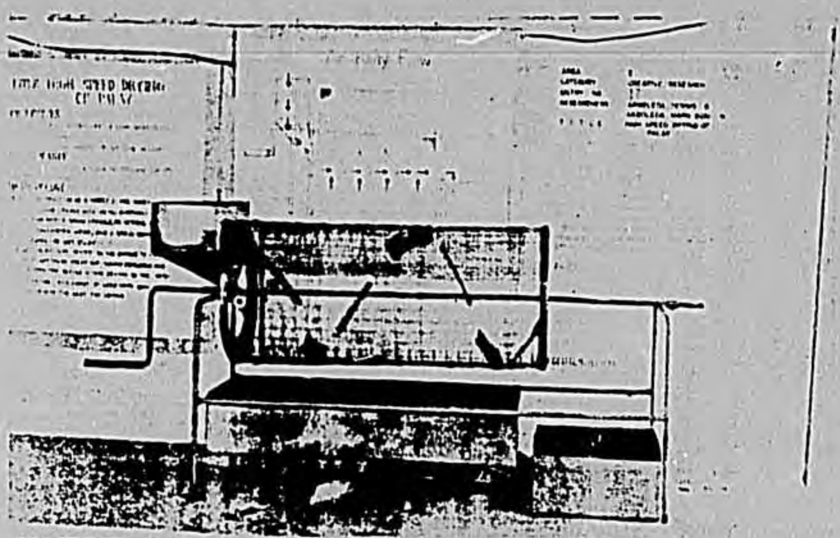
2. Engr. Teofilo Vergara
Chief, Food Processing Division
National Food Authority, Metro Manila

3. Engr. Crestituto C. Mangaoang
Chief of Extension Division
National Food Authority
Metro Manila

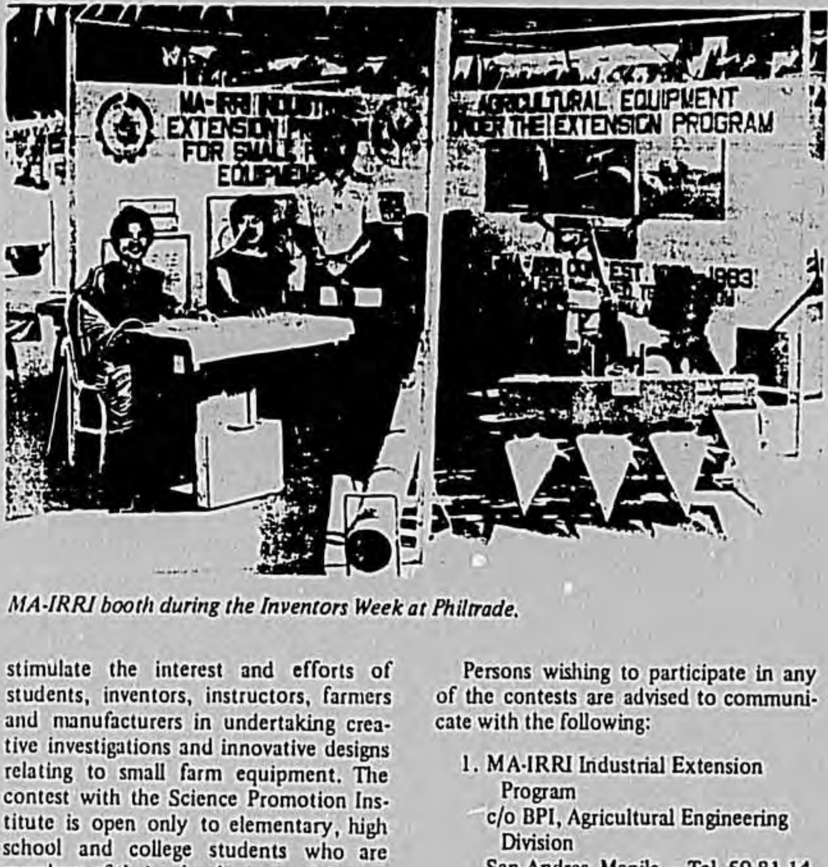
4. Engr. Teresita C. Silva
Supervising Agricultural Engineer
BPI, Manila

Cash prizes provided for the above mentioned contests and for the succeeding contests were solicited from the following:

1. Agricultural machinery Mfg. & Dist. Association
2. Alpha Machinery & Engineering Corporation
3. Ayala Agricultural Development Corporation
4. C & B Crafts
5. Delta Motors Corporation
6. Galzon Construction
7. Norkis Trading Company
8. Philippine Packing Corporation
9. Planters Products Inc.
10. R & D Tuazon Construction
11. Warner Barnes and Co. Inc.



MA-IRRI Design Contest winner during the Inventors Week.



MA-IRRI booth during the Inventors Week at Philtrade.

The MA-IRRI Industrial Extension Program for Small Farm Equipment undertook this design contest in order to stimulate the interest and efforts of students, inventors, instructors, farmers and manufacturers in undertaking creative investigations and innovative designs relating to small farm equipment. The contest with the Science Promotion Institute is open only to elementary, high school and college students who are members of their school science clubs.

For the contest of the Philippine Invention Development Institute during its annual Inventors Week at the PHILTRADE, any individual may participate including agricultural engineering students, college and high school students, professional agricultural engineers, inventors, farmers and manufacturers. Cash prizes given each year are no less than P2,000.

Persons wishing to participate in any of the contests are advised to communicate with the following:

1. MA-IRRI Industrial Extension Program
c/o BPI, Agricultural Engineering Division
San Andres, Manila – Tel. 59-81-14

2. Science Promotion Institute
PTRI Bldg., Bicutan, Taguig, Metro Manila

3. Phil. Invention Development Institute
Bicutan, Taguig, Metro Manila

The PSAE encourages its members to participate in the MA-IRRI Design Contests.

ANNEX C

MA-IRRI INDUSTRIAL EXTENSION PROGRAM FOR SMALL FARM EQUIPMENT

LIST OF COOPERATING MANUFACTURERS OF THE MA-IRRI PROGRAM

(September 1984)

Region I

1. Farmers Association Salsalamagui
   Barangay 16, Vintar
   Ilocos Norte
   President: Angel Agcaoili
   Products : (TH)

2. Me-Ca Trading
   Malasigui, Pangasinan
   Owner : Ildefonso Medel
   Products : (TH), (PU)

3. Paitan West Welding Shop
   Paitan, Sual, Pangasinan
   Owner : Regalado Edrosolan
   Products : (RE), (PT)

4. Philippine-German Manufacturing.Co,
   Calasiao, Pangasinan
   Owner : Mr. H. Thoman
   Products : TTP

5. V.G. Machine Shop
   Agoo, La Union
   Owner : Rodolfo Canillas
   Products : PT, TH, (RE), (PU)

Region II

1. Cagayan Valley Dev. Cooperative, Inc,
   Cauauan, Isabela
   Owner : Fernando Echague
   Products : (TH), (RE), (PT)

2. Collado Metalcraft
   Centro Ballesteros, Cagayan
   Owner : Conrado Collado
   Products : (RE), (PT), (TH)

3. Jorge Welding and Repair Shop
   Centro Mallig, Isabela
   Owner : Jorge Nuñez
   Products : (TR), (SFA), (TH/CS)

4. Four Brothers Metalcraft
   Dist. II Maharlika Metalcraft
   Cauayan, Isabela
   Owner : Alberto Lee
   Products : (RE), (PT), (TH)

5. Katipunan Metal Work
   Km. 423, Liwanag
   Tumauini, Isabela
   Owner : Edilberto Katipunan
   Products: (TH/CS), (SFA)

6. L.T.I. Welding Shop
   Bugallon Proper
   Ramon, Isabela
   Owner : Leonardo T. Imbag
   Products: TH, (RE), (PT), (TR),(TH/CS)

7. La Suerte Machine Shop
   Cauayan, Isabela
   Owner : Isagani T. Cruz
   Products: TH, TR

8. 2M Industrial Shop
   Sinamar Sur, San Mateo, Isabela
   Owner : N. Agcaoili
   Products: PT, RE

9. People's Machine Shop
   Alvarado St., Aparri, Cagayan
   Owner : Juan B. Romero
   Products: PT

10. Samahan ng Bagong Anyo ng Buhay
    Bantug, Roxas, Isabela
    Owner : Elnardo M. Mangunay
    Products: TH

11. Tom Metalcraft Industry
    Minante 2, Cauayan, Isabela
    Owner : Tomas O. Monte
    Products: PT, TH, (RE), SFA, (RIP)

12. Vergara Metal Works
    Daang Maharlika, Villasis
    Santiago, Isabela
    Owner : Danilo M. Vergara
    Products: PT, RE, TH

ABBREVIATIONS: PT = Power Tiller; TH = Thresher; RE = Reaper; PU = Axial Flow Pump; TR = Transplanter; SFA = Seed and Fertilizer Applicator; RIP = Rolling Injection Planter; TH/CS = Thresher/Sheller; CM = Chipping Machine; TTP = Tapak-Tapak Pump.

NOTE: Equipment abbreviations are enclosed within parentheses if the manufacturer has not yet finished fabricating one unit and had it tested by MA-IRRI.

Region III

1. BJ Engineering & Machine Works
   1238 Rizal St., Baliwag, Bulacan
   Owner : Antonio B. de Jesus
   Products: TH, RE

2. Bagong Sikat Metalcraft
   Bagong Sikat, Muñoz, Nueva Ecija
   Owner : Eliseo Ruiz
   Products: BD, TH

3. Bulacan National Agricultural School
   San Ildefonso, Bulacan
   Owner : Macario S. Pagdanganan
   Products: (TH)

4. Castillo Machine Shop
   Encarnacion Subd., San Jose City
   Nueva Ecija
   Owner : Jaime A. Castillo
   Products: (PT), (TH)

5. C&B Crafts
   Maginao, San Rafael,. Bulacan
   Owner : Bonifacio R. Isidro
   Products: TH, RE, PT, (TR), (TH/CS)

6. CNC Handtractor & Rice Thresher Mfg.
   Aldana St., Sta. Barbara
   Baliwag, Bulacan
   Owner : Celestino N. Collantes
   Products: PT, TH, RE

7. D.M. Nozawa Trading Corporation
   Highway, San Fernando, Pampanga
   Owner : Daniel M. Nozawa
   Products: RE

8. Erdy's Machine Shop & Iron Works
   F. Tañedo St., San Nicolas
   Tarlac, Tarlac
   Owner : Erdy H. Dytianquin
   Products: (SFA), (PT), (TH/CS)

9. Jessan Metal & Wood Works
   Bagong Sikat, Plaridel, Bulacan
   Owner : Jesus M. Antonio
   Products: PT, TH

10. Juanito Samson Iron Works
    San Juan, Sta. Ana, Pampanga
    Owner : Juanito Samson
    Products: PT, TH, PU, W

11. Lacroose Farmcraft
    1577 MacArthur Hi-way
    San Nicolas, Tarlac, Tarlac
    Owner : Conrado T. Cruz
    Products: (RE), (PT), (RIP), (TH)

12. L.P. Engineering Services
    San Jose, Baliwag, Bulacan
    Owner : Luis T. Parada
    Products: PT, TH

13. Maharlika Iron Works
    Lugam, Malolos, Bulacan
    Owner : Lolita Garcia
    Products: PT, (PU)

14. New Tarlac Northern Cottage Industry
    Tañedo St., Tarlac, Tarlac
    Owner : Benito Que
    Products: PT, TH, (SFA)

15. Omar Yapchiongco
    Longos, Balagtas, Bulacan
    Owner : Omar H. Yapchiongco
    Products: RE, PT

16. Palayan Agro-Enterprises
    1043 Burgos Avenue
    Cabanatuan City
    Owner : Ernesto M. Escuadro
    Products: PT, TH

17. Phil. Rural Reconstruction Movement
    PRRM, Nieves, San Leonardo
    Nueva Ecija
    Owner :
    Products: -

18. R.D. Intal Metalcraft
    San Vicente, Apalit, Pampanga
    Owner : Jose Intal
    Products: PT

19. Rinos Enterprises
    243 Intan St., Paco Roman Ext.,
    Cabanatuan City
    Owner : Cesar Concepcion
    Products: PT, TH

20. Tarlac Iron Works
    262 F. Tañedo St.
    Tarlac, Tarlac
    Owner : Danilo Gonzales
    Products: (SFA), (TH/CS), (PT)

21. Techno-Adaptors Corporation
    San Isidro, San Fernando, Pampanga
    Owner : Feliciano P. Miranda
    Products: TH

22. Von Machinery
    Diversion Road, Cabanatuan City
    Owner : Felipe Ciron, Sr.
    Products: PT, TH

ANNEX C

MA-IRRI INDUSTRIAL EXTENSION PROGRAM FOR SMALL FARM EQUIPMENT

LIST OF COOPERATING MANUFACTURERS OF THE MA-IRRI PROGRAM

(September 1984)

Region I

1. Farmers Association Salsalamagui
   Barangay 16, Vintar
   Ilocos Norte
   President: Angel Agcaoili
   Products : (TH)

2. Me-Ca Trading
   Malasigui, Pangasinan
   Owner : Ildefonso Medel
   Products : (TH), (PU)

3. Paitan West Welding Shop
   Paitan, Sual, Pangasinan
   Owner : Regalado Edrosolan
   Products : (RE), (PT)

4. Philippine-German Manufacturing.Co,
   Calasiao, Pangasinan
   Owner : Mr. H. Thoman
   Products : TTP

5. V.C. Machine Shop
   Agoo, La Union
   Owner : Rodolfo Canillas
   Products : PT, TH, (RE), (PU)

Region II

1. Cagayan Valley Dev. Cooperative, Inc,
   Cauauan, Isabela
   Owner : Fernando Echague
   Products : (TH), (RE), (PT)

2. Collado Metalcraft
   Centro Ballesteros, Cagayan
   Owner : Conrado Collado
   Products : (RE), (PT), (TH)

3. Jorge Welding and Repair Shop
   Centro Mallig, Isabela
   Owner : Jorge Nuñez
   Products : (TR), (SFA), (TH/CS)

4. Four Brothers Metalcraft
   Dist. II Maharlika Metalcraft
   Cauayan, Isabela
   Owner : Alberto Lee
   Products : (RE), (PT), (TH)

5. Katipunan Metal Work
   Km. 423, Liwanag
   Tumauini, Isabela
   Owner : Edilberto Katipunan
   Products: (TH/CS), (SFA)

6. L.T.I. Welding Shop
   Bugallon Proper
   Ramon, Isabela
   Owner : Leonardo T. Imbag
   Products: TH, (RE), (PT), (TR),(TH/CS)

7. La Suerte Machine Shop
   Cauayan, Isabela
   Owner : Isagani T. Cruz
   Products: TH, TR

8. 2M Industrial Shop
   Sinamar Sur, San Mateo, Isabela
   Owner : N. Agcaoili
   Products: PT, RE

9. People's Machine Shop
   Alvarado St., Aparri, Cagayan
   Owner : Juan B. Romero
   Products: PT

10. Samahan ng Bagong Anyo ng Buhay
    Bantug, Roxas, Isabela
    Owner : Elnardo M. Mangunay
    Products: TH

11. Tom Metalcraft Industry
    Minante 2, Cauayan, Isabela
    Owner : Tomas O. Monte
    Products: PT, TH, (RE), SFA, (RIP)

12. Vergara Metal Works
    Daang Maharlika, Villasis
    Santiago, Isabela
    Owner : Danilo M. Vergara
    Products: PT, RE, TH

ABBREVIATIONS: PT = Power Tiller; TH = Thresher; RE = Reaper; PU = Axial Flow Pump; TR = Transplanter; SFA = Seed and Fertilizer Applicator; RIP = Rolling Injection Planter; TH/CS = Thresher/Sheller; CM = Chipping Machine; TTP = Tapak-Tapak Pump.

NOTE: Equipment abbreviations are enclosed within parentheses if the manufacturer has not yet finished fabricating one unit and had it tested by MA-IRRI.

Region III

1. BJ Engineering & Machine Works
1238 Rizal St., Baliwag, Bulacan
Owner : Antonio B. de Jesus
Products: TH, RE

2. Bagong Sikat Metalcraft
Bagong Sikat, Muñoz, Nueva Ecija
Owner : Eliseo Ruiz
Products: BD, TH

3. Bulacan National Agricultural School
San Ildefonso, Bulacan
Owner : Macario S. Pagdanganan
Products: (TH)

4. Castillo Machine Shop
Encarnacion Subd., San Jose City
Nueva Ecija
Owner : Jaime A. Castillo
Products: (PT), (TH)

5. C&B Crafts
Maginao, San Rafael,. Bulacan
Owner : Bonifacio R. Isidro
Products: TH, RE, PT, (TR), (TH/CS)

6. CNC Handtractor & Rice Thresher Mfg.
Aldana St., Sta. Barbara
Baliwag, Bulacan
Owner : Celestino N. Collantes
Products: PT, TH, RE

7. D.M. Nozawa Trading Corporation
Highway, San Fernando, Pampanga
Owner : Daniel M. Nozawa
Products: RE

8. Erdy's Machine Shop & Iron Works
F. Tañedo St., San Nicolas
Tarlac, Tarlac
Owner : Erdy H. Dytianquin
Products: (SFA), (PT), (TH/CS)

9. Jessan Metal & Wood Works
Bagong Sikat, Plaridel, Bulacan
Owner : Jesus M. Antonio
Products: PT, TH

10. Juanito Samson Iron Works
San Juan, Sta. Ana, Pampanga
Owner : Juanito Samson
Products: PT, TH, PU, W

11. Lacroose Farmcraft
1577 MacArthur Hi-way
San Nicolas, Tarlac, Tarlac
Owner : Conrado T. Cruz
Products: (RE), (PT), (RIP), (TH)

12. L.P. Engineering Services
San Jose, Baliwag, Bulacan
Owner : Luis T. Parada
Products: PT, TH

13. Maharlika Iron Works
Lugam, Malolos, Bulacan
Owner : Lolita Garcia
Products: PT, (PU)

14. New Tarlac Northern Cottage Industry
Tañedo St., Tarlac, Tarlac
Owner : Benito Que
Products: PT, TH, (SFA)

15. Omar Yapchiongco
Longos, Balagtas, Bulacan
Owner : Omar H. Yapchiongco
Products: RE, PT

16. Palayan Agro-Enterprises
1043 Burgos Avenue
Cabanatuan City
Owner : Ernesto M. Escuadro
Products: PT, TH

17. Phil. Rural Reconstruction Movement
PRRM, Nieves, San Leonardo
Nueva Ecija
Owner :
Products: -

18. R.D. Intal Metalcraft
San Vicente, Apalit, Pampanga
Owner : Jose Intal
Products: PT

19. Rinos Enterprises
243 Intan St., Paco Roman Ext.
Cabanatuan City
Owner : Cesar Concepcion
Products: PT, TH

20. Tarlac Iron Works
262 F. Tañedo St.
Tarlac, Tarlac
Owner : Danilo Gonzales
Products: (SFA), (TH/CS), (PT)

21. Techno-Adaptors Corporation
San Isidro, San Fernando, Pampanga
Owner : Feliciano P. Miranda
Products: TH

22. Von Machinery
Diversion Road, Cabanatuan City
Owner : Felipe Ciron, Sr.
Products: PT, TH

174

Region IV

1. 3-A's Industries, Inc.
   54 A. de Jesus St., near Roosevelt Avenue, Metro Manila
   Owner : Avelino Asi
   Products: (TH), (PU), (RIP)

2. AC Machineries, Inc.
   1142 Pres. E. Quirino Avenue
   Paco, Manila
   Owner : Jose Ernesto C. Rodriguez
   Products: (TH), (PT)

3. A. Consteel Construction Co., Inc.
   458 Baranca Drive, Mandaluyong
   Metro Manila
   Owner : Arny Abad
   Products: PT, TH, RE

4. Algar Bene Machine Shop
   40 MacArthur Hi-way, Malabon
   Metro Manila
   Owner : Domingo Bene
   Products: (TH), (PT)

5. Amason Industries
   107 Lapu-lapu, Parang
   Marikina, Rizal
   Owner : Albino F. Maglalong
   Products: (RE), (PT), (TH)

6. Atin Engineering Center
   Laurel St., City Subdivision
   San Pablo City
   Owner : Arsenio Dungo
   Products: TH, TH/CS, (PT)

7. Asian Industries Corporation
   Rm. 311 Medalla Bldg., EDSA cor. MacArthur, Cubao, Quezon City
   Owner : Gualberto S. Morco
   Products: (TH), (PT), (RE)

8. B&G Machine Shop
   Colago Avenue, San Pablo City
   Owner : Angelo B. Ibañez
   Products: (TH)

9. Borja Machine Shop
   13 Sgt. de Roma St., San Pablo City
   Owner : Avenar P. Carándang
   Products: TH, RE, PT

10. CDF Artistic Design Services
    Singalong, Malate, Manila
    Owner : Fernando R. Falcon
    Products: -

11. Cipriano Agro-Enterprises
    #2 Hagonoy, Taguig, Metro Manila
    Owner : Bienvenido C. Cipriano
    Products: TR, (RE), (PT)

12. Crown Industries
    9 12th Avenue, Caloocan City
    Owner : Calixto J. Lorenzo
    Products: (RE), (PT)

13. Euvibo Engineering Contractors
    180 Pepin St., Sampaloc, Manila
    Owner : Vicente C. Perez, Sr.
    Products: PT, (TH), (PU), (SFA)

14. Filipinas Electro Industrial Corp.
    341 MacArthur Hi-way, Valenzuela
    Metro Manila
    Owner : Luis G. Tan
    Products: (RE), (PT)

15. Floripis Industries
    #5 Borman St., Doña Faustina Village
    Tandang Sora, Quezon City
    Owner : Floripis Manso
    Products: (PT)

16. Frecosa Metalcraft
    Brgy. San Juan, Calamba, Laguna
    Owner : Bonifacio P. Marual
    Products: TH

17. Gintong Ani Metal Works
    Monteverde Subd., Cainta, Rizal
    Owner : Ofelio Reyes
    Products: TH

18. Golden Industrial & Eng'g. Works
    #14 F. Lazaro St., Marulas
    Valenzuela, Metro Manila
    Owner : Bonifacio H. Adriano
    Products: PT

19. Gracar Equipment Corporation
    16 Tirad Pass cor. General Tiron St.
    Caloocan City
    Owner : Graciano Borja, Jr.
    Products: -

20. Inventive Engineering Works
    San Juan, Batangas City
    Owner : Bayani B. Bautista, Sr.
    Products: (RE), (PT)

21. JCCE Industries
    242 Mayondon, Los Baños, Laguna
    Owner : Francisco M. Lapiz
    Products: PT, TH, RE, PU, RIP

179

22. JARVIS Manufacturing
    No. 30-D T. Santiago St., Canumay
    Valenzuela, Metro Manila
    Owner : Joseph C. Lopez
    Products: RE, PT, TH

23. Kalayaan Engineering Corp., Inc.
    Rm. 218, Comfoods Bldg., Buendia Ave.
    Cor. P. Tamo St., Makati, Metro Manila
    Owner : Rafael A. Lahoz, Jr.
    Products: (RE), (PT), (TH)

24. Kasaganaan Industries
    2253 Bonifacio St., San Jose
    Mindoro Occidental
    Owner : Juanito Dimaano
    Products: PT, TH

25. Kato International
    98-B P. Santiago St., Paso de Blas
    Valenzuela, Metro Manila
    Owner : Hubert C. Ong
    Products: TH, RE, (TH/CS)

26. L.M. Cruz Welding Shop
    Sampalukan Kiskisan
    E. Rodriguez Avenue, Taytay, Rizal
    Owner : Luisito M. Cruz
    Products: RE, PT

27. Los Baños Agricultural Machineries
    Maahas, Los Baños, Laguna
    Owner : Jose Maligaya
    Products: PT, TH, RE, SFA, TR

28. Macro Metallurgical Eng'g. Corp.
    52 Times St., Quezon City
    Owner : Abelardo B. Nerida, Jr.
    Products: (TH)

29. Mariñas Machinery Mfg., Inc.
    Pila, Laguna
    Owner : Ernesto M. Mariñas, Sr.
    Products: (TR), (RE), (PT), (TH)

30. MBP Engineering
    Km. 16, MacArthur Hi-way, Malanday
    Valenzuela, Bulacan
    Owner : Adrelino Pascual
    Products: PT, RE, PU, TR, RIP

31. Mechanical Factors Phils., Inc.
    Ground Floor, Greenfields Dev. Bldg.II
    710 Shaw Bldg., Mandaluyong, Metro Mla.
    Owner : Ludivico C. Lazarte
    Products: TH, RE, PT, (TH/CS)

32. Mendoza & Sons Iron Crafts
    Lalud, Calapan, Oriental Mindoro
    Owner : Nestor Mendoza
    Products: TH

33. Micro Machineries
    9837 Legaspi St., Makati, Metro Mla.
    Owner : Camilo Mendez
    Products: (RE), (PT)

34. Millmaster Engineering Works
    4760 Sampaguita St., Miramar I
    South Superhighway, Parañaque
    Metro Manila
    Owner : Jesus Fernandez
    Products: (TH)

35. Montojo's Machine Shop
    Calapan, Mindoro Oriental
    Owner : Mario A. Montojo
    Products: (RE), (PT)

36. Nayon Farm Eqpt. Mfg. Corporation
    136 Gen. Luis St., Novaliches
    Quezon City
    Owner : Ernesto B. Flores
    Products: PT, TH, RE

37. Nibros Machinery Corporation
    Doña Rosario Heights, Novaliches
    Quezon City
    Owner : Roberto G. Nicolas
    Products: PT, TH

38. Northstar Industrial Mfg., Co., Inc.
    Deparo St., Caloocan City
    Owner : Vicente Agas
    Products: RE, PT

39. P.I. Farm Products, Inc.
    Km. 16, Malanday, Valenzuela, Metro Mla.
    Owner : Johnny V. Tin
    Products: PT, TH, RE, (TH/CS), (TR)

40. PADISCOR
    114 Plaza Rizal, Pasig, Metro Manila
    Owner : Candido B. Miguel, Jr.
    Products: TH

41. Pan-Asia Agricultural Dev., Inc.
    125 Pioneer St., Mandaluyong
    Metro Manila
    Owner : Juan A. Alado
    Products: -

42. Pee Bee Industries
    16 R. Castillo St., Kalawan Sur
    Pasig, Metro Manila
    Owner : Jose A. Beduya
    Products: (TH), (PT)

43. Pigeon Frame Bicycle Mfg. Co.
    Real, Bacoor, Cavite
    Owner : Arsenio Majano
    Products: (PU), (PT), (TH)

176

44. Polygon Agro-Industrial Corp.
No. 32 Road B, St. Anthony Village
Project 7, Quezon City
Owner : Constantino B. Aguilar
Products: TH, (SFA)

45. Poying Welding Shop
Anos, Los Baños, Laguna
Owner : Floro M. Bautista
Products: PT, TH, RE, TR, RIP, SFA

46. Quiling Metalcraft
Calamba, Laguna
Owner : Buenaventura Quiling
Products: (TH)

47. R. Fuster Builders Corporation
52 V. Noble Extension, Pasay City
Owner : Romeo Fuster
Products: RE, PT, (TH)

48. R&R Lescano Metalcraft & Machine Shop
~~Brgy. Pila, Bay,~~ Laguna
Owner : Rodolfo Lescano
Products: (RE), (PT)

49. Reyes Machine Shop
Doña Juana Subd., Dampalit
Malabon, Metro Manila
Owner : Daniel Reyes
Products: (RE), (PT), (TR), (SFA)

50. Roadside Motors
183-A Erembo, Fort Bonifacio
Makati, Metro Manila
Owner : Isaias M. Godoy
Products: (RE), (PT)

51. Robles Metal Mfg., Inc.
126 20th Avenue, Cubao
Quezon City
Owner : Mariano B. Robles, Jr.
Products: PT, RE

52. Ryan Machine Works
47 A. Mabini St., Mandaluyong
Metro Manila
Owner : Mirlobin V. Gaa
Products: (RE), (PT), (TH)

53. Salvador Eng'g. & Rubber Products
168 Balagtas St., Pamplona
Las Piñas, Metro Manila
Owner : Reynaldo B. Salvador
Products: (PT), (TH)

54. SANIV-JOHNSON Agri-Industrial
Development Sales & Service
Ground Floor, J & T Bldg.
3908 R. Magsaysay, Sta. Mesa
Metro Manila
Owner : Federico H. Saculpao
Products: (TH), (SFA)

55. Sea Commercial Company, Inc.
3085 R. Magsaysay Blvd., Sta. Mesa
Metro Manila
Owner : Hector Sanvictores
Products: TH

56. Vicgar Trading, Inc.
1951 Taft Avenue, Pasay City
Owner : Victoria Garcia
Products: TH, RE, PT, CM

57. Wright-Patterson Mfg. Corporation
Mapaya II, San Jose
Occidental Mindoro
Owner : Cesar J. Santos
Products: (CM), (RIP), (SFA)

Region V

1. Amar's Grain Center
   Handong, Libmanan, Camarines Sur
   Owner : Avelino M. Atienza
   Products: PT, TH, TR,

2. Borbe's Welding Shop
   Centro Polangui, Albay
   Owner : Angel S. Borbe
   Products: PT, TH.

3. CVC Metalcraft
   Natupasan, Gubat, Sorsogon
   Owner : Ben-hur E. Dugan
   Products: PT, TH

4. Elep Thresher
   Plaza Rizal, Libmanan, Camarines Sur
   Owner : Rogelio Nano
   Products: TH, TR

5. Isarog Industries
   826 Renacimiento St., Tabuco
   Naga City, Camarines Sur
   Owner : Ernesto Cayetano
   Products: PT, TH, W

6. Madera Trading Establishment
   Capalonga, Camarines Norte
   Owner : Florentino Madera, Jr.
   Products: PT, TH

7. Morallo Iron Works
   661 Hi-way, San Miguel, Iriga City
   Camarines Sur
   Owner : Ernesto N. Morallo
   Products: PT, TH, RE, TR

8. SM Agri & General Machineries
   No. 21, Zone 5, Peñafrancia Avenue
   Naga City, Camarines Sur
   Owner : Sebastian N. Moll
   Products: PT, TH, PU, (RE)

9. Sabio Agricultural Equipment
   Sta. Lucia, Magarao
   Naga City, Camarines Sur
   Owner : Flaviano Sabio
   Products: TH

10. Salson Welding Shop
    San Roque, Canaman, Camarines Sur
    Owner : Arturo Jerome J. Salcedo
    Products: PT, TH, PU

11. Tolledo's Metalcraft
    Bagumbayan, Libmanan.
    Camarines Sur
    Owner : Juanito M. Tolledo
    Products: PT, TH, TR

12. Tropics Agro Industries
    25 Panganiban Street
    Naga City, Camarines Sur
    Owner : Salvador T. Albia
    Products: PT, TH

178

Region VI

1. A-1 Enterprises
116 Iznart Street, Iloilo City
Owner : Lim Tai
Products: PT, TH, PU, RIP

2. Aleco Enterprises
Lopez Jaena St., Capitol Shopping Center, Bacolod City
Owner : Lorenzo Ang
Products: (SFA)

3. Alto Agro Industries, Inc.
Mary Mart Bldg.
Valeria St., Iloilo City
Owner : Pepito T. Lim
Products: PU

4. Bebing's Metalcraft
Rizal St., Villadolid
Negros Occidental
Owner : Vivencio L. Baria, Jr.
Products: TH

5. Betsy Marketing (VILSICO)
Huervana St., La Paz, Iloilo City
Owner : Salvador S. Silva
Products: PT, TH

6. Carvel Engineering Works
Km. 1, National Road, Roxas City, Capiz
Owner : Carlos Velado
Products: TH, PU

7. Compin Manufacturers
Dao, Capiz
Owner : Wella Compuesto
Products: TH

8. DA-NILL Industries
Crossing Buswang, Kalibo, Aklan
Owner : Danilo R. Buyco
Products: (RE), (PT), (PU)

9. Gallinero Metalcraft Industries
Bantayan, San Jose, Antique
Owner : Antonio O. Gallinero
Products: PT, TH

10. Hand Tractor Parts & Agro Industrial Corp.
Quezon-Delgado Sts., Iloilo City
Owner : Rolando T. Chua
Products: TR

11. Hontarciego Metalcraft
Gonzaga St., Pavia, Iloilo City
Owner : Melecio Sotomil, Jr.
Products: PT, PU

12. J. Balista Manufacturing
149 F. Luna St., La Paz, Iloilo City
Owner : Jesus Balista
Products: PT, TH

13. Jamandre Industries, Inc.
88 Rizal St., La Paz, Iloilo City
Owner : Vita Jamandre
Products: PT, TH, RE, RIP, TR

14. Jaspe Metalcraft
Evangelista St., Pavia, Iloilo City
Owner : Andres D. Jaspe
Products: TH, PT, (TH/CS)

15. JIRRIS Marketing, Inc.
Mandalagan, Bacolod City
Owner : Franklin G. Fuentebella
Products: (TR)

16. MB Enterprises
IPSTA Bldg., La Paz, Iloilo City
Owner : Augusto Banusing
Products: TH

17. Macasa Machine Shop
Caltex Station, Sum-ag, Bacolod City
Owner : Vicente Macasa
Products: RE, PT

18. Mambusao Auto Repair Shop
Mambusao, Capiz
Owner : Eulogio Pimentel
Products: PT, TH

19. Nortam Metalcraft
43 D.B. Ledesma St., Jaro, Iloilo City
Owner : Norberto G. Tamonan
Products: TH

20. Oreceo Motor & Iron Works
Navarra Avenue, Mambusao, Capiz
Owner : Manuel F. Oreceo, Jr.
Products: TH

21. SV Agro Industries Enterprises, Inc.
65 Commission Civil St., Jaro
Iloilo City
Owner : Magdalena Villaruz
Products: PT, TH, PU, RIP, (TH/SH)

22. STRIDES
Gustilo St., Poblacion
Leganes, Iloilo City
Owner : Jose J. Jaspe
Products: TH

23. V&L Trading Company, Inc.
    314 Rizal St., La Paz, Iloilo City
    Owner : Romeo B. Buyco
    Products: PT, TH

24. Vicmac Manufacturing Industries, Inc.
    Mandalagan, Bacolod City
    Owner : Victor M. Talbigan
    Products: PT, TH

25. Welbilt Enterprises
    111 Burgos St., Bacolod City
    Owner : Manuel Villanueva
    Products: TH, RE, PT

Region VII

1. Bosconian Producers Cooperative, Inc.
   Mantech Drive, Subang Daku
   Mandaue City
   Owner : Petronilo F. Balbuena
   Products: (PT), (RE), (TH)

2. Conspec Molded Products
   Silliman Avenue Extension
   Dumaguete City
   Owner : Carmen I. Gloria
   Products:. (SFA), (TH/CS)

Region VIII

1. Allied Farmers Center
   143 P. Burgos St., Tacloban City
   Owner : Noel de Guzman
   Products: (TH)

2. B. Separa Enterprises
   Corner Real-Independencia Sts.
   Tacloban City
   Owner : Benjamin Separa
   Products: PT, TH

3. Bandalan Industries
   Baybay, Leyte
   Owner : Roso B. Bandalan
   Products: (RE), (PT)

4. Farmhouse Marketing
   Rizal Avenue, Tacloban City
   Owner : Edwin Yao
   Products: RE, TH

5. P. Kuizon Enterprises
   Bato, Leyte
   Owner : Porfirio G. Kuizon
   Products: -

6. Pastor Metalcraft
   Brgy. Don F. Larrazabal, Ormoc City
   Owner : Alfeo Arendain
   Products: PT, TH, (RE)

Region IX

1. Balogay & Sons Machine Shop
   Ipil, Zamboanga del Sur
   Owner : Jose P. Balogay
   Products: (TH), (RE), (PT)

2. D'Refrigeration Service Center
   033 Bonifacio St., Pagadian City
   Owner : Elias Darang
   Products: TH

3. Eddie Gonzales Automotive Shop
   Guiwan, Zamboanga City
   Owner : Eduardo Gonzales
   Products: TH

4. Ipil Automotive Body Building Shop
   Lower Ipil Heights
   Ipil, Zamboanga del Sur
   Owner : Gaudencio Quebayen
   Products: TH (double drum)

5. JAS Machine Shop
   Ipil, Zamboanga del Sur
   Owner : Gilbert Albrecht
   Products: (RE), (PT)

6. Jumamil Welding & Repair Shop
   Brgy. Rizal, Molave
   Zamboanga del Sur
   Owner : Lauro Jumamil
   Products: PT, TH, RE, (TR)

7. Lagura Mechanical Shop
   Imelda, Zamboanga del Sur
   Owner : Leopoldo Lagura
   Products: PT, TH

8. Montañez Welding Shop
   Pulukan Lower, Labangan
   Zamboanga del Sur
   Owner : Rodolfo Montañez
   Products: TH (double drum)

9. New Unity Foundry
   Veteran's Avenue, Zamboanga City
   Owner : Felipe A. Lim
   Products: (PT), (RE)

10. Q&M Engineering & Machine Shop
    Buug, Zamboanga del Sur
    Owner : Edgar Gonzales
    Products: RE, PT, TH, (TR)

11. RVB Manufacturing Shop
    Brgy. Blancia, Molave
    Zamboanga del Sur
    Owner : Ramon Blancia
    Products: PT, (RE)

12. Tiptop Engineering Works
    Rizal Avenue, Tuburan District
    Pagadian City
    Owner : Dionisio Garcia
    Products: TH

13. Tryme Agro Industry
    Lumbia District, Pagadian City
    Owner : Carlito Nacalaban
    Products: TH, RE, PT, PU

14. Vocational Technical Institute of
    Andres Bonifacio College
    College Park, Dipolog City
    Owner : Ernesto S. Amatong
    Products: (PU), (PT)

181

Region X

1. Atlas Farm Supply & General Merchandise
825 Zamora St. Butuan City
Owner : Manuel T. del Rosario
Products: PT, TH

2. B-J Machine Shop
Valencia, Bukidnon
Owner : Emmanuel L. Alkuino
Products: TH, (SFA), (TH/CS)

3. Cavalier's Welding Shop
Balingasag, Misamis Oriental
Owner : Dominador V. Salvane
Products: (RE), (PT), (TH)

4. Jupiter Enterprises
National Hi-way, Centro Tagoloan
Misamis Oriental
Owner : Ricardo P. Adana
Products: TH, PT

5. KBM Service Center
Cabiltes St., Cabadbaran
Agusan del Norte
Owner : Aurelio P. Malupa
Products: PT, (TH)

6. Lanao Engineering
Casinglot, Tagoloan
Misamis Oriental
Owner : Marcos Booc Patalinghug
Products: TH, CS

7. Mountain View College of the Seventh Day Adventists, Inc.
Malaybalay, Bukidnon
Owner : A. B. Gayao
Products: (TR), (RE), (PT)

8. Multi-Machineries Enterprises
Trento, Agusan del Sur
Owner : Edgar Patron
Products: TH

9. New Pimental Iron Works
Lapasa, Cagayan de Oro City
Owner : Onido I. Pimentel
Products: TH, (PT), (RE)

10. Ozamis Engineering
Manabay, Ozamis City
Owner : Pascual Godinez
Products: TH, PT, (RE)

11. P&J Welding Shop
Poblacion, Cabadbaran
Agusan del Norte
Owner : Paterno M. Aboloc, Sr.
Products: PT

12. Pete Lim Industries
San Francisco, Agusan del Sur
Owner : Pedro T. Lim
Products: PT, TH, RE, PU

13. R.G. Farm Equipment Shop
Patin-ay, Prosperidad
Agusan del Sur
Owner : Romulo P. Guay
Products: TH, PT

14. Rosman Machine Shop
Valencia, Bukidnon
Owner : Manuel Araniego
Products: PT, RE, TH

15. Times Machine Shop
Km. 1, National Hi-way, Surigao City
Owner : Teodulo R. Reyes
Products: (RE), (PT)

16. VGL Industries, Inc.
Puntod, Cagayan de Oro City
Owner : Vicente G. Lava, Jr.
Products: SFA

17. Wagas Handtractor Industry
R. Calo St., Butuan City
Owner : Esteban S. Wagas
Products: PT, TH, RE

18. WYNRUJ Agro Metalcraft
Km. 3, Libertad, Butuan City
Owner : Napoleon Nonan
Products: (RE), (PT), (RIP)

19. Young Metalcraft
Bo. Baan, Butuan City
Owner : Alonzo T. Young
Products: PT, RE, TR

128

Region XI

1. Arciso's Metalcraft
   BAEcon Office, Koronadal
   South Cotabato
   Owner : Balitan Arciso
   Products: SFA
2. Bismanos Metalcraft Industry
   Magsaysay, Davao del Sur
   Owner : Conrado Bismanos
   Products: TH*, (RE), (PT), (SFA)
3. Bordon Repair Shop
   Osmeña St., Koronadal
   South Cotabato
   Owner : Alfonso Bordon, Sr.
   Products: (TH), (RE), (PT), (TR)
4. Damo Auto Repair Shop
   Doña Aurora St., Digos
   Davao del Sur
   Owner : Sotilo P. Damo
   Products: PT, RE, SFA
5. Davao Kaisa Fabrication Machine Shop
   FSDC BLSA Program Office
   Provincial Capitol, Tagum
   Davao del Norte
   Owner : Candido S. Balunos
   Products: PT, RE, TR, TH
6. Digos Industrial Service Centers Association, Inc.
   Gen. Luna Ext., Digos
   Davao del Sur
   Owner : Florentino M. Casas
   Products: (TH), (RE), (PT)
7. Grain Master Metalcraft
   99 Judge Echavez St., National Hi-way
   Nabunturan, Davao del Norte
   Owner : Jorge Benedicto
   Products: PT, TH (double drum), SFA
8. King's College at Marbel
   Koronadal, South Cotabato
   Owner : Felipe Fernandez/Steve Ramer
   Products: (SFA), (RIP)
9. Knew-Way Metalcraft
   National Hi-way, Tagum
   Davao del Norte
   Owner : Francisco C. Lapiz
   Products: PT, RE
10. Managuit Blacksmith Shop
   General Santos City
   Owner : Pio Managuit
   Products: SFA
11. Marikina-Uma/Southwest Pacific
   Agdao, Davao City
   Owner : Maari E. Gimeno
   Products: (PT), (RE)
12. Payo Manufacturing Shop
   MacArthur Hi-way, Davao City
   Owner : Leodegario Payo, Sr.
   Products: (TR), (RE), (PT)
13. Pinto Shop
   Crossing 2, Koronadal
   South Cotabato
   Owner : Marcelino C. Pinto
   Products: TH*, (RE), (PT), (TR), (PU)
14. Pueblo Metalcraft
   237 Pioneer Avenue, Tagum
   Davao del Norte
   Owner : Eduardo Pueblo
   Products: PT, TH, PU
15. Tormon Mfg. & Repair Shop
   Sto. Tomas, Davao del Norte
   Owner : Elpidio Tormon
   Products: TH*, (RE), (PT), (PU)
16. Venancio O. Anselmo, Jr.
   Poblacion, Carmen, Surigao Sur
   Owner : Venancio O. Anselmo, Jr.
   Products: (TH), (PU)

---

* Thresher is double-drum design.

Region XII

1. A. Perez Enterprises & Welding Shop
   Kalawag II, Isulan, Sultan Kudarat
   Owner : Ignacio G. Perez
   Products: TH*

2. Agustin General Eng'g. Services
   Quezon Avenue, Midsayap
   North Cotabato
   Owner : Hospicio L. Agustin, Sr.
   Products: SFA

3. Atsons Welding & Repair Shop
   Quezon Avenue, Midsayap
   North Cotabato
   Owner : Melencio P. Atchivarra, Sr.
   Products: TH*

4. Aujero Soloren Enterprises and Metal Craft
   Isulan, Sultan Kudarat
   Owner : Restituto B. Aujero
   Products: (TH/CS)

5. Cecile Welding Shop
   Udtong, Don Mariano Marcos
   Sultan Kudarat
   Owner : Edmundo Neyra
   Products: (TH), (SFA)

6. Chua Pang Tinsmith
   Cotabato City
   Owner : Johnny Tan
   Products: (PT)

7. Ernesto O. Raymundo
   Esperanza, Sultan Kudarat
   Owner : Ernesto O. Raymundo
   Products: (TR)

8. Erning's Iron Works & Agricultural Machinery Supply
   Brgy. 8, Poblacion, Midsayap
   North Cotabato
   Owner : Ernesto J. Panglao
   Products: TH

9. F. Buenacosa Repair Shop
   Alunan Hi-way, Tacurong, Sultan
   Sultan Kudarat
   Owner : Bibiano M. Buenacosa
   Products: PT, RE, SFA

10. Feliciano Agricultural Machinery Welding Shop
    Quezon Avenue, Midsayap
    North Cotabato
    Owner : Virgilio Daus Feliciano
    Products: TH*, RE, PT

11. G. de Ala Machine Shop
    Tacurong, Sultan Kudarat
    Owner : Gaudencio C. de Ala
    Products: (PT)

12. Guilbros Iron Works & Agricultural Machineries Supply
    Pigcawayan, North Cotabato
    Owner : Edilberto R. Guilbros
    Products: PT, TH, RE, RIP, SFA, TR

13. HG Agri Industrial Machineries
    Quezon Avenue, Midsayap
    North Cotabato
    Owner : Alan B. Uy
    Products: (TH)

14. Kabacan Eng'g. Works and Services
    Kabacan, North Cotabato
    Owner : Francisco D. Caldito, Jr.
    Products: TH*, RE, PT

15. Lopez Eng'g. Works & Handtractor Mfg.
    Antonio Sousa St., Cotabato City
    Owner : Roberto R. Lopez
    Products: PT

16. Marz Machine Shop
    Poblacion 8, Midsayap
    North Cotabato
    Owner : Manuel I. Dizor
    Products: PU

17. Niccons Research & Repair Shop
    Kapatagan, Lanao del Norte
    Owner : Nestor G. Romo
    Products: PT, (RE)

18. Presto Reyes Farm Machineries & Integrated Equipment
    Matalam, North Cotabato
    Owner : Basilio C. Presto
    Products: TH*

19. R. Mangoba Welding Shop
    Kabacan, North Cotabato
    Owner : Rolando R. Mangoba
    Products: RE, PT, (TR)

20. Villarica Integrated Agro Industrial Corporation
    Villarica, Midsayap
    North Cotabato
    Owner : Romulo B. Molina
    Products: PT

---
*Thresher is double-drum design

184

SEED AND FERTILIZER APPLICATOR (SFA)

For planting:

- CORN
- SORGHUM
- MUNGBEAN
- SOYBEAN
- UPLAND RICE

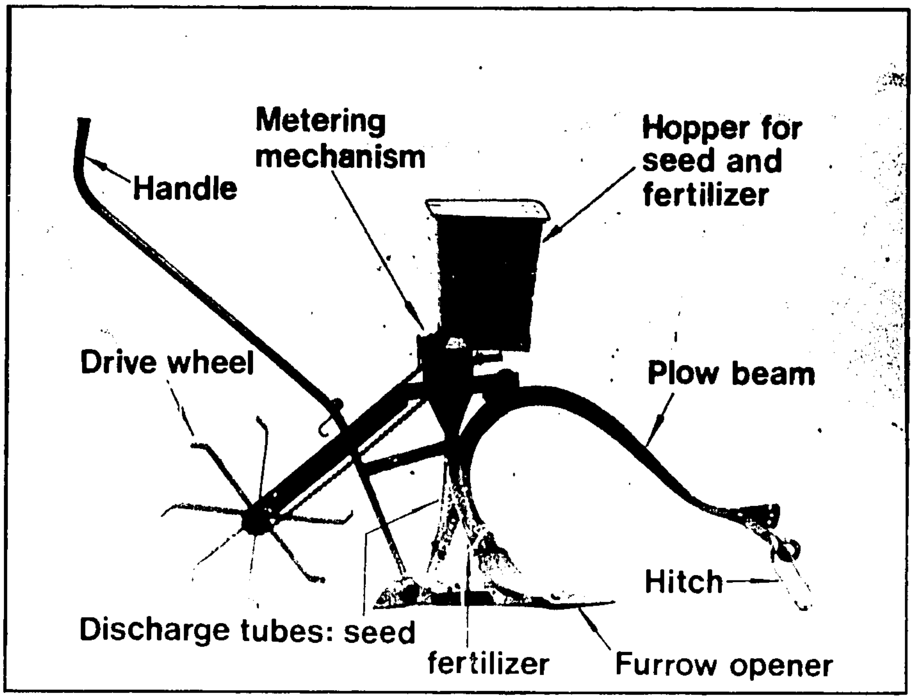
In a single operation, this unit makes a furrow and applies fertilizer, seeds, and a soil covering over the seeds.

Features:

* Rates of application of fertilizer and seed are easily adjusted by changing the metering rollers
* Fertilizer is placed at the desired depth below and to the side of the seeds
* Seed spacing is adjusted by changing the metering roller or press wheel
* Thickness of soil covering on seeds is easily varied
* Saves on fertilizer, seeds, and labor
* Low cost; easy to fabricate with tools and materials available in rural areas

-/OVER

SEED AND FERTILIZER APPLICATOR (SFA)

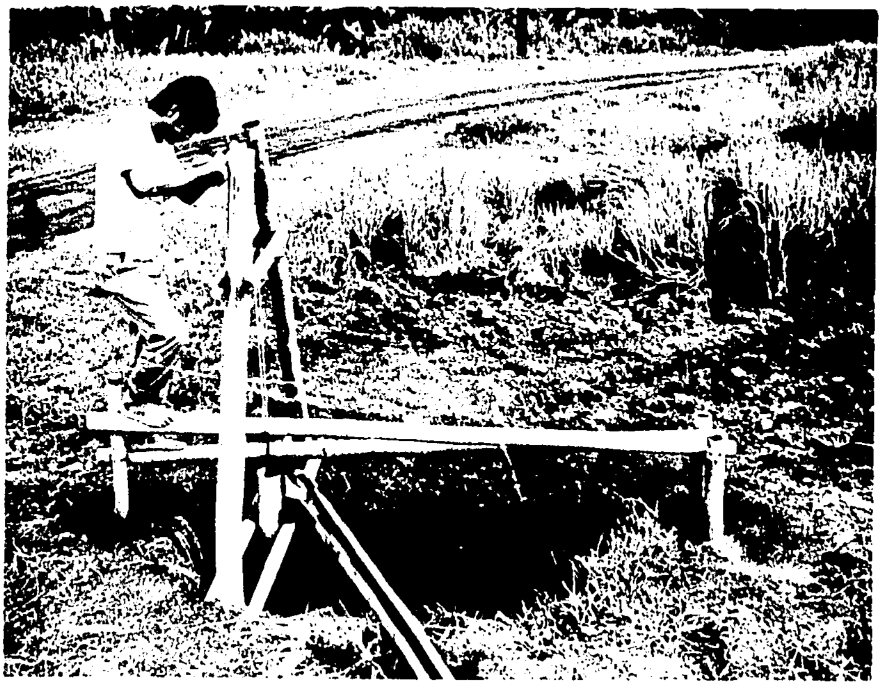


Technical information and blueprints may be obtained from:

MA-IRRI INDUSTRIAL EXTENSION PROGRAM
FOR SMALL FARM EQUIPMENT

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

Telephone: 59-81-14



MA-IRRI "TAPAK-TAPAK" PUMP

Ideal for small-farm irrigation where engine-driven pumps are generally too expensive and bucket-lifting by hand is limited to very small areas because of its high labor requirement.

ADVANTAGES

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

LOW COST: About ₱400.00 (US $20) for all materials and labor for complete pump, including bamboo framework (but excluding 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.

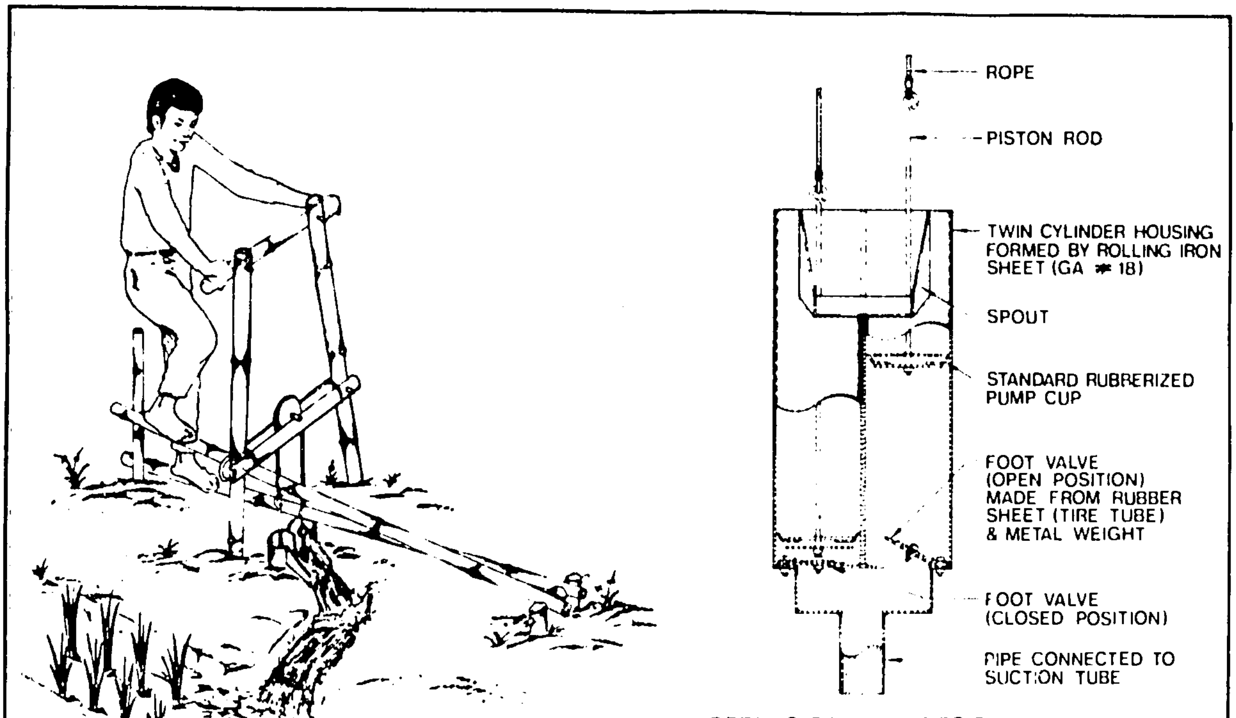
ADAPTABLE: Can be portable or stationary; suitable for open-pit wells, tube wells, canals, lakes, and rivers; no priming required for depths as great as 5 meters (16 feet).

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

3 liters/second (48 gallons/minute) for a 2 meter lift.
2 liter/second (32 gallons/minute) for a 4 meter lift.

- /over/ -

MA-IRRI "TAPAK-TAPAK" PUMP*



DETAILS OF PUMP DESIGN

Technical information and blueprints may be obtained from:

MA-IRRI INDUSTRIAL EXTENSION PROGRAM
FOR SMALL FARM EQUIPMENT

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

Telephone: 59-81-14

*Note: The Tapak-Tapak Pump is based on a design developed in Bangladesh by the Rangpur Dinajpur Rehabilitation Service.

122

MA·IRRI THRESHER/SHELLER

ONLY 5 COMPONENTS ARE MODIFIED TO CONVERT THRESHER TO SHELLER:

1. Concave grill is strengthened by using heavier bars and/or extra lateral reinforcing bars.

2. Hopper to facilitate feeding corn into the machine is installed in place of the horizontal tray used for feeding paddy.

3. Baffle is installed in discharge tube to prevent passage of corn cobs and kernels.

4. Door in side-wall of discharge tube is opened to allow cobs and kernels to pass to oscillating screen.

5. Oscillating screen for paddy is replaced with one having larger holes for corn kernels.

Detailed information may be obtained from:

MA-IRRI INDUSTRIAL EXTENSION PROGRAM
FOR SMALL FARM EQUIPMENT

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

Telephone: 59-81-14

RICE THRESHER — converts in 15 minutes to — CORN SHELLER

MA·IRRI THRESHER/SHELLER

The popular axial-flow thresher* has been modified so that the same machine may be used both as a corn sheller and as a rice thresher.

ADVANTAGES

- o Economical: - The cost of the thresher/sheller is only about 5% higher than the cost of a conventional axial-flow thresher.
- o Convenient: - Easy to change from threshing to shelling in less than 15 minutes; only five components are modified (see details on reverse side).
- o Versatile: - Even existing (used) threshers may be modified at low cost. Capable of shelling all sizes and varieties of corn.
- o High Performance: - Comparable to single-purpose corn shellers:

Corn:	Capacity**	Up to 5 tons per hour
	Shelling Efficiency**	over 99%
	Total Shelling Loss**	less than 0.3%
	Kernel Breakage**	less than 2.5%
	Cleaning Efficiency**	over 99% purity
Rice:	Capacity	20-30 cavans (1-1.5 tons) per h
	Separation Recovery	98% (weight basis)

---

*Originally designed by IRRI (Phil. Patent No. 12001; U.S. Patent No. 3776242).

**Performance data of AMTEC for modified TH8 thresher with 16 hp gasoline engine or 11 hp diesel engine and built-in grain cleaner (oscillating screen with blower).

- /over/ -

BPI CASSAVA CHIPPING MACHINE

Function:

For cutting cassava tubers or other root crops into chips to improve drying and storage.

Advantages:

- high capacity; powered by pedal or engine
- adjustable blades for desired chip thickness
- except for the blades, little maintenance is required
- low cost; simple in design and easy to fabricate
- saves on time and labor

Specifications:

Power requirements	a) foot pedal; or b) small motor or engine (1-3HP)
Weight	70 kgs
Length	76 cm
Width	76 cm
Height	91 cm
Power transmission	a) bicycle chain and sprocket when powered by pedal; b) V-belt when powered by engine
Capacity	a) 300 kg/hr when powered by pedal; b) 1300 kg/hr when powered by engine

Technical information and blueprints may be obtained from:

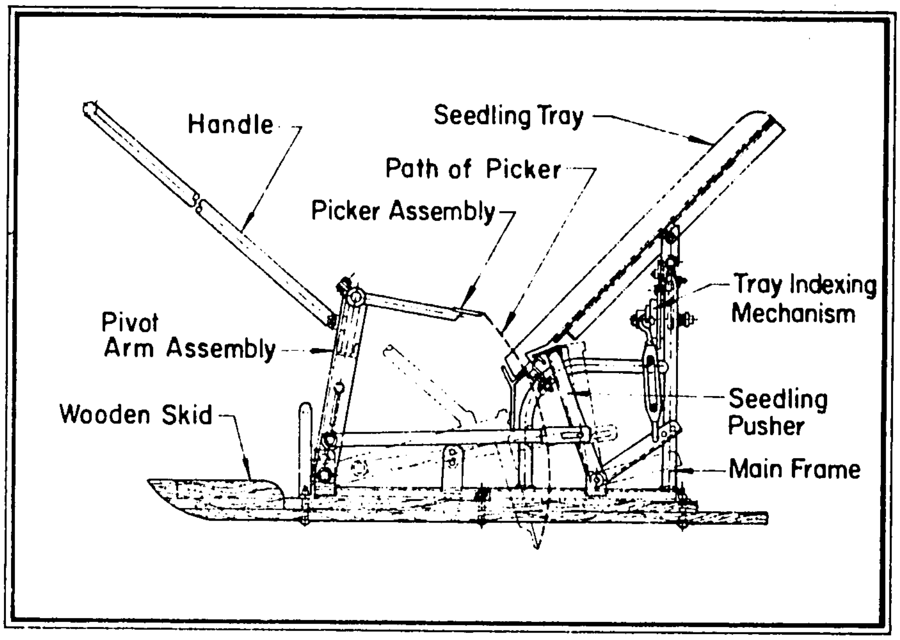
MA-IRRI INDUSTRIAL EXTENSION PROGRAM
FOR SMALL FARM EQUIPMENT

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

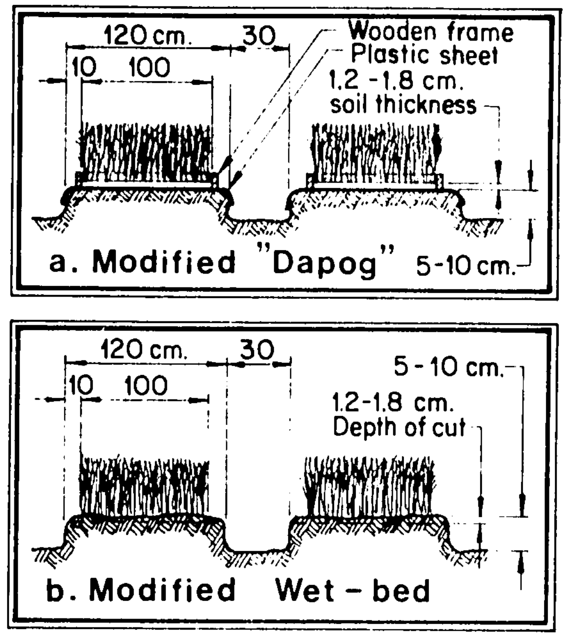
IRRI TR4 6-Row rice transplanter

FEATURES

HIGH CAPACITY	0.3 - 0.4 hectare per day, depending upon the skill of the operator.
EASY TO OPERATE & MAINTAIN	Machine is operated by single push-pull of the handle. Requires few adjusments.
LOW POWER REQUIREMENT	Machine is operated by one person.
SIMPLE CONSTRUCTION	Can be fabricated by small shops using readily available materials.
HIGHLY PORTABLE	Can be carried by one or two persons.



Schematic of IRRI 6-Row Mechanical Rice Transplanter



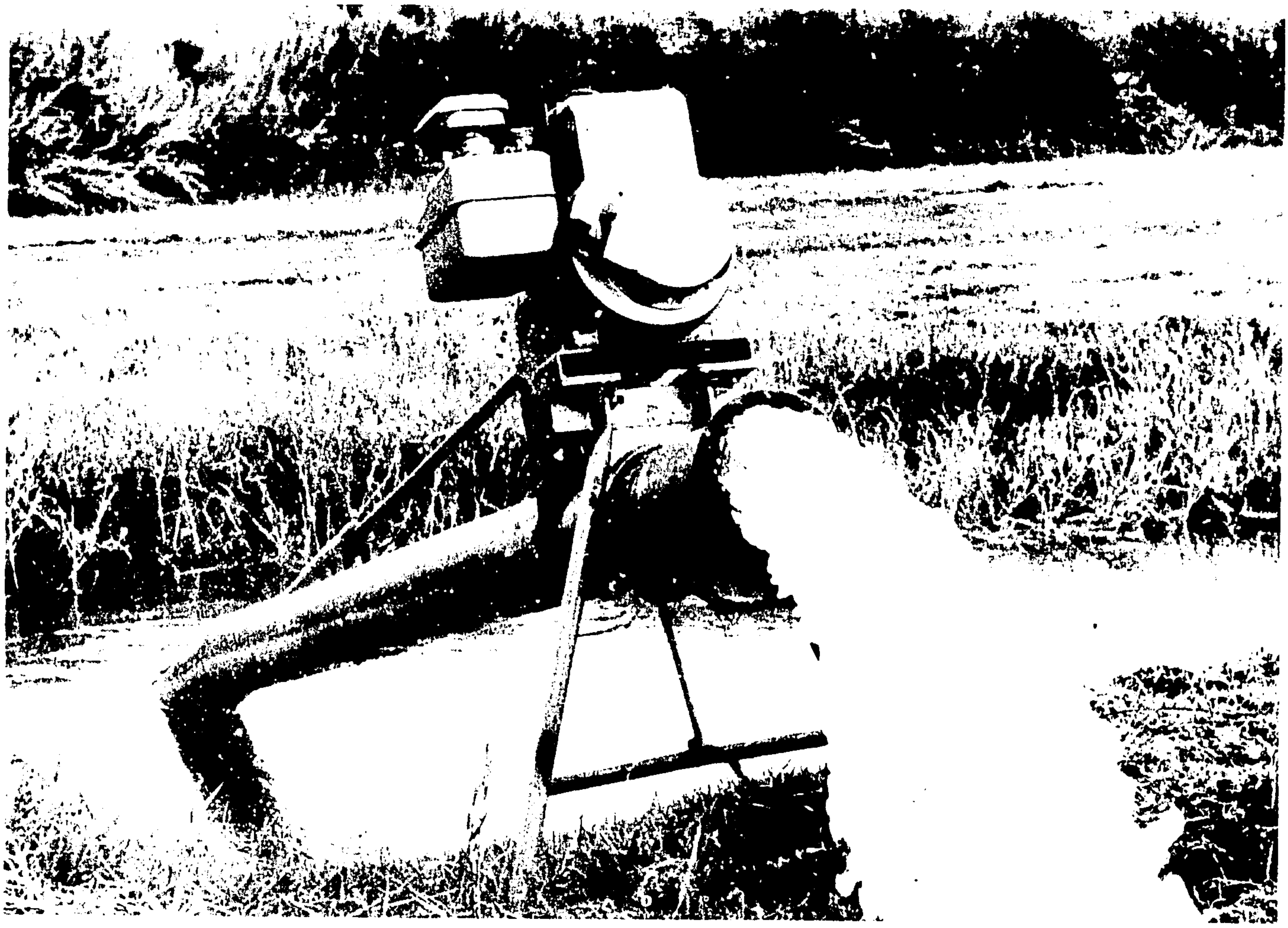
SEEDLING PREPARATIONS suitable for IRRI Mechanical Transplanter.

MACHINE SPECIFICATION

POWER	1 person
FIELD CAPACITY	0.3 – 0.4 ha. per day
PLANTING DEPTH	3 to 5 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 – 40 kgs.

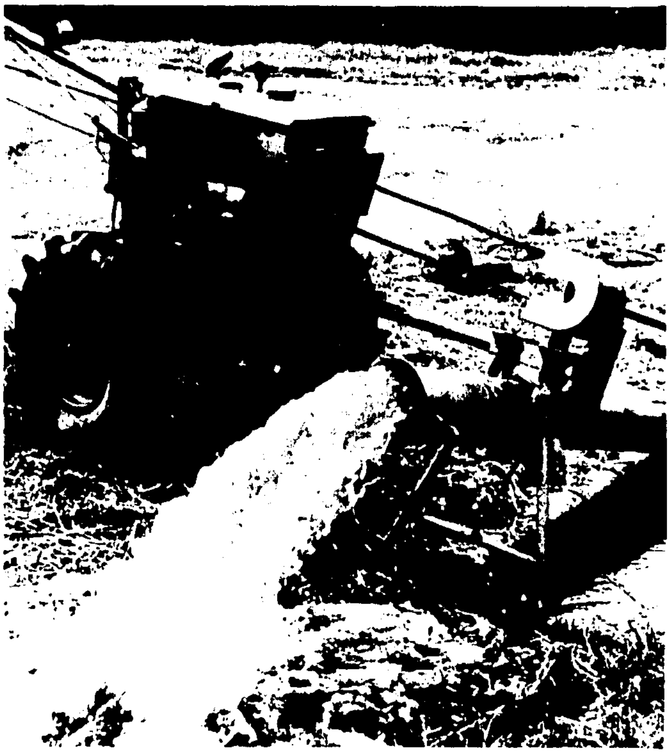
For further information write: Agricultural Engineering Department
The International Rice Research Institute
P. O. Box 933, Manila, Philippines
Cable : RICEFOUND, MANILA

IRRI axial flow pump



FEATURES

HIGH CAPACITY	Up to 3000 liters per minute
LOW HORSEPOWER REQUIREMENT	5 hp engine
SELF-PRIMING	Pump impeller is submerged
PORTABLE	Can be carried by two men.
VERSATILE	Can be direct-coupled to an engine or belt driven by a power tiller
SIMPLE CONSTRUCTION	Can be fabricated by small machine shops.



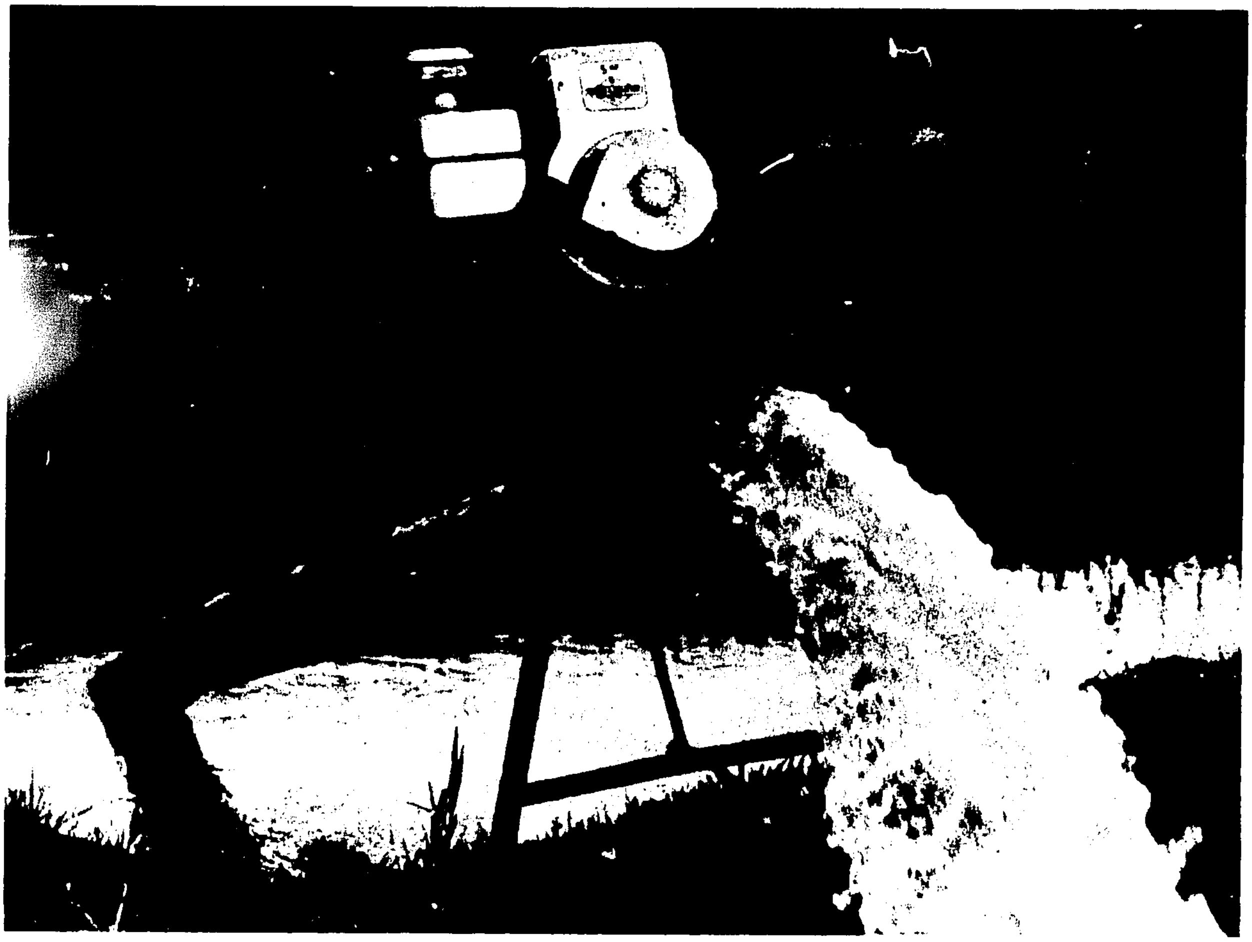
Power tiller drive arrangement

Pump being transported

Machine specifications

CAPACITY	Up to 3000 liters per minute.
TOTAL LIFT	1-4 meters
POWER	5 hp gasoline or diesel engine or 3 hp electric motor.
WEIGHT (without engine)	45 kg.
DIAMETER OF DISCHARGE TUBE	150 mm
LENGTH	3.7 m
WIDTH	58 cm
MAXIMUM RECOMMENDED OPERATING SPEED	3000 rpm
POWER TRANSMISSION	Direct-coupled or belt drive.
CONSTRUCTION	Steel and wood
FUEL CONSUMPTION (approx.)	1.2 liters per hour (gasoline).

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



AXIAL FLOW PUMP FOR FISHPOND OPERATIONS

- TILAPIA - - BANGUS (MILKFISH) - - PRAWNS -

- Useful for pumping water for:

  * draining and filling fishponds
  * adding water to control salinity, temperature, transparency, (turbidity), etc.
  * "refreshing" water when stocking density is high
  * aerating pond water to prevent oxygen depletion
  * harvesting by "pasuba" method in low tidal range fishponds
  * enabling efficient and effective fishpond water management

- The Axial Flow Pump is:

  * Suitable for brackish or fresh water
  * Portable
  * Self-Priming
  * More economical than centrifugal pumps for low-lift (low head) applications

(See reverse side for Technical Information)

191

TECHNICAL SPECIFICATIONS

Axial flow pumps are available in different sizes to meet your particular pumping need. Information on three common sizes are given below:

Pump Specifications	Diameter of Pump Tube		
	15 cm (6 inch)	20 cm (8 inch)	25 cm (10 inch)
Power:			
Gasoline or diesel engine (hp)	5	7	10
Electric motor (kw)	2	3.5	5
Pumping Capacity*			
Cubic meters per hour	145	250	410
Gallons per minute	635	1100	1800
Total Lift (vertical distance from water surface to pump discharge)	From 0 to approx. 3 m (0 to 10 feet)		
Weight, without engine (kg)	45	55	65
Materials			
For fresh water :	- - - Common steel - - -		
For brackish water :	- - Stainless steel - -		
Power transmission	- Direct coupled or belt drive -		

*NOTES:

1. The power requirement and pumping capacities given above are for lifting water 1.5 m (5 ft); the capacity increases as the lift decreases.
2. IRRI performed a test to compare the capacities of axial-flow (15 cm) and centrifugal pumps when powered by the same 5 hp gasoline engine. For a lift of 1.5 m (5 ft), *the capacity of the axial flow pump was approximately 3 times greater than that of the centrifugal pump.* This means that to pump the same amount of water the centrifugal pump requires 3 times more fuel than the axial flow pump.

For further information, contact:

MA-IRRI INDUSTRIAL EXTENSION PROGRAM FOR SMALL FARM EQUIPMENT
Agricultural Engineering Division
Bureau of Plant Industry
San Andres Street, Malate, Metro Manila
Philippines

1192

IRRI 3 hp power tiller

FEATURES:

SIMPLE CONSTRUCTION . . . . Tiller can be fabricated by small shops with standard forming tools. Parts are standard and readily available.

LIGHT AND EASY OPERATION . . . . Tiller weighs only 88 kgs and is equipped with idler clutch and throttle controls for simple and easy operation.

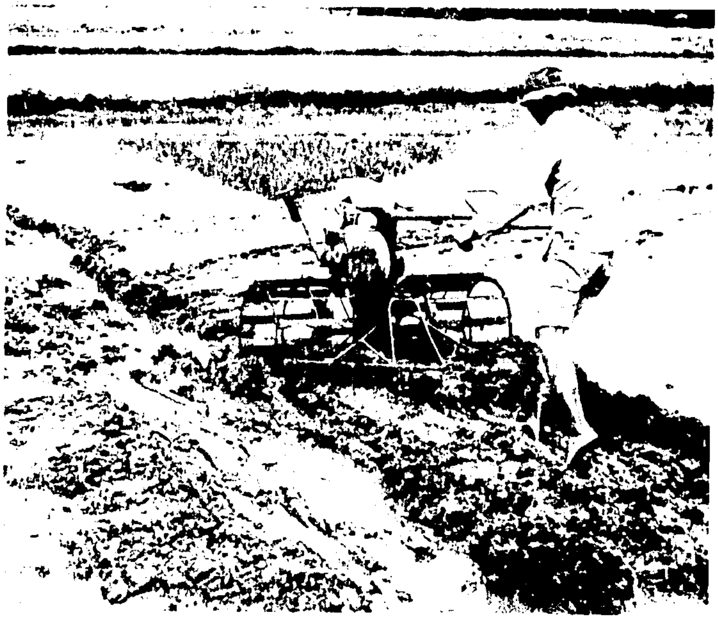
RUGGED DESIGN . . . . Heavy-duty sprocket and chain transmission for reliable performance.

VERSATILE . . . . Tiller can be used for plowing and harrowing and with the 1.0 meter reaper attachment, it can also be used for harvesting. The tiller can accept either gasoline or kerosene engine.

FUEL ECONOMY . . . . Tiller uses a 3 hp engine for lower fuel consumption.

LOW MAINTENANCE . . . . Fewer moving parts. Sealed transmission with oil bath lubrication for longer service periods.

199



Harrowing

Reaping

Machine specifications:

POWER	3-4 hp (gasoline or kerosene)
WEIGHT	88 kg (gasoline)
LENGTH	182 cm
WIDTH	129 cm (with puddling wheels)
HEIGHT	99 cm
SPEED	2.5 - 4.5 kph
POWER TRANSMISSION	V-belt to chain and sprockets
STEERING SYSTEM	Manual
FUEL CONSUMPTION	1.08 lit/hr (gasoline)
FIELD CAPACITY:	
PLOWING	0.6 ha/day
HARROWING	0.9 ha/day
REAPING	2.4 ha/day

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

CAAMS*-IRRI 1.0 m reaper

Harvests paddy of different varieties

FEATURES:

HIGH CAPACITY . . . . 2.4 hectare per day

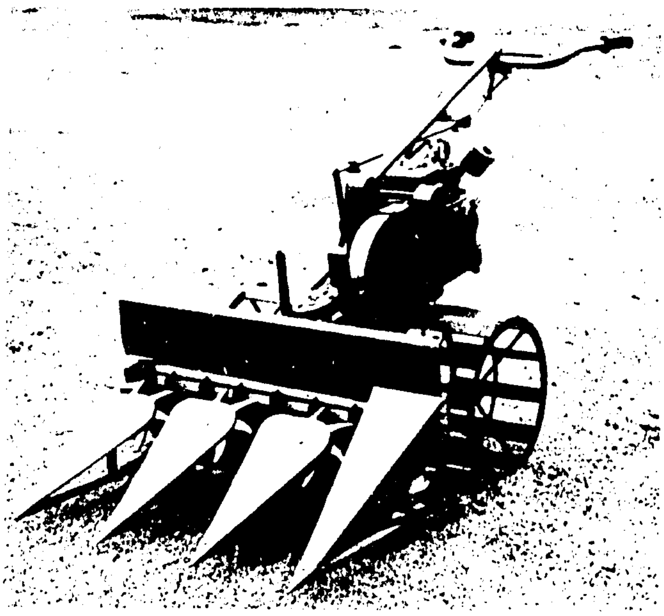
LOW HORSEPOWER REQUIREMENT . . . . 3-hp engine

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

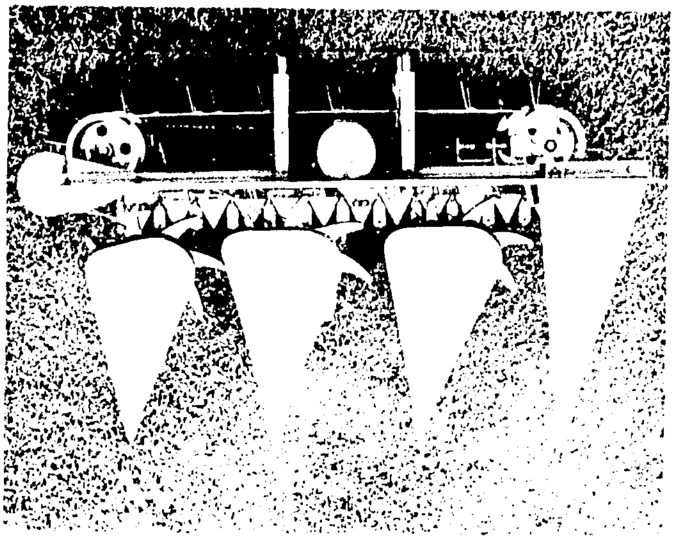
EASE OF OPERATION . . . . Simplicity of design-reduces operation and maintenance problem.

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

* CHINESE ACADEMY OF AGRICULTURAL MECHANIZATION AND SCIENCES



Compact design



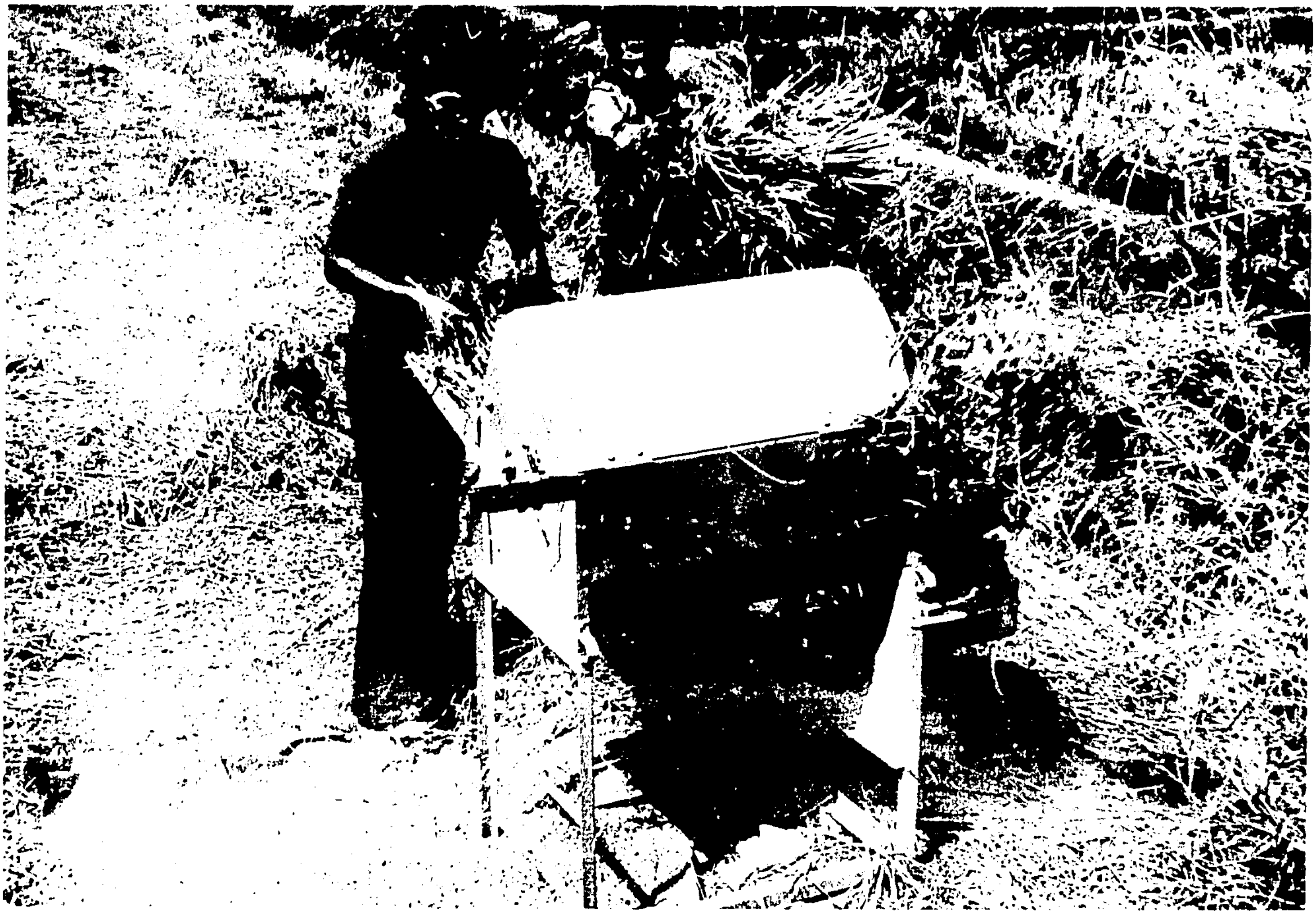
Reaper is adaptable to other hand tractor unit

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

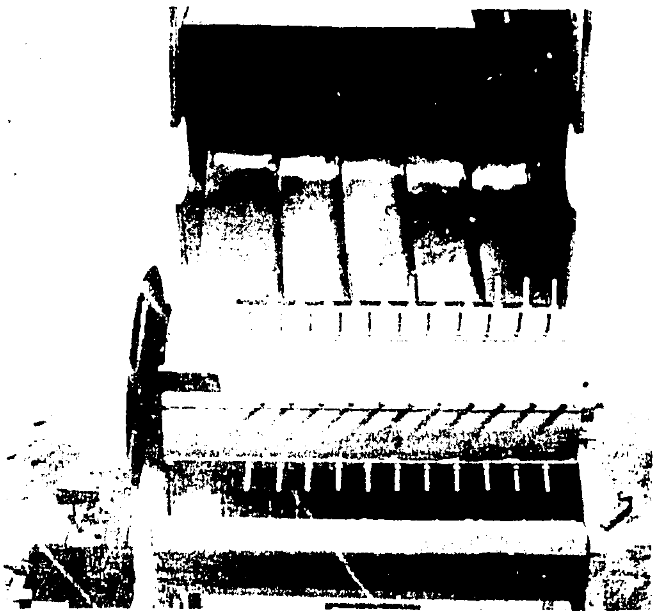
IRRI portable thresher



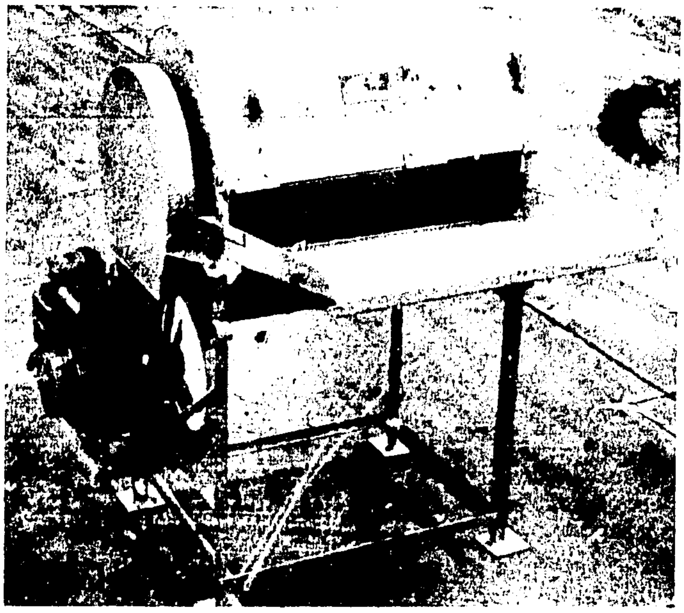
Threshes paddy and some sorghum varieties.

Features

HIGH OUTPUT	300-600 Kg/Hr of threshed paddy depending on crop conditions
LOW HORSEPOWER REQUIREMENT	5-hp engine
LOW LABOR REQUIREMENT	Two to three men to feed, thresh and bag grain
EASE OF OPERATION	Simplicity of design reduces operation and maintenance problems
THRESHING AND WINNOWING COMBINED	Throw-in or hold-on threshing combined with air winnowing
HIGHLY MOBILE	Can be carried by two men



Threshing cylinder exposed



Compact, efficient design

Machine specifications

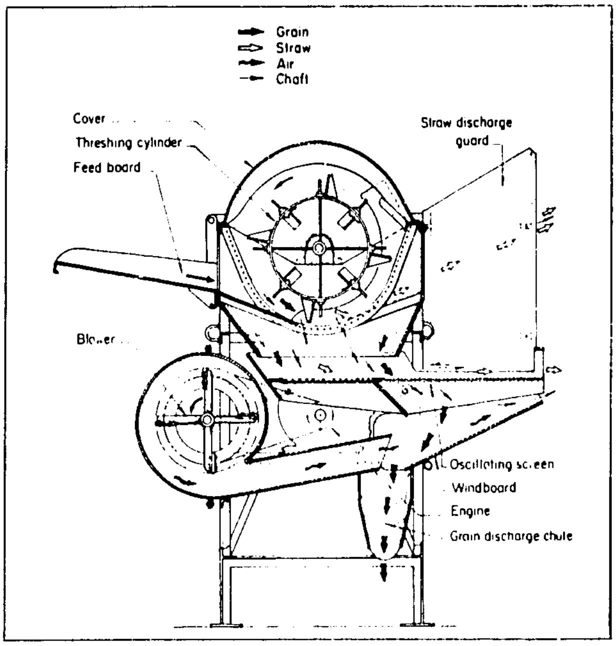
POWER	5- hp engine
WEIGHT (with engine)	105 kg
LENGTH	95 cm
WIDTH (with feed tray folded)	76 cm
HEIGHT (with feed tray folded)	138 cm
CAPACITY	up to 600 kg/hr (rough rice)
SEPARATION RECOVERY	98% (weight basis)
GRAIN PURITY (w/o cleaning screen)	94%
GRAIN BREAKAGE	Less than 2%
CYLINDER	Spiketooth, 30.5 cm O.D. x 71.1 cm length
CONSTRUCTION	All steel
COMPONENT SPEEDS	
Cylinder	600-630 rpm
Fan	Engine speed
LABOR REQUIREMENT	2-3 men
FUEL CONSUMPTION (approx.)	1 Liter/hour

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

IRRI TH7 axial flow thresher

FEATURES

HIGH OUTPUT	Up to one-half ton per hour when threshing paddy
LOW HORSEPOWER REQUIREMENT	7 hp engine
LOW LABOR REQUIREMENT	Three to four men to feed, thresh, and bag grain
EASE OF OPERATION	Simplicity of design reduces operation and maintenance problems
THRESHING AND WINNOWING COMBINED	Throw-in threshing combined with air and screen cleaning mechanisms
HIGHLY MOBILE	Can be carried by 4 men



Schematic of thresher

Good portability

Machine specifications

POWER	7 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 % (weight basis)
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
LABOR REQUIREMENTS	3-4 men

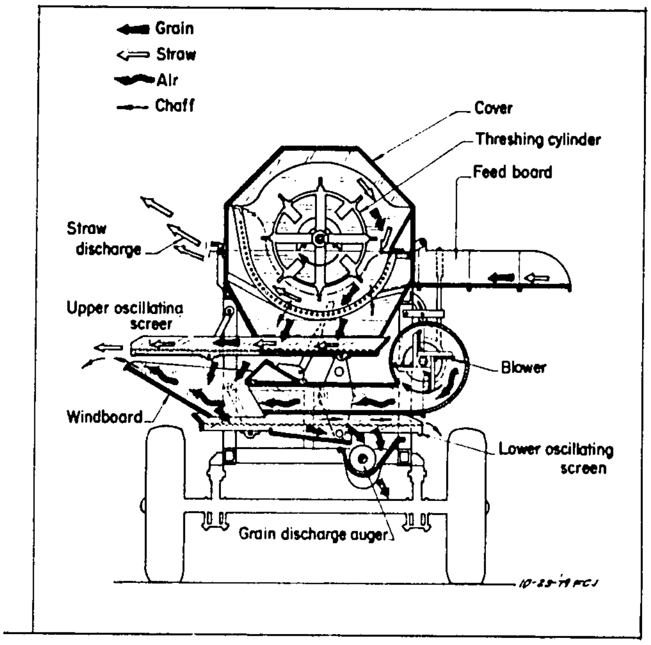
For further particulars write: International Rice Research Institute, P. O. Box 933, Manila, Philippines
Cable: RICEFOUND, MANILA

208

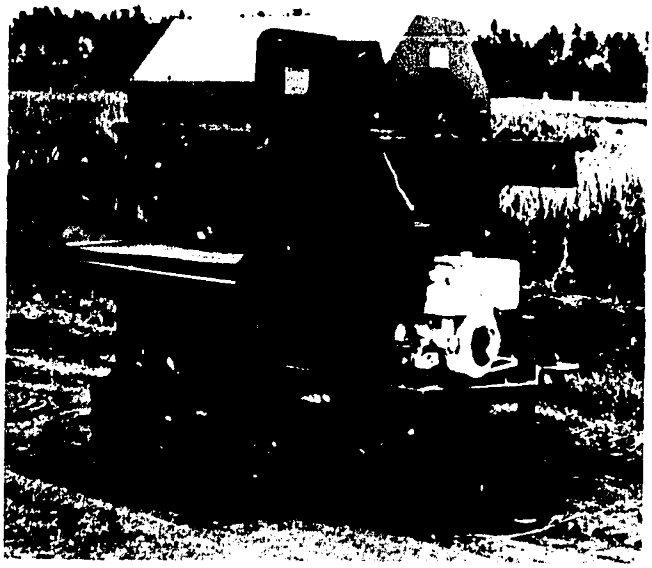
IRRI TH8 axial flow thresher

FEATURES

HIGH OUTPUT	Up to one ton per hour when threshing paddy
LOW HORSEPOWER REQUIREMENT	10 hp engine
LOW LABOR REQUIREMENT	Three to four men to feed, thresh, and bag grain
EASE OF OPERATION	Simplicity of design reduces operation and maintenance problems
THRESHING AND WINNOWING COMBINED	Throw-in threshing combined with an air and double screen cleaning system
HIGHLY MOBILE	Can be pulled by a power tiller, light truck, or animal



Schematic of thresher



Compact design

Machine specifications

POWER	10 hp engine
WEIGHT (with engine)	465 kg
LENGTH	190 cm
WIDTH (with tray folded up)	150 cm
HEIGHT	178 cm
FIELD CAPACITY	800-1000 kg/hr (rough rice)
GRAIN BREAKAGE	less than 4 %
SEPARATION RECOVERY	98 % (weight basis)
CYLINDER (open type)	Spiketooth, 39.4 cm O.D. x 111 cm length
CONSTRUCTION	All steel
COMPONENT SPEEDS	
Cylinder	540-600 rpm
Fan	800 rpm
Oscillating screen (frequency)	340 cycles/min
Oscillating screen (stroke)	3.2 cm
ADJUSTMENTS	Blower shutter, angle of windboard
LABOR REQUIREMENTS	3-4 men

For further particulars write: International Rice Research Institute, P. O. Box 933, Manila, Philippines
Cable: RICEFOUND, MANILA

210

IITA-IRRI Rolling injection planter

FEATURES:

APPLICATION .... Designed for seeding in fields with zero tillage.

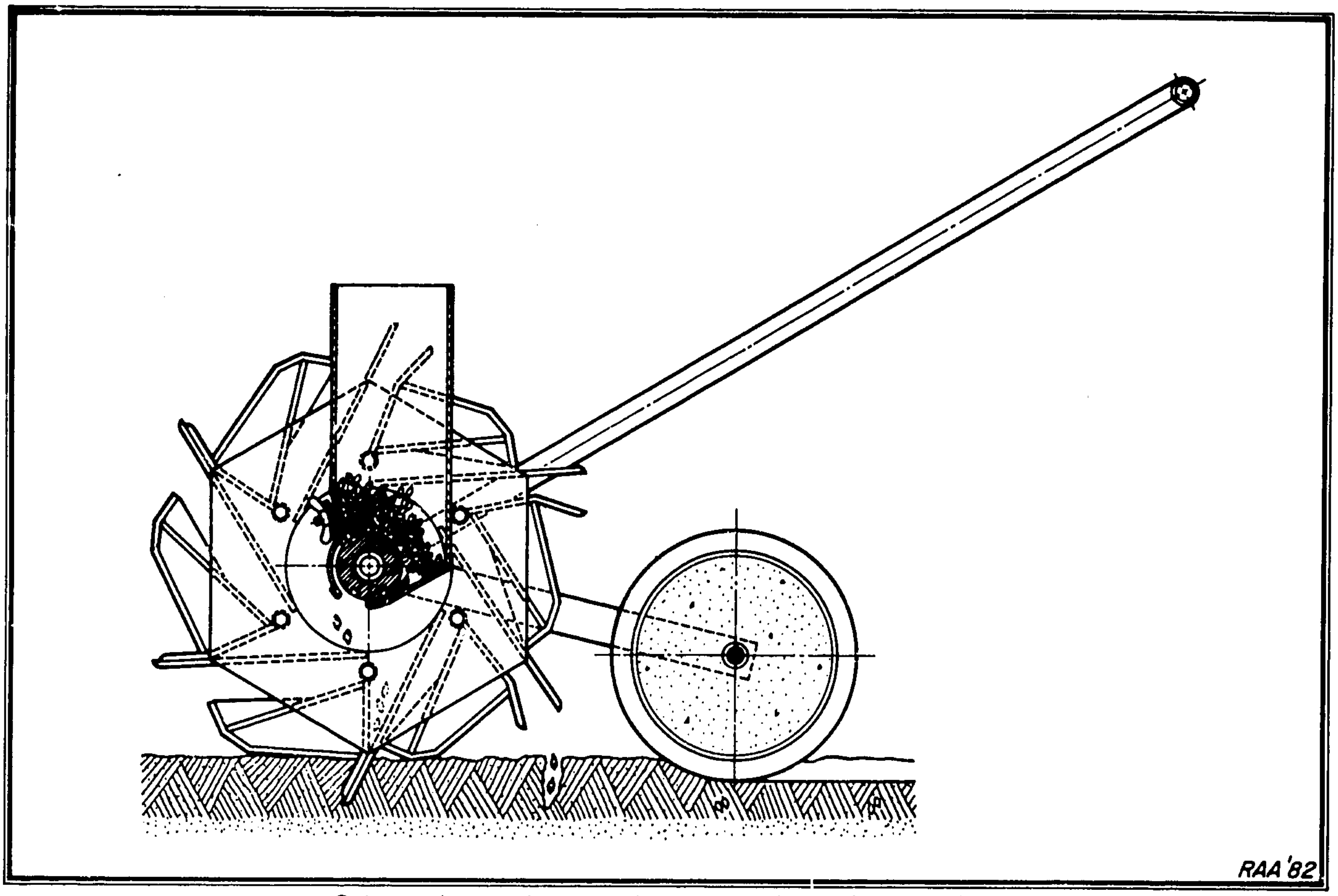
MANUAL OPERATION .... One man can power planter because no furrow is made.

FIELD CAPACITY .... Up to 16,000 hills per hour.

MULTICROP CAPABILITY .... Plants corn, sorghum, mungbean, cowpea, soybean, rice, etc.

SIMPLE ADJUSTMENTS .... Wheel changed for 18 or 25 cm in-row spacing. Metering roller changed for different types of seed and spacing.

LOW COST .... Simple construction results in low cost.



Schematic drawing showing 25 cm planter in operation.

Machine specifications:

FIELD CAPACITY . . . . From 6,000 to 16,000 hills/hr

IN-ROW SEED SPACING . . . . 18 or 25 cm

TOTAL WEIGHT . . . . 25 kg

WITHOUT PRESSWHEEL . . . . 18 kg

OVERALL DIMENSIONS (L x W x H) . . . . 211 x 51 x 56 cm

HOPPER CAPACITY . . . . 3 liters

CONSTRUCTION . . . . Steel pipe, plate and bar

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

210

ACTIVITIES	1983				1984							
	9	10	11	12	1	2	3	4	5	6	7	8
18. ASSIST FORMULATION OF POLICIES ON FARM EQUIPMENT:												
(a) Participate in meetings of Agricultural Mechanization Committee; collaborate in activities												
(b) Assist IRRI with workshop on Consequences of Mechanization Project; follow-up on recommendations												
19. TRAINING COURSE ON SMALL FARM EQUIPMENT:												
(a) Assist IRRI with the three-week agricultural engineering course, presented twice per year												
20. PROGRAM MONITORING/EVALUATION:												
(a) Maintain on-going monitoring of progress												
(b) Annual survey of cooperating manufacturers												
(c) Annual evaluation of MA-IRRI Program												
21. PREPARATION OF QUARTERLY PROGRESS REPORTS AND WORKPLANS												
22. MEETINGS OF ADVISORY COMMITTEE TO REVIEW PROGRESS AND PLANS												

211

ACTIVITIES	1983				1984							
	9	10	11	12	1	2	3	4	5	6	7	8
14. ESTABLISHMENT OF EQUIPMENT DEVELOPMENT CAPABILITIES AT REGIONAL LEVEL:												
(a) Formulate plan for establishing equipment development projects in at least two regions												
(b) Seek funds for proposed regional projects												
(c) Implement projects												
(d) Evaluate progress and formulate workplan for following year												
15. PROMOTION OF R&D ON SMALL FARM EQUIPMENT:												
(a) Collaborate with ARO and PCARRD in promoting R&D on priority equipment by agricultural colleges and R&D institutions												
(b) Assist in the organization and implementation of a meeting of R&D institutions to promote specific activities on small farm equipment (perhaps following the annual meeting of PSAE)												
16. DEVELOPMENT OF INNOVATION & INVENTION CAPACITIES RELATING TO SMALL FARM EQUIPMENT:												
(a) Coordinate three annual contests on the design of small farm equipment (PIC, SPI, BPI)												
17. ANNUAL MEETINGS OF COOPERATING MANUFACTURERS:												
(a) Plan annual meetings of cooperators in three convenient locations												
(b) Distribute invitations to cooperators												
(c) Prepare presentations and materials for meetings												
(d) Carry out meetings												

- CONTINUED -

212

ACTIVITIES	1983				1984							
	9	10	11	12	1	2	3	4	5	6	7	8
9. EVALUATION OF LOW-VOLUME SPRAYER:												
(a) Review results of Dr. Calora's test of low-volume sprayer												
(b) Plan and carry out additional trials and evaluations												
(c) Organize meeting to review results and decide if sprayer warrants further study and/or extension												
10. EVALUATION OF FERTILIZER APPLICATORS:												
(a) Continue to collaborate with IRRI, MA, and FPA in evaluating fertilizer applicators												
(b) Coordinate fabrication of prototype applicators by cooperating manufacturer												
11. EVALUATION OF ONE-WHEEL HAND TRACTOR:												
(a) Modify tractor to improve traction and stability												
(b) Test modified tractor and decide if project should be continued or terminated												
12. EVALUATION OF CORN-HARVESTING HOOK:												
(a) Complete on-farm evaluations												
(b) Review results and decide if project should be continued or terminated												
13. EVALUATION OF AXIAL FLOW THRESHER FOR SHELLING CORN:												
(a) Prepare proposal to NFA for corn shelling study												
(b) Conduct preliminary tests of shelling corn with TH6 thresher												
(c) Review results of preliminary tests and formulate workplan for further development and testing												

- CONTINUED -

ACTIVITIES	1983				1984							
	9	10	11	12	1	2	3	4	5	6	7	8
6. DEVELOPMENT OF TRANSPLANTER:												
(a) Collaborate with IRRI in on-farm tests of new transplanter												
(b) Assist IRRI to develop extension materials on fabrication, seedling preparation, operation, and economic considerations												
7. DEVELOPMENT OF ROLLING INJECTION PLANTER (RIP):												
(a) Collaborate in conducting on-farm trials of RIP in different areas of Philippines												
(b) Conduct second workshop on RIP to review results of 1982-84 trials and plan future trials and extension												—
(c) Preparation of materials for extension of RIP (if results of trials indicate that RIP should be promoted)												
8. DEVELOPMENT OF DRYER:												
(a) Complete study of sun drying and prepare report with results and recommendations												
(b) Develop extension materials for promoting improved sun-drying practices												
(c) Evaluate cooperative dryer at Kitobo, Bukidnon		—										
(d) Collaborate with Jeon of IRRI in development and testing of rice hull furnace for 10 ton vertical bin dryer												
(e) Install prototype 10-ton dryer at cooperative for intensive testing and economic evaluation												

- CONTINUED -

ACTIVITIES	1983				1984							
	9	10	11	12	1	2	3	4	5	6	7	8
EXTENSION OF THRESHER (cont'd)												
(e) Develop final design: blueprints, operator's manual, promotional materials												
(d) Initiate extension of improved thresher by means of a workshop for manufacturers and field demonstrations in regions												
4. DEVELOPMENT AND EXTENSION OF SEED AND FERTILIZER APPLICATOR (SFA):												
(a) Continue field trials and on-farm demonstrations of SFA												
(b) Prepare technical drawings, operator's manual, and other materials for extension of SFA												
(c) Plan extension activities with appropriate public and private institutions												
(d) Implement extension of SFA, in collaboration with other institutions (e.g., NFAC, Maisagana, seed producers, equipment manufacturers and distributors)												
5. DEVELOPMENT AND EXTENSION OF ROOT CROP EQUIPMENT:												
(a) Plan extension of root crop equipment developed by BPI												
(b) Implement extension project in pilot area												
(c) Develop and test other root crop equipment												
(d) Evaluate results of (b) and (c), and formulate workplan for the following year												

- CONTINUED -

MA-IRRI INDUSTRIAL EXTENSION PROGRAM FOR SMALL FARM EQUIPMENT

SCHEDULE OF ACTIVITIES: SEPTEMBER 1983-SEPTEMBER 1984

ACTIVITIES	1983				1984							
	9	10	11	12	1	2	3	4	5	6	7	8
1. EXTENSION OF REAPER & HAND TRACTOR:												
(a) Continue to provide technical assistance to manufacturers on fabrication and marketing the reaper and hand tractor												
(b) Modify original designs on the basis of feedback from manufacturers and farmers												
(c) Collaborate with IRRI in developing and testing implements for PT5 hand tractor (e.g., off-set plow, combined harrow-leveler, improved cage wheels, trailer)												
(d) Promote PT5 hand tractor for land preparation												
(e) Conduct second survey of reaper manufacturers, owners, and users												
2. EXTENSION OF AXIAL FLOW PUMP:												
(a) Prepare promotional materials on utilization of axial flow pump for irrigation, drainage, and fish ponds												
(b) Meetings with agencies which are potential promoters of pump												
(c) Formulation and implementation of extension efforts with collaborating institutions												
3. DEVELOPMENT & EXTENSION OF THRESHER:												
(a) IRRI to fabricate prototype of improved TH6 thresher and perform preliminary test												
(b) Conduct intensive on-farm tests, making improvements as needed												

- CONTINUED -

At present there are approximately 65 cooperating manufacturers in Mindanao. If we assume that 25 of them request loans of materials and components from the Association in the first year, - and that the average amount of each loan is ₱20,000, then a total budget of ₱500,000 is estimated for the first year. Since these funds would serve as a revolving fund, there would be no need for additional inputs in subsequent years unless the number of loans increases due to the participation of additional manufacturers. A certain percentage would be added to each loan in order to cover the administrative and operating expenses of the Association, as well as to contribute to increasing the total amount of the revolving fund and/or to repay the initial loan to the Association.

We would appreciate your suggestions on how to improve this preliminary proposal, as well as on possible sources of funds for the loan. We will be contacting you next week to arrange for a meeting to discuss the matter in more detail.

Sincerely yours,

BENITO C. GONZALO
BPI Co-Leader

ROBERT E. STICKNEY
IRRI Co-Leader

/smm

211

small farm equipment (e.g., threshers, hand tractors, reapers, corn shellers, etc.). By purchasing materials and components in large quantities, the Association would qualify for discounts that would substantially reduce the cost to the manufacturers and, therefore, reduce the price to farmers.

2. The Association would loan these materials and components to cooperating manufacturers, with the quantity being sufficient to fabricate up to 5 units of equipment per manufacturer. Note: each manufacturer's request for a loan would specify the quantity and type of equipment to be fabricated.

3. The manufacturers would then sell the units to farmers on an installment basis. This would be possible because the manufacturers receive loans (in the form of materials and components) from the Association, which enable them to provide partial loans to their customers.

4. The manufacturers would be responsible for collecting the installment payments from the purchasers, and they would utilize these payments to repay the Association or to obtain additional materials and components from the Association via a revolving fund arrangement.

We believe that the proposed plan offers the following advantages:

- reduces the cost of materials and components, thereby reducing the sales price to the farmers and increasing total sales.

- enables manufacturers to offer credit (installment payments) to their customers, thereby avoiding problems associated with the past system of individual loans from banks for each sale.

- promotes better service and repair of equipment because farmers may withhold paying installments if a manufacturer fails to repair the equipment.

- unites the manufacturers so that they may work together for common goals, while remaining as competitors in the marketplace.

.../

farmers on an installment payment basis. This is especially true for small-scale manufacturers who are now finding that the necessary raw materials and component parts are either out-of-stock, poor quality, or have sharply increasing prices.

Of the 180 cooperating manufacturers of the MA-IRRI Program, about 65 are located in Mindanao. They are encountering the following situation:

1. Many farmers want to buy agricultural equipment because their yields and cropping intensity are increasing due to improved technology, thereby making it increasingly difficult for them to carry out the required farm operations in a timely and efficient manner. Moreover, there are frequent shortages of farm labor in Mindanao because the population density is lower and the average farm size is higher than in most areas of the Philippines.

2. These small farmers do not have sufficient savings to purchase equipment on a cash basis, and it is virtually impossible for them to obtain loans.

3. Although manufacturers of small farm equipment do exist in most areas in Mindanao, they generally are small-scale shops and therefore do not have sufficient capital to finance sales of equipment on an installment payment basis.

It appears that the principal problem in Mindanao is the unavailability of credit for purchasing farm equipment by small farmers, rather than the lack of appropriate technology and/or manufacturers.

In February 1984, the MA-IRRI Program held an annual meeting of cooperating manufacturers in Mindanao. It was attended by 30 manufacturers representing 19 different firms. This group formed an association of MA-IRRI cooperating manufacturers in Mindanao, with the objective of working together to find ways to: a) reduce the cost of materials and components; and b) facilitate marketing.

Based on these considerations, a tentative proposal has been formulated for consideration by PBSP and/or other institutions interested in helping small farmers and manufacturers in Mindanao. The main elements of the proposed plan are:

1. It is proposed that a loan be given to the Association to enable it to purchase materials (sheet metal, iron bars, etc.) and components (e.g., engines, bearings, etc.) needed by cooperating manufacturers to fabricate

MA-IRRI INDUSTRIAL EXTENSION PROGRAM
FOR SMALL FARM EQUIPMENT
BUREAU OF PLANT INDUSTRY
AGRICULTURAL ENGINEERING DIVISION
SAN ANDRES ST., MALATE, MANILA
TELS. 59-81-14 OR 50-08 01

March 5, 1984

Mr. Ernesto Garilao
Executive Director
Philippine Business for Social Progress
4th Floor Yutivo Building
270 Dasmariñas Street
Binondo, Manila

Dear Mr. Garilao:

Attached is a brief description of the MA-IRRI Industrial Extension Program for Small Farm Equipment. The objectives of this Program are to provide small farmers with appropriate agricultural equipment through local manufacturers who will adapt the equipment to the farmers' needs and provide repair services. The MA-IRRI Program now has over 180 cooperating manufacturers located throughout the country. The majority of these cooperators are small shops located in agricultural areas.

The purpose of this letter is to ask for your consideration of the current financial problem of farmers and manufacturers with respect to small farm equipment. We begin by giving a brief description of the problem.

During the 1970's, there were several programs which provided loans to farmers for the purchase of agricultural equipment. However, few of the loans were given to small farmers because: a) banks generally required land ownership certificates as collateral, and b) the lengthy application procedures discouraged small farmers. Most loans were limited either to imported brands of equipment or to a few local brands manufactured by large firms which were accredited by the government. These factors, plus artificially inflated prices and unofficial "handling charges", resulted in considerably higher prices to the farmers. In many areas, farmers failed to repay the loans for a number of reasons, including: uneconomic utilization of equipment; breakdown of equipment and lack of repair facilities and parts; rising cost of fuel; and inadequate motivation regarding collection and/or repayment of loans.

At present, there are almost no loans available to farmers for agricultural equipment, and small farmers do not have sufficient savings to purchase threshers, corn shellers, hand tractors, or other basic machines. Moreover, most local manufacturers of agricultural equipment do not have the capital to sell machines to

.../

220

We sincerely hope that your effort to improve local manufacturing of farm equipment will be successful, and we are most willing to help in any possible manner.

Sincerely yours,

BENITO C. GONZALO
BPI Co-Leader

ROBERT E. STICKNEY
IRRI Co-Leader

/smm

cc: Mr. Agapito Kalingking
Board of Investments

221

3. Credit. According to our cooperating manufacturers, farmers want to buy their products (small farm equipment such as two-wheel tractors, threshers, shellers) but they cannot find suitable loans, especially if they do not have land titles or if the manufacturer's equipment is not accredited. One possible way of overcoming this problem would be for banks to provide small loans (₱25,000 to ₱100,000) to the manufacturers in order that they may provide direct financing to their farmer customers for purchasing equipment on an installment payment basis. We believe that local manufacturers are highly qualified to select responsible buyers and to collect installment payments in a reliable manner. Moreover, the farmers who purchase equipment from local manufacturers would benefit by being able to demand repair and/or replacement of defective equipment as a condition to their making the installment payments.

4. Import of Engines. Many types of agricultural equipment used on small farms require engines ranging from 1 to 16 HP. These engines are not manufactured within the Philippines, nor would it be economical to do so because the lack of competition would no doubt lead to higher prices to the farmers and limited availability of certain sizes. At present, the importation of engines has decreased, and this situation will prevent the sale of locally built two-wheel tractors, threshers, shellers, and other equipment requiring small engines. Although the importation of engines is undesirable with respect to the outflow of dollars, it is absolutely essential to the progress of local manufacture of small farm equipment and to the production of food crops in the Philippines. It would be detrimental to the small farmers if the import duty on small engines were increased.

We are attaching a brief description of our Program and would be pleased to provide any additional information that might be helpful. We are unable to provide reliable estimates of the supply and demand for small farm equipment because there does not exist an adequate mechanism for monitoring the production of the thousands of small manufacturers throughout the Philippines. Furthermore, the demand has dropped off severely as a result of the problems mentioned above, but we believe that this situation could be reversed by means of the steps proposed herein.

ANNEX F

MA-IRRI INDUSTRIAL EXTENSION PROGRAM
FOR SMALL FARM EQUIPMENT
BUREAU OF PLANT INDUSTRY
AGRICULTURAL ENGINEERING DIVISION
SAN ANDRES ST., MALATE, MANILA
TELS. 59-81-14 OR 50-08 01

February 9. 1984

Governor Federico V. Borromeo
Ministry of Trade and Industry
Trade and Industry Building
Buendia Avenue Extension
Makati, Metro Manila

Dear Governor Borromeo:

We were pleased to be invited to attend the meeting on February 6 in which you expressed your concern with improving the manufacturing of farm equipment in the Philippines. The purpose of this letter is to respond to your request for information and suggestions relating to possible incentives for import substitution by local manufacturers.

Our comments are limited to only one portion of the local manufacturers of agricultural equipment: - those manufacturers of equipment for small farms, particularly rice and corn farms. Therefore, the following comments do not apply to the problems of manufacturing equipment for larger farms, such as those producing sugar. Our comments are based mainly on communication with some of the 180 manufacturers of small farm equipment who are cooperating members of the MA-IRRI Industrial Extension Program for Small Farm Equipment.

1. Incentives. We believe that local manufacturers of small farm equipment do not need special incentives to encourage them to develop substitutes for imported equipment. The recent devaluation and the depressed economic conditions of small farmers are strong disincentives to the purchase of costly imported equipment rather than locally produced equipment available at substantially lower prices. However, the demand for locally produced equipment has fallen off severely, and we make the following suggestions on ways by which the demand may be stimulated.

2. Raw Materials. As was expressed during our meeting, one of the main complaints of manufacturers has to do with the high price and low quality of the raw materials (mainly metal plate, sheet, and bars) used to fabricate agricultural equipment. This is certainly a problem that deserves the attention of MTI.

3. Axial-flow Pump

The axial-flow pump (or propeller pump) was developed in Vietnam and Thailand where it gained widespread acceptance by small farmers for low-lift irrigation. In the 1970s IRRI developed a design with higher efficiency than the original axial-flow pump.

The MA-IRRI Program has promoted the axial-flow pump in areas where low-lift irrigation is technically feasible and economically profitable. Acceptance has been limited by two factors: (1) Filipino farmers are familiar with centrifugal pumps which are available throughout the country; and (2) rice areas suitable for low-lift irrigation are far less common in the Philippines than in Vietnam and Thailand. To overcome the first problem, we have compared the axial-flow pump with the centrifugal pump to illustrate the markedly higher efficiency of the former for lifts below 3 meters. A report attached to the 1982-83 Annual Report summarizes test results together with an economic analysis estimating the savings realized by the axial-flow pump.

The Program's attempts to promote the axial-flow pump include collaboration with the National Irrigation Administration (e.g., 10 pumps were installed in Libmanan, Camarines Sur) to provide water to areas which are slightly higher than the canals of the irrigation system. The pump has also been promoted to owners of fishponds, and it is estimated that about 40 have been sold for this purpose, with the best potential market for future sales being the prawn producing areas, such as Capiz.

We propose to continue promoting the axial-flow pump for both irrigation and fishponds, but will attempt to modify the design to reduce initial cost.

4. Rolling Injection Planter (RIP)

The International Institute for Tropical Agriculture (IITA) developed this manually-operated planter suitable for zero-tillage applications. IRRI has attempted to adapt the implement for use by small farmers to plant upland crop immediately after harvesting their rice crop so as to utilize residual soil moisture at the end of the wet season. The potential of this implement is attractive because it would enable farmers to grow an extra crop during the dry season, thereby adding to their income and increasing the demand for labor.

The MA-IRRI Program organized a workshop at IRRI in 1982 to: (a) review experiences of various groups with the RIP; (b) define its most promising uses; and (c) formulate collaborative efforts for on-farm evaluations needed to guide decisions regarding possible extension activities. A second workshop will be held in mid 1985 to review the results of these evaluations of the RIP and to decide if it is ready for extension. This will involve the collaboration of groups working with the RIP at UPLB, Isabela State University, MA regional offices, and IRRI.

The MA-IRRI Program assisted two manufacturers in Iloilo to fabricate 20 RIPs used by IRRI's Technology Transfer and Training Department for field trials during 1983 and 1984. The results were sufficiently encouraging that the KABSAKA project of the MA regional office in Iloilo has purchased 100 RIPs for on-farm trials to begin in late 1984. We assisted the manufacturer who fabricated the 100 units and will collaborate closely with KABSAKA during the trials. The Program has fabricated 10 units at BPI, and these have been loaned to MA regional offices for field trials.

5. Seed and Fertilizer Applicator (SFA)

In response to the government's priority on increasing production of yellow corn, we have developed an animal-drawn seed and fertilizer applicator (SFA) suitable for small farms and easily fabricated by small shops. In a single pass, the SFA opens a furrow, places fertilizer and seeds at desired rates, and applies a soil covering. The fertilizer is placed below and to one side of the seeds to increase efficiency and utilization, as well as to avoid "burning" the seeds.

225

The MA-IRRI Program employed an engineer who had been one of three manufacturers of earlier versions of SFA in South Cotabato, Mindanao. We improved the design with the objective of promoting it in corn-growing areas where it was not yet known. Demonstrations and field trials have been carried out in the major corn areas through collaboration with the regional offices of the Ministry of Agriculture and the Experiment Stations. Simplified engineering drawings and a fabrication guide were prepared and disseminated to interested cooperators beginning in late 1983. Our engineers have provided technical assistance to these cooperators, and more than seven have successfully completed at least one unit of SFA.

We plan to continue extension of the SFA through close collaboration with the MA regional offices, with emphasis on the target areas of the Government's corn program (Maisagana Program). Through collaboration with MA agronomists in Iloilo and South Cotabato, we have learned that some farmers are enthusiastic about using the SFA for a wide variety of crops, including both hybrid and native corn, soybeans, mungbeans, and dry-seeded rice. We will work closely with these groups to evaluate the potential applications of the SFA.

6. Transplanter

The manually-operated transplanter developed by IRRI in 1980 was not accepted by rice farmers in the Philippines because of problems encountered in field operation and with the special method of preparing seedlings. Through collaboration between IRRI, MA-IRRI, and the PPC Rice Farm, most of these problems have been overcome. Feedback from farmers during demonstrations and field trials has also contributed to improving the apparatus and the seedling preparation procedure. An intensive promotional campaign and training effort were carried out in Libmanan, Camarines Sur, where farmers claim that transplanting by the traditional manual method resulted in detrimental delays in crop establishment. We have helped three cooperating manufacturers in Libmanan to learn to fabricate the transplanter, and the total sales has reached 21 units. Through collaboration with IRRI economists, we are evaluating farmer acceptance and the socio-economic impact of the transplanter in Libmanan.

Based on the results obtained, we will formulate a plan for future extension of the transplanter. The MA-IRRI program is collaborating with the AMDP group at UPLB to develop a transplanter attachment for the PT5 hand tractor, and the prototype should be ready for field tests late in 1984.

7. Root Crop Chipping Machine

In 1983 the MA-IRRI Program decided to initiate an activity on root crop equipment because: (1) root crops are important staple foods for low income groups in several areas of the Philippines; (2) the Government has launched a major program to increase national production of root crops for animal feed, thereby reducing imports of yellow corn; and (3) BPI had developed root crop equipment through the efforts of a PCARRD-funded project. The first step of this activity was to improve the BPI rootcrop chipping machine and carry out tests and demonstrations in collaboration with the Government's task force on root crop production, coordinated by the Bureau of Animal Industry and BPI. These demonstrations included collaboration with the Visayas State College of Agriculture (VISCA) in Leyte.

MA-IRRI engineers will now begin to provide technical assistance to cooperators regarding fabrication of the chipping machine. Simplified engineering drawings have been completed and will be given to interested cooperators. Machines will be loaned to cooperators who are not capable of fabricating the unit solely from the drawings. Sales will be stimulated by the Government's program to provide farmers with loans for purchasing 10,000 chipping machines in 1984-85.

8. Paddy and Corn Dryers

High-level members of the Ministry of Agriculture, NFA, and IRRI have expressed a common concern for the need for a low-cost dryer that may be used for crops harvested during the wet season when traditional sundrying is often delayed due to clouds and rain. Various institutions have attempted to develop a dryer of this nature, but none of their designs has achieved satisfactory acceptance by farmers or traders. The MA-IRRI Program reviewed existing studies relating to the problem of drying of paddy and corn in the Philippines, and then carried out a supplemental study in Mindanao. This led to an experimental study of sundrying, the results of which suggested practical methods for improving traditional sundrying practices. The Program then collaborated with IRRI to develop and test two possible concepts - the heated floor dryer and the vertical bin dryer - neither which proved to be satisfactory. We are now considering a rotary dryer, and a prototype will be build only if our approximate calculations indicate that the concept has promise.

At present we are evaluating a UPLB corn dryer which is a modification of their copra dryer. We are also collaborating with IRRI to identify more clearly the economic and technical constraints of drying, with emphasis in Bicol. Based on these results we will formulate a work plan for the coming year.

9. Low-Volume Sprayer

A Sri Lankan engineer, R. Wijewardene, has developed a low-cost (approximately US $10) attachment which converts a common knapsack sprayer into a low-volume sprayer. We purchased 10 units from manufacturers in Sri Lanka and India because low-volume sprayers would be useful to farmers in areas where water is not readily available. The Program arranged for the device to be evaluated by the Cyanamid Agricultural Research Foundation in Laguna. The results indicated that clogging occurred with one of the most common herbicides used in the Philippines. We have discountinued the study because of this problem and due to the lack of suitable personnel.

10. Fertilizer Applicators

The MA-IRRI Program assisted IRRI in contracting cooperating manufacturers to fabricate prototype fertilizer deep-placement applicators for testing in farmers' fields. An additional 50 units were purchased by the Government for the MA-FPA field demonstrations and trials throughout the country. One MA-IRRI regional project engineer has helped to coordinate these trials. The work plan for the coming year will be formulated once the results of the present trials have been analyzed.

11. One-Wheel Hand Tractor

The MA-IRRI Program imported a one-wheel garden tractor (Coleman) from the USA in order to evaluate it as a potential machine for inter-row cultivation of corn and legumes. The conclusion of our evaluation was that the machine would not be suitable for intensive farm use unless major modifications were made. Consequently, this activity has been terminated.

12. Corn Harvesting Hook

In the Philippines, corn is generally harvested by hand, often with the aid of a pointed stick to help open the husk. An alternative is to replace the stick by a metal hook attached to a glove on one hand of the worker. A hook obtained from the USA via the Director of the San Miguel Hybrid Seed Development Center was duplicated and evaluated in Laguna and Isabela. This activity has been terminated because the results indicate that the hook does not increase significantly the harvesting speed of a worker.

16. Tillage Equipment

Rice farmers in the Philippines utilize a variety of technologies for land preparation. These technologies include the carabao plow, imported and locally-built hand tractors with various implements (e.g., moldboard plow, disk plow, spiral plow, harrow), floating rotavator tillers, and 4-wheel tractors. The farmers' choice of equipment varies from one area of the country to another, partly due to cultural factors and partly due to technical and economic considerations. We have carried out a field study to compare the different technologies for the purpose of determining their advantages and disadvantages. Results indicate that the floating tiller appears to be the most economic choice for a wide range of conditions. We now plan to attempt to: (a) modify the conventional hand tractor so that it will acquire some of the advantages of the floating tiller; and (b) improve the performance of the present floating tiller.

17. Carabao Harness

The carabao (water buffalo) is widely used by small rice farmers for land preparation, cultivation, and transport. The most common harness is the wooden yoke that concentrates the load on the back of the animal's neck. Studies in various countries have shown that the power and endurance of a draft animal can be increased significantly by using a harness which distributes the load over the appropriate parts of the body. We have recently initiated an attempt to devise such a harness for the carabao. The first step has been to collect and review existing reports of the subject. By the end of October this task should be finished and a preliminary proposal formulated. Work on developing a harness will be undertaken only if there appears to be a significant potential improvement.

13. Thresher/Sheller

The Government has undertaken a major effort to increase local production of yellow corn in order to reduce imports of animal feed. As a result of increased production, it appears that corn shelling is becoming a major bottleneck. For this reason we have developed a simple modification of the widely-used axial-flow thresher so that it may also serve as a corn sheller. The modification may be made to existing or new machines at a cost of less than ₱1,500 (US$80). The performance of the thresher/sheller has surpassed our expectations in terms of capacity and purity, achieving a capacity of 5 tons per hour.

The thresher/sheller was introduced to cooperating manufacturers during the annual meetings held in early 1984. Three cooperators have successfully fabricated the unit, and three others are expected to complete their first unit within the next month. Interest in the thresher/sheller has been stimulated by the Government's recent request for quotations for 100 corn shellers.

14. Tapak-Tapak Pump

The majority of rice farmers in the Philippines are not serviced by irrigation systems during the dry season. Some of these farmers utilize residual moisture plus occasional rainfall to grow upland crops immediately after harvesting their rice crop at the end of the wet season. (See paragraph 4 above). Others dig open wells and lift water either manually or by small pumps, generally for irrigation of vegetables. The MA-IRRI Program has searched for a manually-powered pump suitable for low-lift irrigation, and we were most favorably impressed by the design developed by RDRS in Bangladesh. The advantages of this pump are: (a) low cost (about US $10); (b) ease of fabrication with tools available in small workshops; (c) utilization of readily available materials and parts; (d) simplicity of operation, maintenance, and repair; and (e) effective utilization of body weight to power the pump through a foot-operated treadle.

231

The MA-IRRI Program has fabricated 8 units of the pump and evaluated these in farmers' fields in early 1984. The farmers' response was very positive. The IRRI Co-Leader visited Bangladesh to gain additional information on both the pump and the RDRS extension program. Arrangements were made for an experienced RDRS engineer to spend one week in the Philippines training MA-IRRI personnel on pump fabrication and installation.

We are now preparing a pump fabrication guide to be given to interested cooperating manufacturers. An extension program is being planned in coordination with the Central and Regional offices of the Ministry of Agriculture. We will also demonstrate the pump to IRRI's Multiple Cropping Department with the hope of establishing a collaborative effort to evaluate the pump.

One of our cooperating manufacturers has developed a cast-iron version of the Tapak-Tapak pump and estimates the sales price to be ₱400 (US$20). We are now evaluating the pump before the cooperator initiates commercial production.

15. Steam-Powered Pump Using Rice Straw as Fuel

On small rice farms in the Philippines, rice straw appears to be the best potential fuel because it is abundant and often is not utilized (e.g., is burned in the field). For this reason we have collaborated with two inventors to develop and evaluate different devices for generating useful power from rice straw. The basic idea is to burn straw to produce low-pressure steam which may power either a reciprocating engine or a turbine. The power output could be used for a variety of applications (threshing, winnowing, drying, milling, generation of electricity, etc.) and we have chosen to focus initially on one application, the pumping of water for irrigation.

One inventor already has a working model and we arranged for the IRRI Agricultural Engineering Department to assist in evaluating the performance of the device. The other inventor has been contracted by us to build a working model for pumping water. Field demonstrations and economic analysis will be carried out in order to assess the potential of these concepts.

IRRI MECHANICAL TRANSPLANTER OPERATOR TRAINING PROGRAM

FIRST DAY

0800-0815	Welcome Address	Engr. P.D. Favenir
0815-0845	Opening Remarks	Atty. Bodiao
0845-0915	Introduction of IRRI Mechanical Transplanter in Libmanan and Cabusao, Camarines Sur	Clarence Escober/ Fred Salazar
0915-0930	Introduction of Trainees and Trainors	Nards Nogra
0930-1000	Brief Description of the Transplanter Training Program	Engr. A. Vasallo
1000-1015	Coffee Break	
1015-1100	Development of Mechanical Transplanter in IRRI	Fred Salazar
1100-1200	Socio-economic considerations in the use of the mechanical transplanter	Ms. Bardz Ebron
1200-1300	Lunch Break	
1300-1330	Effect of Plant Density and Plant Geometry on rice yield	Clarence Escober
1330-1430	Seedling and Seedbed Preparation	Engr. A. Vasallo
1430-1500	Other factors affecting the operation of mechanical transplanter	Engr. H. Icatlo
1500-1515	Coffee Break	
1515-1545	Transplanter Construction and Operation	Fred Salazar
1545-1700	Sequence of operators movement in the operation of 6-row IRRI transplanter	F. de Leon/ Roger Abuyog

SECOND DAY

0700-0800	Field Practice - Seedbed Preparation and Sowing	Mody Rapinan
0800-1100	Seedbed Preparation and Sowing* (Each trainee will prepare one seedbed and sow pregerminated seeds)	Mody Rapinan
1100-1330	Lunch Break	
1330-1430	Seedling Mat Cutting and Transport	Mody Rapinan
1430-1530	Transplanting without seedlings	FdL/RA/ED
1530-1545	Coffee Break	
1545-1730	Transplanting with seedlings	FdL/RA/ED

*Arrangement could be made to transplant these seedlings 20 days after sowing by the trainees themselves (June 11).

THIRD DAY:

0700-0900	Seedling Mat Cutting and Transport - Trainee will cut and transport seedling mats	Mody
0900-0915	Coffee Break	
0915-1115	Transplanting (30 min/turn/trainee)	FdL/RA/ED
1115-1330	Lunch Break	
1330-1530	-Continuation-	
1530-1545	Coffee Break	
1545-1730	-Continuation-	

FOURTH DAY:

0700-0900	Transplanting (one hour/turn/trainee)	FdL/RA/ED
0900-0915	Coffee Break	
0915-1115	-Continuation-	
1115-1330	Lunch Break	
1330-1530	-Continuation-	
1530-1545	Coffee Break	
1545-1745	-Continuation-	

FIFTH DAY:

0800-0930	Trasnplanting (1 1/2 hours/turn/trainee)	FdL/RA/ED
0930-0945	Coffee Break	
0945-1115	-Continuation-	
1115-1330	Lunch Break	
1330-1500	-Continuation-	
1500-1515	Coffee Break	
1515-1645	-Continuation-	

SIXTH DAY:

0700-0900	Transplanting (2 hours/turn/trainee)	FdL/RA/ED
0900-0915	Coffee Break	
0915-1115	-Continuation-	
1115-1330	Lunch Break	
1330-1530	-Continuation-	
1530-1545	Coffee Break	
1545-1745	-Continuation-	

SEVENTH DAY:

0700-0900	Trainee A will operate for 2 hours and Trainee B will cut and transport the seedling mat	FdL/RA/ED
1900-0915	Coffee Break	
0915-1115	Trainee B will operate for 2 hours and Trainee A will cut and transport the seedling mat	
1115-1330	Lunch Break	
1330-1530	Trainee A's turn	
1530-1545	Coffee Break	
1545-1745	Trainee B's turn	

EIGHT DAY:

0700-0900	Trainee B will operate the transplanter while Trainee A will cut and transport the seedling mat	FdL/RA/ED
0900-0915	Coffee Break	
0915-1115	Trainee B will continue operating while Trainee A will also continue cutting & transporting the seedling mats	
1115-1330	Lunch Break	
1330-1530	Trainee A's turn to transplant while Trainee B will cut and transport the seedling mats	
1530-1545	Coffee Break	
1545-1745	-Continuation-	

NINTH DAY:

0700-0900	Trainee A will operate the transplanter	FdL/RA/ED
0900-0915	Coffee Break	
0915-1115	Trainee A will continue operating	
1115-1330	Lunch Break	
1330-1530	Trainee B will operate the transplanter	
1530-1545	Coffee Break	
1545-1745	Trainee B will continue operating	

TENTH DAY:

0700-0900	Trainee B will operate the transplanter	FdL/RA/ED
0900-0915	Coffee Break	
0915-1115	Trainee B will continue operating	

1115-1330	Lunch Break	
1330-1530	Trainee B will continue operating	
1530-1545	Coffee Break	
1545-1745	Trainee B will continue operating	

ELEVENTH DAY:

0700-0900	Same as the 10th day except that Trainee A will operate the transplanter continuously	FdL/RA/ED

TWELFTH DAY: (June 2)

0800-1030	Field Day (Competition between trainees)	VITO
1030-1100	Coffee Break	
1100-1200	Questions and answers	GS
1200-1300	Lunch	
	Closing Program Emcee:	CEE
	Opening Remarks	Engr. Favenir
	Inspirational Message	Dir. Gimpaya Mayor Bulaong Dr. C.W. Bockhop
	Intermission	
	Remarks	Dr. R.E. Stickney
	Intermission	
	Distribution of Certificates	Dr. C.W. Bockhop Assisted by Dir. Gimpaya and Mayor Bulaong
	Closing Remarks	Atty. Bodiao

Mechanical Transplanter Training Course
Preferred Date of Sowing

A. For Field Practice

1.	Modesto Rapinan	May 2
2.	Rodolfo Jimenez	May 3
3.	Bartolome Pintang	May 4
4.	Leonardo Nogra	May 5

B. For Final Examination

1.	Eugenio Castro	
2.	Miguel Mina	May 7
3.	Moises Talay	
4.	Igmedio Abarrientos	May 8
5.	Domingo Castro	May 9
6.	Jaime Nogra	May 10
7.	Roberto Gueruela	
8.	Domingo Bertumer	May 11
9.	Elmer Nogra	

IRRI MECHANICAL TRANSPLANTER
TECHNOLOGY TRANSFER: THE LIBMANAN EXPERIENCE

Godofredo C. Salazar*

INTRODUCTION

Mechanical transplanter performance greatly depends upon several factors such as the quality of seedling preparation and skill of the operator and at a lesser degree on the quality of land preparation and standing water level in the field. This is the main reason why IRRI mechanical transplanter requires more time and effort to promote compared to other agricultural machineries like thresher, reaper and power tiller.

Even though the IRRI Engineering Department have improved the design of the transplanter in the early part of 1983, the search for a simple seedling preparation which can be easily done by ordinary farmer still elude us until we visited Libmanan, Camarines Sur last August 1983.

Transplanter Introduction in Camarines Sur

Through the invitation of IRRI Irrigation and Water Management Department, a field demonstration of power tiller, reaper and transplanter was held last August 1983 in Libmanan, Camarines Sur. It was attended by the directors and members of Libmanan-Cabusao Irrigators' Association (see Appendix A for background information) and interested IRRI manufacturers/cooperators in Bicol Region. The IRRI TR-4 6-row

---

*Senior Research Assistant, Agricultural Engineering Department, The International Rice Research Institute, Philippines.

transplanter (Fig. 1) performed satisfactorily using modified "Dapog" seedlings (Fig. 2) brought to Libmanan from IRRI. The local method of seedling preparation for hand transplanting called "Laplap" (Fig. 3) was also tried and was found also suitable to the transplanter.

Due to the warm response of the farmers during the demonstration, an applied research project (Fig. 4) was proposed and was approved by the Agricultural Engineering department head. To erase the doubts of some farmers that the machine cannot be operated continuously for 8 hours by one man, an experienced operator was invited from the Philippine Packing Corporation (PPC) Rice Garden Project in Bukidnon, Southern Philippines. This operator can transplant 1/2 hectare a day. The director of the Irrigators' Association was impressed by the transplanter performance in the duration of the extended demonstration. After 10 ha. were planted, it was found that there is still a need for further modification of the machine. Some farmers suggested that the machine should be capable of planting the remaining rows less than 6 in the last pass. This was incorporated in the revised transplanter design.

After the demonstration, the directors of the irrigators association agreed to buy the first 9 units of the 6-row transplanter provided that their designated operator will be trained. Six units of the revised transplanter design were ordered from the three welding shops in Libmanan and another 6 units were fabricated in IRRI. The three manufacturers were given technical assistance. They were also provided with thin wall tubings since the material is not available in that area during that time.

The two weeks training program was held last May 28 to June 8, 1984 (See Appendix B). The trainees were trained in the seedbed and seedling preparation (Fig. 5) operation (Fig. 6 & 7), maintenance and adjustment of the machine (Fig. 8), and trouble shooting. On the last day, a contest was held to determine the three best operators among the trainees. The winner were given special prizes. All the trainees were also given a certificate of completion (Fig. 9) and all the units used during the training program were disposed at a special price.

After the training program, an 8-row model (TR5) (Fig. 10) with 15 cm row spacing was fabricated in the prototype shop. This is in response to Libmanan farmer's request since majority of them are using 15 cm row spacing. It was sent to Libmanan as a guide to manufacturers. One Libmanan manufacturer had built more than 10 units of these new model as of September, 1984. To further promote the use of the transplanter, another demonstration intended for all the manufacturers in the whole province of Camarines Sur will be held in Libmanan this coming November. This will convince them that the mechanical transplanter is already accepted in Libmanan and Cabusao.

SUMMARY

The following were the most salient points in the transplanter applied research project in Libmanan and Cabusao, Camarines Sur;

1. Training of the operator in the seedbed and seedling preparation operation, maintenance and adjustments of the machine and trouble shooting is a necessary component in the extension program of the mechanical transplanter.

240

2. The required seedling preparation can be done by ordinary farmers as demonstrated in Libmanan and Cabusao. Almost all the farmers in those areas knew how to prepare good seedlings at a density suitable to IRRI transplanter. In fact, they don't even measure the quantity of pregerminated seeds during sowing. This is mainly due to the fact that the existing practice in those places is to sow 2 cavans of seeds uniformly in a seedbed 1 to 1.5 meters wide and approximately 80 meters long per hectare which we found suitable to the machine. Also, their method of slicing the seedling mat to the required thickness by a special knife and the methods they employed in transporting the seedlings (Fig. 11) shows the ingenuity of the farmers in that area. This is a very good example of an indigenous technology developed by the farmers and adopted by the researcher.

3. In almost all Japanese literature on seedling preparation for mechanical transplanter, they don't recommend the use of heavy clay for mat soil. Our experience in Libmanan shows that with the 1.0 cm thickness of seedling mat, and with 1-3 cm standing water level in the field, the machine also performed well with that type of mat soil which is prevalent in Bicol region.

4. The fabrication of the transplanter requires some degree of precision (Fig. 12). Out of the three manufacturers in Libmanan, only one had fabricated two units as per specifications and their machines performed very well in the field. The others need further technical assistance in order to fabricate good quality machines. At present only one had been receiving orders from the customers. To remedy

the situation, we are now designing new jigs and fixtures for the transplanter to minimize errors during fabrication.

5. The machine could be readily accepted in areas where random or one way straight planting are the usual practice. The field capacity will be very much lower if it will be used in places where uniform distance between hills is required.

6. The machine works well in a fairly level field and with a standing water level of up to 5 cm.

7. However, the machine has some limitation. It is not suitable for water logged areas since the skids will sink deeper and will affect the stand of the seedlings (Fig. 13). The area should be drained 3-7 days before transplanting to be able to use the machine.

8. Carefully planned demonstration is a must to avoid negative comments from the farmers. It is very hard to convince the farmers once you have failed them.

9. Transplanter design should be revised according to the farmers need. The TR5 8-row model was designed to meet the requirement of 15 cm row spacing which is prevalent in Bicol region.

10. Lastly, promotion of mechanical transplanter or any farm equipments will be faster if it is coordinated with well-organized farmers association.

242

Fig. 1a TR4 6-row rice transplanter in operation.

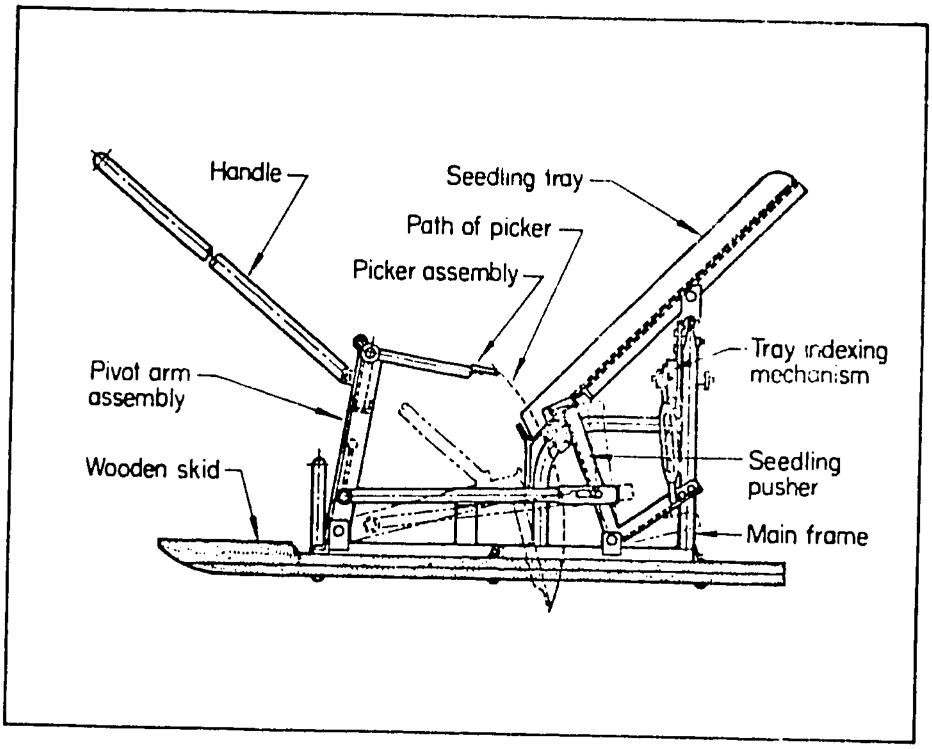


Fig. 1b Schematic diagram of TR4 6-row rice transplanter.

243

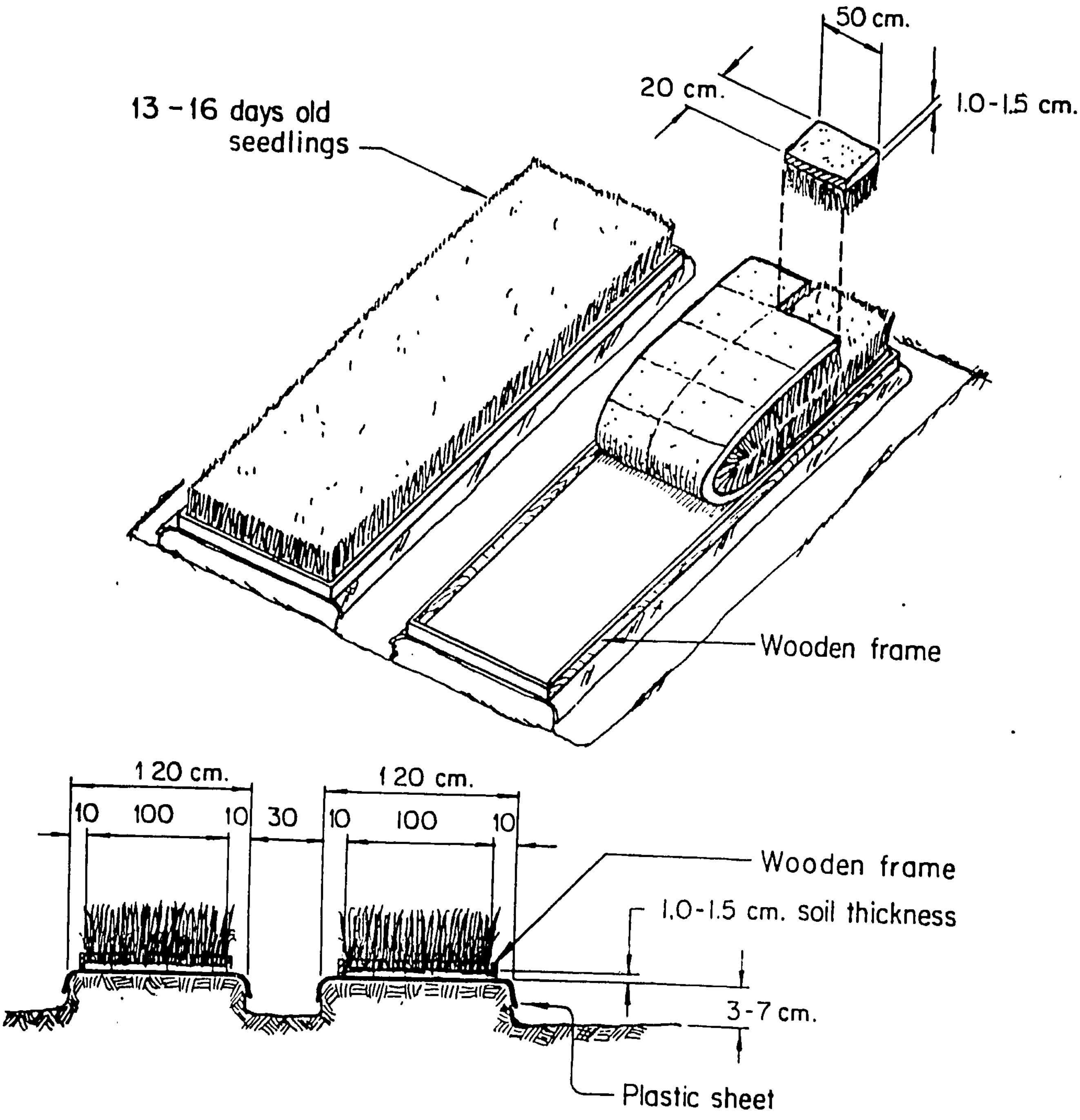


Fig. 2. Modified "dapog" method of seedling preparation.

2411

Fig. 3a. "Laplap" method.

Fig. 3b. Close-up sketch of "Laplap" method.

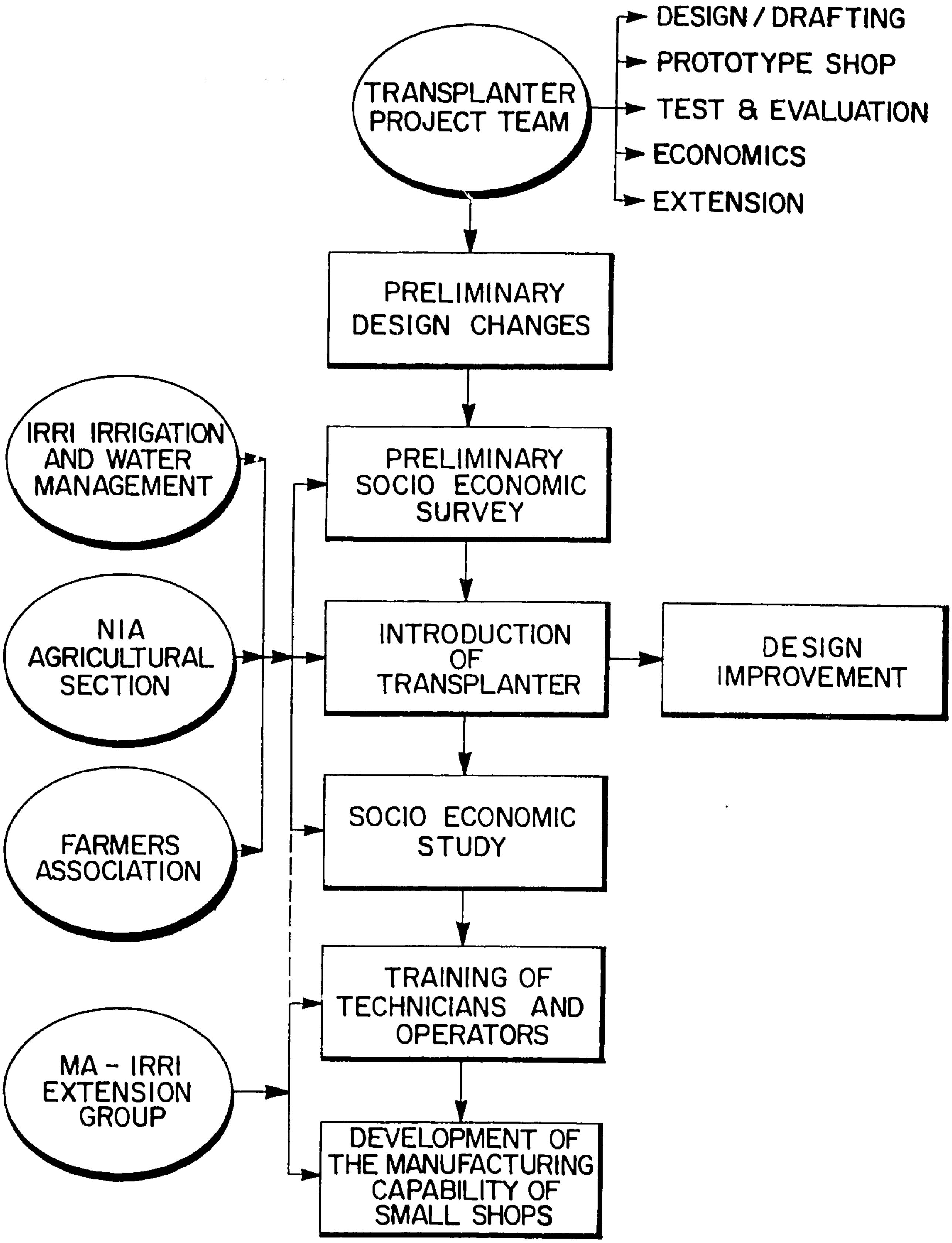


FIG. 4. TRANSPLANTER PROJECT SET-UP IN LIBMANAN, CAMARINES SUR.

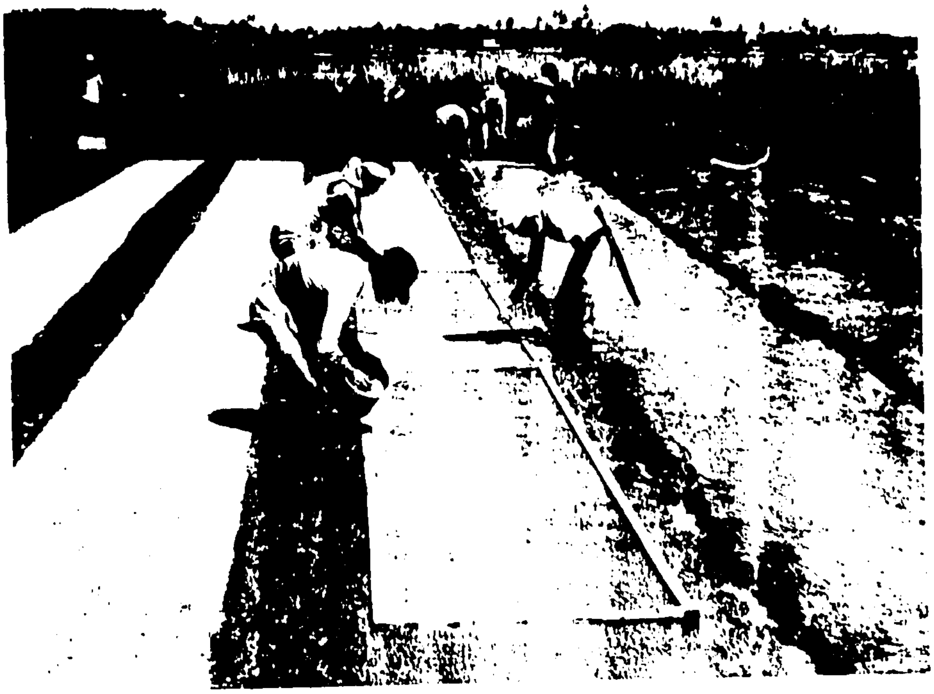


Fig. 5a. Seedbed and seed sowing.

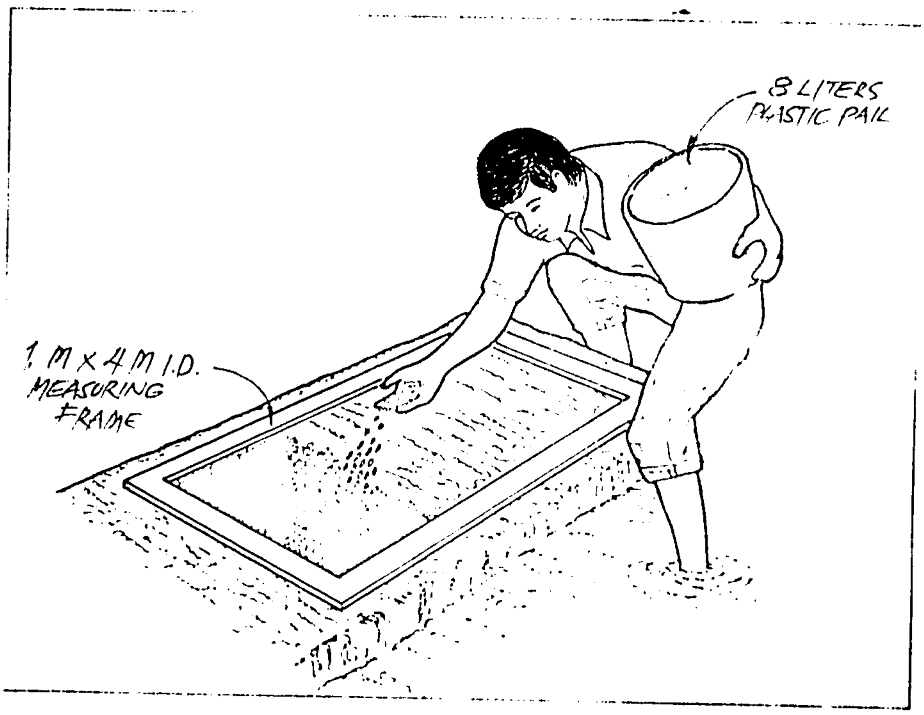


Fig. 5b. Detail of seed sowing.

249

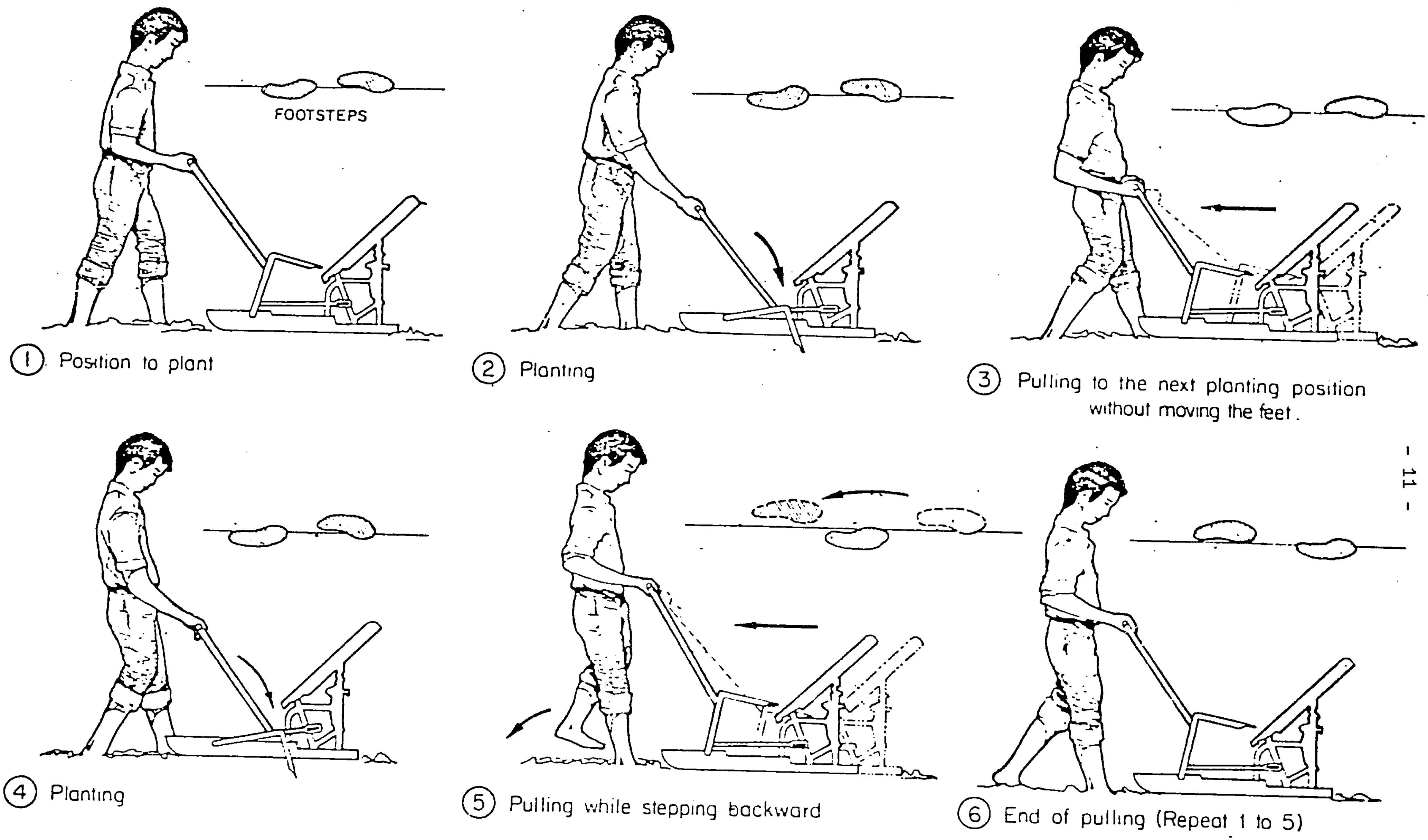


Fig. 6. Sequence of operator's movements in the operation of IRRI TR4 6-Row Rice Transplanter.

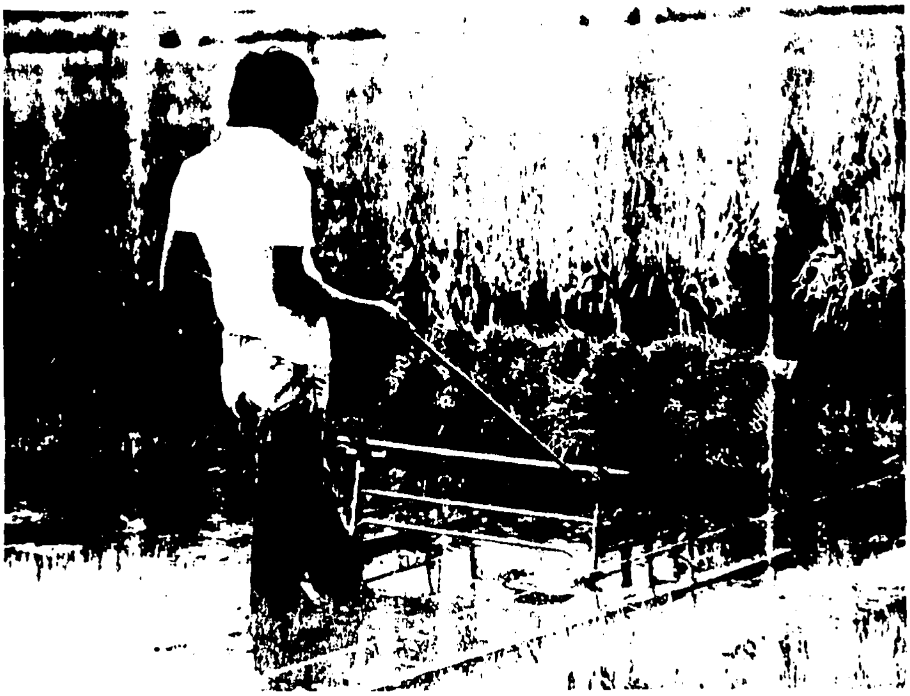


Fig. 7. Actual operation of the machine.

Fig. 8. Disassembly, assembly and adjustment of the machine.

THE AGRICULTURAL ENGINEERING DEPARTMENT

OF THE

INTERNATIONAL RICE RESEARCH INSTITUTE

CERTIFIES THAT

HAS SATISFACTORILY COMPLETED

IRRI RICE TRANSPLANTER OPERATOR TRAINING COURSE

GIVEN AT LIBMANAN, CAMARINES SUR, PHILIPPINES

THIS DAY OF JUNE 9,1984

R. E. STICKNEY	C.W. BOCKHOP
Agricultural Engineer	Department Head

Fig. 9. Certificate of completion.

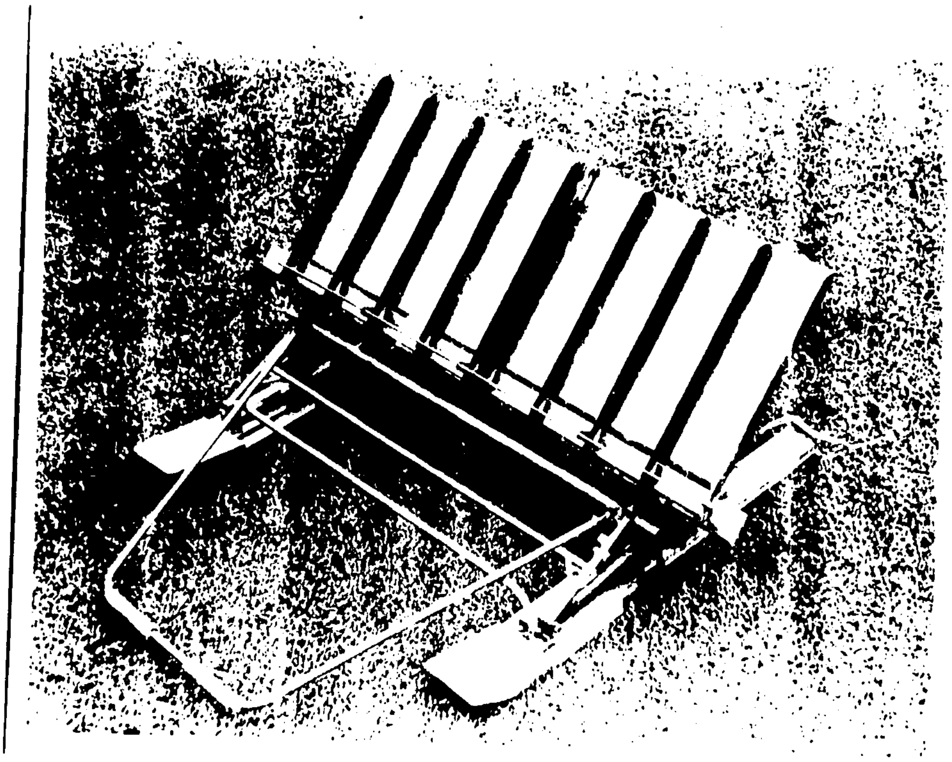


Fig. 10. TR4 8-row IRRI Rice Transplanter.

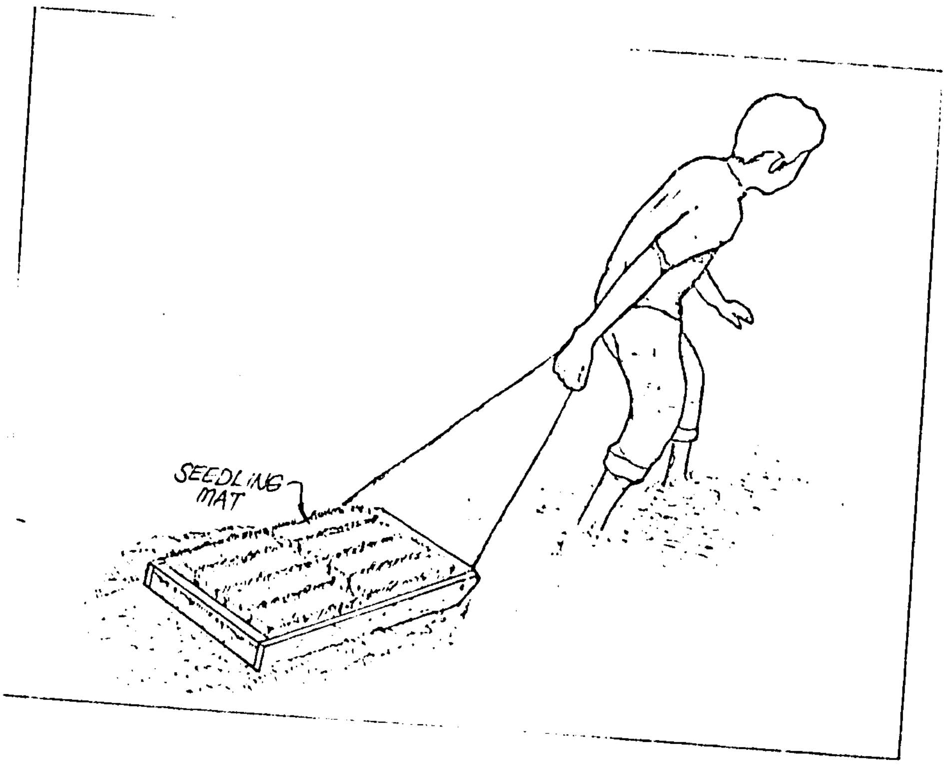


Fig. 11. Seedling transport in Libmanan.

251

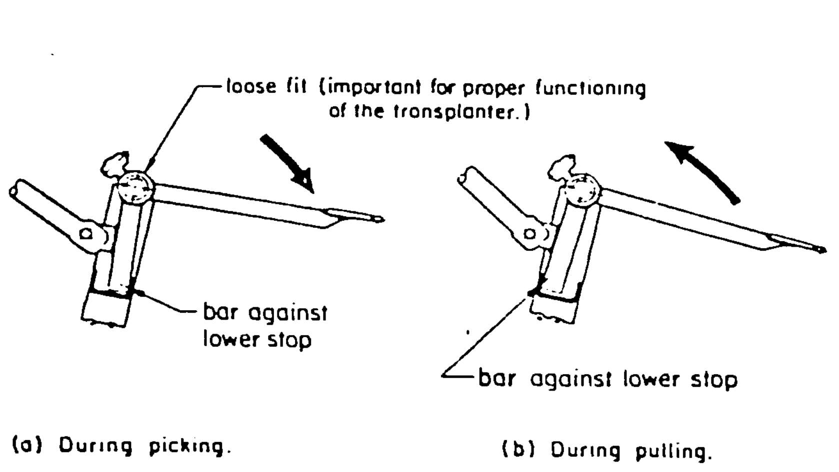


Fig. 1. Picker Assembly Movement.

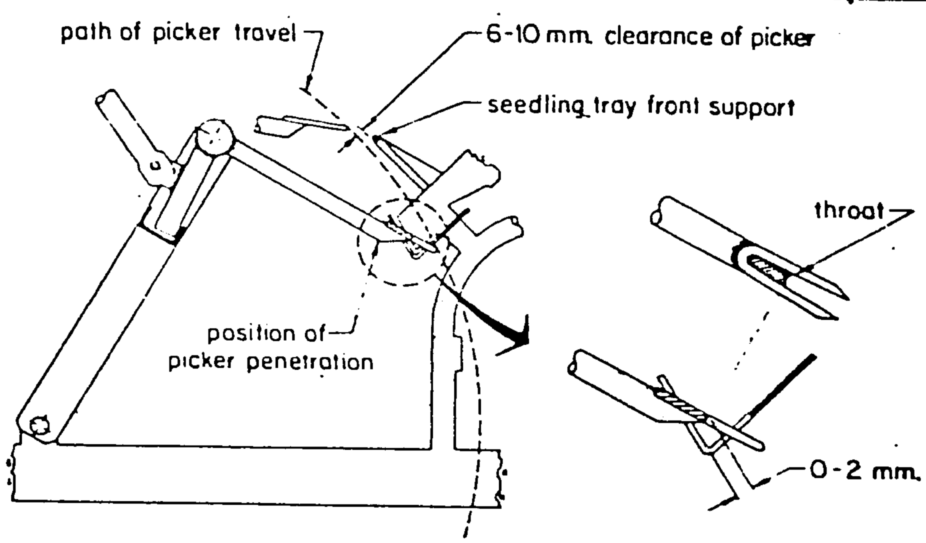


Fig. 2. Picker Penetration.

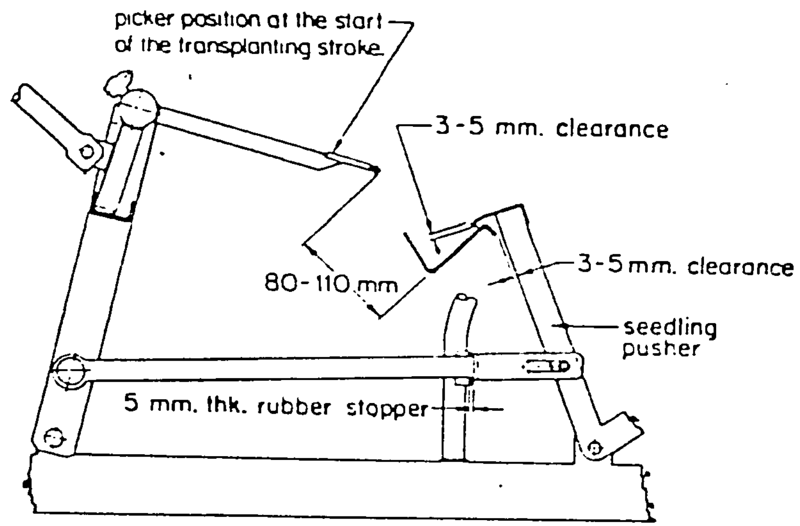


Fig 3. Ideal Position of Important Parts.

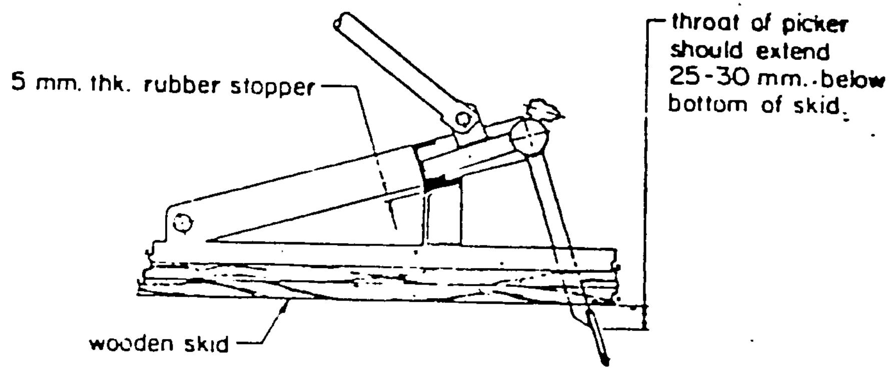


Fig. 4. Planting Depth.

Fig.12. Critical Manufacturing Tolerance for TR4 6-Row Transplanter.

254

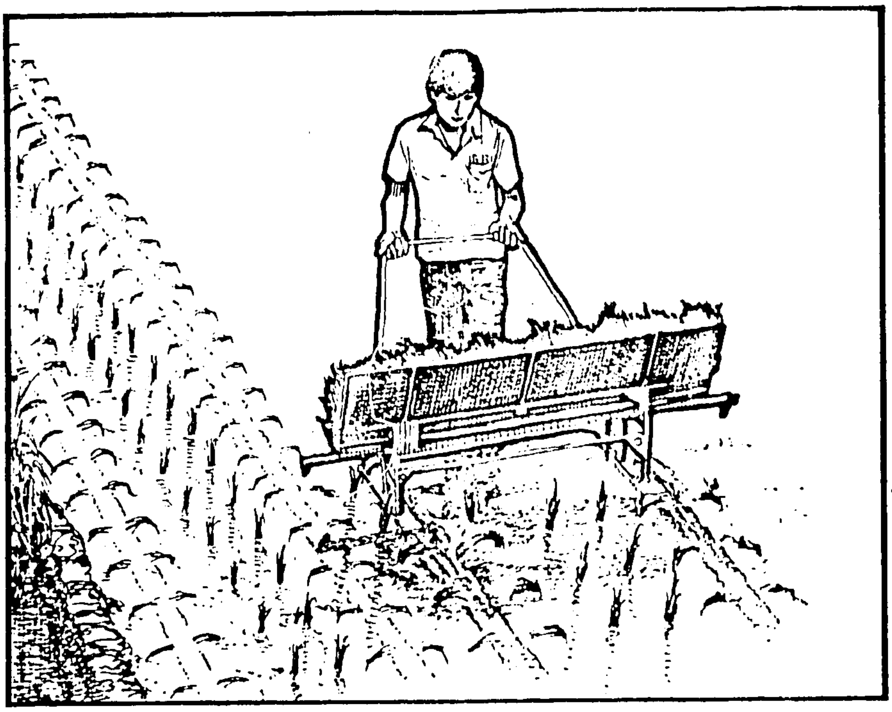


Fig. 13. Effect of soft soil on the stand of the seedlings near the skid

APPENDIX A

BACKGROUND

The Libmanan-Cabusao Pump Irrigation System (LCPIS) has irrigation, drainage and flood protection facilities for a potential service area of 3,916 hectares with approximately 2,310 farmers. The pumping plant, which consists of four 36" propeller pumps run by electrical motors, draws water from the Libmanan river at a point about 30 kilometers upstream of the mouth of the Bicol river on the San Miguel Bay (Fig. a). The water conveyance network consists of 12.5 kilometers of main canal, 34.6 kilometers of lateral and sub-lateral canals, with a main system canal density of about 12.7 meters per hectare. The basic irrigation service unit of the system is the Compact Farm. There are about 127 compact farms within the system and each consists of 20-50 hectares served by a common turnout. Each compact farm is provided with water control and a measuring device at the turnout, and main and supplementary farm ditches.

The drainage network consists of 41 kilometers of lateral and 78 kilometers of farm drains. An interceptor channel constructed at the left bank of and parallel to the main canal is to intercept runoff from the adjacent high lands and discharge it to the San Miguel Bay, thereby protecting the service area from excess water. Similarly, a flood protection dike at the lower reaches of the Libmanan and Bicol rivers and along the periphery of San Miguel Bay was constructed to serve as a barrier against tidal intrusion from

251

he San Miguel Bay and flooding from the rivers (Fig. a). Flap gates are provided at the mouth of drainage ways to prevent salt water intrusion from the bay during high tides.

The system's potential service area of 3,916 hectares was mostly rainfed before it started operating in the wet season of 1981. Only about 235 hectares of this was previously irrigated by the existing Handong pump and 150 hectares by the Puro-Batia pump, and 47 hectares by privately owned shallow wells for a total of 432 irrigated hectares. These pump units were to be discontinued with the operation of LCPIS.

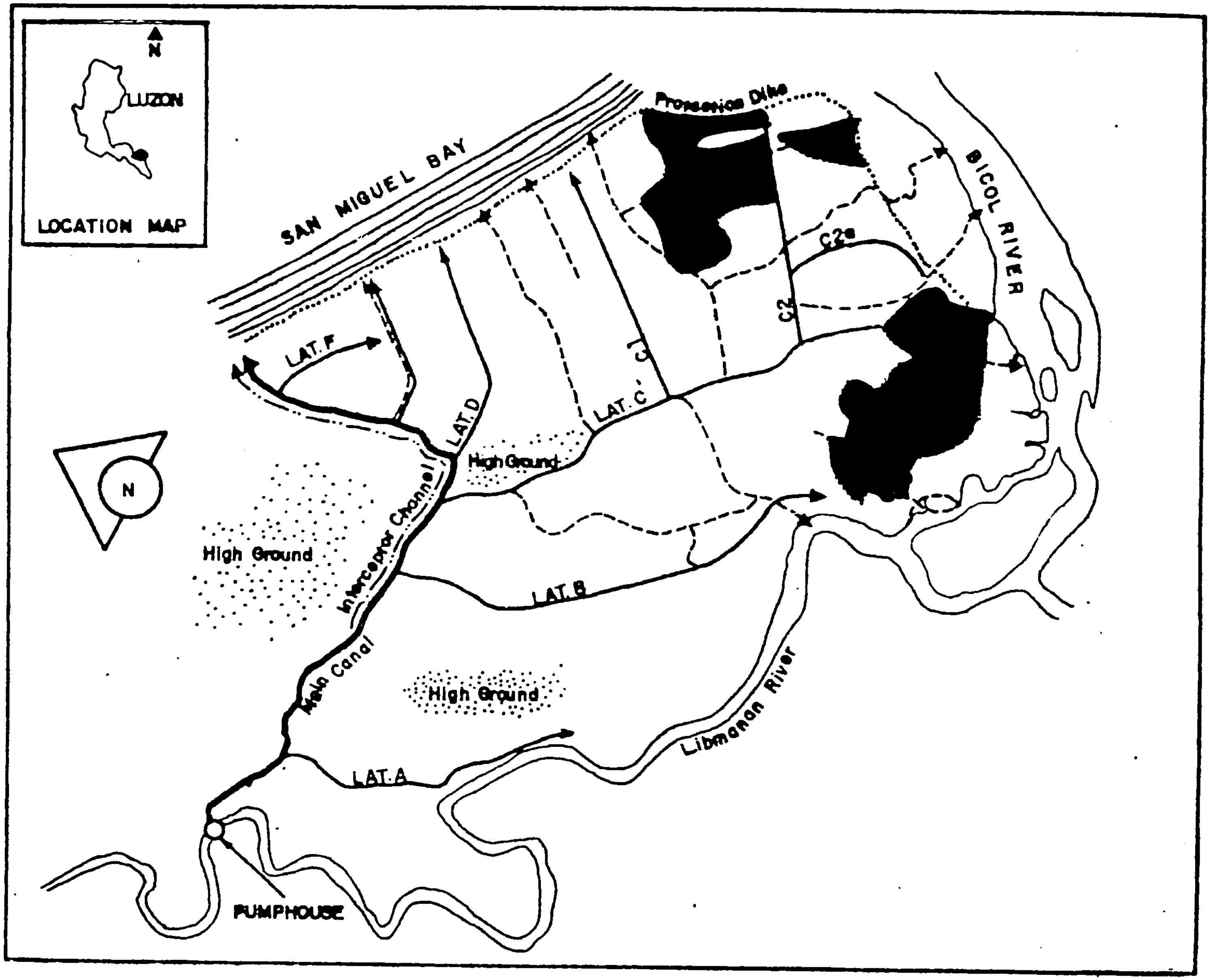


Fig. a General layout of Libmanan-Cabusao Pump Irrigation System showing the Irrigation System showing the irrigation and drainage network and irrigation area. (Shaded portion are unirrigable because of high elevation).

APPENDIX B

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 B - 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

258

ANNUAL REPORT OF IRRI-DITPROD INDUSTRIAL EXTENSION PROJECT IN INDONESIA (OCTOBER 1983 TO SEPTEMBER 1984)

The total number of proto-type units fabricated/modified at Tanjung-Barat workshop, Jakarta during the year are enclosed.

Two volunteers, Peter Watson and Mark Hayton from VSO, U.K. have jointed the project. Peter is attached to Tanjung Barat workshop and assisting in building proto-types, carrying out modification work after field testing and in the standardisation of design drawings. Mark Hayton is attached to the regional workshop at Bukittinggi, mainly training the staff of workshop to build prototypes, field testing them and assisting the local fabricators in improving their products'quality and their productivity. Their contribution is certainly adding to the effectiveness of this project.

As reported earlier, ILO has funded a study on 'Diffusion and Commercialisation of Rice post harvest equipment in West Sumatera' which was conducted jointly by the 'Centre for Agro Economic research' and 'IRRI - DITPROD' staff. After collecting the detail data from 130 respondents, analysing the data, discussing in seminar, final draft of the report has been prepared and sent to ILO . A copy of the summary of findings of this report, is enclosed.

USAID PPC study team from Washington D.C consisting of 4 members have spent 5 weeks (in Jan/Feb '84) visiting the institutions and fabricators assisted by the project in Sumatera and Java. They have concluded that

159

the successful strategy developed and its effective implementation by this project can be replicated in other developing countries with desirable results.

Two successful training programmes were conducted during the year one in West Sumatera for the fabricators focussing on the manufacture of Hand tractors and testing them out in the field and the otherin West - Java for the carpentors to produce pedal threshers and pedal winnowers.

The list of cooperator-fabricators and their production figures upto Aug '84 is enclosed. It may be noted from this list , that while West Sumatera is continuing to show progress in the production of paddy threshers, its spill over effect has reached to its neighbouring provinces, specially in Aceh and North Sumatera. Our present majour focus in West-Sumatera is for hand tractors. Four cooperator fabricators have taken up the production of hand tractors in addition to paddy thresher We are hopeful that the local production figures of hand tractors will start rising in the coming months. However, we anticipate the majour constraint in the spread of hand tractors and reapers later will be the credit availability be purchased by the farmers. The project is making all the efforts needed to involve the local banks in this regard. A note prepared for the banks is enclosed.

Another encouraging development is the spread of pedal threshers and pedal winnowers in West Java due to the special efforts made by this project . In collaboration with a non-Government organisation and with funding assistance of ATI we are planning to intensify and accelerate the diffusion of these simple equipments in this province during the coming months.

A 30 minute video-tape highlighting the project activities was made with the help of outside professional staff. It has been received well by the staff of USAID who saw (about 40 of them) on June 29th at Washington D.C. and it provoked interesting discussion later Dubbed copies in Indonesian language will be made and shown to the policy makers and the concerned staff in Government of Indonesia.

An evaluation of this project is being proposed in Nov/Dec '84.

******

VRR/T-Sept.'84

DRAFT REPORT

DIFFUSION AND COMMERCIALIZATION OF RICE POSTHARVEST EQUIPMENT IN WEST SUMATERA

Cooperative Research Project between :

CAER, DITPROD, IRRI, and ILO

Center for Agro Economic Research,

Agency for Agricultural Research and Development

IRRI DITPROD

MENUJU SWADAYA DAN SWASEMBADA

V. SUMMARY

From the history of lumbo recorded in this study it is clear that it has been introduced through the initiative of a local artisan and after perfecting it through several modifications in the initial years, the usage of this simple equipment by the farmers spread quite rapidly since it was difficult to find farmers who were not using them within the province during the last 15 years. However, the makers of this equipment are concentrated in few villages, the large number being in the village (Batu Hampar) of the originator (Sofian). A similar manually operated * equipment as a compliment for threshing, however, was not yet developed, although the need is felt by the farmers.

While the spread of threshers is increasing quite rapidly, but still it is in early stages in the sense that only up to 3 % of the land and that too in certain districts of the province is being threshed by power threshers.

This rapidly growing trend of threhsers being produced and sold in the province can be attributed to the important role played by the following institutions :

1. IRRI-DITPROD
2. DIPERTA , West Sumatera
3. Bank Indonesia in West Sumatera
4. Machinery dealers of the province

263

Since in West Sumatera there is a general shortage of agriculture labour showing up in the higher wage levels (twice as high as in Java), the problem of unemployment/underemployment does not seem to have yet arisen due to the introduction of power threshers inspite of the land less laborers.
However, this being the most important aspect, another study in depth needs to be made to look into this aspect specifically.

As stated above, the majour constraints for further growth/ spread of similar small farm equipment :

1. Credit availability for the purchase of equipment by farmers
2. Investment credit and working capital for the growth of fabricators
3. Sustaining the intensive field extension by the various concerned agencies of the Government such as DIPERTA, Industries Department, Cooperatives, under the unified central coordinating agency such as IRRI-DITPROD.

The potential for the future growth of small farm equipment industry in this province particularly and in the country in general is enormous.

This case study provides an important experience for the replicability of such diffusion/commercialisation process to take place in other developing countries.

IRRI-DITPROD brought the technology to the province for the first time and with very active participation of DIPERTA in creating interest for threshers among the farmers and identifying small workshops to fabricate them.

It was very important step to create confidence among farmers and demand for the locally produced threshers. This was achieved through series of demonstrations and exhibitions that were organised periodically.

Although the Bank Indonesia has given the directive to handling banks for providing credit to the needy farmers through their branches, but less than 7 % of farmers availed bank credit. This aspect needs to be further strengthened to accelerate the tempo of growth of this nascent industry.

The profitability of fabricators and custom hirers is quite high and that explains for the ever increasing numbers of producers and leasers of threshers. The rent for hiring threshers to the farmers has not shown any decline mainly because of more demand and less competition as yet. The farmers, however, presently saving the cost of meals provided to the hired labour and due to less delay in threshing after harvesting post harvest losses are decreased from 1 to 3 % as per the few measurements made in this study.

The majour difference observed between the thresher owner farmers and non owner farmers is that the former has a higher social status and higher income base. Similarly among the small workshops the ones which are fabricating threshers are bigger with more workshops floor space and more equipment.

DAFTAR I.

DAFTAR ALAT-MESIN PERTANIAN YANG
TELAH DI BUAT DI BENGKEL IRRI-DITPROD
TANJUNG BARAT PASAR MINGGU
1983/1984

Nama Alsin	Jumlah	Keteranga
Jig & Fixture Reaper besar dan Reaper kecil	1 unit	
Modifikasi Thresher TH-6	2 unit	Dana D.I.P.
Bajak singkal model Thailand	1 unit	
Leveller (perata lumpur)	1 unit	
Cage wheel Traktor kecil	2 unit	
Reaper 1.0 m	2 unit	1 unit dengan dana D.I.P.
Reaper 1,6 m	1 unit	
Roda sangkar Traktor besar	3 unit	
Roda karet Traktor besar	3 unit	
Transplanter 5 Row	1 unit	
Pompa aksial vertikal 6"	1 unit	
Gear box Traktor besar	2 unit	
Modifikasi pedal Thresher dari koperasi Mandiri Yogya	1 unit	
Modifikasi Threhser Dian Desa	1 unit	
Thresher dengan pedal gigi speda	3 unit	
Bajak singkal kecil	1 unit	
Pompa tali		
Transplanter 6 Row	2 unit	Dana D.I.P
Thresher pedal model lipat	1 unit	
Pudler (gelebeg)	1 unit	
Fertilizer Aplicator	1 unit	Dana D.I.P
Rolling Injection Planter 2 Row ditarik dengan Traktor	1 unit	Dana D.I.P
Pedal Winnower	2 unit	Dana D.I.P.

CREDIT REQUIREMENT TO STIMULATE LOCAL PRODUCTION-AND MARKETING OF FARM MACHINERY IN WEST SUMATERA

BY

V.R. REDDY
CONSULTANT IRRI
P.O.BOX 18/KBYPM
JAKARTA-INDONESIA

September 1984.

267

INTRODUCTION :

Under the guidance of the cooperative project work of IRRI - DITPROD/DIPERTA in West Sumatera, a number of small fabricators have taken up the production of small farm equipment such as paddy threshers, weeders and hand tractors. List of these local fabricators and their production figures of farm equipment is enclosed (#1)

While there has been an impressive increase in the number of local fabricators (about 20 as on Aug '84), however, the majour constraint for the further growth of this rural industry is the availability of credit to the farmers to purchase the equipment and to the fabricators for producing and creating their own market.

It is therefore very important that the local development banks take the initiative in providing the needed credit to further stimulate and sustain the development tempo in the province.

Feasibility of leasing of farm equipment to needy farmers.

Leasing of farm equipment is not a new concept, and infact it is already in wide practice in case of small rice milling units, paddy threshers, pedal winnowers, specially in West Sumatera. Promoting and extending of this 'leasing' concept has been elaborated in a paper " Promoting Leasing of Locally Manufactured Small Farm Equipment In Indonesia " which is enclosed (# 2)

Ultimately in all such transactions what is important is the feasibility/viability of the scheme so that sufficient profits are made by all the concerned parties. In this case they are fabricator, leaser/custom - hirer & farmer who hires the equipment.

The profitability statements worked out (under West Sumatera conditions) for the fabricator, Leaser/custom hirer & farmer user are enlosed (# 3). Considering the high returns in these transactions, proper climate is said to be existing for the rapid growth of this industry provided much needed credit (the missing link) is made available to all the concerned parties.

Suggestions for Providing Bank Credit :

The first need for the credit to fabricators as we reckon is to make first few units which are preferably used for leasing to the nearby farmers which will act both as demonstration to create his own market and also meanwhile to improve the quality of his product specially during the initial stages.

We recommend that the selected fabricator is given credit for atleast two units for leasing and for the additional working capital of atleast one month production capacity. For example if a unit is producing hand tractors 2/month and paddy threshers 5/month, he could be considered for giving credit as following :

a). <u>Credit for leasing units</u>

- Cost of 2 hand tractors + 2 paddy threshers =

  2 X Rp. 1.000.000,- + 2 X Rp. 650.000,- = Rp. 3.300.000,-

- Credit to be given at the 75 % of its value =Rp. 2.475.000,-

  Say = Rp. 2.500.000,-

b). <u>Credit for the working capital</u>

- One month's finished stock of 2 hand tractors + 5 paddy-threshers = 2 X Rp. 1.000.000,- + 5 X Rp. 650.000,-

  Cost comes to = Rp. 5.250.000,-

- Two month's raw material stock comes to =

  2 X 2 X Rp. 200.000,- + 5 X 2 X Rp. 200.000,- = Rp. 2.800.000,-

  (without engines)

* The total capital employed = Rp. 8.050.000,-

  Eligible for credit at 75 % of its value = Rp. 6.037.500,-

  Say = Rp. 6.000.000,-

Total credit needs of this fabricator comes to =

Rp. 2.500.000,- + Rp. 6.000.000,- = Rp. 8.500.000,-

For the profitability of each producer unit please refer to figures given in enclosure # 3.

210

In order to give credit to the enterprising farmers/individuals for purchasing the equipment and use for leasing purposes, the profitability figures can be also referred from the enclosure # 3. Our suggestion will be to provide credit to the local farmers on the recommendation of local DIPERTA/official or PPL about 75 % value of the selling price to be returned in 4 to 6 equal instalments, at the end of each harvesting season, i.e. credit with interest to be paid back within 2 to 3 years.

Our other suggestion would be to channel credit through the selected fabricators again through the involvement of local DIPERTA official PPL, so that the performance of the equipment is assured and the return of the credit to the banks is even more assured.

In oder to test out the workability and the likely success of these above mentioned suggestions, we feel it may be desirable to try out on pilot scale with two or three selected fabricators.

As found in other countries, the credit institutions have an important role in the rural development of the area and in our estimate West Sumatera can reach a take off stage with a more dynamic role of the local banks.

****

VRR/T - Sept.'84.

271

PROGRESS OF MANUFACTURE OF IRRI SMALL FARM EQUIPMENT IN INDONESIA

UNTIL AUGUST 1984

NO :	MANUFACTURERS	Hand Tractors up-to 79/83	Hand Tractors 83/84	Axial Flow Pump up-to 79/83	Axial Flow Pump 83/84	Transplanters up-to 79/83	Transplanters 83/84	Threshers up-to 79/83	Threshers 83/84	Dryers up-to 79/83	Dryers 83/84	Other Implements up-to 79/83	Other Implements 83/84	REMARKS
	WEST SUMATERA													
1.	P.T. Sutan Kasim, Padang	-	-	-	-	-	-	45	-	-	-	10*	-	* weeder
2.	P.T. Saraaah Industri, Bukittinggi	1	-	-	-	-	-	158	150	-	-	85*	-	* weeder
3.	Bengkel Tembok Jaya, Agam	1	-	-	-	-	-	60	120	-	-	20*	25*	* weeder
4.	Bengkal Altan Gadut, Agam	-	1	-	-	2	-	32	80	-	-	-	50*	* weeder
5.	Bengkel Saraaah Indah, Sijunjung	1	1	-	-	-	-	21	55	-	-	52*	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.	Bengual Medan Tehnik, 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 URHA, Bukittinggi	-	-	-	-	-	-	6	-	-	-	200*	-	* weeder
16.	Bengkel DIPERTA, Bukittinggi	4	6	3	-	4	-	10	4	-	-	200*	-	* weeder
17.	Bengkel Adan, 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	-	-	-	-	-	-	-	3	-	-	-	-	
45.	Aceh Tenggara, 2 workshops	-	-	-	-	-	-	-	2	-	-	-	-	
	Sub Total	-	-	-	-	-	-	-	315	-	-	-	-	
	SOUTH KALIMANTAN													
46.	Bengkel H.Sabli, Banjarmasin	1	-	19	-	-	-	6	-	-	-	24*	-	* weeder
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 Sidodadi, 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	-	-	-	-	
	Sub Total	3	2	1	-	-	-	13	20	-	-	10	-	
	JAVA													
54.	P.T. TUGAS, Jakarta	49	20	6	10¢	5	-	8	-	2	-	37*	-	¢ 6 " * 20 weeders, 4RIP, 13 transmission box
55.	P.T. NIM Ruhaak, 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*	-	-	*) not reported for 82/83 * weeder
63.	Bengkel Jatibarang	-	-	6	-	-	-	-	-	-	-	-	-	
64.	Bengkel TANJUNG BARAT, 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 PRODUCTS = 10.316

272

PROFITABILITY OF LEASING SMALL HAND TRACTOR AND PADDY THRESHER IN WEST SUMATERA

TRACTOR P.T. 3

Fixed Costs

Purchase price	Rp.1.000.000
Average yearly interest (12 % per year over 4 years)	Rp. 75.000
Average yearly depreciation (Salvage value 10% of purchase price)	Rp.225.000
Total fixed cost/year	Rp.300.000

Variable Costs/Ha (28 hrs/Ha)

Labour (2 operators - Rp. 2.500/day)	Rp. 17.500
Maintenance	Rp. 2.380
Petrol + Oil	Rp. 19.740
Total variable cost/Ha	Rp. 39.620

*)Work capacity = 26 Ha/year

$$\text{Total cost/Ha} = \frac{\text{Rp.}300.000}{26} + \text{Rp.}39.960$$

= Rp. 51.158,-

Leasing rate = Rp. 65.000/Ha

Profit/Ha = Rp. 13.842

Profit/year = 13.842 X 26 =Rp.360.000/yr

Return on initial investment = 36 %

(After providing for interest and depreciation)

THRESHER TH 6

Fixed costs

Purchase price	Rp. 650.000
Average yearly interest	Rp. 48.750
Average yearly depreciation	Rp. 146.250
Total fixed cost/year	Rp. 195.000

Variable Costs/Ha (12 hrs/Ha)

Labour (5% of crop value)	Rp. 8.750
Maintenance	Rp. 804
Petrol + Oil	Rp. 8.400
Total variable cost/Ha	Rp. 17.954

*)Work capacity = 60 Ha/year

$$\text{Total cost/Ha} = \frac{\text{Rp.}195.000}{60} + \text{Rp.}17.954$$

= Rp. 21.204,-

Leasing rate (5% of Crop value) Rp.26.250

Profit/Ha = Rp. 5.046

Profit/year = 5046 X 60 = Rp.303.000/yr

Return on initial investment = 47 %

(After providing for interest and depreciation).

*) in two seasons working 45 days/season

PROFITABILITY FOR MANUFATURER OF IRRI SMALL HAND TRACTOR AND PADDY THRESHER (WEST SUMATERA)

TRACTOR P.T. 3		THRESHER TH 6	
Fixed Costs		**Fixed Costs**	
Materials	Rp.400.000 (Including-engine)	Materials	Rp.350.000 (Including-engine Rp.180.000)
Labour	Rp.100.000 (30 man days	Labour	Rp. 25.000 (7 man days)
Total fixed cost	Rp. 500.000	Total Variable cost	Rp.375.000
Variable Costs		**Variable Costs**	
Over heads (Electricity + tools)	Rp.100.000	Over Heads	Rp. 65.000
After sales-service, Advertising, Demonstration	Rp.100.000	After sales-Service, Advertising, Demonstration	Rp 60.000
Total	Rp. 200.000	Total	Rp.125.000
Fixed cost + Variable cost	Rp. 700.000	Fixed cost + Variable cost	Rp.500.000
Selling Price	Rp.1.000.000	Selling Price	Rp.650.000
Profit	Rp. 300.000	Profit	Rp.150.000
% Profit on Selling Price	$\frac{\text{Rp. } 300.000}{1.000.000} \times 100 = 30\ \%$	% Profit on Selling Price	$\frac{\text{Rp. } 150.000}{650.000} \times 100 = 23\ \%$

274

SAVINGS OF FARMERS HIRING THE SMALL HAND TRACTOR

PADDY THRESHER

TRACTOR P.T 3		THRESHER TH 6	
Present of land preparation/Ha (manual or animal ploughing ready for transportation)	Rp. 80.000	Present cost of manual threshing/Ha (5 % of crop value) + meals (Rp.600/man-day for 10 man-days)	Rp. 26.250 Rp. 6.000 + Rp. 32.250
Custom hiring rate by tractors	Rp. 65.000 -	Custom hiring rate by thresher/Ha	Rp. 26.250 -
Saving / Ha	Rp. 15.000	Saving / Ha	Rp. 6.000

Peter Watson/H
Sept. '84.

9 1/5

IRRI - DITPROD INDUSTRIAL EXTENSION PROJECT

P.O. BOX 18/KBYPM. PASAR MINGGU, JAKARTA SELATAN INDONESIA TELEPHONE : 782557

843/VRR/T

September 25, 1984

M/S. Miziar Noerdin S.H.
Director
Bank Pembangunan Daerah
Sumatera Barat

Dear M/s Miziar Noerdin S.H.,

This is to thank you for the opportunity you gave me along with Mr. Nurmawan, Inspector DIPERTA to visit you and your colleagues during my last visit to Padang on September 10, 1984.

We have expressed our full appreciation on the initiative your Bank has already taken by providing credit to two of our cooperator-manufacturers in West Sumatera.

As we mentioned then, in order to stimulate local production, there is a further need of credit for purchasing farm equipment and hire it out to the farmers. In the light of our above discussion, I had prepared a brief note on this subject making a case, for providing credit through 'Pengrajin2' with the involvement of DIPERTA officials so that the return of your credit is more assured.

We sincerely hope that this will receive your full attention and that it merits your favourable consideration.

In case you need further information or clarification in this regard, please donot hesitate to contact me.

I am sorry on my in ability to communicate with you in Bahasa Indonesia.

Thank you once again for all the coutesy you have accorded to me during the above meeting.

I look forward to remain in touch with you,

With regards, I remain

Yours truly,

V.R. Reddy.

CC. Mr. Walter C. Tappan
Bp. Ir. Nurmawan.

IRRI - DITPROD INDUSTRIAL EXTENSION PROJECT

P.O. BOX 18/KBYPM. PASAR MINGGU, JAKARTA SELATAN INDONESIA TELEPHONE : 782557

September 24, 1984

To : Mr. Walter C. Tappan
IRRI Liaison Scientist

From : V.R. Reddy
Agricultural Engineering Consultant

Subject : Quarterly Report
July through September 1984.

Trips :

* June 17th - August 12th : To USA to attend ASAE meeting and go on home leave.

* September 9th - September 13th : To West Sumatera for monitoring and preparing budget.

* September 26th - October 3rd : To Los Banos for presentating this project report to the review team of board of trustees.

On June 27th evening, Video-tape on our project (just then completed) was played to the interested ASAE members (about 30 of them) at Knoxville, Tennese. It was followed up with an interesting questions and answers session about the project.

Again this tape was played on June 29th to the AID staff at Washington D.C. and more than 40 members attended. A lively discussion followed for more than 90 minutes after 30 minutes of tape run. I was personally pleased with the enthusiasm and the interest it generated about our project work.

During my home leave, DITPROD has transferred the equipment and staff from their Ragunan workshop to our project's workshop at Tanjung Barat. Due to the scarcity of space for the additional equipment brought and for the staff, the whole place is crowded and needs badly to be reorganised. Meanwhile we are going through a transition period and the tempo of our proto-type building and field testing work is affected. Considering that this is the final year of the project funding, this is perhaps in the right direction that this project's activities and staff are being merged with the Subdirectorate programme.

West Sumatera continues to show progress in the spread of paddy threshers and lately hand tractors. Among the twenty fabricators of paddy threshers, four have taken up the production of hand tractors through the guidance of our VSO volunteer stationed at Bukittinggi. Two locally produced hand tractors have been sold and are working satisfactorily. This development again is generating a great deal of enthusiasm and self-confidence among the DIPERTA staff, local fabricators and leader farmers in the province.

However, for the hand tractors to reach a stage of self-sustaining growth as in the case of paddy threshers in this province, We feel some more custom hiring cum demonstration work is to be undertaken through the initiative of DIPERTA and providing credit facilities by the banks for the purchase of these hand tractors is rather cruicial.

We have made a programme to make six hand tractors available to the local leader farmers to enable them to hire them to the needy farmers in their areas and create the demand. Project's assistance programme for 84/85 to DIPERTA is enclosed.

We have met BPD (Provincial Development Bank) officials along with the inspector of DIPERTA to persuade them to provide the needed Bank credit for the purchase of hand tractors and paddy threshers and meet the local fabricators' credit needs. Letter to BPD showing the feasibility of such loans is enclosed.

In this province two training programmes are being planned, one for the local fabricators focussing on the production of hand tractor and reaper attachment, and the second one for the provincial extension staff in the coming months.

On the special request of DIPERTA from South Sulawesi, we are sending the following equipment :

1. PT 5 hand tractor with one meter reaper
2. Rolling injection planter

We have also supplied spare-parts and components required by the Luwu project for keeping the IRRI hand tractors running. There seems to be increasing demand by the farmers to own such tractors, but unless the credit is made available and FCC project takes the initiative in this regard, it is difficult to move further in this matter. Our letter to FCC of Luwu Project is enclosed.

Similarly, in the absence of involvement and follow up measures of DIPERTA officials in South Kalimantan, we are unable to help them any further. However, we understand that the production and sales of axial flow pumps and threshers by two local fabricators is continuing.

As a result of the training programme we conducted in May'84 for carpentors from West Java for making pedal threshers and pedal winnowers, the reports we have received so far are that more than 25 units are produced and sold. In order to intensity and accelerate this process of multiplying these units in the province, we are able to involve PPPM (a non-Government Organisation) assisted by ATI (Appropriate Technology International in Washington) for the inital seed capital and training programmes required to launch the extension efforts in high gear.

USAID, Jakarta mission has taken the initiative to prepare the scope of work for the proposed team to evaluate this project during November/December'84.

****

280

RENCANA KEGIATAN DAN ANGGARAN TAMBAHAN DARI IRRI-DITPROD

UNTUK PROYEK PENYULUHAN INDUSTRI ALSINTAN DI SUM-BAR TAHUN ANGGARAN 84/85

NO	KEGIATAN	VOLUME	WAKTU MULAI/SELESAI	ANGGARAN (Rp.)	CATATAN
1.	Pengiriman 10 set (4 besar+ 6 kecil) komponen transmisi untuk penjualan kepada pengrajin-pengrajin.	10	*Sept.84-Sept.85 sudah dikirim	1.200.000	Bengkel Bukittinggi mengkoordinir penggunaan da perputaran wang dana tsb.untuk pebelian bahan-baha dari Jakarta.
2.	Penggunaan traktor pada kelompok tani maju didaerah	6	Oct.84-Apr.85	1.000.000	Biaya ini digunak untuk memonitor staff DIPERTA I + DIPERTA II guna Pembayaran perdic transportasi..... Bahan bakar perlu dibayar oleh kelompok tani sendi
3.	Penyebaran informasi ke LKMD mengenai alat perontok, traktor tangan yang dibuat di propinsi	3.600 LKMD	Oct.84-Nov.84	350.000	DIPERTA perlu membuat surat informasi mengenai alamat-alamat, pengrajin, harga-harga produk.
4.	Studi/survey untuk menentukan daerah potensial penggunaan pompa axial	Didaerah 50 kota + Sijunjung	Nov.84-Dec.85	500.000	Mengadakan kerja sama yang baik antara Universita Andalas & staff DIPERTA.
5.	Latihan untuk staff bengkel Bukittinggi ke Bandung	1	Dec.84-Jan.85	300.000	Khusus untuk management bengkel
6.	Training ke Philipina untuk staf DIPERTA	1	Dec.84 atau June 85	650.000	-
7.	Latihan coaching pengrajin-pengrajin 10 peserta untuk 2 minggu	1 kali	Jan.85-Feb.85	2.000.000	Perincian dari acara akan segera dikirim dari JKT

8.	Pembuatan dan pengujian alat penanaman terbaru.	2	Feb.85-March 85	500.000	Bengkel Bukittin
9.	Latihan staff penyuluhan PPL (20) staff untuk 1 mg.	1 kali	March 85-April 85	1.500.000	Perincian dari acara akan seger dikirim dari JK
10.	Penggunaan 2 set pompa & memonitornya dilapangan selama 1 musim.	2 unit	March 85-July 85	1.500.000	Untuk pembuatan 2 pompa + memonitornya
11.	Seminar Alsin lokal bersama pengrajin, Bank, petani, Staff DIPERTA, Perindustrian	1 hari	March 85 atau April 85	500.000	-
	J U M L A H			10.000.000	

VRR/T

Jakarta, 17 September 1984

282

IRRI - DITPROD INDUSTRIAL EXTENSION PROJEC

P.O. BOX 18/KBYPM PASAR MINGGU JAKARTA SELATAN INDONESIA TELEPHONE : 78255

28/VRR/T

August 20, 1984

Mr. Jim Tenbrink
FCC
Jl. Tandipau 1
Palopo
Sulawesi Selatan

Dear Mr. Jim Tenbrink,

This is to acknowledge the receipt letter from (Benyamin Tonapa) and am sorry to learn that you have not yet received the spare-parts list with the prices & address sent with my previous letter to you a copy of the same enclosed again.

Once again I am sending herewith the above list to enable you to purchase the spare parts required. We suggest it is better if one person comes here with the money and buys them and takes them with him personally. We can assist him in this regard.

Please let us know, if anymore hand tractors were made & supplied by Bengkel Sidodadi to the farmers there.

I have encouraged FCC also to undertake the manufacture of these hand tractors in their workshop. If required we can assist by giving practical training to one or two FCC candidates for a period of two weeks here in Jakarta. At the same time he could carry with him the spare parts required along with the fixture for making the transmission boxes.

Alternatively, we suggest to start with you can buy the transmission boxes from any of the two following parties

1. P.T. TUGAS
   Jl. Raya Bekasi Km. 18 Pulo Gadung Telp. 481786 Jak-Tim
   Price : Rp.

2. P.T. KUBOTA INDONESIA
   Jl. Setyabudi 279 Semarang Telp. 31249
   Price : Rp.

The fabrication of the remaining frame and attachements for hand tractor is simpler.

With regard to the credit availability it is not clear whether FCC, BRI or BPD who has agreed to give the credit of Rp. 2.500.000,- to farmers as mentioned in your above letter. According to us the selling price

283

IRRI·DITPROD

need not be higher than Rp. 2.000.000,- including plough, puddler, rubber tyres & one ton trailer. Once again please let us know how many farmers are ready to purchase in Luwu with and without ----. Credit to enable us to follow up and assist you further in this regard.

I am still awaiting to know if the REC hand tractors have been repaired and sold to the farmers as agreed during my last visit and mentioned in my last letter dated June 7, 1984.

If I hear your reply early and find your serious interest in following it up along the lines suggested above, I shall plan to visit your area in September. Therefore I shall await to hear from you soon.

Truly,

V.R. Reddy

Encls. Price list of raw materials

CC : Ms. Nancy Tumavick-USAID
Mr. Walter C. Tappan

284

THAI-IRRI INDUSTRIAL EXTENSION PROGRAM
FOR SMALL FARM MECHANIZATION

ANNUAL REPORT

(September 1, 1983 — August 31, 1984)

265

THAI-IRRI INDUSTRIAL EXTENSION PROGRAM
FOR SMALL FARM MECHANIZATION

ANNUAL REPORT

(September 1, 1983 - August 31, 1984)

Prepared by

Chak Chakkaphak

CHAK CHAKKAPHAK

DOA-AED-Co-Leader

Bill Cochran

BILL COCHRAN

IRRI Co-Leader

284

TABLE OF CONTENTS

LIST OF FIGURES

290

LIST OF TABLES

284

APPENDIX

290

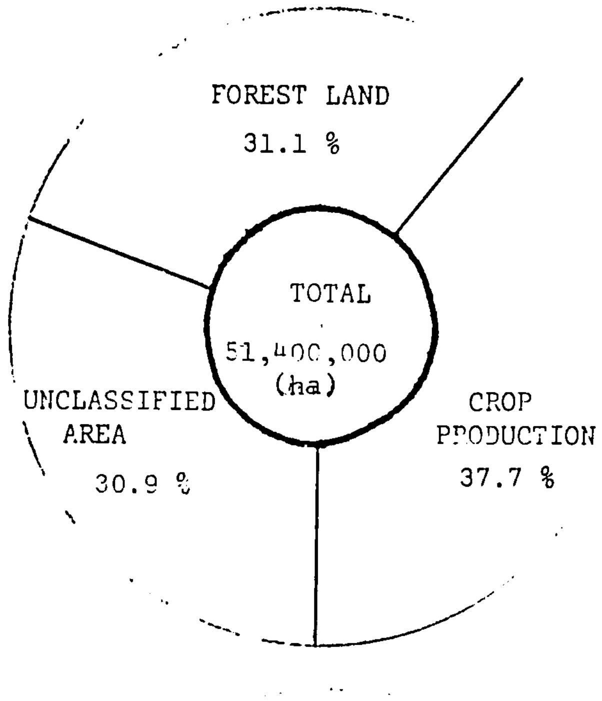
GENERAL

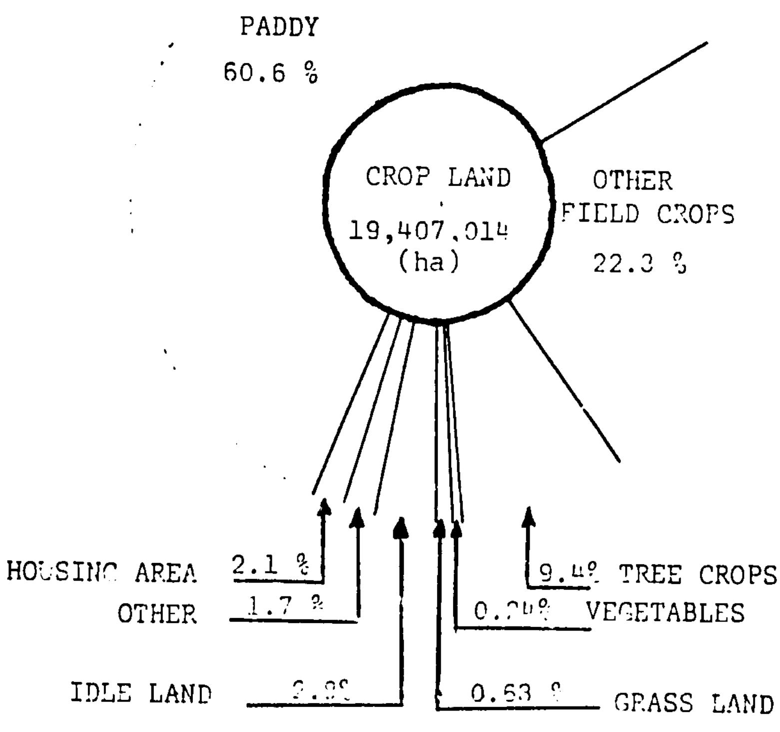
Thailand has a population of approximately 49 million people of which 75 to 85 percent live in the rural areas. The total land area is 514,000 square kilometers with 38 percent devoted to farm holdings and 31 percent to forest land , Figure 1. Of the 19 million hectares of cultivated land, 14 million is farmed underrainfed conditions. The country can be divided into 4 distinct regions, each having different climatic and soil characteristics. The regions include the North, Northeast, Central and South as shown in Figure 2.

The present level of farm mechanization in Thailand is diverse and include three principle power sources, manual, animal, and mechanical. Technology and improved machines and/or implements are needed for each source of power. As in the past and also in the future it is necessary to determine the appropriate technology best suited to each power source environment and determine the pace of technological change that can be absorbed by each system.

Agriculture's contribution to the economy continued to decline during 1982 but remains as the country's most important industry. Employment in agriculture during 1982 was estimated to be 15.4 million people which accounts for 74 percent of the labor force. This compares to 82 percent in 1960.

Figure 1. Land Utilization of Thailand





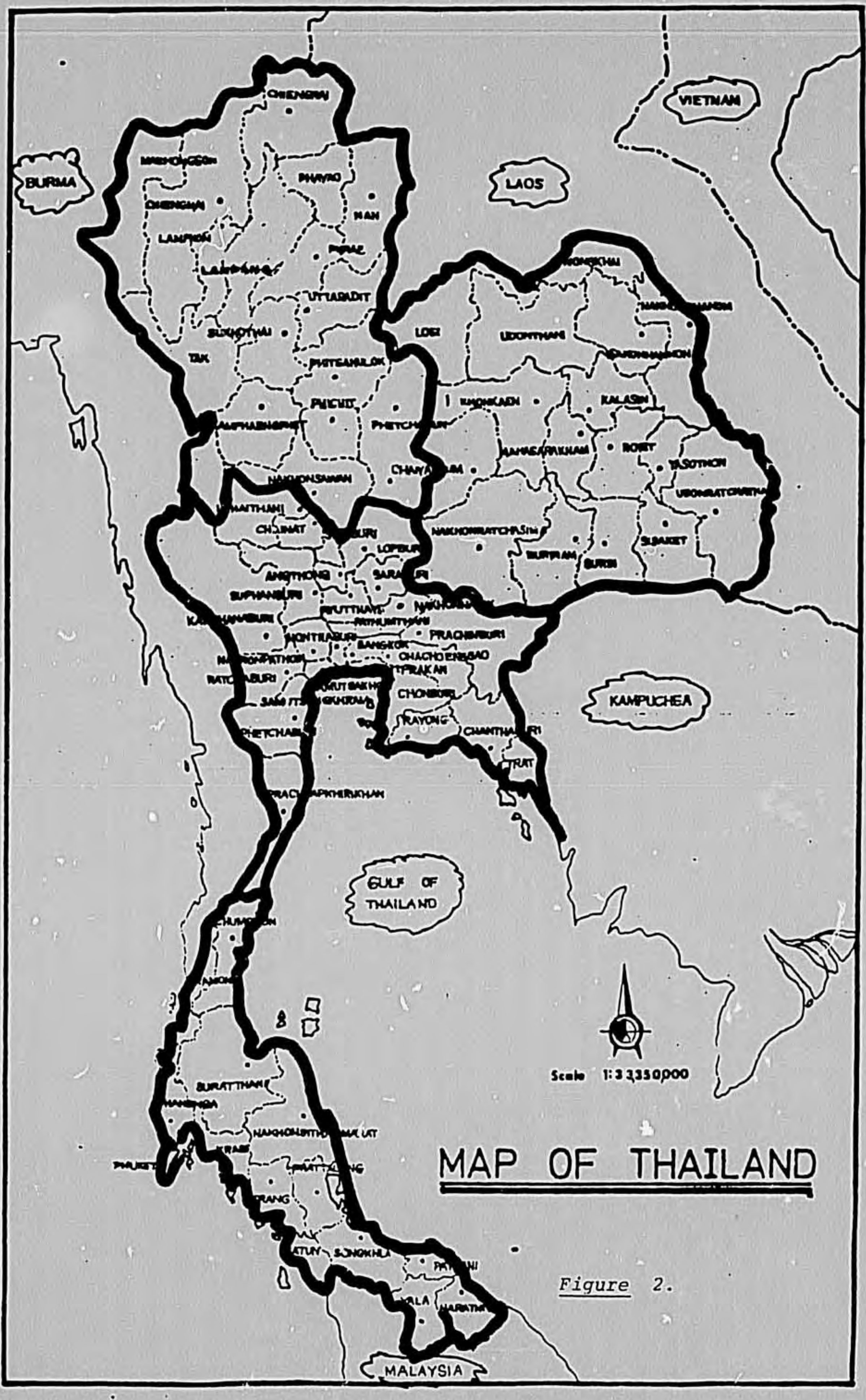

BURMA
LAOS
VIETNAM
KAMPUCHEA
GULF OF THAILAND
MALAYSIA
CHIENGRAI
CHIENGMAI
LAMPHUN
PHAYAO
NAN
PHRAE
UTTARADIT
SUKHOTHAI
TAK
PHITSANULOK
LOEI
UDONTHANI
KHONKAEN
KALASIN
ROIET
YASOTHON
UBONRATCHATHANI
NAKHONRATCHASIMA
BURIRAM
SURIN
SISAKET
NAKHONSAWAN
CHAINAT
LOPBURI
ANGTHONG
SUPHANBURI
PRACHINBURI
BANGKOK
CHACHOENGSAO
CHONBURI
RAYONG
TRAT
SURATTHANI
TRANG
SONGKHLA
MAP OF THAILAND
Scale

Figure 2.

293

Despite some gradual erosions in significance, rice cultivation, transport, processing and marketing continue to be the most important economic activities in Thailand agriculture. Although there has been more diversification in the country's agricultural cropping patterns into crops other than rice, the area planted to rice continues to account for more than 60 percent of the total cultivated area and is the most important food item in the locl consumption pattern. The annual per capita consumption of rice is approximately 170 kilograms.

Hand-tool technology is the most predominant in Thai agriculture. Except for seedbed preparation and threshing there is little animal-draught or mechanical-power technology used in the country. Farming on the basis of hand tool technology seldom exceeds a subsistance level. The area which can be cultivated by a single family is typically not more than two hectares. Humans are not efficient sources of power under Thailand climatic conditions.

Buffalo are the main draught animal being utilized. In 1981 there were about 6.12 million buffalo in the country. Their total number in 1981 was about 4.47 million head. No data are available to indicate what percentage of the total land preparation is done with animal power. The buffalo is used approximately 30 days per year in actual field operations. The single-beam plough with a single steel mouldboard in addition to a harrow-levelling board are the only animal drawn implements used throughout the country.

Figure 3. Buffalo Plowing for Upland Crop

Historically animal drought technology is adapted and used to increase the area cultivated and not to increase yields per unit of land. Thailand has reached this stage in agricultural production. The use of drough animals for cultivation do not reduce the amount of physical labor required of the farmer in a given hour or day. The farmer must still walk the same number of kilometers as the animal and guiding the implement and the animals require considerable effort. However, the total effort required to plough one hectare is considerably less with animals compared to hand. Approximately 60 man-hours per hectare is required by animals as opposed to about 500 man-hours if done by hand.

95

PROJECT STATUS

The THAI-IRRI cooperative project is a joint effort betweem the Agricultural Engineering Division (AED), Department of Agriculture (DOA), Ministry of Agriculture and cooperatives (MOAC). The AED has concentrated on the development and promotion of farm mechanization since 1957 and began participating as a sub-contractor in the IRRI mechanization project during 1971. In March 1976 the THAI-IRRI cooperative project began with IRRI providing an expatriate agricultural engineer and some supporting staff. The cooperative project has had considerable personnel changes and additions during the period of this report. Dr. B.J. Cochran joined the project as project director, Mr. Kanoksak Eam-o-pas became the new senior research assistant, Mr. Thanisorn Nakgoue accepted the position of junior engineer, Mr. Vichien Sommai joined the project as driver, Dr. Winit Chinsuwan was assigned special research assistant on a sabatical leave from Khon Kaen University and Miss Somporn Saitan began a special mechanization economic study in the Northeast region of Thailand. Table 1 presents the total cooperative personnel including AED personnel assigned to the project.

196

Table 1. IRRI-THAI cooperative project staff.

Name	Title	Employer	Degree	Experience
Bill Cochran	Agri. Engineer (Project Leader)	IRRI	Ph.D	IRRI 1981-1982, project 1983
Chak Chakkaphak	Head,Research & Testing	AED	MS	Ministry
Kanoksak Eam-o-pas	Sr. Res. Asst.	IRRI	MS	Lecturer Univ. in Nigeria 2 yrs, Project since Jan. 1984
Prasarn Kradangnga	AED Engineer	AED	BS	Ministry 2 yrs
Suphasit Sangiamphong	AED Engineer	AED	BS	Ministry 1 yr
Thanisorn Nakgoue	Jr. Engineer	IRRI	BS	Private Industry 2 years, Project since Jan. 1984
Chalit Choensombat	Techician	IRRI		IRRI-THAI project since Feb. 1975
Naruemon Chaikittiratana	Secretary	IRRI		IRRI since 1976 Project since April 1983
Vichien Sommai	Driver	IRRI		Iranian Embassy 14 years, Project since Oct. 1983
Winit Chinsuwan	Sp. Res. Asst.	IRRI	Ph.D	Head Agricultural Engineering Dept. Khon Kaen Unversity, 1 yr sabatical leave beginning Aug. 1,1984
Somporn Saitan	Ag. Economist	IRRI	MS	IRRI consequence of Mechanization 1982-84 10 month special stuc beginning July 1984

There is no distinction between the AED and IRRI engineers as regards to work assignments. Personnel from both sectors participate in exhibitions, demonstrations, industrial extension and training assignments. The secretary for the cooperative program assists in english typing and word processor for personnel in the AED and visiting IRRI personnel. Thai language typing is provided by AED secretaries and the Thai word processor the IBM PC is used by all staff. Chak Chakkaphak, Head of the Research and Testing Section of AED provided guidance that reflected government policies and priorities as well as consultation relating to personnel and project site locations.

A new strategy statement was developed during September 1983 and approved for implementation during 1984-85. The principle objective of the Small Farm Mechanization Extension Project is to introduce and promote improved machinery developments to small rice or rice based farms with emphasis on the farmers in the northeast region. The strategy of work has been directed toward utilizing government institutions, manufacturers and progressive farmers capable of introducing appropriate mechanization. Institutions, projects and progressive farmers were loaned equipment for at least one cropping season. During the year feedback was obtained relative to the machine's acceptance, needed modifications or resources for rejection.

The project has worked to accomplish the general objective by directing its efforts in six areas.

1. Participating in national and regional farm machinery exhibitions and demonstrations. Appropriate equipment was demonstrated in cooperation with the Cooperative Regional office in the Northeast, Department of Agricultural Extension, Universities and the National Agricultural week in Kampang Saen.

2. Equipment was loaned to government agencies and farmers on a selected basis. The Northeast Agricultural Center located at Khon Kaen has been the Center of the project activities in the Northeast. Equipment was loaned to the center after a memorandum of agreement and a definitive work plan was developed. Engineers identified manufacturers and worked with them to develop quality prototype machines for demonstrations. As the demand for machines increase, the manufacturer should be capable of providing equipment upon requests from farmers.

3. Equipment designed by IRRI, Los Banos, served as a base for equipment introduced to farmers. Appropriate modifications were made to make the machines operate effectively under Thailand farming conditions. Since IRRI equipment was not available to meet all the needs of the farmers, the project introduced new designs or selected equipment commercialy available from other sources to introduce into some areas.

4. Selected equipment was loaned to Universities with Agricultural Engineering Programs. The amount and type of equipment depended on the needs of the department. The machines are to be used as laboratory teaching equipment for agricultural students. Special problems can be assigned for engineering students to modify or redesign the machines for specific conditions. Visitors to the universities will be able to observe the machines and the staff can assign students to demonstrate as requested by farm groups.

5. The production of a video tape on machanization of rice in Thailand began in cooperation with the AED and Kasetsart University. Dr. Taworn Prakhongchit of the Kasetsart University Extension and Training Center provided video equipment and technical assistance for producing the tape.

6. Training programs were initiated for government employees including Agricultural Engineering Division engineers, Department of Extension staff, project staff, and manufacturers. The courses are normally taught in Thai language by project engineers and selected individuals who have attended the IRRI Agricultural Engineering Course in Los Banos, Philippines.

COOPERATING PROJECTS

According to the new strategy statement and work plan small farm machinery has been introduced utilizing government agencies, projects and other organizations. The agencies and projects cooperating in the small farm mechanization program during 1984 are listed in Table II. Selected machines and tools were loaned to cooperators through a memorandum of agreement (appendix A). The main purpose of the agreement was to assure feedback relative to the performance of the equipment in the respective programs.

The agencies participating with the project were selected based on their programs that included mechanization and a sincere interest in adopting mechanization into their programs.

TABLE II. COOPERATING AGENCIES AND PROJECTS-1984

	Project	Location
1.	Prae Rice Research Center	Prae
2.	Haui Hong Crai King's Project	Chiang Mai
3.	King's Cropping Systems project	Narathiwat
4.	King's Cropping System project	Hatyai
5.	Underground Water Project	Sawankhalok
6.	Royal Soybean Project	Mae-Jo
7.	Appropriate Technology Association	Bangkok
8.	Khon Kaen University	Khon Kaen
9.	NERAD (USAID)	Khon Kaen
10.	Northeast Pumping Project (THAI)	Khon Kaen
11.	Ubonrat Dam Project (World Bank)	Nong Wai
12.	Forestry Village Project	Khon Kaen
13.	Extension Service Farm Mechanization	Chainat
14.	Asian Institute of Technology	Phatumtani

The type of cooperative programs varied among the agencies. All participants were common in that their scope of work and objectives were to improve the productivety of small farmers.

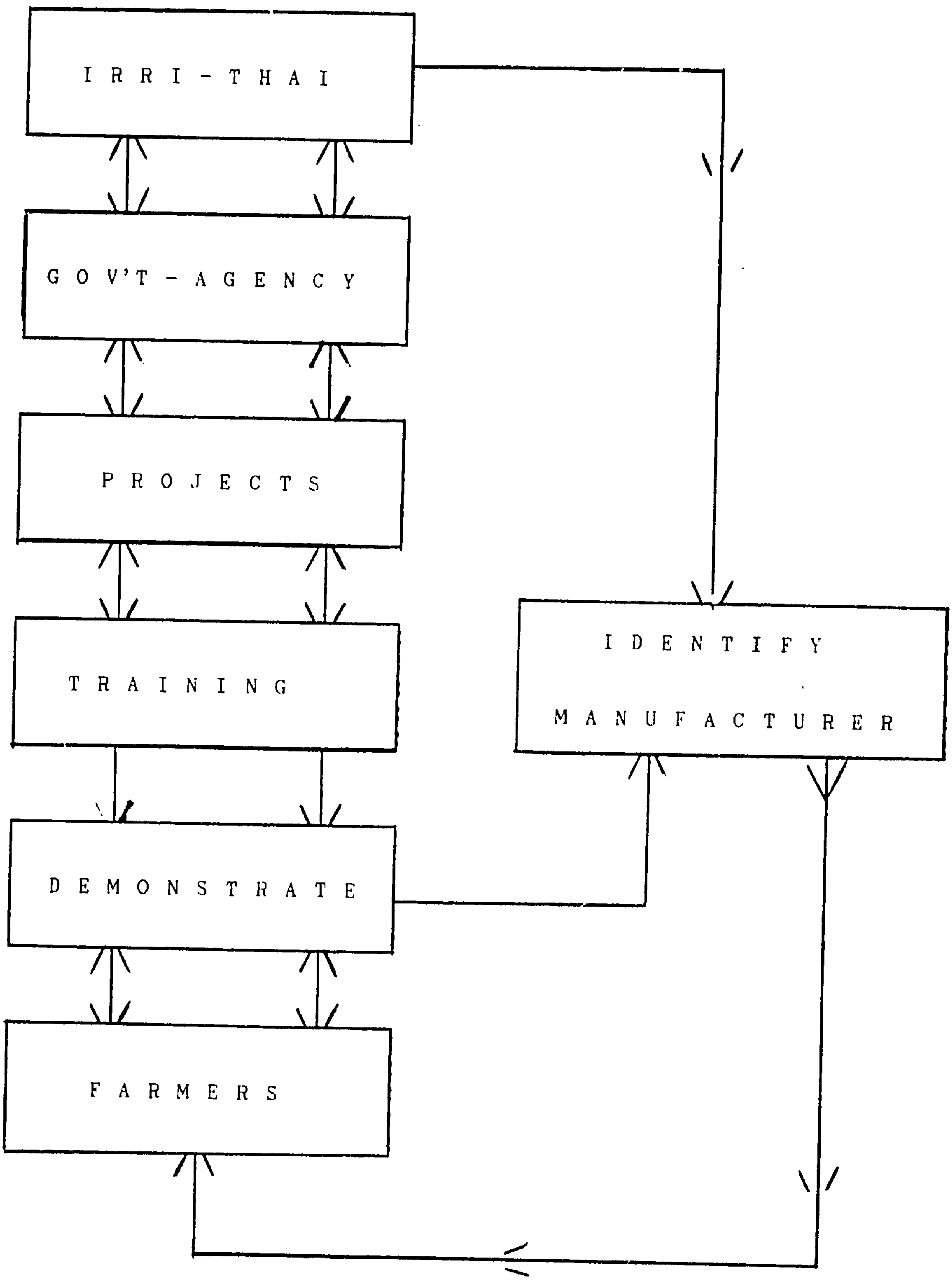
After appropriate cooperating agencies were selected, projects and locations were considered. Preference was given to projects in the northeast of Thailand since the area consists of a high percentage of small rice based farmers with relatively low incomes. Loaned equipment was available to projects within the agencies for exhibitions and demonstrations.

TRAINING

Figure 4. Project leaders and agency staff trainees - Khon Kaen NERAC

Training has become an important component of the Small Farm Mechanization Project. The logistics of accomplishing the work plan objectives through training courses and demonstrations is shown as Figure 5.

Figure 5. Farm Mechanization Extension Logistics.



Training in the operation and adjustment of the equipment was provided by the mechanization project through lectures, literature distribution, and field exercises. Training courses for project managers has been designed for a period of 3 to 5 days. Due to time limitations and project objectives, one day workshops were also given. During the training courses the project staff learns from the participants what type of mechanization would have the greatest potential in their area. The project then loans interested participants a set of specific implements to take back his tambon or district. After the project leaders were trained they are capable of returning to their Tambons and organizing training for village leaders.

The training of village leaders is less formal and consists of more field use of the equipment. The objective is to make the village leader familiar with each implement the project manager recommended for his area. Staff from the IRRI-THAI mechanization project assists with training the village leaders but the project manager organizes the course and has the overall responsibility based on his earlier training. As the village leader became familiar with operating and adjusting the implements, he selects the machines with the greatest potential and possibility of acceptance by farmers in his village. Village leaders were provided with machines to demonstrate and encouraged farmers from his village to use.

305

If the machine does not meet the needs of the farmer, the village leader tries to determine the reason why the machine is not acceptable, what modifications the farmer would suggest, and what specific machine would be most beneficial to the farmers. This feedback comes back through the village leader, the project manager, the project leaders and the IRRI-THAI engineers. Examples of feedback of this program implemented through the Departement of Agricultural Extension and the Appropriate Technology Association are attached as appendix B.

Training at different levels of technology was initiated among the groups associated with the project. Dr. Winit Chinsuwan former head of the Agricultural Engineering Department at Khon Kaen University joined the project staff for a sabatical leave and has been given responsibility for training programs. The types of programs and participants are summarized as follows.

1) AGRICULTURAL ENGINEERING DIVISION STAFF: A planning committee from the AED and IRRI staff was established to coordinate lectures and lecturers for monthly seminars within the division. The purpose of the seminars will be to strengthen the professional abilities of the staff. A series of topics with corresponding lecturers have been developed and approved by the planning committee. The seminars are scheduled to be held once each month beginning November 1, 1984.

2) AGENCY STAFF AND PROJECT LEADER TRAINING

* Agency	Trainees	Location	Number	Duration
DOAE	Provincial Extension Officers	Chainat	17	5 days
FSI	Provincial Agri. officers	Sawankhalok	25	1 day
ATA	ATA staff	Bangkok	5	1 day
** NEAC	Project Leaders	Khon Kaen	41	4 days
NERAD	(Training schedule Appendix C)			

* DOAE - Department of Agricultural Extension

* FSI - Farming Systems Institute

* ATA - Appropriate Technology Association

NEAC - Northeast Agricultural Center

NERAD - Northeast Regional Agricultural Development Project

** Whenever possible the lecturers for the training courses were individuals who had attended the 3 weeks Agricultural Engineering Training Course at IRRI, Los Banos, Philippines.

3) VILLAGE LEADERS AND PROGRESSIVE FARMERS TRAINING

Location	Organizer	Number	Duration
Chaiyaphom	NEAC	15	1 day
Roi-et-Ban Laon	NERAD	30	1 day
Roi-et-Ban Nang Tone	NERAD	50	1 day
Roi-et-Ban Na Kom	NERAD	50	1 day
Roi-et-Ban Pa Chee	NERAD	30	1 day
Chainat	DOAE	80	1 day

Figure 6. Training Village Leaders and Farmers in cooperation with DOAE, Chainat 1984.

?o8

4) IRRI AGRICULTURAL ENGINEERING TRAINING COURSE, LOS BANOS

The project selected two individuals from Thailand to participate in each of the two training courses held during the year. The course was originally designed to train small farm machinery manufacturers, however the trainees must be proficient in the english language. Since few manufacturers in Thailand speak english, the trainees were selected from other groups.

As a means of strengthening the training programs in Thailand, participants were selected based on their potential to be lecturers for the in-country training programs. The development of trainees to become in-country trainees using the Thai language was successful during 1984.

1984 Trainees attending the IRRI Training Course included:

1. Mr. Maitree Preecha - Department of Agricultural Extension.
2. Mr. Surasak Bamrongwong - Ag. Engr. Dept., Chaing Mai University.
3. Mr. Kanoksak Eam-o-pas - IRRI-THAI Industrial Extension Project.
4. Mr. Sutin Sakranukit - Ag. Engr. Division, Department of Agriculture.

DEMONSTRATIONS

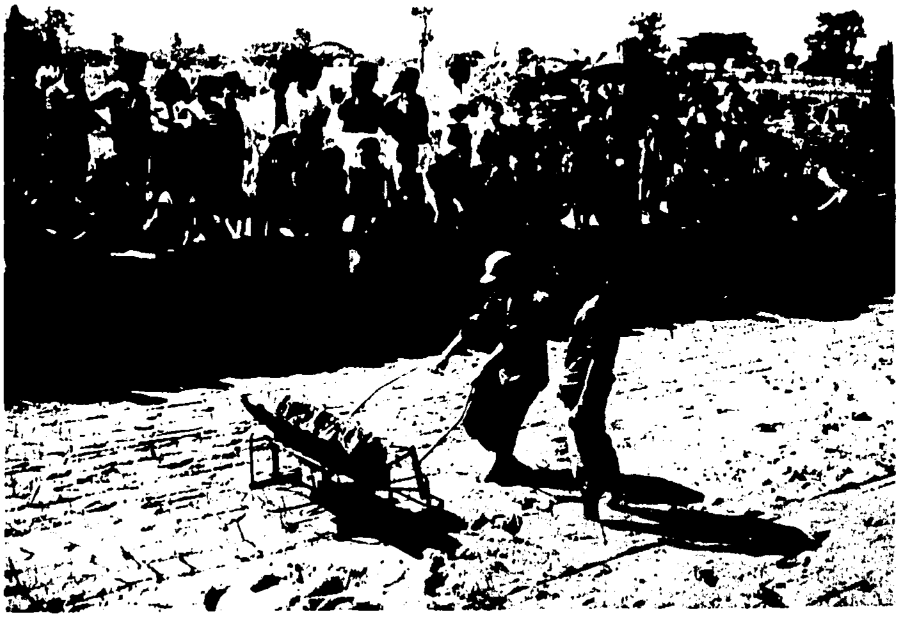


Figure 7. Demonstration of transplanter during National Agriculture week, Kampang Saen, 1984.

Demonstrations provide a means of introducing new machine technology to large non-technical groups. Although many factors effect the acceptability of mechanization by farmers considerable interest was shown at all demonstrations.

Field demonstrations were performed using selected equipment where field condition would ficilitate. Machinery used in the field demonstrations included 1) Inclined plate planter, 2) Cyclone seeder, 3) Rolling injection planter, 4) Seedling transplanter 5) Direct paddy seeder, 6) Improved buffalo plow, 7) Hand jab planter and 8) Reaper.

Location	Organizers	Number (est.)
Nakhon Phanom - Na Phaeng	DOAE-NEAC	350
Nakhon Phanom-Nawa	DOAE-NEAC	300
Chainat	DOAE	150
Sri Saket	DOAE-NEAC	300
Khon Kaen	NEAC	600
Kampang Saen	National Agri. Day	400
Nakhon Sawan	National Farm Mach. Exhi.	500

The demonstrations were successful and there was interest shown among the observers, however the reaction of young people to mechanization was very noticeable. A stronger agricultural mechanization program for young people would be beneficial. The project cooperated with the Northeast Agricultural Center in the youth agricultural competition and resulted in farm mechanization being included as part of the competitive examination for the first time. Staff from the project served as members of planning committees and assumed responsibility for field demonstrations of equipment provided by commercial companies as well as project machinery during the field days at Kampang Saen Nakhon Sawan and Khon Kaen.

311

EXHIBITIONS

All of the 14 machines, the project is extending were put on exhibit during three national level exhibitions. Literature and posters were provided by the AED and project staff to introduce mechanization to the public.

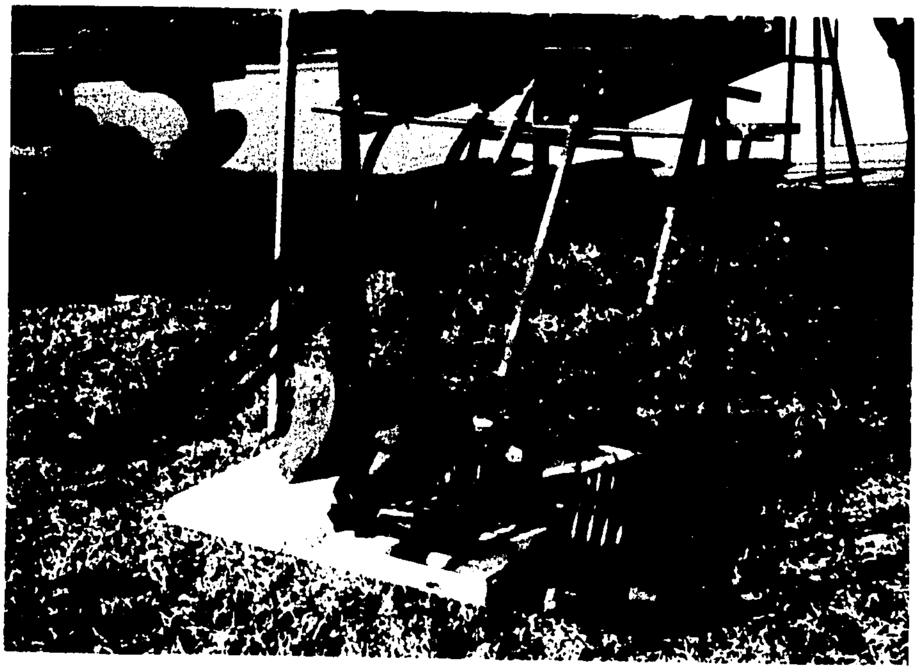
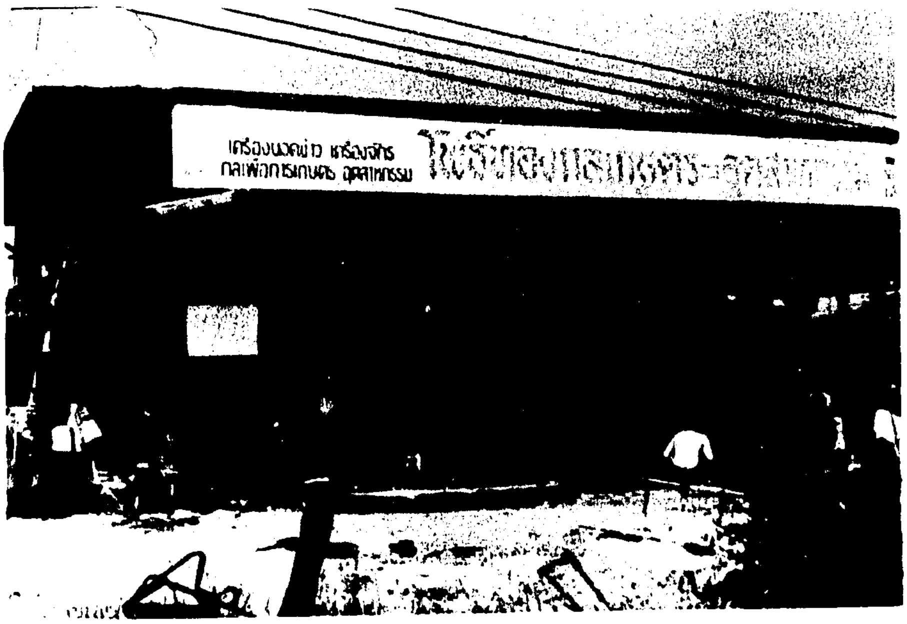


Figure 8. Exhibiting THAI-IRRI Small Farm Implements.

Location	Agency	Duration	Est. Attendance
Khon Kaen	NEAC	3 days	40,000
Nakhon Sawan	National Farm Mach. Comm.	3 days	20,000
Kampang Saen	National Agricultural Wk.	5 days	50,000

MANUFACTURERS



The project has worked to develop small manufacturers of agricultural equipment. In the past a significant effort was given to introducing IRRI designed machines and locating coopera-ting manufacturers. Interested companies began as cooperators through a memorandum of agreement developed by the mechanization project. One hundred and twenty nine manufacturers were listed as cooperators in 1982. The cooperating manufactures were disperse throughout the country including the north, south, east and western parts of the country. Results from a random survey of the list of cooperating manufacturers during December 1983 showed a small percentage of the total were producing IRRI designed machines. Threshers and power tillers are the predominant machines being manufactured. Approximately 30 manufacturers produced an estimated 2000 threshers during 1983. A larger number of companies produced an estimated 50,000 two wheel tractors (power tillers) of various sizes and models. There has not been large numbers of other IRRI introduced machines manufactured.

During 1983 more emphasis was placed on developing a market for machines and assisting manufacturers in the interested farmer areas to produce prototype machines. Machines identified through the training, demonstration and feedback programs included 1) inclined plate planter 2) cyclone seeder 3) improved buffalo plow and 5) pendulum weeder. The project has a total of 14 machines and implements, Table III, that has shown some potential for acceptance by farmers and manufacturers. Initially village manufacturers were selected to produce quality prototypes in areas where there was a potential sales market. The manufacturers and the number of machines produced during 1984 are presented in Table IV.

314

Table III. Machines Introduced during 1984.

	Equipment	1984, cost
1.	Inclined Plate Seeder	= 4,200.- Baht
2.	Rolling Injection Planter	= 2,200 Baht(2 row)
3.	Cyclone Seeder	= 500.- Baht
4.	Transplanter	= 2,300.- Baht
5.	Direct Paddy Seeder	= 1,200.- Baht
6.	Fertilizer Applicators	= 2,000.-
7.	Jab Planter a) AIT	= 350.- Baht
	b) Farm Suwan	= 350.- Baht
8.	Upland weeder	= 300.- Baht
9.	Paddy weeder	= 400.- Baht
10.	Buffalo Plow	= 150.- Baht
11.	Reaper	
12.	Thresher	= B 16,000 w/o engine
13.	Axial Flow Pump 4 inch	= B1,600 w/o engine
	6 inch	= B 2,600 8 hp
	8 inch	= B 3,000 10 hp

Table IV. Manufacturers of Acceptable Prototype Machines during 1984.

	Machine	Manufacturer	Location	Number of machine's producte'84	1985 estimated productio
1.	Inclined Plate Planter	Kunasin Mfg. Co.	Sawankaloke (North Central)	90	500
		Jakpetch Tractor	Bangkok		
2.	Cyclone Seeder	Aree Athorn - Karnchang	Takli (Central)	50	300
3.	Buffalo Plow	Chan Thai Lek	Khon Kaen (Northeast)	40	200
4.	Pendulum weeder	Powsila Borikarn	Korat (Northeast)	38	200
5.	Upland weeder	Anusarn	Chiang Mai	20	60
		Powsila Borikan	Korat	20	80
6.	Transplanter	Aree-Athorn-Karnchang	Takli	5	0
7.	Paddy weeder	Powsila Borikarn	Korat	40	40

Parts of the program to develop the agricultural mechanization industry is to assist in establishing credit to farmers and manufacturers. The Bank of Agriculture and Agricultural Cooperatives (BAAC) is the major lending agency for farmers. During

1984, 1,500 million Baht was targeted to purchase equipment and other necessities by farmers. This represents a 25% increase over 1983. Money for tractors accounted for 37.9 percent of the credits. Planning meetings were held with BAAC, IRRI, AED staff and manufacturers to develop effective methods by which new machines can be produced and credit made available to farmers. Information was provided to BAAC and distributed to provincial branchs on the availability of the inclined plate planter, buffalo plow, cyclone seeder and the pendulum weeder. Now machines developed through IRRI and AED can now be purchased through BAAC and cooperating manufacturers. Future demonstration to farmers will include manufacturering and BAAC representatives so farmers can purchase machines during the demonstration if necessary.

ECONOMIC STUDY

A Mechanization Economic Study was initiated June 1, 1984 in the northeast region to assess the potential role of new or improved mechanization techniques in alleviating research constraints of the region. Questionaires developed for the survey will provide information to determine the present as well as the potential resource level available relative to Small Farm Mechanization. Utilization of the results should provide some insight into improving resource use efficiences and reducing production cost with the goal of increasing productivity and income of the small farmer. An outline of the study is presented as Appendix D.

The study was designed to sample villages, farmers and manufacturers of five provinces in the northeast as shown Figure 9. A separate questionnaire has been developed for each group. Data from a total of 17 villages 333 farmer's housholds and 18 manufacturers as outlined in Table V and will be collected by seven enumerators and a study leader. Khun Somporn Saitan joined the project as the study leader July 1. The study timetable has been planned to allow 10 months to prepare questionnaires, collect data, analyze the results and report the findings. Office space and housing for the study in being provided by the Northeast Regional Office at Tha Phra. The IRRI-THAI mechanization project acknowledges and express appreciation for the excellent cooperation from the NERAC. Although results of the study cannot be implemented under the current Small Farm Mechanization project since the termination is scheduled for September 31, 1985, the results should provide recommendations and guidelines for the Agricultural Engineering Division and future projects relating to mechanization and resource development in the northeast. A separate report of the economic study will be made and distributed through IRRI channels.

Teble V. Structure of Data Collection for Mechanization Economic Study.

Province	Amphur	Tambon	Name of village	No. of samples
Khon Kaen	Banphai	Koksamran	Koksamran	14
			Koksamran	14
	Nampong	Sa-ad	Khambong	17
			Khambong	17
Roi-et	Muang	Nong-kaew	Nongkara	28
			Nongtoon	13
			Lae-nontan	20
Nakorn-Phanom	Na-va	Na-va	Na-col	21
			Nangmo	21
			Tarus	21
Srisaket	Uthum-pornpisai	Tae	Tae	35
		Taket	Kasaemsuk	14
			Du	16
Korat	Sri-kue	Kudnoi	Kudnoi	20
		Nang-ya-kew	Nong-ya-kew	20
	Pong - chang	Tuntuk	Sub-muang	24
		Nong-sa-rai	Tha-ma-nao	20
			TOTAL SAMPLES	333

Table VI. Manufacturers to be Sampled for Mechanization Economic Study.

	Name	Location
1.	Chan Thailek LPK Steel Industry	Amphur Muang Khon Kaen
2.	Thai Heng Haud (Sin Pheanmuang)	Amphur Muang Khon Kaen
3.	dongthong Thailek	Amphu Banphai Khon Kaen
4.	Thailek Changsin	Amphur Banphai Khon Kaen
5.	Thongjinseng	Amphur Banphai Khon Kaen
6.	Asia Industry	Tambol Ban thum Khon Kaen
7.	Seng Panich Company Ltd.	Amphur Muang Roi-et
8.	Nong Kae Plag beam of Noi Yud	Amphur Muang Roi-et
9.	Peng jew	Amphur Muang Roi-et
10.	Roi-et Miller Company Ltd.	Amphur Muang Roi-et

COMPUTER

An IBM PC with a color monitor and letter quality printer was purchased to support the project in word processing, equipment inventory, loan transactions, listing of cooperating manufacturers, projects, and government agencies. The computer is also used to train and improve the effectiveness of the AED staff. Analysis of data, plotting graphs and regression curves has been helpful during preparation of papers. Photographic slides can be made of color charts and graphs developed on the computer. Using a shutter speed of 1/8 second or more and the appropriate "F" stop depending on film speed and lighting, multicolor slides can be made. Software is being accumulated to meet the needs of the project. The Thai - word processing software has been an assist in writing letters, reports and descriptive literature of the IRRI designed machines in the Thai language. Two project staff were provided some computer training during the year but additional short courses would be beneficial in the future.

321

VIDEO TAPE

A video tape of various aspects of mechanization and rice production techniques is being produced with the cooperation of the Department of the extension service of Kasetsart University. A total of 6 rolls of video tape has been exposed. Editing and developing a script for the final tapes will be completed with six months. The purpose of the video tapes will include training of farmers through the DOAE agricultural mechanization seciion, introducing mechanization to BAAC officials and staff and for use during workshops, symposiums and exhibitions. Plans are to have three tapes. One that describe and shows mechanization to the non agricultural public, one for the agricultural sector and mechanization oriented individuals. Copies can also be made available to libraries, University Agricultural Engineering Departments and international organizations.

FUTURE ASSESSMENTS

History will verify in Thailand, Philippines and other countries where mechanization is introduced into the agricultural production system, there is a need for cooperative work among agricultural scientist and machinery development. Unfortunately sometimes mechanization is not considered until other technology has been developed and ready to be extended to farmers. Machines need time for development also. Time and duplicated effort can be saved and a better machine can be developed if the agricultural engineer can work with other scientist during the development stages of research or extension projects. In the beginning after the problem has been properly identified by each scientist there may be a need for separate basic laboratory work keeping the overall problem and solution in mind. When the technology in each area reaches a significant development stage, combined coordinated research experiments should be tested in the field.

Training is an important part of mechanization development. Just as a computer is no better than its programmer, a machine needs a competent operator to perform as it was designed. It is not uncommon for machines to be evaluated and discarded because of improper adjustment or use. Fortunately IRRI has a strong Agricultural Engineering Department that can serve as a training base for various levels of mechanization. But needs must be

322

properly defined and implemented.

Mechanized agriculture has been successfully introduced into Thailand and some areas are considered highly mechanized. However, other areas still use hand and animal power for all farming operations. This will change and as it changes with new varieties, cropping systems and improved technical operations, mechanization should be involved. To be prepared to effectively contribute to the changes, agricultural engineers should have a part in obtaining technological solutions.

Future Cooperative Plan of Work:

I. Cropping systems:

a) Cooperative work with cropping system scientist in planning parameters to be included in system development. Selection of the types of crops to be produced and method of production i.e. irrigated or rainfed.

b) Evaluate machine systems available within economic limits of the system.

c) Determine the effectiveness of the machines in the selected cropping system in replicated plots. Appropriate data will be collected and analyzed.

d) Extend proven prototypes to farmer's field.

e) Work with selected manufacturers or distributors to assure quality machines are available to farmers.

f) Train project staff and farmers in the operation, adjustment, and maintenance of machines.

II. Fertilizer use efficiency:

a) Cooperate with agronomist and or other scientist in identifying the most effective parameters for increased fertilizer plant use efficiency.

b) Design prototypes of application systems and analyze in the engineering laboratory for appropriate component speeds, draft requirement and metering efficiency.

c) Develop cooperative field experiments with agronomist and or other scientist to evaluate machine performance relative to metering selected forms of fertilizer and placement coordinates.

d) Modify tested prototypes as needed for trials in farmer fields. Evaluate machine field efficiencies, draft, metering efficiency, and crop yield.

e) Extend tested prototypes to appropriate manufacturers according to fermer acceptance.

Prototypes developed at IRRI Los Banos will be evaluated depending upon reliability in Thailand rice production systems. Modification or new designs will be developed as needed in to complete the above objectives.

III. Mechanization Extension

a) Introduce plans of tested prototypes to manufacturers.

Assist in solving machinery manufacturing problems to provide quality and economical machines for farmers. Encourage manufacturers to develop a field sales department to contact and work with farmers.

b) Work with manufacturing organizations and engineering societies to develop machine standards among manufacturers.

c) Cooperate with cooperatives and agricultural extension specialists in demonstrations of tested equipment to farmers.

d) Develop and update video tape presentations of farm mechanization in Thailand.

IV. Training

a) Develop a continuing education programme for engineers that will teach current and appropriate engineering application principles.

b) Develop training courses for staff of cooperating agencies on the use, adjustment and maintenance of small rice farm machines.

c) Develop a training programme for manufacturers of agricultural machines.

d) Assist graduates of the farm mechanization training course in organizing and teaching training courses to farmers.

e) Develop programs, including mannuals, for training farmers to use, adjust and maintain from machinery.

328

APPENDIX A

MEMORANDUM OF AGREEMENT

A major objective of the agricultural engineering program at the International Rice Research Institute is to foster training and machinery development for mechanization of small rice farms in developing countries. This objective is achieved by providing appropriate agricultural equipment designs for demonstration, exhibitions and university or vocational teaching laboratories. This agreement specifies the policies and procedures under which IRRI designs are made available to cooperating institutions.

Provisions

The International Rice Research Institute, a non profit coorporation with headquarters at Los Banos, Laguna, Philippines, hereinafter referred to as IRRI, disseminator of agricultural equipment and/or designs, and ___________________________________

____

hereinafter referred to as the lending recipient and user of such designs and machines, consent to enter into an agreement containing the promissions stated herein, and the procedure that follows.

Phase I: IRRI will loan to the lending recipients machines and other technical information describing the equipment as follows:

MACHINE	IDENTIFYING NUMBER	DESCRIPTION	QUANTITY

The lending recipient will submit to IRRI a proposed utilization plan for the machines. Reports will be submitted periodically (_________) of activities involving the machines that will rate the machines performance:

a) Submit any improvements or modifications to IRRI for revies and approval.

b) Report repetitive field problems to IRRI who will provide assistance in solving these problems.

c) Report to IRRI, every 6 months, the number of demonstrations held, exhibits and approximate number that was bought by a farmer as a result of this program.

d) Not obtain patents or other encombrances on any equipment of IRRI designs or use for personnel gain.

General Conditions

All machines and drawings provided by IRRI remain the property of IRRI unless another agreement is consummated. The institution agrees to return all materials supplied by IRRI upon the termination of this agreement unless specified. The lending recipient agrees to provide IRRI with complete information on alterations or modification made on equipment. IRRI will have the right to distribute such information to other agencies.

The Institute will not be held responsible for any liability from any claims due to injury to life, property or otherwise which may arise due to manufacturing, design or using any of the IRRI designed machines.

This agreement will be in effect for one year. The lending recipient can apply for renewal by submitting a written request to IRRI.

This agreement can be terminated by either party upon submission of a written notice 30 days prior to termination.

SIGNED

For the International Rice Research Institute:	For Lending Recipient:
____________________________	______________________
DATE: ______________________	DATE: __________________
WITNESS: ___________________	WITNESS: _______________

-324

APPENDIX B-1

REPORT ON DISSEMINATION IRRI AGRICULTURAL TOOLS SUBMITED TO IRRI BY APPROPRIATE TECHNOLOGY ASSOCIATION

During the two years ATA has disseminated appropriate technology in Northeast Thailand, we realized that agricultural technology was needed, so, with the cooperation of IRRI, some agricultural tools, which were improved by IRRI were demonstrated in 3 Northeast provinces.

The tools for demonstration included:

1. Punch Planter
2. Cyclone Seeder
3. Weeder
4. Buffalo Plough

Dissemination:

ATA disseminated these agricultural tools in Khon Kaen, Koraj and Ubonrajchathani, by cooperating with 3 organizations and meeting with villagers. In the meetings, we demonstrated and discussed the efficiency and the operation of these tools.

We had meetings in 3 provinces:

1. Khon Kaen, with Redd Barna in "Rural Development in the Northeast Project I-II", there are 175 villagers from 7 villages in November 20-30, 1983.

2. Korach, with Drug Study Group in "Health Promotion in

Community Project, there are 35 villagers from 2 villages in January 17-19, 1984.

3. Ubonrajchathani, with Mahidol University Nutrition Research Centre in "Leader Training Programme", there are 31 villagers from 11 villages in February 23-25, 1984.

From the meetings we can summarize that:

1. PUNCH PLANTER is the most interesting tool, the farmers can work quicker and they are not so tired. The operation of Punch Planter is not complicated, the villagers can make and repair it by themselves. About 30 villagers wanted to have the Punch Planter for the next growing season. Some farmers copied the model so they could make some when they went back.

2. CYCLONE SEEDER, The farmers who grow rice by broadcast seeding were very interested in the Cyclone Seeder because it works better, rice can grow in good form. But some farmers commented that some seedlings would be broken, so they wanted to try it first. They though it would be more difficult to make because they cannot find the gears to fit the machine.

3. WEEDER, is suitable for corn and cassava fields, it is easy to use even for the children and they though it could be made by local technicians because it is not difficult to find the materials and the system is not complicated.

4. A. BUFFALO PLOUGH (small), there were only some farmers in one village interested in this plough and tried it in the field.

333

They had some comments:

1. It is suitable for sandy soil which can grow upland crops.

2. It is not so different from the local plough.

B. BUFFALO PLOUGH (big), the farmers were very interested in it and had a lot of comments.

1. It is suitable for sandy soil which can grow lower land rice.

2. The plough is too big, they were afraid the buffalo would work too hard, and only the strong male buffalo could pull it. The young and female buffalo can not pull it.

3. It is too heavy to carry when the field is far from their house, and it is difficult to lift when women and youth to have change direction.

4. The tiller is not only necessary but dangerous also because when the farmer left the plough to change a direction it might hurt him.

5. This plough can turn over the soil and cover up the grass better than the local plough.

6. They though that if this plough is not so expensive many farmers would like to try it. B 130

332

The list of the villages in Dissemination Project:

Khon Kaen

1. Ban Kra Pee, Ampur Phang
2. Ban Don Hun, Amphur Nong Rua
3. Ban Phang, Amphur Nong Rua
4. Ban Nong Koong, Amphur Nong Rua
5. Ban Koke Soong, Amphur Nong Rua
6. Ban Soke Nam Kwao, Amphur Wang Noi
7. Ban Lao Kwaein Hak, Amphur Muang

Koraj

1. Ban Gud Doke, Amphur Dan Koon Tod
2. Ban Nong Kra Tium Tai, Amphur Dan Koon Tod

Ubonrajchathani

1. Ban Hwang, Amphur Varinchamrap
2. Ban Non Bon, Amphur Varinchamrap
3. Ban Non, Amphur Varinchamrap
4. Ban Mod Ngam, Amphur Varinchamrap
5. Ban Yang, Amphur Varinchamrap
6. Ban Kang Dook Sai, Amphur Varinchamrap
7. Ban Pone Sai, amphur Varinchamrap
8. Ban Na rai Yai, Amphur Muang Sam Sip
9. Ban Song Korn, Amphur Amnat Charoen
10. Ban Nong Hai, Amphur Piboon Mangsaharn
11. Ban Kome Pradid, Amphur Piboon Mangsaharn

APPENDIX B-2

REPORT ON SURVEY OF FARMER'S ATTITUDE AND ACCEPTANCE OF IMPROVED PLOW (DOA-IRRI) AT WAT SING DISTRICT, CHAI NAT PROVINCE

BY

Mr. Kasom Skultab*
Principal Investigator

Mr. Veera Piriyapan**
Supervisor

* Agricultural Engineer
Farm Mechanization Promotion Center
Chainat Province 17000

** Chief of Farm Mechanization Sub - Division
Department of Agricultural Extension
Bangkhen, Bangkok 10900

BACKGROUND

Farm Mechanization Promotion Center had demonstrated the Improved Plows, both large and small model, which have been developed by Agricultural Engineering Division and IRRI. The demonstration was held at Tambol Nong Noi and Tambol Nong Khun, Wat Sing District, Chainat Province. According to preliminary data, we found that farmers in this area use animal plow intensively. After the demonstration most farmers interested in the small model. So we lent them 2 sets of small model for one crop season. We expected that they might practice this plow much enough for evaluation.

OBJECTIVES

1. To determine the feasibility and acceptation of Improved Plow for future promotion in this area.

2. To assign the strategy of Improved Plow promotion.

PROCEDURE

Farm Mechanization Promotion Center in contacted with District Extension Office, Wat Sing District had designed the questionnaire for the evaluation.

Evaluation date: January 4, 1984

Co-operator: Mr. Samran Powsombat
District Extension Office,
Wat Sing District

Wat Sing District preliminary data:

- farm are	268,463	rai*
- irrigated area	12,500	rai
- farmer family	6,245	family
- farm size (Av)	34.7	rai/family
- number per family (Av)	5	person
- income/family/year	23,209	Baht
- income/head/year	5,820	Baht
- soils texture		

PADDY (first crop)

- season	May - August (depen on rainy season)	
- planted area		
germinate seed	7,000	rai
upland	123,860	rai
transplant	81,519	rai
- average yield	3,230	kg/rai
paddy (second crop)		
- season	January - March	
- planted area	12,000	rai
- total number of water buffalo	13,498	animals
- walking tractor	378	units
- riding tractor	303	units
- animal plow	6,516	sets

Remark: data collected during 1982-1983

1 rai = 0.16 ha

OBSTACLES

1. During the time of demonstration, there were only 2 sets of small model, insufficient for rotatable practicing.

2. Flooding from October to December 1983 delayed the evaluation.

3. Travelling during rainy season difficult

RESULT:

Because of limitation of plow set quantity, only 8 questionnaire were returned so the collected data were not adequate for statistical method.

For the eight farmers, they had used the Improved Plow (small model) in tilling the area of 17, 10, 40, 7, 23, 5, 45 and 4 rai.

They choose the preferable choice in each comparision item as follows (digit in each block represents the number of farmers)

- Effective field capacity and maneuverability.
  - [2] Improved Plow had more
  - [1] Local Plow had more
  - [5] similar
- Animal draft force requirement
  - [2] Improved Plow did less
  - [2] Improved Plow did more
  - [4] Similar
- Uniformity of furrow slice and trash coverage
  - [7] Improved Plow did better
  - [1] Local plow did better
  - [-] Similar
- Breakage of furrow slice
  - [7] Improved Plow did better
  - [1] Local plow did better
  - [-] Similar

- Plowing depth, if both require equal draft force

  [1] Improved plow deeper

  [2] Local plow deeper

  [4] Similar

- Comfort in plow adjusting. (hitch point, degree of share and etc.)

  [1] Improved Plow more

  [3] Local plow more

  [4] Similar

- Comfort in plow direction control*

  [5] Improved plow more comfortably, straight plow direction.

  [1] Local plow more comfortably, straight plow direction.

  [5] Improved Plow seldom run of straight but less than local plow.

  [1] Improved Plow seldom run of straight but more than local plow.

  [1] Similar

- Wear and tear of plow bottem*

  [5] Improved Plow more expecially at point of share**

  [2] Local plow more

  [4] Similar

- Weight of plow when being carried on shoulder.

  [2] Improved Plow lighter

  [1] Local plow lighter

  [4] Similar

Remark: * Farmers choice more than one

** Five farmers agreed that point of share wear quickly.

777A

ANALYSIS:

1. Each farmer had tilled by Improved Plow in an area enough for evaluation.

2. Effective field capacity, maneuverability, depth of plow, weight when carried and animal draft force requirement of both are similar.

3. Improved Plow gave the furrow slice more uniform than local plow and the breakage of furrow slice was slightly better.

4. According to various adjustment of local plow, the farmer implied that local plow adjustment are more comfortable.

5. Most farmers pointed that plow direction control of Improved Plow, sometimes, not straight. They may try to adjust but unable to, so they implied that the adjustment was inconvenient.

6. Five farmers commented that the point of share worn out shortly.

FARMER'S COMMENT:

1. The farmer strictly commented that moldboard and share should be separated into 2 pieces for the convenience of replacement when worn out.

2. The conversion of improved angle of improved Plow should be adjustable.

3. Average price of Improved Plow sets should be 187 Baht.

CONCLUSION:

1. The evaluation should be repeated again to get enough samples for statistical analysis.

2. The farmers in this area are rather poor. Therefore, to extend wide use of the Improved Plow we should provide them with low cost equipment.

3. The share of Improved Plow should be replacable, so the total plough cost will be less when they renew the share.

APPENDIX C

TRAINING SCHEDULE

IRRI-THAI SMALL FARM MECHANIZATION TRAINING COURSE

TRAINING CENTER: Northeast Regional Office of Agriculture and Cooperatives, Thapra, Khon Kaen

DATE: April 16-19, 1984

Monday, 16 April'84

1300-1700 - Participants arrive/Registration

Tuesday, 17 April'84

0830 Lecture: - Land preparation by Mr. Chanchai
- a) Power tiller
- b) Buffalo plow
- c) Disk plow
- d) Levelling
- e) Clod breaking

1030 Lecture: - Planting (Upland) by Dr. Winit

1330 Laboratory/Field work

1) Land preparation by Mr. Prasarn, Mr. Suphasit
   - a) Power tiller w/disk plow
   - b) Buffalo plow
   - c) Land levelling (buffalo)

2) Planting (Upland) by Mr. Kanoksak & Mr. Thanisorn
   - a) Cyclone seeder
   - b) Inclined plate planter
   - c) Jab planter

Wednesday, 18 April'84

0830	Lecture:	- Planting (Paddy) a) Transplanter b) Direct Seeder	by Mr. Maitree
1030	Lab/Field work:	- Planting (Paddy) a) Transplanter b) Direct seeder c) Seedling preparation d) Hand direct seeding	by Mr. Kanoksak & Mr. Thanisorn
1300	Lecture:	- Weed Control a) Paddy weeder b) Upland weeder c) Pendulum Hoe	by Mr. Kanoksak
1530	Lab/Field work	- Weed Control a) Paddy weeder b) Upland weeder c) Pendulum Hoe d) Standard (conventional)	by Mr. Kanoksak & Mr. Thanisorn

Thursday, 19 April'84

0830	Lecture:	- Reaper	by Mr. Suraweth
1030	Lecture:	- Thresher	by Dr. Winit
1330	Lab/Field work:	- Reaper & Thresher	by Mr. Prasarn & Mr. Suphasit
1800		- Closing ceremony awarding of certificates	

APPENDIX D

ASSESSING THE POTENTIAL IMPACT OF IMPROVED ENGINEERING TECHNOLOGY ON AGRICULTURAL IN NORTHEAST THAILAND

1. Objective

To assess the potential role of new or improved engineering techniques in alleviating resource constraints, improving resource use efficiencies and reducing production costs with the goal of increasing production, incomes and enhancing gainful employment opportunities for the rural population of Northeast Thailand.

2. Methods

It is proposed to undertake a field survey of a sample of 300 households in selected Changwats in the Northeast region. To the degree possible, this sample would coincide with households included in earlier surveys such as the Rural-off Farm Employment Study. Incorporation of these households would permit a limited assessment of changes in farming techniques and economic conditions over time. A supporting set of interviews would also be conducted with engineering equipment manufaturers, distributors and service shops throughout the area. Evidence from these visits would provide a profile of the level and composition of current machinery patterns in the area. Secondary evidence would also be sought from a recent IBRD study of similar firms in the area.

3. Scope

The sample frame would be developed from secondary sources including the Division of Ag. Economics, Ag. Economics Department at Kasetsart University and Ag. Economics Department at Khon Kaen University, Northeast Regional office. The rural household survey would focus on: a) the calendar of crop operations, (b) existing cropping patterns, (c) resource use patterns, (d) costs and returns, and (e) an inventory of present techniques used for land preparation, stand establishment, weeding, pest control, supplemental irrigation, harvesting, threshing and household storage/processing. Interviews would be conducted during a single visit and would be structured to last no more than one hour using precoded questionnaires administered by trained enumertors. Interviews with support firms would be largely anecdotal using a free form questionnaire designed to capture minimal quantitative data and generate mazimum information on impressions, trends, problems and perceived equipment requirements. sample size for the household survey would be confined to 250 - 300 observations located in four districts of the region.

4. Timing

Implementation of the survey should coincide with completion of the main season harvest to ensure that data relating to yields, cropped and cultivated area and resource use patterns are available. It is estimated that it will take three months to develop the sample, recruit and train a field staff (6 persons) and prepare for field interviews. About 2-1/2 months would be spent in the field conducting interviews. While some data processing can be conducted in conjunction with the field survey, it is projected that an additional three months will be required to tabulate and analyze the data and prepare a final report. a micro-computer will be employed for data entry, validation, analysis and report preparation. the entire project will require 9 to 10 months to complete.

5. Funding

A rough estimate of resource requirements for the survey and analysis puts the cost at $21,500. This would cover support for the project coordinator who would be located in Khon Kaen, the hiring and training of 6 enmerators, field support and transport during survey activities and the preparation and reproduction of the final report. Five thousand dollars is included in the estimate to cover the cost of a micro-computer system to expedite data processing and analysis.

APPENDIX E

AID 492-1707, EXTENSION OF SMALL SCALE AGRICULTURAL EQUIPMENT,

THAI-IRRI PROPOSAL SEPT. 1, 1983 - AUG. 31, 1984

	US $	Baht ฿ (a)
1. Salaries and wages		
a) Support staff	26,200	602,600
b) Hourly laborers	1,200	27,600
c) Consultants (b)	2,000	46,000
2. Overhead	3,694	84,962
3. Fringe Benefits	8,415	193,545
4. Travel and Transportation		
a) South & Southeast Asia	2,500	57,500
b) Attendance to Scientific Meeting	3,000	69,000
c) Local Travel (project)	5,630	129,490
5. Equipment, Materials and Supplies (c)	22,000	506,000
6. Training	8,000	184,000
	$ 82,639	฿ 1,900.697

(a) Conversion at a rate of ฿ 23 = $1
(b) IRRI trained personnel for Thai Training Course and demonstrations.
(c) Includes purchase of replacement of project vehicle

345

AID 492-1707, EXTENSION OF SMALL SCALE AGRICULTURAL EQUIPMENT

THAI-IRRI PROPOSED BUDGET SEPT. 1, 1984 - SEPT. 31, 1985

		US $	Baht ฿ (a)
1.	a) Salaries and wages	29,350	672,115
	b) Hourly labor	500	11,450
	c) Consultants(b)	2,000	45,800
2.	Overhead (1984 + 10%)	4,063	93,042
3.	Fringe Benefits (1984 + 10%)	9,256	211,962
4.	Travel and Transportation		
	a) South and Southeast Asia	2,500	57,250
	b) Attendance to Scientific Meeting	3,300	75,570
	c) Local Travel (project)	10,000	229,000
5.	Equipment, Materials and Supplies	15,000	343,500
6.	Training	15,000	343,500
		$ 90,969	฿2,083,190

a) Conversion Rate of ฿ 22.9 = 1$

b) IRRI Trained personnel to assist with Thai Training Courses

34k

Figure 9. Map of Northeast Region showing the relative location of the five provinces sampled for the Mechanization Economic study.

Report No IEP/2

Official Use Only

Interim Consolidated Report

OCT. 1983 To SEPT. 1984

CIAE - IRRI

Industrial Extension Project

LAWLEY ROAD, COIMBATORE-641003

348

Report No. IEP/2

Official Use Only

INTERIM CONSOLIDATED REPORT

OCT. 1983 TO SEPT. 1984

CIAE-IRRI

INDUSTRIAL EXTENSION PROJECT

LAWLEY ROAD, COIMBATORE-641003

349

It may be argued that some manufacturers have started manufacturing these machines in the country and Industrial Extension Project may procure these items from them. But it may kindly be noted that these machines are in the stage of initial fabrication in India and cannot be used for demonstration purposes because a small breakdown can cause adverse effect during a demonstration in a new area.

V.S.S.
17/11/84

350

TABLE OF CONTENTS

15

ABBREVIATIONS

Amp	Ampere
C.I.A.E.	Central Institute of Agricultural Engineering
cm	centimeter
cc	centre to centre
cc	cubic centimeter
g	gram
ha	hectare
hr	hour
hp	horse power
I.C.A.R.	Indian Council of Agricultural Research
I.E.P.	Industrial Extension Project
I.R.R.I.	International Rice Research Institute
km	kilometre
kg	kilogram
l	litre
m	metre
m.b.	mould board
mm	millimetre
No.	Number
%	Per cent
R.C.C.	Reinforced Cement Concrete
rpm	Revolution per minute
Rs.	Rupees
sq.	square
T.N.	Tamil Nadu
T	Tonne
T.N.A.U.	Tamil Nadu Agricultural University
VCR	Vertical Conveyer Reaper

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 of Indian Council of Agricultural Research, New Delhi.

4. Duration

   a) Year of start : 1983

   b) Year of completion : 1985

5. Staff position : As on 1st October, 1984:

S. No.	Designation	Scale of pay	No. of posts	Present incumbent	Date of joining the Project
		Rs.		S/Shri/Smt.	
1.	Project Engineer (S-3)(Project Leader	1500-2000	1	F. 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)	260-430	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	-	-
12.	Security Guard	196-232	1	-	-

* 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.

.....2

6. Unaudited approximate expenditure upto 30-9-1984 :

	1983-84 Rs.	1984-85 (upto 30-9-84) Rs.	Total Rs.
I. Establishment Charges			
i) Salary of Establishment (Nett)	3,926.00	13,957.90	17,883.90
ii) Allowances			
a) Medical charges	-	305.45	305.45
b) Travelling allowance	-	295.25	295.25
II. Other Charges			
1) Assets acquired	69,973.34	1,75,093.66*	2,45,067.00
2) Expenditure on Stationery	510.37	367.30	877.67
3) Expenditure on postage	296.50	295.00	591.50
4) Other office expenditure	307.20	379.20	686.40
5) Expenditure on casual labour	1,100.00	1,254.00	2,354.00
6) Other contingencies	1,315.57	7,352.48	8,668.05
7) Expenditure on non-consumable stores	240.00	2,503.30	2,743.30
		Total	2,79,472.52

Note: *An amount of Rs.1.40 lakhs has been sanctioned by Indian Council of Agricultural Research, as informed in letter No.8-42/83-84/P&S/15095 dated 9-3-1984 of the Director, addressed to ICAR and copy to this Project and in his letter No.8-42/83-84/P&S/240 dated 6-4-1984, the Assistant Administrative Officer has stated that the Demand Draft is ready for placing indent. The exact amount of expenditure incurred on Matador Van and establishment will be available at the CIAE, Bhopal.

357

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 adopted equipment.

WORK PLAN FOR FIRST YEAR

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 Engineering 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) Designs from IRRI and other locations will be tested under local conditions and modified as needed.

DEVELOPMENT OF INFRASTRUCTURE

The Project became functional on 31-10-1983 when the Project office was started in the buildings provided by Tamil Nadu Agricultural University, Coimbatore. The buildings consis of a 10 m x 14 m plinth area, RCC roofed structure with a celar and a 12.5 m x 20 m plinth area shed with attached rooms for supervisors. The RCC roofed building which has two rooms, a hall and a celar now houses the office of the Project which includes rooms of the Project Engineer and the Consultant. The Accountant and the Stenographer sit in the hall where office records and small instruments are also stored. The shed is used as workshop. The Project vehicle (Jeep) is also kept in the shed. Now three phase electric supply line has been connected to the shed and a small workshop has started functioning.

Thus the Project now has a reasonably decent office and modest workshop facility. It has procured some equipment and others are at various stages of procurement as given below:

A. Already Procured:

1.	Gedee Weiler Model LZ-300 all geared lathe with necessary accessories	- 1 No.
2.	Bharat Make ARC Welding set (300 Amp) with accessories	- 1 No.
3.	Drilling Machine (Shimato)	- 1 No.
4.	Bench Grinder	- 1 No.
5.	Hand operated shearing machine	- 1 No.
6.	Bench vice	- 1 No.
7.	Tables	- 4 Nos.
8.	Chairs (steel)	- 15 Nos.
9.	Revolving Chairs	- 2 Nos.
10.	Steel cupboards	- 4 Nos.
11.	Steel side racks	- 2 Nos.

359

12. Typewriter - 1 No.
13. Duplicator - 1 No.
14. Reaper (1.0 m on PT-5) without engine - 1 No.
15. Lombardini Engine (523) - 1 No.
16. Keltron Calculator - 1 No.
17. Set of hand tools - 1 set
18. Drawing board and accessories - 1 set
19. Mitutoyo Micrometer 0 to 25 mm - 1 No.
    25 to 50 mm - 1 No.
20. Techometer - 2 Nos.
21. Various screw gauges - 1 set
22. Steel tapes of various sizes - 3 Nos.

All machines procured so far have been installed and are being used.

B. Orders Placed:

1. Rockwell Hardness Testing Machine - 1 No.
2. Moisture Meter - 1 No.

C. Quotations Received (to be finalised at CIAE)

1. Drafting Machine - 1 No.
2. Ammonia Printing Machine - 1 No.

D. Quotations Invited:

1. Workshop Tools and Raw Materials

E. Purchase Sanction Awaited from ICAR:

1. Jeep

Since none of the two vehicles proposed for the Project has been procured yet, the Director, Central Institute of Agricultural Engineering was requested to transfer one jeep from Bhopal to Industrial Extension Project, Coimbatore. He has kindly agreed and transferred one jeep (Petrol) which was received on 13-6-1984.

358

CONTACT WITH MANUFACTURERS

Introductory letters were first sent to 19 agricultural machinery manufacturers of Coimbatore. The manufacturers were then contacted personally. Addresses of these manufacturers are given at Appendix I.

The possibility of developing equipment was discussed with the manufacturers. The manufacturers were confident that they could manufacture any machine if the marketing was assured. They think that the purchase by Government agencies cannot sustain production in small scale industries as the delay in payment results in financial loss which is beyond the capacity of small manufacturers. Banks give loan upto Rs.30,000/- easily but it is difficult to convince banks for higher loans. Interest rate for private loans is very high. Private loans can be utilised only if quick payments are assured for machines produced and sold.

Some of the manufacturers do not have regular production staff at all. To avoid labour problems, they give orders for fabrication and assembly, to different groups whenever they receive orders for a product. They were informed that the Industrial Extension Project will help them in creating demand through large scale demonstrations.

359

BENCH MARK SURVEY OF INDUSTRY

A questionnaire (Appendix II) was prepared and 17 manufacturers were contacted personally. Out of the 19 addresses given at Appendix I, two manufacturers have either shifted or stopped manufacturing.

The manufacturers can be classified as given below:

Type	No.
Those manufacturing mainly tractor operated conventional implements	4
Those taking up miscellaneous jobs including job orders for fabricating farm machines to given specification	12
Those manufacturing one or more types of farm machines as a regular production	1

It was observed that all the manufacturers have the equipment and expertise required in manufacture of agricultural equipment. All of them feel that they have no technical problem in manufacture of agricultural machines. They are acquainted with machines like reapers, threshers and rotavators. One knowledgeable manufacturer felt that getting special materials of correct specification is difficult. In future, Industrial Extension Project can think of providing material and component testing facility to eliminate this problem.

Most of the manufacturers have spare capacity and take up miscellaneous job works for turning, welding and fabrication.

Total number of farm machines produced by the above manufacturers in 1983 are given below:

Power source	Implement or Machine	Production in 1983
Tractor	m.b./disc ploughs	70
	cultivators	154
	Disc harrows	21
	Cage wheels	374
	Levellers	32
	Ridgers	9
	Bund former	1
	Front end dozens	15
	Potato diggers	1
	Trailer	51
	Post hole digger	2
	Rotavator	1
	Seed drill	1
Engine or electrical motor	Thresher	164
	Dal Mill	6
	Drier	1
	Paddy winower	4
	Cotton dilinter	3
	Power sprayer (Knapsack type)	350
	Groundnut grader	3
	Groundnut stripper	8
Manually operated	Sprayer/Duster	165
	Groundnut decorticator	190
	Dryland weeder	55
	Fertilizer applicator	5
	Rotary weeder	30
Animal drawn	Seed drill	134
	Helical blade puddler	6
	Chisel plough	3
	Tool carrier	21

The status of farm machinery manufacturing industry in Coimbatore can be shown by following figures, estimated on the basis of the bench mark survey:

1.	Total investment in installed machinery and 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/-

CONTACT WITH FARMERS

For trial and demonstration of machines, the Project requires contact with farmers of rice producing areas near Coimbatore. Beyond a circle of about 200 km radius around Coimbatore, one finds lot of vast rice growing areas. But within this circle of about 200 km radius around Coimbatore, paddy is grown in some patches where irrigation facility is available. Three such patches around Coimbatore are:

1. Thondamuthur - 25 km
2. Kotur Malayandipattinam -- 70 km
3. Gobichettipalayam - 80 km

Thondamuthur has about 1,000 acre area under paddy in a long stretch extending upto Siruwani. Irrigation is done by deep wells. Yields are average. There is no mechanisation and farmers feel that labour is available for most of the jobs. There is only one tractor in the area, it was informed.

Kottur Malayandipattinam has about 2,000 acre area under paddy in a patch near Aliyar dam. Paddy-paddy rotation is being followed there traditionally. Yields of 6 T/ha are common. Plenty of irrigation water is available from Aliyar dam. Labour is getting costlier day by day because the labourers are well organised The area is partially mechanised in the sense that complete puddling operation is done by tractors. Bullock drawn ploughs have become things of the past. Power tillers are not used in this area. Some rasp bar type threshers are being used but threshing by beating on stone remains the method followed by most of the labourers. Farmers do not work with their own hands. The labourers are a distinct class who come from areas as far as 15 km away for harvesting operations in this area.

Gobichettipalayam has several thousand acres of paddy area irrigated by canals and has good drainage system also. In this area, more than two hundred power tillers are being used. Mitsubishi power tiller is popular. Shortage of labour is felt at the time of transplanting. Good yields (upto 6 T/ha) of paddy are obtained. Harvesting is a contract job involving reaping, threshing, cleaning and transport. Farmers pay in kind equivalent to about Rs.1,000/- to Rs.1,200/- per hectare for the harvesting operation. This area has the potential to become the neucleus for spreading the use of small farm machinery in paddy growing areas of the southern part of the country.

Three contact farmers in each of the above three regions acquainted with the activity of this Project, are given below:

1. Mr. Aruchamy,
   Poluvampatti,
   Thondamuthur,
   Coimbatore (T.N.)
2. Mr. Ramakrishna,
   Kottur Malayandipattinam,
   Pollachi,
   Coimbatore (T.N.)
3. Mr. K.S. Thangavelu/Mr. K.T. Sivakumar,
   Shree Basuveswara Farms,
   Kondayampalayam,
   Kallippatty,
   Gobichettipalayam,
   Periyar (T.N.)

EQUIPMENT NEED AND AVAILABILITY

To assess the availability of designs of machine developed by research institutions and Universities, a questionnaire (Appendix III) was sent to relevant institutions listed at Appendix IV. Following machines have been offered:

1. Tractor front mounted VCR
2. Bullock drawn disc harrow-cum-puddler (float harrow)
3. 5 row manually operated paddy transplanter
4. Pulverising roller-cum-puddling attachment to cultivator

The tractor front mounted vertical conveyer reaper has been included in the project activity. But this will be taken up after some experience with 1.0 m vertical conveyer reaper.

The bullock drawn disc harrow-cum-puddler (float harrow) shall be developed and tried with power tiller (PT-5) and with bullocks.

Instead of 5-row manually operated paddy transplanter, the Project is working on 6-row improved model.

Pulverising roller-cum-puddling attachment to cultivator is a tractor mounted equipment. Presently it will be difficult to take up this activity. This may be taken up in the third year of the Project. By that time, Project have its own tractor also.

364

PRIORITY NEEDS

It was observed from survey of industry that the industry is capable of manufacturing machines provided that there is demand from farmers. It was felt that the real demand could be created by large scale demonstrations. At present most of the small farm machines made by the industry have been sold through Government or semi-Government agencies. This could not generate continuous demand and due to one reason or the other, the manufacturers stopped manufacturing after supplying one or two orders. The production can be sustained when farmers like to buy a machine and for this, large scale demonstration and later on custom hiring can be a method of creating demand for useful farm machines.

A proposal was made for obtaining 5 threshers (TH 8) and 5 reapers (1.0 m VCR on PT-5) from International Rice Research Institute as given at Appendix V. The reasons for selecting reaper and thresher as the first set of machines to be demonstrated are given below:

1. There is shortage of labour at harvesting time and there is a natural instinct in the farmer to harvest, thresh and store his crop at the earliest to avoid loss due to natural hazards, fires and thefts. A matured crop in field is something like currency notes spread in the open.

2. In the northern areas of country, thresher has been accepted and may be accepted in southern areas also.

3. In this region, harvesting and threshing is a combined contract job and a farmer can avoid waiting for availability of labour only if he is provided with machines for both harvesting and threshing and so it is necessary to demonstrate both reaper and thresher.

4. Both 1.0 m VCR on PT-5 and TH-8 thresher have been observed in operation and it is felt that they are some of the few well designed and manufactured machines available for small farmers. The problem of small length of straw from TH-8 and higher height of cut of 1.0 m Vertical Conveyer Reaper on PT-5 as argued by some reports can be taken care of by minor adjustments and modifications by Industrial Extension Project, Coimbatore.

5. It has been observed that in Philippines also, these two machines are being used by the rice farmers.

6. At some places in India also, fabrication of these machines has been started. But such initially fabricated models are not useful for demonstration as they are likely to breakdown more often in field and cannot give desired impact on target population during demonstrations. So, it is necessary to import these machines from International Rice Research Institute.

7. Some manufacturers have shown interest and asked for drawings of these machines and as the demand picks up through demonstrations, they may be able to market their product with profits enough to provide incentive for continuous production.

The above proposals were considered at the first Project Advisory Committee meeting held at Madras on 6-3-1984. It was concluded that it may not be possible to import the machines from Philippines at an early date due to Government restrictions on import of such machines. It was suggested that the machines may be procured from local fabricators and used for testing and demonstration. It was decided that the Project should work on following machines:

1. Vertical Conveyer Reaper on PT-5 Power Tiller/ Other power tillers/Tractors.
2. Thresher
3. Manual Rice Transplanter
4. Puddling Equipment

However, it was felt that if needed, the priority needs may be redefined after working in villages in paddy growing areas.

VERTICAL CONVEYER REAPER

During the contact with manufacturers in January-February, 1984, while conducting Bench Mark Survey of Agricultural Machinery Manufacturing Industry of Coimbatore, it was found that none of the IRRI designed machines were being manufactured by the industry in this region. But some of the manufacturers showed interest when the working of IRRI 1.0 m reaper, TH-8 thresher and rice transplanter were explained to them and photographs on operators' manual were shown. Since one thresher (with rasp bar type cylinder and straw walkers for separation) was being manufactured in the region, the manufacturers were reluctant to try the manufacturing of TH-8 thresher but they were interested in the development of reaper. A unit of 1.0 m reaper received from International Rice Research Institute by Tamil Nadu Agricultural University was used by the manufacturers for fabricating the first prototypes. The manufacturers who were interested in the development of 1.0 m Vertical Conveyer Reaper are given below:

1. Ms. Elseetee Industries,
   P.O. Box No.1808,
   Singanallur,
   Coimbatore - 641 005.

2. Ms. Swathi Industries,
   262, Maruthamalai Road,
   P.N. Pudur,
   Coimbatore - 641 041.

3. Ms. Valampuri Industries,
   1-B, Thiyagi Kumaran Street,
   P.N. Pudur,
   Coimbatore - 641 041.

To accelerate the pace of this activity, the Industrial Extension Project sponsored one engineer of Ms. Elseetee Industries, for training at International Rice Research Institute. The engineer, Mr. Aravindan has started working seriously on development of the reaper and during the visit of the Project Engineer and the consultant to the Industry in September, 1984, they were shown components of the reaper being made by them. They have already developed two reapers. They have been advised to use a diesel engine instead of the petrol engine that they are using. They may be able to fabricate 10 pieces by March, 1985.

They were purchasing knife sections from a local manufacturer at 10 times the expected price. They were introduced with the following two leading knife section manufacturers located in the northern part of the country.

1. Ms. Union Forgings,
   Focal Point, Sherpur,
   Ludhiana - 141 010.
2. Ms. Union Tractor Workshop,
   8-B, Phase II,
   Mayapuri Industrial Area,
   New Delhi - 110 064.

Ms. Valampuri Industries, Coimbatore are also developing the reaper and they have shown some components fabricated by them. They may be able to complete a unit in next two or three months.

Ms. Swathi Industries, Coimbatore were given the drawings of IRRI 1.0 m reaper and a reaper was purchased from them without engine. It was decided to mount a 6.0 hp diesel engine on the PT-5 power tiller (which is used for mounting the reaper) due to following reasons:

1. A 6 hp diesel engine provides a versatile power source which can be used for pumping, threshing and land preparation (on PT-5 power tiller).

2. The diesel engine has less starting trouble, low running cost, less fire hazards and the farmers are well acquainted with diesel engines which they use for pumpsets.

Considering the weight, power and speed requirements, a Greaves Lombardini 6 hp diesel engine Model 523 was mounted on the PT-5 power tiller, which was used to drive the reaper. Minor changes were made in the engine mounting arrangement and the clutch linkage to facilitate mounting of this engine on the PT-5 power tiller. With these changes, the reaper had following relevant specifications:

Make & Model of Engine	:	Greaves Lombardini 523
Fuel used	:	Diesel
Rated Speed	:	1800 rpm (output through cam shaft)
Horsepower of engine	:	6.0 hp at 1800 rpm
Weight of engine (dry)	:	38 kg
Forward Speed Control for Reaper	:	Accelerator lever provided at the handle
Speeds at full accelerator (No load)		
Engine Pulley	:	1590 rpm
Transmission shaft driven by engine	:	380 rpm

370

Vertical shaft of Reaper (knife crank)	:	310 rpm		
Pulley of the flat belt conveyer	:	156 rpm		
Ground wheel	:	31		
Theoratical forward speed	:	2.92 km/hr		
Actual length of cutting stroke of knife	:	68 mm		
Average knife speed	:	2.53 km/hr		
Effective cutting width	:	880 mm		
Spacing between tip of guards	:	73 to 82 mm		
Spacing of lugs on vertical conveyer belt	:	135 mm		
		From right to left*		
		1	2	3
Tip dia of star wheels (mm)	:	276	288	286
		From right to left*		
		1	2	3
Minimum spacing between star wheel tip and nearest star wheel cover during feeding(mm)	:	-5	-9	+35
		From right to left*		
		1	2	3
Minimum spacing between top conveyer belt and star wheel tip (mm)	:	52	47	49
Minimum Height of divider tips above ground level	:	2 to 3 cm		

Trial and Demonstration

By the time the reaper was ready, it was last week of September, 1984. The crops had been harvested at Thondamuthur as well as at Gobichettipalayam. Some area was available for harvesting at Kottur Malayandipattinam (70 km) and so the

---

* As viewed from operator's position

771

reaper was shifted for trial in that area. During these trials, the manufacturers' representatives were also present. Trials were conducted on two days. The details of crop and field condition are given below:

Date of Trial	28-9-1984	29-9-1984
Field Condition		
Type of soil	Black cotton soil	Black cotton soil
Plot size	2 plots of 31 m x 35 m each	1 plot of 35 m x 40 m
Water	Saturated soil with water standing at some patches	Saturated soil with water standing at some patches
Crop condition		
Variety	Vaigai	Vaigai
Height of plants (cm)	80 to 90	80 to 110
Tillers per sq. m.	356, 410	360, 433
General	-	Rain soaked mature crop with lot of dead but wet leaves at the lower portion of stems.

The reaper was working perfectly when it was not stopped due to chocking. But test readings could not be taken because the reaper chocked frequently and could harvest only about one acre area in two days. Sometimes few plants were left uncut also.

On the first day, the operators were getting tired due to the tendency of the handle to go downwards. This problem was eliminated by shifting the engine forward and by mounting a weight of 15 kg on reaper hitch frame.

372

The chocking of the reaper was due to following factors:

1. Improper contact between star wheels and the lugs of cross conveyer belt.
2. Improper clearance between left hand divider and the star wheel near it (the chocking started from this place)
3. Wrapping of straw and mud on the lower cross conveyer flat belt pulleys resulting in belt slip and choking of reaper.
4. Divider tips moving close to ground thus picking dead and wet straw leaves which were being released in bundles which resulted in chocking of cross conveyer and lower flat belt pulleys.
5. Entry of straw between star wheels and their covers because the covers were not having bent edges as per design.

The plants were left uncut sometimes due to following reasons:

i) The length of knife stroke was 68 mm which is less than the centre to centre distance of guards.

ii) The divider pipes were not centred properly near the guard tips.

iii) Average knife speed was less.

iv) Ledger plates were projecting out of guards in front portion.

Modifications

Following modifications were done after the trials:

1. Engine was moved ahead so that the distance (cc) between the engine pulley and the transmission input pulley was 47 cm.
2. The divider pipes were bent upward so that height of divider tips was 4 to 6 cm with cutterbar supporting frame resting on horizontal surface.
3. The 7.8 cm diameter pulley driving the quarter turn V-belt was replaced by 8.9 cm diameter pulley for increasing the cross conveyer and knife speed in relation to forward speed.
4. The star wheel positions were modified to give minimum clearance of 27 to 30 mm between the tip of star wheel and the upper flat belt of the cross conveyer.

With these modifications, the relevant specifications changed as given below:

Speeds at full accelerator (No load)

Engine pulley	:	1590 rpm
Transmission shaft driven by engine	:	380 rpm
Vertical shaft of reaper (knife crank)	:	380 rpm
Pulley of the flat belt conveyer	:	190 rpm
Ground wheel	:	31 rpm

114

Theoratical forward speed	:	2.92 km/hr
Average knife speed	:	3.18 km/hr
Actual forward speed	:	2.3 km/hr
Minimum spacing between star wheel tip and top flat belt (mm)	:	From right to left* 1 2 3 28 30 27
Minimum spacing between star wheel tip and divider covers near feeding positions (mm)	:	From right to left* 1 2 3 -9 -3 +25
Minimum height of dividers above ground	:	4 to 6 cm

The spacing between star wheel tip and the third divider (left) is still high and is to be reduced. Further modifications are being done and the reaper will be tried with these modifications during next harvesting season. The reaper fitted with Greaves Lombardini diesel engine model 523 and complete with above modifications is shown in Fig. 1.

---

* As viewed from operator's position.

375

PADDY THRESHER

In the Coimbatore region, only one type of thresher is available. This thresher has rasp-bar type threshing cylinder and straw walker type separating system. This thresher is being manufactured for the last 15 to 20 years by Ms. Elseetee Industries and now others are also selling similar threshers. Some farmers use it for both paddy and maize crops but this thresher is more popular for maize shelling. Peak production of this thresher from Ms. Elseetee Industries is about 300 threshers per year. This production is very low considering the requirement of threshers in this region.

Small manufacturers who are offered designs of other threshers fear that they may not be able to compete in the market. Due to this reason, the design for thresher (TH-8) has not been accepted yet. Two manufacturers have shown interest but considering that the TH-8 thresher is a costly machine, they have been advised to first search suitable buyers for the machine before fabricating one. One of the manufacturers may be able to take up production of TH-8 thresher next year. However, this activity will get major boost after the Project receives the TH-8 thresher which is being imported from International Rice Research Institute. This thresher will be used for demonstrations as a combination with 1.0 m Vertical Conveyer Reaper.

376

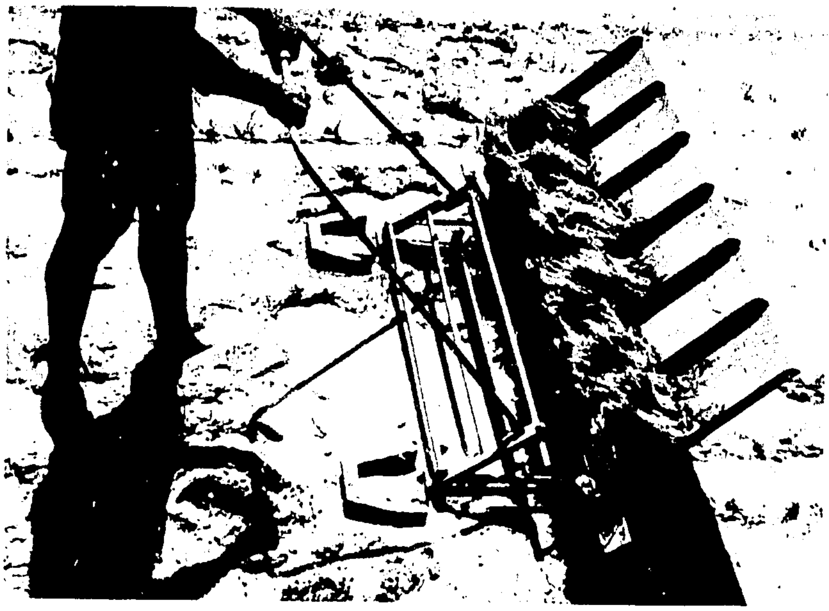


Fig 1. The diesel engine operated self propelled reaper manufactured by a local manufacturer with the guidance of IEP.

Threshing Trial

A TH-8 thresher was supplied by International Rice Research Institute to the Tamil Nadu Agricultural University. The thresher had following brief specifications.

Name of the manufacturer of the thresher	: Poying Welding Shop
Make and Model and Type of the engine	: Briggs and Stratton i/c Series, 4 stroke petrol engine of 392 cc
Power	: 10 hp at 3600 rpm
Type of thresher	: Axial flow of IRRI design
Type of threshing cylinder	: Spike tooth (round)
Size of the threshing cylinder	: 51.5 cm dia 111 cm length
Type of concave	: 0.6 cm dia steel rods with 16 mm spacing
Speeds (No load)	
Cylinder	: 600 rpm
Fan	: 800 rpm
Cross auger	: 340 rpm
Length of screen stroke	: 3.2 cm
Adjustments	: Air shutters on blowers, angle of chaffer wind board and engine speed
Labour used during trial	: Three

This thresher was tried once for threshing paddy, in collaboration with the Zonal Research Centre. During the trial, the engine no load speed was set to give 600 rpm at the threshing cylinder. The thresher was run continuously and one minute

378

readings were taken after uniform feeding was obtained. The feed rate was increased and readings were taken at 6 feed rates. Cylinder chocking was the limiting factor for increasing the feed rate beyond the last reading. The crop conditions and trial results are given below:

Crop condition:

Variety	:	Co 43
Length of straw (harvested condition) (cm)	:	48 to 67
Grain/Straw ratio	:	0.497
Grain Moisture Content	:	23 to 25%
Test Data and its Analysis	:	

Trial No.	Wt. of clean grain output (kg)	Wt. of clean grain in Chaff (g)	Wt. of grain in straw (g)	Output (kg/hr) Grain	Straw	Total	Per cent Loss*
1	6.70	8	NIL	402	809	1211	0.12
2	8.55	32	NIL	513	1032	1545	0.37
3	8.27	38	NIL	496	998	1494	0.46
4	9.53	25	NIL	572	1151	1723	0.26
5	9.52	NR	NIL	571	1149	1720	NR
6	9.65	17	NIL	579	1165	1744	0.18

* Does not include loss due to grain breakage (which is negligible) and impurities in grain.

Fuel consumption : 2.07 l/hr

Considering the losses of 0.12% to 0.46% at through puts of 1211 to 1744 kg/hr and fuel consumption of 2.07 l/hr, the performance of the thresher is satisfactory.

379

Further trial-cum-demonstrations will be arranged in next year when the Project receives a threshor from IRRI or from local manufacturers.

RICE TRANSPLANTER - 6 ROW

For sometime, IRRI designed 5-row rice transplanters were being tested at various locations in India. But it could not reach the farmers due to two reasons mainly (i) the manual operation was difficult and (ii) the transplanter required special nursery. International Rice Research Institute has now developed a 6-row rice transplanter which covers 20% more area per unit time and weighs 20% less than the 5-row model. But this also requires special nursery. However, if rice transplanters are to be used, farmers have to be trained in growing nursery raising techniques with procedures already perfected at other places. Shortcut methods for nursery raising give non-uniform mat thickness resulting in missing hills and muddy operation. It was decided to fabricate a 6-row rice transplanter and test it with nursery raised on dry (unpuddled) soil in frames of suitable sizes.

Manufacturers' Participation and Development

Drawings of the 6-row rice transplanters were released to the two manufacturers given below who showed interest in manufacturing it.

1. Ms. Karthic Industries, Coimbatore.
2. Ms. Valampuri Industries, Coimbatore.

They have got some orders also and they have already fabricated two 6-row rice transplanters with the help of the Industrial Extension Project.

Ms. Marudamalai Andavan Industries, P.N. Pudur, Coimbatore, who were also interested in manufacturing this transplanter have fabricated some major parts with the guidance of the Project. One unit of 6-row rice transplanter has been fabricated by this Project for test and is shown in Fig. 2. The transplanter will be used for demonstration in the next transplanting season.

Nursery Raising in Steel Frames

Efforts were made to raise nursery for the transplanter using steel frames developed at Industrial Extension Project. Each frame costs Rs.30/- when purchased from a local fabricator. Fifty frames are required for nursery preparation for one hectare. A farmer having about two hectare paddy area shall have to purchase 50 frames, considering that one month time is available for completing transplanting. Thus the total cost of frames will be Rs.1,500/-. Dry nursery can be raised on dry firm ground in field with a thin polythene sheet kept below the frame or on concrete floors without polythene sheet. The transplanter will be demonstrated with this type of nursery during next transplanting season.

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 initiated in the first year will be continued.

(b) The contact with manufacturers will be expanded 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.

With the present condition of the Project when all the scientific and technical posts are vacant, above targets seem to be beyond reach in general. Specially, the training programme at (c) above may not even start unless the scientific and technical posts are filled up.

V.S.S.
16/11/84

383

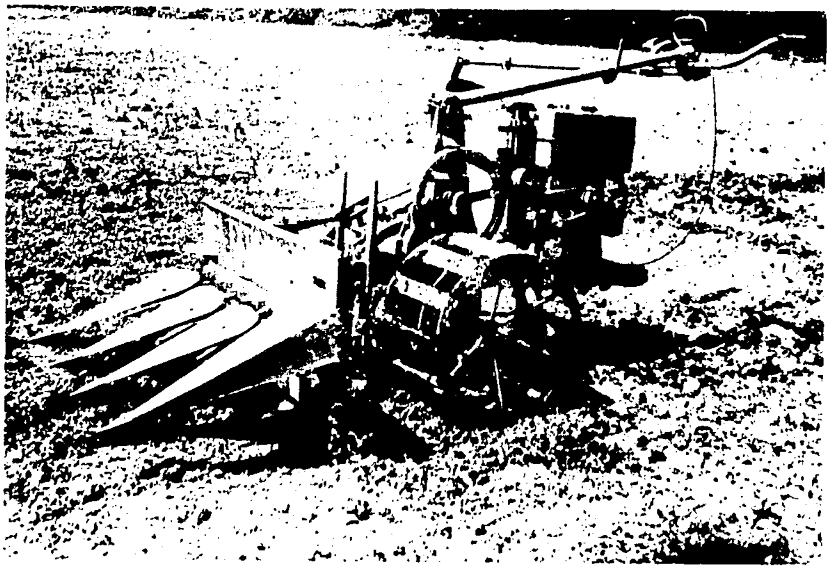


Fig 2. The 6-row rice transplanter fabricated by IEP with components made by local manufacturers.

APPENDIX-I

LIST OF ADDRESSES
OF
MANUFACTURERS OF AGRICULTURAL MACHINERY IN COIMBATORE REGION

1. Ms. Arasu Engg. Works,
   35/467, Selvapuram,
   Siruwani Main Road,
   Coimbatore.

2. Ms. Saraswathi Industries,
   9, Trichy Road,
   Singanallur,
   Coimbatore - 641 005.

3. Ms. Elsoetee Industries,
   P.O. Box No.1808,
   Singanallur,
   Coimbatore - 641 005.

4. Shri Krishna Engg.Tdg.Co.,
   13/35, Velandipalayam Road,
   Coimbatore - 641 011.

5. Ms. Ganga Engg. Products,
   4/460, Puliakulam Road,
   P.N. Palayam,
   Coimbatore - 641 027.

6. Ms. Ram Kumar Industries,
   G.N. Mills P.O.,
   Coimbatore - 641 029.

7. Ms. V.C.S.Industries P.Ltd.,
   G.N. Mills Road,
   Tudialur,
   Coimbatore - 641 029.

8. Ms. Hema Engg.Industries,
   26, Ramakrishna Nagar,
   Mettupalayam Road,
   Kavundampalayam,
   Coimbatore - 641 030.

9. Ms. Dineshkumar Engg.Works,
   41, Tudiyalur Main Road,
   Idigarai Post,
   Coimbatore - 641 031.

10. Ms. Sundaram Industries,
    Idigarai Main Road,
    Idigarai,
    Coimbatore - 641 031.

11. Ms. Tucas Ltd.,
    Tudiyalur Post,
    Coimbatore - 641 034.

12. Ms. Vasavi Industries,
    195, Thadagam Road,
    Coimbatore - 641 040.

13. Ms. Maruthamalai Andavan Industries,
    Gokulam Colony, P.N.Pudur,
    Coimbatore - 641 041.

14. Ms. Swathi Industries,
    262, Maruthamalai Road,
    P.N. Pudur,
    Coimbatore - 641 041.

15. Ms. Parasakthi Engg.Industries
    Maruthamalai Road,
    P.N. Pudur,
    Coimbatore - 641 041.

16. Ms. Valampuri Industries,
    1-B, Thiagi Kumaran St.,
    P.N. Pudur,
    Coimbatore - 641 041.

17. Ms. Balamurugan Industries,
    Maruthamalai Road, PN Pudur,
    Coimbatore - 641 041.

18. Ms. National Eqpt. Mfrs.,
    36, Rangaswamy Road,
    Coimbatore - 641 002.

19. Ms. V.K. Devarajan Company,
    Sugarcane Breeding Institute
    Post Office,
    Coimbatore - 641 007.

V.S.S.
16/11/84

12. List of machines used in production:

1. ______ 2. ______ 3. ______

4. ______ 5. ______ 6. ______

7. ______ 8. ______ 9. ______

13. Whether job work undertaken or not: Yes/No
(answer by putting (/) mark)

turning, shaping, milling, welding, forging, casting, gear cutting, heat treatment.

14. Problems in manufacturing (if any):

15. Problems in financing and sale (if: any)

16. Suggestions or expectations from Government, research, financing, testing and standardizing institutions (if any)

17. Future plans on Agricultural Machinery Production:

V.S.S.
16/11/84

PROPOSAL FOR REQUESTING OUR COLLABORATORS, MS. INTERNATIONAL RICE RESEARCH INSTITUTE, TO SUPPLY HARVESTER AND THRESHERS

A matured crop standing in the field is something like currency notes spread in the open. It is natural that the farmers like to harvest and store the crop at the earliest to avoid the problems like rain, hailstorm, cyclone, lodging, shattering, thefts and fires. Due to these factors, during harvesting time, the labour demand/rates are at their highest and hence the introduction of machines for harvesting and threshing is likely to be accepted by farmers. It has happened in the northern wheat growing areas of the country and if suitable machines are introduced, it may happen in the Southern paddy growing areas also. With this hypothesis, the CIAE-IRRI Industrial Extension Project has proposed to work on demonstration, training and custom hiring of suitable paddy harvesting and threshing machines, to create a demand which will attract the manufacturers.

Since our collaborators, Ms. International Rice Research Institute have developed both the Harvester and Thresher suitable for paddy crop, we may request them to supply the following:

S.No.	Item	Specification	Quantity
1.	Self Propelled Vertical Conveyer Reaper	1.0 meter	5 Nos.
2.	Cutter bar with knives, guards and ledger plates for above	-	For 20 cutter bars
3.	Spare parts for the petrol engine of the reaper	For five years operation of 5 reapers	
4.	Axial Flow Thresher	TH-8	5 Nos.
5.	Spare parts for the engine of the thresher	For five years operation of 5 threshers	

APPENDIX-II

CIAE-IRRI
INDUSTRIAL EXTENSION PROJECT
LAWLEY ROAD, COIMBATORE-641003

1. Name of the Firm visited ______________________

2. Address of the Firm visited ______________________

3. Name of visiting IEP official ______________________

4. Date of visit ______________________

5. No.of employees engaged

	Maximum	Minimum
Production	________	________
Non-Production	________	________

6. Peak production season (if any, give months) ______________________

7. Minimum production season (if any, give months) ______________________

8. Year of starting agricultural Machinery production ______________________

9. First commercial product ______________________

10. Name of financing institution ______________________

11. List of products presently on commercial production:

S.No.	Product	Year of starting production	Units produced In 1983	Units produced Total	Unit price 1983

/p.t.o./

CIAE-IRRI
INDUSTRIAL EXTENSION PROJECT
LAWLEY ROAD, COIMBATORE-641003

Name of the implement/machine :

Brief specifications and capacity — Approximate cost of fabricating one unit in January, 1984

Name of developing agency/organisation — Project No. if any

Applied for patent? Yes/No — Patented? Yes/No — Patent No. if any

Year of testing first prototype :

No. of prototypes made upto December, 1983 :

Years (hours) of operation completed by one prototype :

Name and address of manufacturer (if any)	Selling price with taxes	Production Monthly	Production Upto Dec., 1983

Can you supply production drawings?

Can you supply one prototype?

Names of two engineers who shall be contacted in future by IEP

1. 2.

Signature and designation of the sponsoring authority:

LIST OF UNIVERSITIES AND INSTITUTIONS

1. The Dean,
College of Agrl.Engineering,
Punjab Agricultural University
Ludhiana, PUNJAB.

2. The Head,
Deptt. of Farm Power & Machinery,
Punjab Agrl. University,
Ludhiana, PUNJAB.

3. The Head,
Deptt. of Agrl. Engineering,
Indian Institute of Technology,
Kharagpur - 721 302 (W.B.)

4. The Director,
Central Rice Research Institute,
Cuttack - 753 006.

5. The Dean,
College of Agrl.Engineering,
Tamil Nadu Agrl.University,
Coimbatore - 641 003.

6. The Head,
Deptt. of Farm Machinery & Power,
Tamil Nadu Agrl.University,
Coimbatore - 641 003.

7. The Dean,
College of Agrl.Engineering,
Jawaharlal Nehru Krishi Vishwa Vidyalaya,
Jabalpur - 482 004 (M.P.)

8. The Head,
Deptt. of Farm Machinery & Power,
College of Agrl.Engineering,
Jawaharlal Nehru Krishi Vishwa Vidyalaya,
Jabalpur - 482 004 (M.P.)

9. The Head,
Divn. of Agrl. Engineering,
Indian Agrl.Res. Institute,
New Delhi - 110 012.

10. The Project Coordinator,
FIM & Prototype Development
Central Instt.of Agrl. Engineering,
GTB Complex, T.T. Nagar,
Bhopal - 462 003.

11. The Dean,
College of Technology,
Orissa Univ.of Agrl. and Technology, Bhubaneshwar,
ORISSA.

12. The Head,
Deptt. of Farm Machinery & Power,
College of Technology,
G.B.Pant Univ.of Agri. & Technology, Pantnagar(UP)

13. The Dean,
College of Technology,
G.B.Pant Univ. of Agri. & Technology, Pantnagar (UP)

14. The Head,
Deptt.of Farm Machinery & Power,
Orissa Univ.of Agrl.&Tech.,
Bhubaneshwar, ORISSA.

15. The Head,
Deptt.of Agrl.Engineering,
Andhra Pradesh Agrl.University
Rajendranagar, HYDERABAD.

16. The Head,
Deptt.of Agrl. Engineering,
Kerala Agrl. University,
Vellanikkara,Trichur,KERALA

17. The Head,
Deptt.of Agrl. Engineering,
Allahabad Agrl.Institute,
Naini, ALLAHABAD.

18. The Head,
Divn. of Agrl. Engineering,
Central Rice Res.Institute
Cuttack - 753 006.

V.S.S.
17/11/84

AGRICULTURAL ENGINEERING REPORT FOR 1984
OF THE IRRI BURMA COOPERATIVE RESEARCH PROJECT
YEZIN, BURMA

The Small Scale Farm Mechanization (SSFM) had very little benefit from the first phase. The decision to adjust to appropriate technology for the present day, and work through the Agricultural Research Institute ARI, instead of the Agricultural Mechanization Department (AMD), deprived the project of the engineering expertise and equipment gained under the first phase. However, working upwards from "grass roots" through the agronomist gives a better understanding of what is appropriate and what is best in an agronomic sense, but there is eventually a problem in putting the agronomists ideas into effect and testing them, modifying them, and putting them into production. This can only be done by engineers. Then comes the most important task of getting the improved implements into the farmers hands.

Up until September 1984 SSFM has had to use the local expertise in building prototypes. The CAAMS-IRRI reaper was redesigned in Rangoon to carry the heavy water cooled diesel engine instead of the lightweight air cooled petrol engine. This is still undergoing tests. The fertilizer applicator from IRRI was also redesigned to reduce rates of application. In the Yezin Pyinmana area the village foundry blacksmith and carpenter have been our means of R and D and production. This has been a most efficient method of getting ideas to the farmer.

A.M.D. during the second year, were brought in to assist the SSFM. This gave some advantage of the training given to U Mya Thein (M.S.) and equipment purchased under the first phase. But lack of material and staff is still a handicap. A.M.D. also have their own objectives from within AMD within which to fit in assistance to SSFM.

The SSFM, in spite of its handicaps, has, and is still, developing that kind of equipment available and affordable by the small farmer. This is equipment fabricated mainly of wood, and is animal drawn.

Although some attention has been paid to fuel powered pumps, threshers, and a reaper, the main thrust of SSFM has been to the animal powered and hand operated equipment. The change in emphasis during Phase II to appropriate technology is correct but has caused some problems. The foundations for an Agricultural Engineering Division within ARI are here, and three years is little enough time to make such a transition. There is therefore an essential third phase requirement.

Staff

The lack of trained staff has been a continuing limiting factor. U Arthur Mundt, Assistant General Manager, ARI has been in charge for the whole period. His time is stretched between the administrative (ARI) work, supervision of workshops, and working on developments with his own hands. Daily paid labour has to be trained, and then they move on to better paid jobs, and are lost to us. Students have been allocated to SSFM and receive some instruction and are valuable for equipment test reporting. During these periods of increased manpower more work is started up, but then these people are transferred away to another division so that SSFM activities are slowed down.

U Than Shein, Assistant General Manager, ARI, I/C General Service Workshops and Station maintenance, inspite of his many activities, is a great help to the project, and giving us free access to his machine shop. His Chief Machinist can be taken on by the project as he is a skilled operator, and has time to do SSFM work. U Than Shein will go overseas on an M.S. Engineering Course sponsored by IBCP II and will be replaced by U Nyunt Sein, Assistant Engineer who is already familiar with SSFM work and recently went to India on a SSFM study tour.

With the opening up of the A.M.D. workshops in September, under U Mya Thein and U Htun Aung Phyo, we have had the staff to take on the higher technology. U Mya Thein (graduated from the Philippines) has pursued the transplanter improvement, and both UMT and UHAP have just completed 10" and a 14" high volume low lift pumps.

The presence of the AMD staff and workhop has been a great boost to our work. It is not known how long this workshop will remain at ARI.

It is expected that with the planned formation of an Agricultural Engineering Division this year, with the provision of senior and junior engineering counterpart staff, the SSFM group will make an even greater contribution to the IBCP II project targets.

3919

Equipment

Orders were placed as soon as permission was given by ECC. Equipment has started to arrive which by the end of 1985 will give us a competent workshop. Equipment orders allowed for 1985 will arrive too late for the project.

Since a completely new workshop has to be started up, and there is an emphasis on wood construction and foundry work, the demands under the equipment budget are many. More materials are also urgently required and additional funds are required under this heading. Both IRRI and CIDA have been approached on the possibility of moving funds across from one head to another. Early on, and to a lesser extent now, funds have been spent on expensive local purchases. This was purely because ECC would not sanction purchases during the first year of the project, and there is no carry over from Phase I.

During the first half of 1984 private workshops were again used for the higher technology developments such as the reaper and fertilizer applicator. The wooden implement research and development was taken care of by SSFM workshops but limited by machine tools and lack of trained personnel.

A.M.D. set up workshops at ARI in September bringing lathes, drill press, grindstones, welding (gas and electric), and other equipment, with U Mya Thein and U Htun Aung Phyo, in charge. They are limited in their productivity by manpower and materials.

Purchases of machine parts and tools for an incomplete machine purchased by UNDP in the ARI general workshops, costing $10,000 were kindly purchased for us by USAID. This gave us the ability amongst others to cut key ways. This was the first SSFM purchase of machine shop equipment, but not using the intended Canadian funds. Land for a field experiment station was allocated in June, a well was dug, and a windmill and building were erected.

Training

With the limited capability of ARI in its present strength, in the engineering field, it has not been possible to find candidates for the IRRI Agricultural Engineer Training Course. However AMD had the advantage of this and sent more than the allocated slots. ARI and AMD sent U Arthur Mundt, Assistant General Manager and U Nyunt Sein (ARI) together with U Ba Kyaing, Assistant Workshop Officer, AMD, and U Hla Myint, Dy. Township Head of Dept., AMD (now working with us at Yezin), to a study course at IRRI Engineering Workshops and to see Philippine industrial development. This was in November/December and was followed by a visit to India particularly to see draught animal power, a very informative and comprehensive trip that was led by Mr. M. M. Hammond, Agricultural Engineer.

A library and collection of training materials have been built up, together with projection equipment that will be used to train operators.

Work Programme

The guidelines for SSFM group work were laid down as under:

Item no.	Particulars	YEARS I	II	III	Total
1	Tillage implements	1	1	1	3
2	Animal drawn implements	1	1	1	3
3	Hand farm tools	1	1	1	3
4	Sowing/seeding machine	1	1	1	3
5	Fertilizer applicator	1	1	1	3
6	Field crop thresher	1	1	1	3
7	Water pumps & irrigation equipment	0	1	1	2

The above was qualified by some work running on from the first phase, e.g., mounting of the locally produced water cooled diesel engine on the IRRI reaper/power tiller.

The actual programme for work cannot be judged under the project objectives as laid down by C.I.D.A. If the project had continued under A.M.D. the magnitude of Outputs or Output Indicators would have been as written, i.e., "Some hundreds of threshers, transplanters, reaper, windrower acquired by farmers".

If this phase had been a run on the first phase then it would have been possible through AMD to produce quantities of IRRI machines -- tillers, reapers, threshers, pumps etc., but work now is research and development with the demand for appropriate equipment coming from the farmers and the Agronomist Scientists. There is not such widespread contact with the farmers in the field such as A.M.D. enjoy with their equipment operating service.

ARI does have the capacity through its internal training and central training programmes to introduce new technology and equipment to the farmers. This is, either directly or indirectly, through the Extension Division Township Manager or Village Tract Manager etc., and Party member who attend training courses. In their turn these officials keep farmers uptodate with new developments. The cropping systems sites can also play their role in introducing improved implements and animal usage.

The SSFM working group have met and discussed the parameters of the farms' requirements. The group includes Dr. Palis and counterpart, Asst. General Manager, Extension and others invited representing the locality of the meeting. The following factors modify the direction of the work programme.

1. There are bottlenecks of reaping, threshing and replanting with second or non-rice crop.

2. Fuel supplies are not readily available to the farmer.

3. There are 6.5 million trained working animals. These should be used to a greater extent and more efficiently.

4. Metal, except for cast iron, is not cheap or readily available; but wood is.

5. Compared with other countries throughout the world Burma has in certain areas very good wooden implements that are worth improving.

6. Although the harnessing of work animals is better than in most other countries there is room for improvement farming at:

   (a) Greater comfort for the animal with a larger area of contact between skin and yoke/collar

   (b) Increased pulling power and hours of work by improving the angle of pull and place of attachment of pole, chains or rope.

The Quarterly Working Group sets targets for the subsequent quarter.

ACCOMPLISHMENTS DURING 1984

Cultivation

1. Tillage Implements   2. Animal Drawn Implements

The quadrilateral or triangular wooden plough is now built in a simplified form using straight pieces of wood, using the many hardwoods other than teak, costing Kyat 60. The tubular metal plough in Thailand and evaluated in Burma costs Kyat 300.

Two types of iron plough share have been introduced with an improved mouldboard (see Figure 1). The two differ in the degree of turn to the furrow. Both are fitted with replaceable tips or cutting edges. Both these are obtainable from local foundries.

A single animal drawn rotary puddler made from metal and wood, and transportable on the road, was manufactured for cropping systems. This will be produced by village craftsmen in Pyinmana.

A chisel plough for faster shallow cultivation has been developed but not fully tested.

A single animal cultivator has been designed and is still in the testing stage.

The soil test tank has been constructed and now requires the running gear and fitting of strain gauge and other electrics. This will give faster results than going to the far off fields and hitching animals on, as well as getting a precise measurement.

There has been a demand for a lightweight sturdy ox cart. This was produced at the request of U Aung Khin, General Manager, ARI. This is of growing popularity with the farmer using only a single animal and a lighter but strong cart costing half the price of the normal indigenous two bullock cart. The wheels are obtainable as they are the same as used by the horse driven Ghari. Fifteen of the carts have now been produced.

A basic requirement for DAP is that the best use is made of available power and for the maximum number of hours each day without overtaxing the animal. Some measurements of types of animals, weights, lengths, heights and girths have been made at Yezin. This information will be eventually obtained to represent the different regions in Burma and therefore the abilities of each to provide known power. The draught power measurements have not yet been accurately measured, but will be as soon as the electronic gear is assembled, meanwhile the primitive spring gauge, and the hydraulic dynamometer made during Dr. Townsend's time is being used.

3. Hand Farm Tools

The star wheel, push type hoe and modified Dutch hoe hand weeders have been developed and built and reproduced in quantity by the local blacksmith. One thousand of the latter have been ordered. 400 have already been completed by village industry. The quality is good.

A large wheel hoe with interchangeable feet has been made. The frame work is of wood; the wheel and feet are metal. This has been designed, developed and tested, and with some further modifications, ready for manufacture in quantity. This is a popular tool with the farmer.

4. Sowing Seeding

The manual rice transplanter has been made in thousands by A.M.D., but not sold to farmers. In order to work efficiently levelling, puddling and optimum depth of water must be attained. Water control is impossible in most of the rice growing areas, since rainfed rice growing predominates, so there is only a very short duration when the manual rice transplanter has the optimum conditions.

Evaluation of the Manual Transplanter took place in Burma and arrived at similar conclusion to IRRI who brought out the improved 6 row planter. This has yet to be fully tested in Burma. A.M.D. under U Mya Thein has continued developing the mechanism that will allow the operator to proceed without stopping when the planting action takes place. Also under development is the cam to lift the pickers and draw them backwards before finally raising them, so as to avoid uprooting seedlings.

Reports have reached Burma through the Philippine India study team of IRRI developments on a transplanter with a different planting action that will handle ordinary rice seedlings. It is felt that if early developments like this are shared, before they reach the final blueprint stage, then progress would be faster and some repetition of unprofitable experiments avoided. It is noted that U Soe Tint now on an M.S. course at Manitoba is working under Dr. J. S. Townsend on the Manual Rice Transplanter. SSFM looks forward to the outcome of this development.

Multicrop Multirow Wood Seeder

The principle decided on was to use the wooden harrow frame with the tubes adjustable to numerous row settings. The seeding mechanism would then be mounted on the harrow for duration of planting and be easily detachable. The first prototype had a central seed box, feeding the required number of tubes, with a slotted wooden roller to lift the seed over and down the tubes. This was produced in a handwheel driven version as well as a hand cranked version. Trials with this implement were an improvement on the type where the funnel is fed by handfulls of seed.

The second development has been the multicrop multirow seeder with individual seed boxes for each row

391

again mounted on the harrow frame. Each seed box having its own seed box drive, but with a seed dispensing system with an inclined plate. This certainly is a much more gentle action and causes less seed damage. The study tour delegates recently at IRRI noted that an inclined bevel gear driven by a single land wheel appeared to have a good potential.

Zero Tillage Seeder

Lack of staff and facilities have held back developments. It was hoped that a trial could be run in conjunction with the Chemistry Department at ARI. The aim was to examine the presence of a mechanical pan, and note seedling and plant growth under subsoiling, normal cultivation, and Zero Tillage, in a follow on crop situation following the residual moisture. The equipment including a Bush Penetrometer are available but sufficient staff is not obtainable. This is an important area of development which it is hoped will be continued for the post paddy crop in the 1985 season.

5. Fertilizer Applicator

Further improvements have taken place with the vertical prilled applicator originally designed at IRRI. The application rate is correct at 26 lbs and 52 lbs but dependent on the state of the fertilizer varying with humidity and water content. The improved version is to have a variable piston stroke feeding the auger. This will allow an adjustment rate, plus or minus, according to the flow rate of the fertilizer. 50 vertical applicators of this design modified for Burma have been made for the Extension Division.

6. Field Crop Thresher

The TH7 has been evaluated alongside the Vortex Rice Fan. Although the Vortex has less moving parts, needs less maintenance and costs less, it does not thresh out all the grain. The output per hour is the same.

718

7. Water Pumps

There is an urgent need within the limitations of fuel supplies to provide farmers with low lift high volume pumps, either for filling paddy fields regulating water levels or emptying fields. The difference in levels between the water course and the field is often only about 1 meter and advantage of this fact can be increased output. There are 50,000 Kubota diesel engines that have been produced and sold in Burma. Many of these could be utilized for a longer duration in the year if applied to water pumping. Most of the pumps used at present are centrifugal pumps.

The idea for the high volume low lift pump was given to IRRI who produced a 15" prototype with 3 ft lift. This was tested in Burma and found to require more than 10 hp to produce 3000 G.P.M. and only at 3 ft lift. Two more versions have been built by A.M.D. and are under test. One is 10" and the other 12", both with different combinations of pulley for different speeds using 3, 5 and 10 hp petrol engines. Each pump is tested with 3" and 2" pitch propeller. So far the 10" with 2" pitch propeller is producing the optimum results yield in the region of 3000 G.P.M. During January 1985 the best prototype will be ready for quantity production.

OTHER WORK IN PROGRESS IN SSFM

Animal Drawn Reaper

Reaping is one of the worst, if not the worst, bottlenecks in the farming system, and reduces the turn around rate for the second crop. Crops are lost through shedding, and residual moisture disappears.

There have been many that have tried to produce an animal drawn reaper. It was satisfactory in the United States and Europe using heavy draught horses. France and India have pursued the grass mower system for reaping, because of reduced power requirement, but this needs a team of rakers to pull the crop aside for the next round. The next alternative is a sail reaper which was used in Europe and Americas and had a high power requirement. On leave last year the Agricultural Engineer obtained drawings of this type of machine. It was redesigned so as to reduce power requirement. This has now been constructed and is due in Burma February 1985 and will undergo trials and modifications.

It is noted that Silsoe College of Agricultural Engineering is developing a spinning disc type of reaper which will have less power requirement and therefore more power available for moving the crop to one side. The intention is that this machine will be pulled by animals. One scholar from Yezin, U Hla Tun, now on an MS course at Silsoe is working on this machine as a special project.

FUTURE WORK FOR AN AGRICULTURAL ENGINEERING DIVISION

Data Collection

It is essential to have more knowledge of the indigenous implements and animals. The collection of implements representative of the region continues. Where an actual implement is not obtainable then photographs are taken for the record and as an aid to development. This museum collection requires storage and hence SSFM require expansion into another godown. In-country data on the use of each implement, combinations, and farmers problems can be collected. SSFM are just beginning to collect the basic data on animals such as type of animal, its weight, height, length, growth, and pulling power. This will provide correction on the current accepted world figures on Draft Animal Power. These figures are needed to know the limitations of power and the way in which we can improve harnessing.

Woodworking Expertise

Initially there was not the intention to devote so much time to working in wood. This, obviously, is the principal manufacturing material. Some project equipment purchases have included woodworking machines but this has meant stretching the budget. It does also mean that more knowledge of available timber is required together with woodworking expertise in the engineering staff. A visiting consultant is not really sufficient because it is ongoing work. In a third phase woodworking expertise should receive more attention.

400

The Manufacture of Implements and Machines Made of Metal

Whilst IBCP I was with AMD there was the manufacturing capacity for quantity. At present with ARI and IBCP II there is since September 1984 an AMD facility to help on the prototypes and testing of machines, but not quantity production. For quality production in the first instance the private workshop in Rangoon, Mandalay and other centres can be used; or the cooperative workshops can be brought in. The disadvantage here is the Research Development and Testing does not have contact with quality of manufacture, and need, in the early stages, to modify. It is suggested that ARI should be supplied with some manufacturing capacity and that ARI should be the nucleus for the spread of improved equipment.

Drafting Office Facilities and Dissemination of Information

As machines and implements are evolved, modified, and evaluated it becomes important to record on drawings. These drawings should also include the better type of proven indigenous implement. Most of the multiplication of equipment is simply by copying but if we are to keep IRRI in touch with our developments then blueprints must be required. So far it has not been possible to locate a draftsman.

It is possible that Burma could become the world centre and authority on draught animal power -- because there is no other country with so many appropriate skills. Many of the designs here could reach other countries, as do IRRI drawings of the higher technological equipment. The training and use of work animals in Burma is well advanced and the Township and village authorities and farmers ask for improvements to DAP and are most receptive to ideas of appropriate changes.

Liaison Between Burma, Other Countries, IRRI and Other Centres

The IRRI Burma Cooperative Project does not have so much of the "Industrial Extension" as with other outreach programmes. The major part of the project agricultural engineering work is Research and Development. This may be a repetition of IRRI R&D but not always, as the level of mechanization in Burma is to a great extent different from other outreach countries. Nevertheless it would be profitable to have a closer contact at the Research stage of, for example, the new innovations on Rice Transplanters, Fertilizer Applicators, propeller high volume low lift pumps, dry land seeders, etc. It is wrong in that information only percolates through by way of trainees and other visitors to IRRI. There is also the need for IRRI to take note of what are the most urgent developments required, or taking place, in any particular country.

It is also true that other Outreach Programmes have particular areas of development that may not have reached the reporting stage but would be of interest to Burma. In particular is the field of draught animal power (DAP) which is of such great importance to Burma.

The recent visit to ICRISAT by the Burmese Study Tour Group gave an opportunity to see and discuss seeders with wooden roller mechanism and the inclined plate. The Tamil Nadu University was another profitable visit. This tour has been a great spur and much appreciated by the participants. The request is now for a study tour to China to fill the gap found in Indian technological development.

Workers in the field of DAP are only too aware that although there are many individuals in different countries pursuing improvements of animal harness and equipment there is no International body devoted to this work. In all cases it is, at the best, a sideline.

AID-492-CA-1707
Summary
Statement of Expenditures & Commitments
For Fiscal Year Ending August 31, 1984

	Actual Expenditures 09/01/80 08/31/83	09/01/83 08/31/84	Total	Commitments up to 08/31/84	Total Expenditures & Commitments	Total Approved Budget*	Balance
1. Salaries & Wages	$ 635,804.11	$ 259,145.42	$ 894,949.53	$ 35,970.00	$ 930,919.53	$1,166,840.00	$ 235,920.47
2. Overhead	81,290.05	40,394.95	121,685.00	15,180.00	136,865.00	169,940.00	33,075.00
3. Fringe Benefits & Allowances	308,997.66	166,906.96	475,904.62	16,820.00	492,724.62	887,010.00	394,285.38
4. Travel & Transportation	186,383.57	87,918.88	274,302.45	11,685.00	285,987.45	408,770.00	122,782.55
5. Equipment, Materials & Supplies	160,939.36	93,986 27	254,925.63	17,377.00	272,302.63	301,000.00	28,697.37
6. Training	46,373.69	29,821.80	76,195.49	630.00	76,825.49	131,780.00	54,954.51
7. Studies	-	288.39	288.39	1,805.00	2,093.39	101,000.00	98,906.61
8. Workshop	-	-	-	-	-	190,000.00	190,000.00
TOTALS	$1,419,788.44	$ 678,462.67	$2,098,251.11	$ 99,467.00	$2,197,718.11	$3,356,340.00	$1,158,621.89

Certified Correct:
E. & O.E.

for Paul A. Cooper
Director, Budget & Accounts

* Total approved budget for the period September 01, 1980 to August 31, 1984.

/mpr
10.25.84

407

AID-492-CA-1707
Phil. Headquarters
Statement of Expenditures & Commitments
For Fiscal Year Ending August 31, 1984

	Tota Expenditures 09/01/80-08/31/83	09/01/83-08/31/84	Total	Commitments up to 08/31/84	Total Expenditures & Commitments	Total Approved Budget*	Balance
1. Salaries & Wages	$ 478,287.28	$ 206,381.66	$ 684,668.94	$ 26,250.00	$ 710,918.94	$ 796,030.00	$ 85,111.06
2. Overhead	60,400.32	32,617.96	93,018.28	11,500.00	104,518.28	117,000.00	12,481.72
3. Fringe Benefits & Allowances	281,170.94	146,941.34	428,112.28	15,400.00	443,512.28	733,110.00	289,597.72
4. Travel & Transportation	31,658.21	14,608.16	46,266.37	100.00	46,366.37	99,660.00	53,293.63
5. Equipment, Materials & Supplies	3,518.63	10,904.78	14,423.41	440.00	14,863.41	67,000.00	52.136.59
6. Training	22,868.38	3,707.54	26,575.92	-	26,575.92	25,000.00	(1,575.92)
7. Studies	-	-	-	-	-	21,000.00	21,000.00
8. Workshop	-	-	-	-	-	190,000.00	190,000.00
TOTALS	$ 877,903.76	$ 415,161.44	$1,293,065.20	$ 53,690.00	$1,346,755.20	$2,048,800.00	$ 702,044.80

Certified Correct:
E. & O.E.

Paul A. Cooper
Director, Budget & Accounts

* Total approved budget for the period September 01, 1980 to August 31, 1984

/mpr
10.25.84

AID-492-CA-1707
Phil. Headquarters
Schedule of Expenditures
For the period September 1, 1983 - August 31, 1984

Schedule #1. Salaries & Wages

a. Senior Staff August 1983 - July 1984		$190,909.04
b. Local staff September 1983 - August 1984		15,472.62
		$206,381.66

Schedule #2. Overhead

- March 1983 - April 1984 (Senior staff) April 1983 - May 1984 (Local staff)		$ 32,617.96

Schedule #3. Fringe Benefits & Allowances

a. Senior staff		
1. IIE Perquisites August 1983 - June 1984	$ 52,548.51	
2. Housing & Utilities Allow. Sept. 1983 - Aug. 1984	68,248.11	
3. Post Differential Allow. Sept. 1983 - August 1984	11,714.62	
4. Educational Allowance School Year 1984-1985	6,972.43	
5. Medical Allowance 1983 & 1984	219.13	$139,702.80
b. Local staff		
1. Cost of Living Allowances(COLA) February 1983 - August 1984	$ 5,055.39	
2. Social Security System (SSS) August 1983 - July 1984	525.69	
3. Retirement Savings Plan (RSP) Sept. 1983 - August 1984	1,425.19	

.../over

4.	Insurance Sept. 1983 - Jan. 1985	$ 1,088.88	
5.	Vacation/Sick Leave Accrued VL/SL for 1983	(2,854.63)	
6.	13th Mo. Pay & Other Benefits Sept. 1983 - June 1984	1,998.02	$ 7,238.54
			$146,941.34

Schedule #4. Travel & Transportation

a.	Local Travel - Sept. 1983 - July 1984			$ 839.59
b.	International Travel			
	1. ASAE Meeting 1983		$ 278.42	
	2. Home Leave & ASAE Meeting June 16 - July 4, 1984		5,580.94	
	3. Emergency Visitation Travel of Mrs. V. Bockhop on May 21, 1984		2,203.00	
	4. South & Southeast Asia Travel - India & Bangkok -Nov. 1-13, 1983	$2,206.01		
	- Feb. 20-Mar.7, 1984	604.60		
	- India & Indonesia - May 7-18, 1984	2,895.60	5,706.21	13,768.57
				$ 14,608.16

Schedule #5. Equipment, Materials & Supplies

a.	CPD charges for printing & photography - August 1983 - July 16, 1984	$ 404.85
b.	Supplies issued by IRRI Supply Room - Oct. 21, 1983 - March 20, 1984	56.87
c.	Subscriptions , Books & Periodicals - P.O. #83-02198 - 1 copy "Six Simple Pumps": a Construction Guide	9.95

.../over

406

d. Various P.O. issued:

P.O.#83-02393	- 1 unit Z-traction bicycle transmission	$ 120.85	
83-03107	- 50 pkgs. Bruning revolute paper	1,766.03	
83-03402	- 100 pkgs. Bruning revolute paper	3,591.78	
83-15285	- 20 pcs. ring binder & 2 boxes notarial seal	54.95	
83-16262	- 20 pkgs. Diazo Printing paper	948.59	
83-17125	- Socket wrenches	51.97	
83-17126	- 1 Pc. Sony KCA-60	35.53	
83-17220	- Reaper/Harvester	773.87	
83-17825	- 8 rolls film processing & contact printing	555.06	
83-17906	- Video taping	32.30	
83-17938	- Rental of 1 unit power transformer	64.61	
84-19981	- 2 pcs. projector bulbs	15.22	
84-19882	- 1 cork aluminum frame	22.97	
84-22024	- 1000 pcs. bamboo sticks	37.21	
	- 1 unit thresher for display at PICC fair	983.49	
	- 1 flashlight w/cell	2.06	
	- Treadle pump	83.99	$ 9,140.48

e. Shipping, insurance, brokerage & other charges for supplies
- September 1983 - June 1984 — 1,787.69

f. Others (FHS bills)
- January - March 1984 — (495.05)

$ 10,904.78

.../over

407

Schedule #6. Training

a. 3-Week Agricultural Eng'g. Course July 25 - August 12, 1983				
- Noel Lazaro Oguis				
- Training charges				$ 543.75
b. 2-Week Agricultural Eng'g. Course November 28-December 16, 1983				
- Rolando Ansale				
- Travel expenses	$ 86.76			
- Training charges	507.50	$ 594.26		
- Arthur Benedicto				
- Airticket Davao/Mla/Davao	$ 117.66			
- Training charges	507.50	625.16		
- Balbino Geronimo				
- Travel expenses Tacloban City	$ 24.98			
- Training Charges	507.50	532.48		
- Bibiano Buenacosa				
- Airticket Cotabato/Mla/Cot	$ 107.51			
- Training charges	507.50	615.01		2,366.91
c. 3-Week Agricultural Eng'g Course May 25 - June 15, 1984				
- Jessie Abrigo				
- Training charges		$ 507.36		
- Jose Beduya				
- Training charges		507.36		1,014.72
d. Local travel of 18 Agricultural Engineering trainees				(217.84)
				$ 3,707.54

458

AID-492-CA-1707
Phil. Headquarters
Schedule of Commitments
As of August 31, 1984

Schedule #1. Salaries & Wages

a. Senior staff August 1984		$ 26,250.00
b. Local staff		-
		$ 26,250.00

Schedule #2. Overhead

- May 1984 - August 1984 (Senior staff) June 1984 - August 1984 (Local staff)		$ 11,500.00

Schedule #3. Fringe Benefits & Allowances

a. Senior staff		
1. IIE Perquisites July - August 1984	$10,500.00	
2. Housing & Utilities Allow. August 1984	4,770.00	$ 15,270.00
b. Local staff		
1. SSS/Medicare/Employees Compensation etc. - August 1984		130.00
		$ 15,400.00

Schedule #4. Travel & Transportation

a. Local Travel - August 1984		$ 100.00

Schedule #5. Equipment, Materials & Supplies

a. CPD charges for printing & Photography August 1984		$ 50.00
b. Various P.O.s issued up to August 1984		390.00
		$ 440.00

Schedule #6. Training

409

AID-492-CA-1707
Phil. Outreach
Statement of Expenditures & Commitments
For Fiscal Year Ending August 31, 1984

	Total Expenditures 09/01/80-08/31/83	09/01/83-08/31/84	Total	Commitments up to 08/31/84	Total Expenditures & Commitments	Total Approved Budget*	Balance
1. Salaries & Wages	$ 57,726.59	$ 16,795.36	$ 74,521.95	$ 1,500.00	$ 76,021.95	$ 148,500.00	$ 72,478.05
2. Overhead	7,699.43	2,525.64	10,225.07	950.00	11,175.07	21,800.00	10,624.93
3. Fringe Benefits & Allowances	16,092.54	4,019.37	20,111.91	75.00	20,186.91	62,980.00	42,793.09
4. Travel & Transportation	65,914.22	23,818.03	89,732.25	1,680.00	91,412.25	125,620.00	34,207.75
5. Equipment,Materials & Supplies	30,880.17	17,205.53	48,085.70	2,912.00	50,997.70	50,000.00	(997.70)
6. Training	1,481.03	1,813.69	3,294.72	60.00	3,354.72	30,000.00	26,645.28
7. Studies	-	-	-	-	-	18,000.00	18,000.00
	$ 179,793.98	$ 66,177.62	$ 245,971.60	$ 7,177.00	$ 253,148.60	$ 456,900.00	$ 203,751.40

Certified Correct:
E. & O.E.

for Paul A. Cooper
Director, Budget & Accounts

* Total approved budget for the period September 01, 1980 to August 31, 1984.

/mpr
10.25.84

AID-492-CA-1707
Phil. Outreach
Schedule of Expenditures
For the period September 01, 1983 - August 31, 1984

Schedule #1. Salaries & Wages

a.	Local staff September 1983 - August 1984	$ 5,668.98
b.	BPI Personnel June 1983 - July 1984	10,426.38
c.	Honorarium July 19-26, 1984	700.00
		$ 16,795.36

Schedule #2. Overhead

- April 1983 - May 1984 (Local staff) March 1983 - April 1984 (BPI Personnel)	$ 2,525.64

Schedule #3. Fringe Benefits & Allowances

a.	Cost of Living Allowances (COLA) Sept. 1983 - August 1984	$ 1,611.56
b.	Social Security System (SSS) August 1983 - July 1984	247.11
c.	Retirement Savings Plan (RSP) April 1983 - August 1984	540.65
d.	Vacation/Sick Leave Accrued VL & SL for 1983	1,035.10
e.	13th Mo. Pay & Others Sept. 1983 - June 1984	584.95
		$ 4,019.37

.../OVER

411

Schedule #4. Travel & Transportation

a.	Local travel Sept. 1983 - August 1984		$ 16,596.80
b.	Repairs & maintenance of project vehicle Sept. 1983 - July 1984		1,524.80
c.	International Travel		
	1. Emergency Visitation Travel Mrs. Stickney - Sept. 21-29,1984	$1,847.90	
	2. Bangladesh, Thailand & attendance to ASAE Meeting in Knoxville - June 13-July 4, 1984	3,848.53	5,696.43
			$ 23,818.03

Schedule #5. Equipment, Materials & Supplies

a.	Office supplies including supplies issued by IRRI supply room August 21, 1983 - July 1984		$ 2,414.44
b.	CPD charges for printing & photography August 16, 1983 - August 16, 1984		283.43
c.	Subscriptions, Books & Periodicals		
	P.O.#83-02494-1 copy Appropriate Management for Small & Medium Size Industries in Developing Countries	$ 15.00	
	P.O.#83-01965 - 1copy CWD 81-4 Aspects of Irrigation w/ Windmills	9.00	24.00
d.	Chemicals & Laboratory Supplies March 21 - April 16, 1984		40.56
e.	Shipping charges, mailing, photocopying services, telegram etc. August 1983 - July 1984		678.50
f.	Raw materials & shop supplies December 14, 1983 - July 1984		2,105.98

.../over

412

g. Various P.O. issued:

P.O.#18958 -	72 pcs. PCV Coupling	$ 41.35	
#19155 -	1 unit cabin 1000A slide projector	101.79	
#19204 -	Konica Camera	169.42	
#19349 -	1 Unit 10" Stainless Axial flow pump	825.55	
-	1 unit 6" axial flow pump	502.51	
#19809 -	10 units seed applicator	1,263.46	
#19880 -	Plastic I.D. jackets	20.82	
#02971 -	1 Unit Hydromette	582.88	
#03027 -	3 Units Cornsheller & Wallnut huller	213.73	
#03596 -	1 Unit Rice Hull stove, 2 w/ chimney	369.54	
#20162 -	Axial flow thresher	1,651.11	
#20184 -	Calling cards	9.33	
#20602 -	1 Unit Reaper/Harvester	675.44	
-	Power tiller	847.09	
#20750 -	Bamboo	17.95	
#20751 -	Various lumber	86.93	
#20893 -	Wall tubing	12.92	
#20993 -	Pipes & tubings	27.64	
#20994 -	2 units transplanter	172.29	
#20995 -	2 units transplanter	172.29	
#20996 -	2 units transplanter	172.29	
#21027 -	2 units axial & flow pump	480.98	
#21034 -	4 pcs. V-belt	19.81	
#21084 -	1 tambo spade	5.74	
#21043 -	Various tools	18.07	
#22241 -	Foot valve & suction hose	132.87	
#22530 -	1 set blower blade w/ cover assembly	102.74	
#23891 -	1 unit Kato Multicrop Axial flow thresher	1,954.22	
#24020 -	1 unit PU-4 Axial Flow Pump 6" less engine	187.04	
#24072 -	SMAGEM Handtractor, spiral plow/discplow	820.82	$ 11,658.62
			$ 17,205.53

.../over

Schedule #6. Training

a)- Three (3)-Week Agricultural Engineering Training Course - May 25 - June 15, 1984

1) Rodrigo Trio			
- Airtickets - Iloilo/Mla/Iloilo	$58.90		
- Training charges	507.36	$ 566.26	
2) Reynaldo Malibiran			
- Training charges		507.36	$ 1,073.62

b) Local Training
Transplanter training program
May 16 - June 9, 1984

Local Training, Transplanter training program, May 16 - June 9, 1984	740.07
	$ 1,813.69

AID-492-CA-1707
Phil. Outreach
Schedule of Commitments
As of August 31, 1984

Schedule #1. Salaries & Wages

- BPI Personnel August 1984	$ 1,500.00

Schedule #2. Overhead

- June 1984 - August 1984 (Local staff) May 1984 - August 1984 (BPI Personnel) July 19-26, 1984 (Honorarium)	$ 950.00

Schedule #3. Fringe Benefits & Allowances

a. Social Security System (SSS) August 1984	$ 25.00
b. Others August 1984	50.00
	$ 75.00

Schedule #4. Travel & Transportation

a. Local travel August 1984	$ 1,500.00
b. Repairs & maintenance of project vehicle August 1984	180.00
	$ 1,680.00

Schedule #5. Equipment, Materials & Supplies

a. Office supplies, including supplies issued by IRRI supply Room August 1984	$ 70.00
b. CPD charges for printing & Photography August 16 - 31, 1984	50.00
c. Shipping, mailing, photocopying, & others August 1984	60.00

.../over

415

d.	Raw Materials & Shop Supplies August 1984		$ 410.00
e.	Publications, Books & Periodicals P.O.#84-23659 - 2 copies Webster New Collegiate Dictionary		40.00
f.	Various P.O. issued:		
	P.O.#84-03918 - Welding Kit	$235.00	
	-01228 - Wooden Cabinet	108.00	
	-01236 - Moldboard plow	108.00	
	-02326 - Films	72.00	
	-02627 - Combharrow	51.00	
	-06154 - Various tools	78.00	
	-07557 - Flat bar & B.I. Gal.	180.00	
	-21480 - 2 pcs. Pillow block bearing	30.00	
	-22860 - Leather shoes for uniform	10.00	
	-23720 - B.I. thin wall pipes	80.00	
	-23721 - 2 units 6-row rice transplanter & 3 units	235.00	
	8-row rice transplanter	370.00	
	-24157 - MS Turtle Power tiller	390.00	
	-24386 - 1 Unit Jaspe Super tiller	335.00	2,282.00
			$ 2,912.00

Schedule #6. <u>Training</u>

- Three-Week Agricultural Engineering Training Course
  May 25-June 15, 1984

  Reynaldo Malibiran
  - Airticket $ 60.00

416

AID-492-CA-1707
Indonesia
Statement of Expenditures & Commitments
For Fiscal Year Ending August 31, 1984

	Actual Expenditures 09/01/80 08/31/83	09/01/83 08/31/84	Total	Commitments up to 08/31/84	Total Expenditures & Commitments	Total Approved Budget*	Balance
1. Salaries & Wages	$ 51,266.19	$ 15,752.59	$ 67,018.78	$ 4,310.00	$ 71,328.78	$ 65,220.00	($ 6,108.78)
2. Overhead	6,966.74	2,566.06	9,532.80	955.00	10,487.80	8,940.00	(1,547.80)
3. Fringe Benefits & Allowances	7,333.34	3,250.61	10,583.95	680.00	11,263.95	27,860.00	16,596.05
4. Travel & Transportation	59,837.98	23,401.54	83,239.52	2,930.00	86,169.52	56,640.00	(29,529.52)
5. Equipment, Materials & Supplies	96,839.38	27,013.33	123,852.71	4,235.00	128,087.71	51,000.00	(77,087.71)
6. Training	8,951.47	9,793.48	18,744.95	150.00	18,894.95	22,270.00	3,375.05
7. Studies	-	-	-	-	-	22,000.00	22,000.00
TOTALS	$231,195.10	$ 81,777.61	$312,972.71	$ 13,260.00	$326,232.71	$253,930.00	($ 72,302.71)

Certified Correct:
E. & O.E.

Paul A. Cooper

Paul A. Cooper
Director, Budget & Accounts

* Total approved budget for the period September 01, 1980 to August 31, 1984.

/mpr
9.26.84

AID-492-CA-1707
Indonesia
Schedule of Expenditures
For the period September 1, 1983 - August 31, 1984

Schedule #1 - Salaries & Wages

a. Local staff July 1983 - June 1984			$ 8,445.64
b. DITPROD staff June 1983 - June 1984			4,710.61
c. Honorarium November 1983 - June 1984			2,596.34
			$ 15,752.59

Schedule #2. Overhead

Local staff - February 1983 - April 1984 DITPROD staff - March 1983 - April 1984 Honorarium - November 1983 - March 1984	$ 2,566.06

Schedule #3. Fringe Benefits & Allowances

a. Local staff		
1. RSP July 1983 - July 1984	$ 674.24	
2. Medical June 1983 - July 1984	551.21	
3. Insurance January 1984 - Jan. 1985	305.02	
4. Lodging allowance to Volunteers Jan. - May 1984	852.67	
5. Educational allowance For English lessons	21.93	$ 2,405.07
b. DITPROD staff Lebaran bonus		845.54
		$ 3,250.61

.../over

418

Schedule #4. Travel & Transportation

a.	Local travel June 22, 1983 - June 1984		$ 14,185.75
b.	Repairs & Maintenance of Motor vehicle June 22, 1983 - June 1984		1,313.77
c.	International Travel - - Trip to Thailand & USA for ASAE Meeting - May 28-July 12, 1983 (Per diem)	$ 816.14	
	- R&R Travel & ASAE meeting June 16-July 29, 1984 Airticket of VRR	3,091.45	
	- R&R Travel of Mrs. Reddy	1,192.00	
	- Trip to USA by Dr. Reddy in 1982 for ASAE Meeting	2,718.00	7,817.59
d.	Others Visa extension of VRR & Mrs. Reddy		84.43
			$ 23,401.54

Schedule #5. Equipment, Materials & Supplies

a.	Office rent, office supplies, telegram, telex, photocopying services etc. - July 1983 - June 1984		$ 8,365.26
b.	Raw Materials & Shop supplies - June 22,-1983 - July 14, 1984		9,864.96
c.	Shipping & delivery charges for various machines & documents - July - May 1984		2,196.65
d.	CPD charges for printing & Photography - July - October 1983		28.72
e.	Publications - Subscription to Economic Review	$ 28.74	
	- Subscription for Asian/US Journal-Jan.-March 1984	49.90	

.../over

- International Herald Tribune April - July 1984	$ 62.89	
- 1 Appropriate Technology book	15.47	
- AMA Subscription for 1 year	29.21	$ 186.21
f. Others		
- Supplies & materials used for film shooting of a manufacturing of farm equipment in South Sulawesi & West Sumatra (including editing and voice recording fee)	$5,412.56	
- P.O.#84-19462 - Telecine transfer and cost of tape of Indonesian film	43.07	
- P.O. Box Subscription fee	19.60	
- Service contract of Ricoh Photo-copying machine for the period May 1984 - 85	149.25	
- Contract service for the maintenance of IBM typewriter for 1 year	72.35	
- Repair of gutter in the office	36.08	
- Repair of electrical connections of office and Workshop	25.38	
- Service fee for the maintenance of office furniture	5.08	
- Cloth & materials for Engineering office curtain	260.87	
- Installation of ampere meter and box for electrical system	101.52	
- Installation and repair of power switch	35.53	
- Repair of aiphone	15.18	
- Thinner & paint for maintenance of meeting room	10.50	
- Cleaning & washing of seat covers	4.99	
- 1 Pc. table cloth	2.51	
- Electrical supplies	49.38	
- 6 sets drivers uniform	25.38	
- 1 Pc. heater - 220V	7.04	
- Miscellaneous supplies	95.26	6,371.53
		$ 27,013.33

.../over

420

Schedule #6. Training

a. 3-Week Agr. Engineering Training Course
July 25 - August 12, 1983

- Mr. Suhardi (Sufardi)		
Airticket - Jkt/Mnl/Sin/Jkt	$ 475.00	
Training charges	543.75	
Documentation fee	154.64	$ 1,173.39
- Mr. Asparmin (D. Junus)		
Airticket - Mkt/Mnl/Sin/Jkt	$ 475.00	
Training charges	543.75	
Documentation fee	154.64	1,173.39

b. 3-Week Agr. Engineering Training Course
May 25 - June 15, 1984

- Mr. Ramelan		
Airticket - Jkt/Sin/Mnl/Sin/Jkt	$ 475.00	
Training charges	507.36	
Documentation fee	152.66	
Pre & Post departure allow.	150.00	
Excess baggage allowance	61.60	1,346.62

c. Local training

Local training expenditures for training held in West Sumatra on January 6 to January 24, 1984,		6,100.08
		$ 9,793.48

421

AID-492-CA-1707
Indonesia
Schedule of Commitments
As of August 31, 1984

Schedule #1. Salaries & Wages

a.	Local staff July - August 1984	$ 3,000.00
b.	DITPROD staff July - August 1984	750.00
c.	Honorarium July - August 1984	560.00
		$ 4,310.00

Schedule #2. Overhead

- Local staff - May - August 1984
- DITPROD staff - May - August 1984
- Honorarium - April - August 1984 $ 955.00

Schedule #3. Fringe Benefits & Allowances

a.	Provident Fund (Retirement Savings Plan) July - August 1984	$ 100.00
b.	Medical July - August 1984	150.00
c.	Lodging allowance to Volunteers June - August 1984	100.00
d.	Bonus (Lebaran)	330.00
		$ 680.00

.../over

Schedule #4. Travel & Transportation

a.	Local travel July & August 1984	$ 2,370.00
b.	Repairs & maintenance of motor vehicle July & August 1984	220.00
c.	International travel - ASAE meeting - June 28-July 3 Per diem	340.00
		$ 2,930.00

Schedule #5. Equipment, Materials & Supplies

- Office rent - July & August 1984	$ 760.00
- Office supplies, telephone, telegram, telex & photocopying services - July & August 1984	1,270.00
- Raw materials & shop supplies - July & Agusut 1984	1,645.00
- Shipping & delivery charges - June - August 1984	210.00
- CPD charges for printing & photography	50.00
- Miscellaneous	300.00
	$ 4,235.00

Schedule #6. Training

3-Week Agricultural Engineering Training Course
July 25 - August 12, 1983
- Excess baggage for Mr. Suhardi & Mr. Asparmin $ 150.00

AID-492-CA-1707
Thailand
Statement of Expenditures & Commitments
For Fiscal Year Ending August 31, 1984

		Total Expenditures			Commitments up to	Total Expenditures	Total Approved	
		09/01/80-08/31/83	09/01/83-08/31/84	Total	08/31/84	& Commitments	Budget*	Balance
1.	Salaries & Wages	$ 48,524.05	$ 20,215.81	$ 68,739.86	$ 3,910.00	$ 72,649.86	$ 80,620.00	$ 7,970.14
2.	Overhead	6,223.56	2,685.29	8,908.85	1,775.00	10,683.85	11,000.00	316.15
3.	Fringe Benefits & Allowances	4,400.84	12,695.64	17,096.48	665.00	17,761.48	34,450.00	16,688.52
4.	Travel & Transportation	28,973.16	22,924.76	51,897.92	1,975.00	53,872.92	45,830.00	(8,042.92)
5.	Equipment, Materials & Supplies	26,387.30	33,773.01	60,160.31	1,190.00	61,350.31	38,000.00	(23,350.31)
6.	Training	5,128.02	7,545.60	12,673.62	150.00	12,823.62	19,510.00	6,386.38
7.	Studies	-	288.39	288.39	1,805.00	2,093.39	18,000.00	15,906.61
	TOTALS	$119,636.93	$100,128.50	$219,765.43	$ 11,470.00	$231,235.43	$247,410.00	$ 16,174.57

Certified Correct:
E. & O.E.

Paul A. Cooper
Director, Budget & Accounts

* Total approved budget for the period September 01, 1980 to August 31, 1984.

/mpr

AID-492-CA-1707
Thailand
Schedule of Expenditures
For the period September 1, 1983 -- August 31, 1984

Schedule #1. Salaries & Wages

- Local staff July 1983 - June 1984	$ 20,215.81

Schedule #2. Overhead

- Local staff February 1983 - March 1984	$ 2,685.29

Schedule #3. Fringe Benefits & Allowances

a. Retirement Savings Plan (RSP) - 1979 - 1983 (Retroactive) & January 1984 - June 1984	$ 11,281.11
b. Medical allowance July 1983 - March 1984	484.18
c. Insurance - Group Insurance July 1983 - January 1, 1985	930.35
	$ 12,695.64

Schedule #4. Travel & Transportation

a. Local travel July 1983 - June 1984		$ 10,633.74
b. Maintenance of motor vehicle July 1983 - June 1984		2,546.30
c. International travel - Los Baños, Phils. trip November 20-27, 1983 & May 20-22, 1984	$1,510.00	
- Washington trip May 1983	671.00	

.../over

425

- Thailand (Interview trip) May 3-14, 1983 - airtickets & travel expenses	$2,924.41	
- Joining travel Airticket - Manila/Thailand including shipment of personal effects - July 28-Sept. 2, 1983	3,507.31	
- R&R Travel (Australia) May 1983	1,132.00	$ 9,744.72
		$ 22,924.76

Schedule #5. Equipment, Materials & Supplies

a.	Share in Bangkok office expenses July 1983 - June 1984		$ 7,967.09
b.	Office supplies July 1983 - June 1984		2,381.65
c.	Raw materials & shop supplies July 1983 - April 1984		5,863.05
d.	Telephone, telegram, cables & mailing charges July 1983 - March to May 1984		809.36
e.	Others		
	- Toyota Cressida Station Wagon Model RX60RC-XWKDS Engine #21-R 0465897 Frame #RX6 0177698 (including registration & insurance)	$8,145.64	
	- P.O.# 3742-A - 1 Unit IBM Portable computer	2,695.00	
	- 1 Unit - Gestetner Duplicator Machine Model 1560	2,385.65	
	- 1 Unit - 10 HP Honda Power tiller S/N G400 1345998	921.74	
	- P.O.#84-03764 - C&F Value of 1 Unit EPSON FX-100 Printer	700.00	
	- 1 Unit G.E. Room Airconditioner Model 918 W (AD 918 W) S/N AM-235598 including installation	543.48	

.../over

426

- 1 Unit Kodamatic 960 Instant Camera	$ 117.39	
- 1 Filing Cabinet - 4 drawers	74.61	
- 1 set - Lucky Sliding door locker	197.48	
- 1 unit - Lucky chair	32.61	
- Drafting instruments	91.13	
- 1 set Tract type drafting machine with scale	466.30	
- 1 set drafting stand Model TH20	170.99	
- 1 set magnaideboard Model DBM	104.02	
- 1 unit daylight lamp	16.52	
- Service agreement for the maintenance of IBM typewriters January 1 - December 31, 1984	68.87	
- Miscellaneous	20.43	$ 16,751.86
		$ 33,773.01

Schedule #6. Training

a. 3-Week Agricultural Engineering Training Course - July 25-August 12, 1983

- Dr. Winit Chinsuwan		
- Airticket - Bkk/Mla/Bkk	$ 325.65	
- Training charges	543.75	
- Pre-departure allowance	75.00	$ 944.40
- Dr. Chalermsak Bamrungthai		
- Airticket - Bkk/Mla/Hkg/Bkk	$ 431.74	
- Training charges	543.75	
- Pre-departure allowance	75.00	1,050.49

b. 2-Week Agricultural Engineering Training Course November 28 - December 16, 1983

- Mr. S. Bamrungwong		
- Airticket - Bkk/Mla/Hkg/Bkk	$ 431.74	
- Training charges	507.50	
- Pre- & Post-departure allowance	150.00	
- 10-kg. excess baggage	51.20	1,140.44

.../over

- Mr. M. Preecha		
- Airticket - Bkk/Mla/Bkk	$ 325.65	
- Training charges	507.50	
- Pre- & Post departure allowance	150.00	
- 10-kg. excess baggage	51.20	$ 1,034.35
c. 3-Week Agricultural Engineering Training Course - May 25-June 15, 1984		
- Mr. Kanoksak Eam-o-pas		
- Airticket - Bkk/Mla/Bkk	$ 475.22	
- Training charges	507.36	
- Pre- & post departure allow.	150.00	1,132.58
- Mr. Sutin Sakranukit		
- Airticket - Bkk/Mla/Bkk	$ 475.00	
- Training charges	507.36	
- Pre- & Post departure allowance	150.00	1,132.58
d. Local training		
- December 1983	$ 216.07	
- Mechanization training course April 15 - 20, 1984	894.69	1,110.76
		$ 7,545.60

Schedule #7. Studies

Salary of S. Saitan - June 1984	$ 282.61
Local travel incurred by S. Saitan in June 1984	5.78
	$ 288.39

425

AID-492-CA-1707
Thailand
Schedule of Commitments
As of August 31, 1984

Schedule #1. Salaries & Wages

- Local staff
  - July - August 1984 — $ 3,910.00

Schedule #2. Overhead

- Local staff
  April - August 1984 — $ 1,775.00

Schedule #3. Fringe Benefits & Allowances

a.	Retirement Savings Plan July - August 1984	$ 365.00
b.	Insurance/Medical	300.00
		$ 665.00

Schedule #4. Travel & Transportation

a.	Local travel - July - August 1984	$ 1,475.00
b.	Repairs & maintenance of motor vehicle - July - August 1984	500.00
		$ 1,975.00

Schedule #5. Equipment, Materials & Supplies

a.	Office Supplies- July - August 1984	$ 270.00
b.	Share in Bangkok office expenses July - August 1984	420.00
c.	Others	500.00
		$ 1,190.00

.../over

429

Schedule #6. Training

- 3-Week Agricultural Engineering Training Course May 25 - June 15, 1984

- Mr. Kanoksak Eam-o-pas	
- Excess baggage allowance	$ 75.00
- Mr. Sutin Sakranukit	
- Excess baggage allowance	75.00
	$ 150.00

Schedule #7. Studies

Salary - S. Saitan - July & August 1984	$ 566.00
Benefits	100.00
Travel (local)	1,007.00
Supplies	132.00
	$ 1,805.00

479

AID-492-CA-1707
India
Statement of Expenditures & Commitments
For Fiscal Year Ending August 31, 1984

	Actual Expenditures						
	09/01/80-08/31/83	09/01/83-08/31/84	Total	up to 08/31/84	Total Expenditures & Commitments	Total Approved Budget*	Balance
1. Salaries & Wages	$ -	$ -	$ -	$ -	$ -	$ 76,470.00	$ 76,470.00
2. Overhead	-	- -	-	-	-	11,200.00	11,200.00
3. Fringe Benefits & Allowances	-	- -	-	-	-	28,610.00	28,610.00
4. Travel & Transportation	-	3,166.39	3,166.39	5,000.00	8,166.39	81,020.00	72,853.61
5. Equipment, Materials & Supplies	3,313.88	5,089.62	8,403.50	8,600.00	17,003.50	95,000.00	77,996.50
6. Training	7,944.79	6,961.49	14,906.28	270.00	15,176.28	35,000.00	19,823.72
7. Studies	-	-	-	-	-	22,000.00	22,000.00
	$ 11,258.67	$ 15,217.50	$ 26,476.17	$ 13,870.00	$ 40,346.17	$ 349,300.00	$ 308,958.83

Certified Correct:
E. & O.E.

Paul A. Cooper
Director, Budget & Accounts

* Total approved budget for the period September 01, 1980 to August 31, 1984.

/mpr
10/25/84

AID-492-CA-1707
India
Schedule of Expenditures
For the period September 1, 1983 - August 31, 1984

Schedule #4. Travel & Transportation

a.	Interview Trip November 8-14, 1983	$ 1,243.78
b.	Initial travel (India) July 30-August 16, 1984	1,597.14
c.	Trip to Manila August 16-26, 1984	325.47
		$ 3,166.39

Schedule #5. Equipment, Materials & Supplies

a.	Shipping charges for 1 unit TH-8 Thresher & TR 1 Rice Transplanter to India		$ 1,512.81
b.	Various P.O. issued:		
	P.O.#84-22827 - Various lumber & plywood	$ 332.53	
	84-22459 - 2 units TR-4 transplanter 6 rows	222.78	
	84-22459 - 1 unit TH8 Axial Flow Thresher, 1 unit PT 5 Power tiller, combharrow Moldboard tubber tire & reaper	3,021.50	3,576.81
			$ 5,089.62

Schedule #6. Training

a. 3-Week Agricultural Eng'g. Training Course (July 25-August 12, 1983)

1. Prabhakarr Datt - Training charges		$ 543.75		
2. S.K. Makhija - Training charges		543.75		
3. S.C. Patra				
- Training charges	$ 543.75			
- 10-kg Excess baggage	54.66	598.41		$ 1,685.91

.../over

U3V

b. 3-Week Agricultural Engineering Course
May 25-June 15, 1984

1. R. Aravindhan			
- Pre-&Post departure allowance	$ 150.00		
- Training charges	507.36		
- Airticket - Coimbatore/Madras/ Singapore/Mla/Sin/Madras/ Coimbatore	1,067.40	$1,724.76	
2. A. Shanmugan			
- Pre- & Post-departure allow.	$ 150.00		
- Training charges	507.36		
- Airticket - Delhi/Mla/Sin/ Madras	1,035.58		
- Excess baggage	87.90	1,780.84	
3. S.S. Thomar			
- Pre- & Post-departure allow.	$ 150.00		
- Training charges	507.36		
- Airticket - Delhi/Mla/ Hongkong/Delhi	1,087.62		
- Excess baggage	25.00	1,769.98	$ 5,275.58
			$ 6,961.49

433

AID-492-CA-1707
India
Schedule of Commitments
As of August 31, 1984

Schedule #4. Travel & Transportation

a. Initial travel Airtickets & travel expenses including shipping of household effects of Mrs. Nichols	$ 4,200.00
b. International Travel - Trip to Manila - August 16 - 26, 1984	800.00
	$ 5,000.00

Schedule #5. Equipment, Materials & Supplies

- Various equipment, materials, supplies and office furnitures & fixtures for India office	$ 8,600.00

Schedule #6. Training

a. 3-Week Agricultural Engineering Training Course July 25-August 12, 1983		
1. Prabhakarr Datt - Excess baggage	$ 90.00	
2. S.K. Makhija - Excess baggage	90.00	$ 180.00
b. 3-Week Agricultural Engineering Training Course May 25-June 15, 1984		
1. R. Aravindhan Excess baggage		90.00
		$ 270.00