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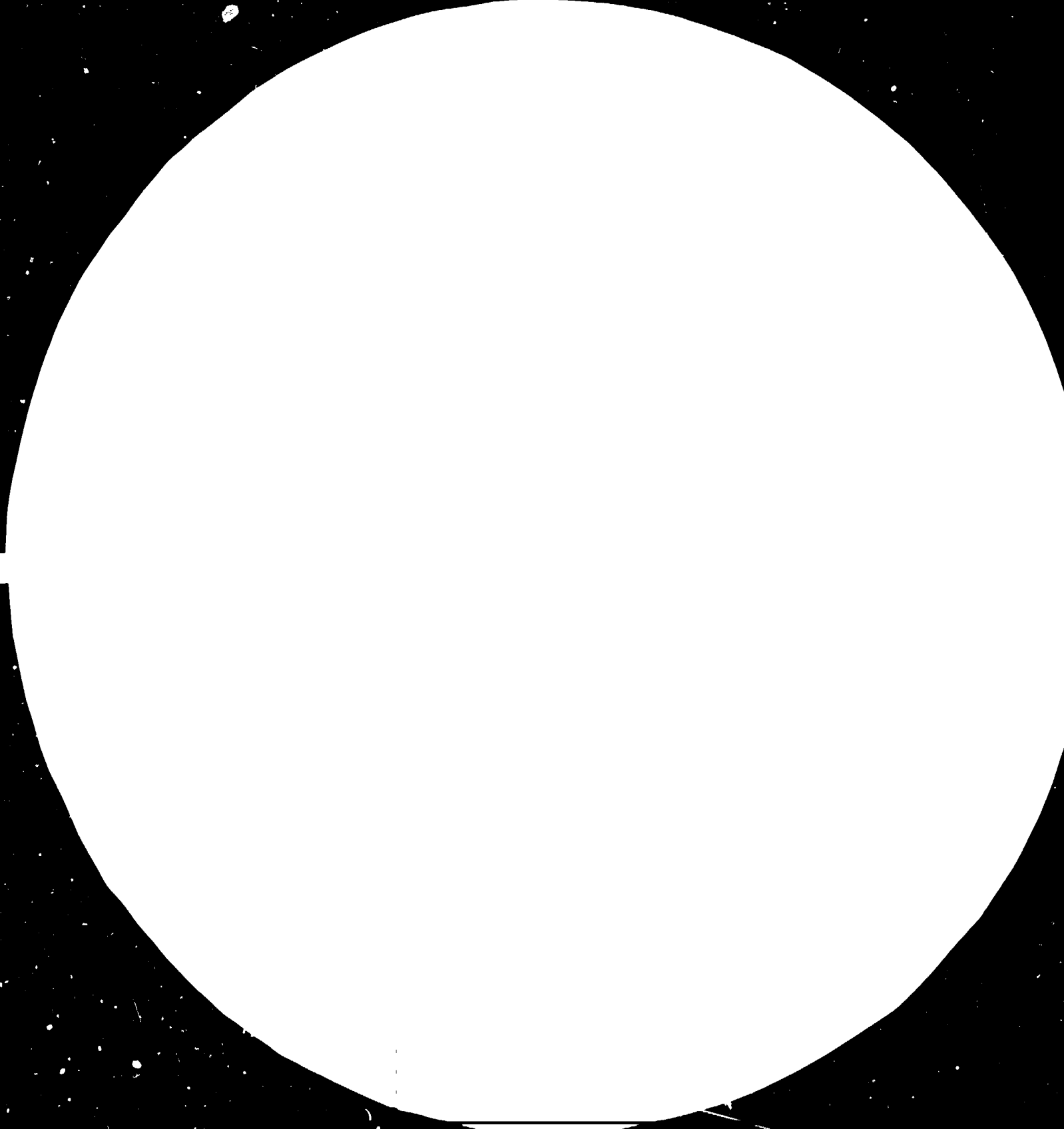

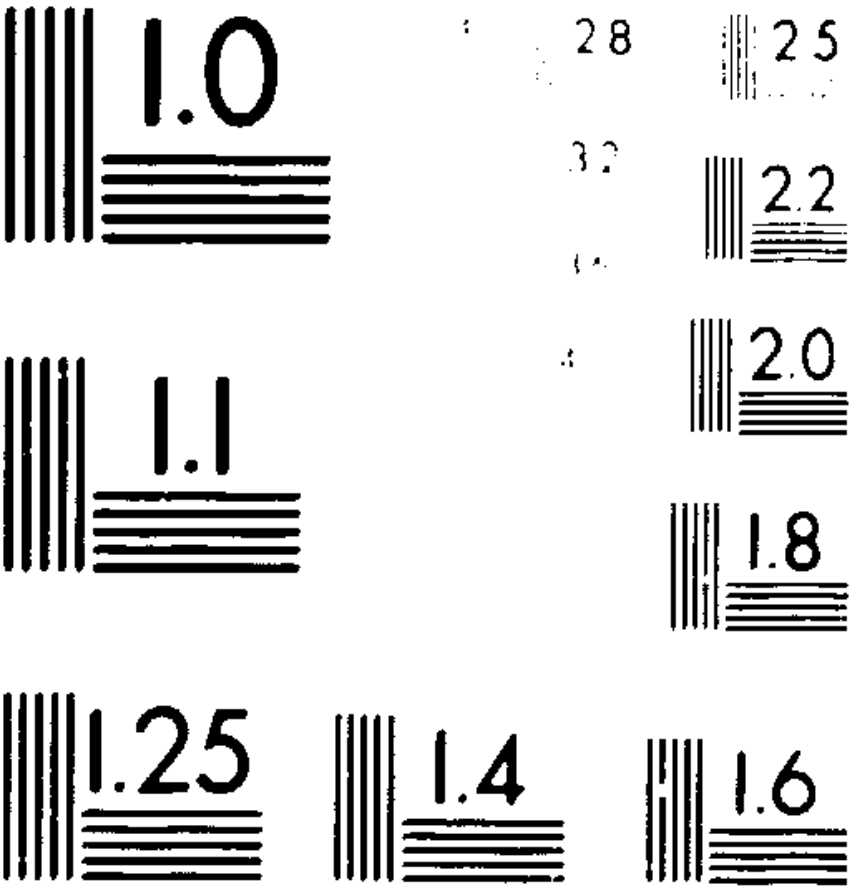

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Distr.
LIMITED

ID/WG.418/9
16 March 1984

ENGLISH

United Nations Industrial Development Organization

Technical Congress held in conjunction
with the Third International Fair -
"Technology for the People"

Manila, Philippines, 23-25 November 1983

INTRODUCTION OF THE CAAMS-IRRI MECHANICAL REAPER IN THE PHILIPPINES *

by

C.P. Fernandez **
H.T. Manaligod **
and
R.E. Stickney **

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** MA-IRRI Industrial Extension Program for Small Farm Equipment, Agricultural Engineering Division, Bureau of Plant Industry, Metro Manila, The Philippines.

V.84-83420

1. INTRODUCTION

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

As of May, 1983, 161 manufacturers had become cooperators in the MA-IRRI Program by signing a memorandum of agreement. These cooperators are located throughout most of the Philippines (see Figure 1) and range in size from small blacksmith and metalcraft shops to large-scale industries. Special attention is given to manufacturers located in agricultural areas, thereby ensuring availability of parts and service, creating rural employment, and stimulating innovations and adaptations to local conditions and farmer preferences. The MA-IRRI Program provides them with designs of agricultural equipment, together with training and technical assistance. In turn, the cooperators agree to provide annual production statistics and to sell units only after testing and authorization by MA-IRRI.

The most recent equipment design to be promoted by the MA-IRRI Program is the CAAMS-IRRI reaper shown in Fig. 2. It is a low-cost unit[1/] which attaches to a lightweight two-wheel hand tractor, both of which may be manufactured in small shops. (See references 1 and 2 for more details). Because of its light weight and low cost, it should minimize problems encountered previously with imported reapers which have failed to be accepted by rice farmers in the Philippines. It should also be competitive with similar reapers now being imported from Japan and China but with higher sales prices and limited availability of parts and service.

2. EXTENSION ACTIVITIES

Selection of Target Areas

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

1/ Approximate average sales prices are ₱4,000 (US $400) for the RE2 reaper, ₱4,000 (US $400) for the PT5 hand tractor, and ₱2,000 (US $200) for a 5HP gasoline engine.

Field Demonstrations/Evaluations/Trials

The second step was to conduct field demonstrations and evaluations of the reaper in the major rice-producing areas of Mindanao and the Cagayan Valley. The MA-IRRI Regional Project Engineers[2/] who live in the areas were vital to the coordination of these demonstrations, particularly with respect to insuring that the group present included outstanding farmers, leaders of cooperatives, local manufacturers, agricultural extension technicians, and rural bank officials.

The major results of these demonstrations were:

1. In evaluation sessions held at the field demonstrations, the majority of the farmers stated that the reaper would be appropriate and beneficial in their areas;

2. By observing the enthusiasm of farmers for the reaper, many manufacturers became interested in fabricating the unit;

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

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

Training Courses

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

At the time of the first course (February 1982), there was a total of 68 cooperators in the MA-IRRI Program and all were invited to attend the course. Twenty four (35%) of these cooperators actually attended first course. Ten (42%) of these attendees have successfully fabricated at least one reaper and hand tractor by the end of the present survey (May 1983).

By the time of the second course (August 1982), the total number of cooperators had increased to 110, of which 86 had not attended the first course and therefore were invited. Nineteen (22%) of these 86 attended

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

the second course, and 6 (32%) of these attendees have successfully fabricated at least one unit by the end of this survey. (Note: As will be discussed in Section 4, 11 cooperators who did not attend either training course have also fabricated at least one reaper and hand tractor.)

It may be concluded that manufacturers will devote their time and money to attend training courses if the topic is of sufficient interest to them. In the present case, many of the attendees were from small-scale firms (Table 1) located in provinces far from Manila (see Fig. 1), the site of the two training courses. The attendees paid for their transportation and lodging expenses, while the MA-IRRI Program covered the cost of providing each attendee with blueprints and instruction materials.

Technical Assistance and Prototype Testing

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

Regarding technical assistance on the reaper, the most common activities are:

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

2. To loan a reaper and hand tractor to manufacturers who have difficulty with reading blueprints.

3. To perform the prototype test of the first unit fabricated by a manufacturer, utilizing a special test procedure and form. The purpose of the test is to determine that the unit has been fabricated and assembled correctly and that it functions properly in the field. It is also an opportunity to advise the manufacturers regarding critical adjustments and operating procedures. After passing the prototype test, the manufacturer is authorized by MA-IRRI to proceed with commercial production of the reaper and hand tractor.

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

5. To maintain two-way communication with manufacturers on both problems and improvements that arise in relation to the design, fabrication, or operation of the reaper and hand tractor.

3. SURVEY METHODOLOGY

The MA-IRRI Program carried out a survey for the purpose of answering the following questions:

a) Which of the methods used by the Program in the extension of the reaper (i.e., methods used in field demonstrations, training courses, technical assistance, loaning units, prototype tests, etc.) were most useful to cooperators?

b) Why have some cooperators successfully fabricated the reaper and hand tractor while others have not?

c) What factors have been most important with respect to facilitating and/or hindering acceptance and sales of the reaper?

d) What innovations or modifications have been made or suggested by cooperators with respect to the design, fabrication, or operation of the reaper and hand tractor?

e) How might we improve future extension of the reaper, hand tractor, or similar equipment?

Questionnaires were developed, pre-tested, and finalized for different groups:

1. *Trained Cooperators*, i.e., those persons (firms) who attended one of the reaper training courses. This group is subdivided into:

   a) *Trained Reaper Manufacturers*, i.e., those trained cooperators who have successfully fabricated at least one unit of reaper and hand tractor by the time of the survey.

   b) *Trained Non-Manufacturers*, i.e., those trained cooperators who have not yet fabricated a unit.

2. *Untrained Reaper Manufacturers*, i.e., firms who did not attend the course but have successfully fabricated at least one unit of the reaper and hand tractor by the time of the survey.

3. *Reaper Owners*, i.e., farmers or contact groups who have purchased a reaper and hand tractor.

The survey was carried out from January through April 1983 by two MA-IRRI engineers who attempted to visit and interview all of the cooperators in groups 1 and 2 above. The survey of the reaper owners (group 3) was postponed because it was found that the first owners who were contacted had not yet utilized their units for more than 5 ha. This survey of owners should be carried out in 1984.

4. SURVEY RESULTS

The accepted classification of industries in the Philippines is:

Scale	Capital Assets[3]
Cottage Industry	below ₱100,001
Small Industry	₱100,001 to ₱1,000,000
Medium Industry	₱1,000,001 to ₱4,000,000
Large Industry	above ₱4,000,000

This classification is used in Table 1 to compare the different survey subgroups with one another and with all cooperators enrolled in the MA-IRRI Program at the time of the survey. Notice that the distributions of capital assets do not differ substantially from one group to another, thereby indicating that capital assets are not the dominant factor influencing cooperators' decisions to attend the training course or to fabricate the reaper and hand tractor. Moreover, in Table 1 it can be observed that: (a) the training course attracted many cooperators (77%) from cottage and small industries; and (b) the majority (about 70%) of the cooperators who have successfully fabricated reapers are cottage and small industries. Labor force data are also included in Table 1, and the results show that most of the cooperators who attended the training course (73%) and who have fabricated the reaper (54%) have less than 15 employees. These results demonstrate that the reaper and tiller can be fabricated successfully by firms which are small in terms of capital assets and labor force.

Based on the survey results, the characteristics of the 27 reaper manufacturers are varied:

1. 22% had not fabricated any type of agricultural equipment before the reaper. Some had been repairing agricultural equipment, while others were repairing or fabricating vehicles (tricycles, cars, trucks).

2. 78% were already fabricating agricultural equipment, with the principal equipment being threshers (86%) and hand tractors (38%). Note: 88% of those fabricating hand tractors were also fabricating threshers.

3. 70% had become cooperators of the Program since September 1981 when it was transferred from IRRI to MA-IRRI. It is estimated that 60-70% of these new cooperators were attracted to the Program by the reaper.

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[3] At the time of the survey, the conversion rate was approximately ₱10 per US dollar.

Of the 27 reaper manufacturers, 11 (41%) had not attended either of the two training courses. Five (45%) of these 11 untrained reaper manufacturers had been invited to the first training course but did not attend because: (a) two were well-established cooperators located near IRRI, one of which had been contracted previously by MA-IRRI to fabricate reaper demonstration units; (b) two were small firms (less than 5 employees) located far from Manila but benefitting from borrowing a MA-IRRI demonstration unit and receiving frequent technical assistance from the Project Engineer; and (c) one was a unique case of a mechanical engineer with only one employee. Another five (45%) had become cooperators after the first course but several months before the second course, and therefore had progressed substantially with fabrication of their first units by the time of the second course. Three of these had reapers available to facilitate fabrication, one hired a consultant who was an experienced reaper fabricator, and one was capable of building the first unit solely from the blueprints. The last of the 11 untrained reaper manufacturers became a cooperator after the second training course, but benefitted from having a mechanical engineer who attended the IRRI Agricultural Engineering Course, as well as from borrowing a reaper from MA-IRRI and hiring workers who had fabricated reapers for another firm.

The 11 untrained reaper manufacturers are not noticeably different from the 16 trained reaper manufacturers with respect to capital assets, labor force, past experience, ability to read blueprints, or geographical location. Both groups include firms having a wide range of these characteristics, and it appears that there is not any simple means for distinguishing them from one another. It is concluded that although the training course may be advantageous to manufacturers, firms can fabricate the reaper without the course if they either have the technical capability (e.g., blueprint reading, fabrication skills and equipment) or are able to hire experienced personnel, borrow or buy a reaper unit, or obtain adequate technical assistance from the MA-IRRI Program.

It is also interesting to consider the reasons why 63% of the cooperators who attended the training course have not yet fabricated a reaper unit. The results given in Table 2 indicate that the main reasons were that the firms were either too busy with orders for other equipment or lacked the necessary capital. It should be mentioned that 24% of these trained non-manufacturers have partially fabricated the reaper or hand tractor, and 29% have either borrowed or purchased a reaper unit to facilitate fabrication.

Table 3 provides a summary of the relative degrees of utilization of blueprints, reaper units, and experienced personnel by reaper manufacturers. It should be pointed out that all of these manufacturers were given a set of blueprints from the MA-IRRI Program, and 78% received direct technical assistance (e.g., training course and/or visits by MA-IRRI engineers). It is expected that all of the manufacturers would have utilized reaper units loaned by MA-IRRI if the Program had offered units to all rather than limiting them to the target areas (Cagayan Valley and Mindanao).

The survey obtained information from each reaper manufacturer on the number of reaper units they had fabricated and the number of these which had been sold. The average number of units fabricated was six per manufacturer, while the average number sold was 3.3 per manufacturer (i.e. 55% of the units produced). However, the data in Table 4 illustrate that 37% of the

manufacturers had fabricated only one unit thus far, and 59% had not yet sold any units. These manufacturers generally were very small with respect to capital assets; a few had only recently completed fabricating their first units.

Only four firms had sold more than 10 units per firm, and their combined sales amounts to 80% of the total sales to date. Three of these four were able to fabricate their first reaper units within three months after the first training course, and two of them attended the course. Three of the four are small; i.e., they are classified as cottage or small-scale industries with respect to capital assets, and none of the three has more than 10 employees. Perhaps the most important characteristic of these three manufacturers is that they all have well-established relationships with IRRI.

Reaper manufacturers reported that the most common method used to promote sales was field demonstrations to farmers. Several have also used other promotional methods: four manufacturers have printed and distributed leaflets describing the reaper, four have published advertisements in newspapers (two in national newspapers and two in a popular farmers' periodical), one mailed announcements to previous customers, and one advertised by radio.

Reaper manufacturers were asked for their opinions on: "what are the main problems encountered in selling the reaper?" According to the results listed in Table 5, the two main problems are that farmers generally lack capital for purchasing equipment and are hesitant to buy a new machine with unproven performance or durability. A third problem mentioned was that the reaper will reduce employment of laborers who are now contracted to harvest rice fields, and this could lead to destructive reactions by the laborers.

It is relevant to mention that, during the past three years, sales of farm equipment in the Philippines has fallen off markedly because of a prolonged period of economic recession and inflation, with the price of rice failing to keep up with rising costs of inputs. The situation has been aggrevated recently by a severe drought.

A related question to the reaper manufacturers was: "In your opinion, what would farmers consider to be the most attractive (positive) and unattractive (negative) features of the reaper?" The responses are summarized in Table 6. The attractive features are those which we would expect, and the unattractive features include the labor and durability problems discussed before in relation to Table 5. A primary complaint is that the reaper is difficult to maneuver, but we have found that this problem diminishes as reaper operators gain experience with handling the machine.

Table 7 lists the manufacturers' views on what are the most common service and repair problems of the reaper. Many manufacturers (37%) said that the reaper was so new that they could not yet respond to this question. Problems with the cutter blades are serious because the hardened steel blades and ledger plates are among the most costly components of the reaper and generally are imported. Thus far, most locally-made blades and ledgers have

either been too hard (thereby easily chipping) or too soft (thereby wearing and becoming dull). The MA-IRRI Program is collaborating with the Metals Industry Research and Development Center (MIRDC) and other institutions in an effort to promote local production of blades and ledgers.

Other service and repair problems listed in Table 7 can be minimized in the following ways:

1. The V-belt from the hand tractor to the reaper wears rapidly because it is twisted 90° in order to drive the vertical reaper shaft from the horizontal tractor shaft. This problem can be minimized by proper adjustment of the belt tension.

2. Several manufacturers have come up with an innovative means for increasing starwheel life: they fabricate starwheels from an inexpensive plastic chopping board that is widely available in local supermarkets.

3. Wear of the conveyor belt may be reduced to an acceptable level by proper adjustment.

4. Loosening of bolts by machine vibration may be reduced either by using fine-threaded bolts with locking washers or nuts (which are often difficult to find in rural areas) or by using rivets in place of bolts.

Manufacturers were requested to give their suggestions regarding what improvements of the reaper and hand tractor would be most useful or desirable. (See Table 8.) Seven manufacturers suggested that the width of the cutter bar (tool steel) be increased from 19 mm (3/4 inch) to 25 mm (1 inch) because the 25 mm bar is more commonly available in the provinces and also improves the rigidity and strength of the cutter assembly. Several manufacturers have already incorporated this change in their reapers. Some have also made changes associated with the other suggestions in Table 8, five of which are related primarily to improving the convenience of reaper operation, while three are related to overcoming problems of wear and breakage. These suggestions and innovations[4/] by reaper manufacturers are being considered by the MA-IRRI Program and the IRRI Agricultural Engineering Department with the objective of proposing modifications that will improve the present design of the reaper and hand tractor. After testing, the modifications will be given to manufacturers for their evaluation and possible use or adaptation.

5. SUMMARY AND CONCLUSIONS

The main results of the survey are:

1. Introduction of the CAAMS-IRRI reaper to manufacturers in the Philippines has been a rapid process: 27 firms have successfully fabricated at least one unit within the first 12 to 15 months.

4/ A few manufacturers have already applied for patents on their improvements of the reaper, and the MA-IRRI Program will not promote these particular improvements. Many manufacturers are eager to patent improvements because the Philippine Government exempts manufacturers from paying income tax on sales of products patented by them.

2. Fabrication of the reaper and hand tractor is sufficiently simple that it can be done by small manufacturing firms having limited capital and equipment.

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

4. Although the training course facilitated introduction of the reaper to interested firms, it was not absolutely essential because 41% of the present reaper manufacturers did not attend the course. However, many of the untrained reaper manufacturers either have close relationships with IRRI or have experienced technical personnel.

5. Since most of the reaper manufacturers have difficulty in fabricating the first unit solely from the blueprints, they benefitted from either borrowing a unit from MA-IRRI, buying a unit, or employing technicians who are experienced in fabricating the reaper.

6. Initial sales of the reaper have been slow, primarily because of the depressed economic conditions of rice farmers in the Philippines. Sales have also been limited by the understandable reluctance of farmers to buy a new machine of unproven performance and durability, along with concern that the reaper may lead to problems with hired farm workers.

7. Manufacturers have identified aspects of the reaper design, fabrication, and operation which should be improved. Several manufacturers have already introduced innovations to achieve these improvements.

8. Based on the data in Table 6, we suspect that it would have been possible to facilitate initial sales of the reaper by helping farmers to become more familiar with the machine, thereby alleviating their concerns about maneuverability, shattering losses, passing over paddy, and durability. For this reason, it is recommended that future extension of the reaper (or other equipment that is new to farmers) would benefit by arranging for intensive on-farm utilization of at least one unit in each of the major target areas. This would provide a site where farmers and manufacturers could observe the equipment being used on a sustained basis by experienced operators.[5]

Since the present survey was carried out at about only one year after he initial introduction of the reaper, it provides only preliminary information on sales and no information on the buyers (farm size, location, ropping intensity, etc.) or on utilization (e.g., used only on owners'

5/ This type of trial was carried out in Bukidnon, and it allowed farmers and manufacturers to observe the reaper under conditions of intensive use.

farms; contract work on other farms; costs and returns; utilization rate (hectares/year); and labor displacement). A second survey will be conducted in 1984 to obtain data on buyers and utilization, including a study of the positive and negative impacts of the machine on those who own reapers, those who hire reapers, and those who are displaced by reapers. Information will also be obtained on the reaper's effects on losses and timeliness of harvesting, while also determining the reaper's limitations with respect to harvesting crops that are either weed-infested, poorly drained, or lodged. Another limitation to be considered is that the length of the straw of a crop harvested by the reaper generally is longer than that harvested by hand, with the result being that the capacity of mechanical threshers may be greatly reduced.

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Table 1. Classification of cooperating firms according to assets, labor, reaper training, and reaper manufacturing[a] - data expressed as percentages -

Range	All Cooperators (124)[b]	Trained Cooperators (30)[b]	Reaper Manufacturers	
			Trained (16)[b]	Untrained (11)[b]
CAPITAL ASSETS				
≤ ₱100,000[c]	44	40	31	45
₱100,001 to ₱1,000,000	44	37	38	27
₱1,000,001 to ₱4,000,000	10	13	25	9
> ₱4,000,000	2	10	6	18
LABOR (Number of employees)				
≤ 5	29	20	31	36
6 to 15	45	53	31	18
16 to 50	21	13	19	36
> 50	6	13	19	9

[a] Data as of March 1, 1983

[b] Number of firms in sample

[c] Approximate conversion rate: per US dollar.

Table 2. Most common reasons why some participants of reaper training course have not yet fabricated a unit.

Reasons	Frequency[a/]
Busy with orders for other equipment	7
Lack of sufficient capital	6
Lack of skilled personnel necessary for fabricating reaper	2
Firm no longer manufacturing agricultural equipment	2

a/ Frequency represents the number of participants who mentioned the particular reason.

Table 3. Principal methods used by reaper manufacturers in fabricating their first prototype unit.

Methods	Number of Manufacturers	Percentage
Followed blueprints provided by MA-IRRI	11	41
Utilized reaper loaned by MA-IRRI	8	30
Utilized reaper purchased by firm	6	22
Hired services of experienced reaper fabricator	2	7
Total	27	100

Table 4. Production and sales of reaper units[a/]

Range (number of units)	Number of firms	Percentage of firms
UNITS PRODUCED[b/]		
1	10	37
2-5	8	30
6-10	3	11
> 10	6	22
	27	100
UNITS SOLD[b/]		
0	16	59
1-5	6	22
6-10	1	4
> 10	4	15
	27	100

a/ Data based on survey conducted from January to May 1983.

b/ At the time of the survey, a total of 161 reaper units had been fabricated, and 88 of these had been sold.

Table 5. Manufacturers' opinions on most common problems encountered in selling the reaper[a/]

Problem	Frequency[b/]
Farmers lack capital to purchase reapers	5
Harvest laborers oppose the use of reapers	3
Manufacturer lacks marketing organization	1

a/ Based on responses of 20 reaper manufacturers, some who mentioned more than one problem

b/ Frequency represents number of manufacturers who mentioned the particular problem

Table 6. Manufacturers' opinions of farmers' views on the most attractive and unattractive features of the reaper[a/]

Features	Frequency[b/]
ATTRACTIVE FEATURES	
Fast reaping or harvesting	16
Uniform windrowing	8
Reduces labor requirements	4
Leaves a clean field after reaping	3
UNATTRACTIVE FEATURES	
Difficult to maneuver	5
Displaces labor	4
Suspect shattering losses will be high	2
Tendency to pass over cut paddy	2
Suspect durability will be poor	2

a/ Based on responses of 27 reaper manufacturers, some of whom gave more than one response.

b/ Frequency refers to the number of manufacturers who mentioned the particular point.

Table 7. Most common service and repair problems of reaper [a/]

Problems	Frequency
Cutter blades chip or become dull	4
Short life of V-belt between PTO and reaper	3
Starwheels wear out	3
Conveyor belt wears out	2
Several bolts often become loose	2

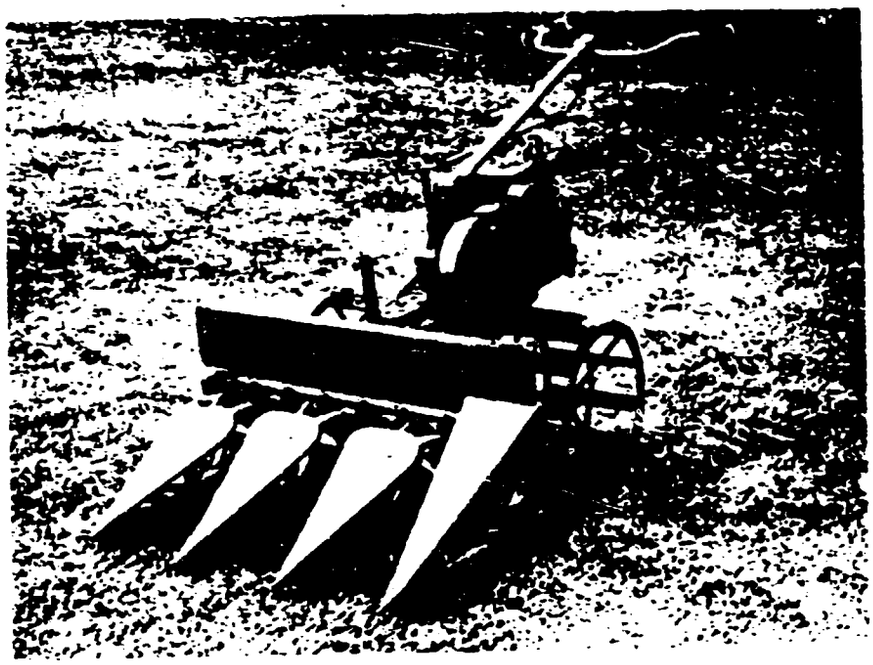
[a/] Based on responses of 27 reaper manufacturers, 37% of whom did not give any comments because of limited experience thus far.

Table 8. Manufacturers' suggestions on improvements of the reaper and hand tractors[a/]

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

a/ Based on responses of 27 reaper manufacturers, some of whom have made more than one suggestion.

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



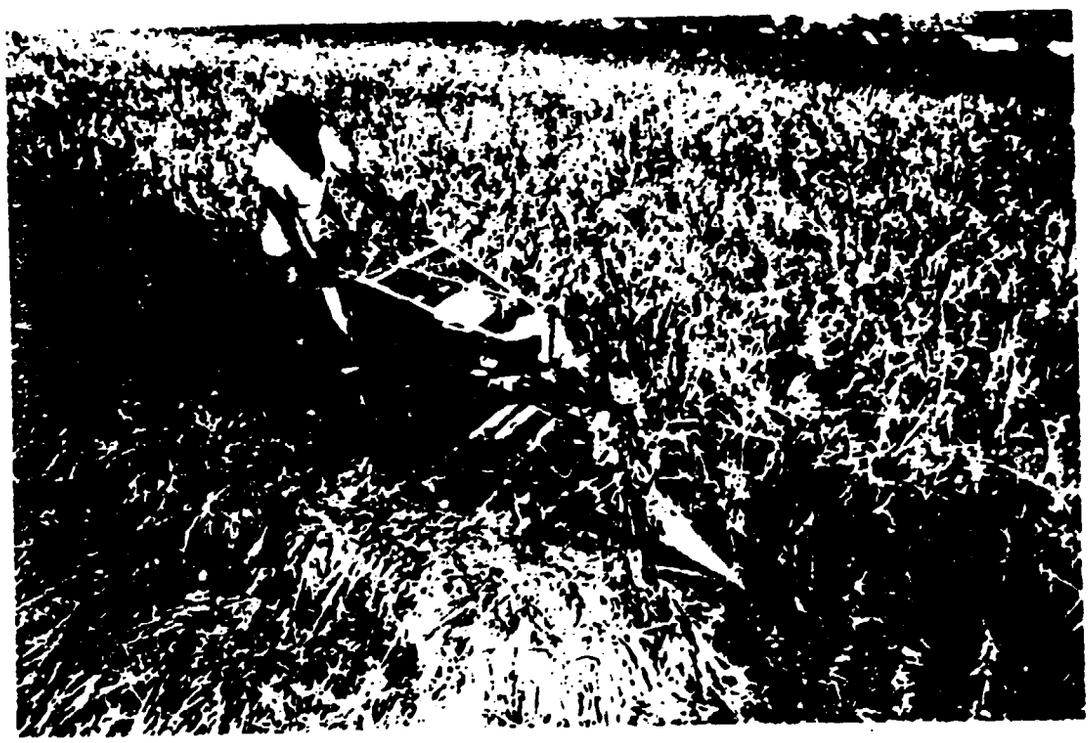


Figure 2. CAAMS-IRRI 1.0 m Reaper.

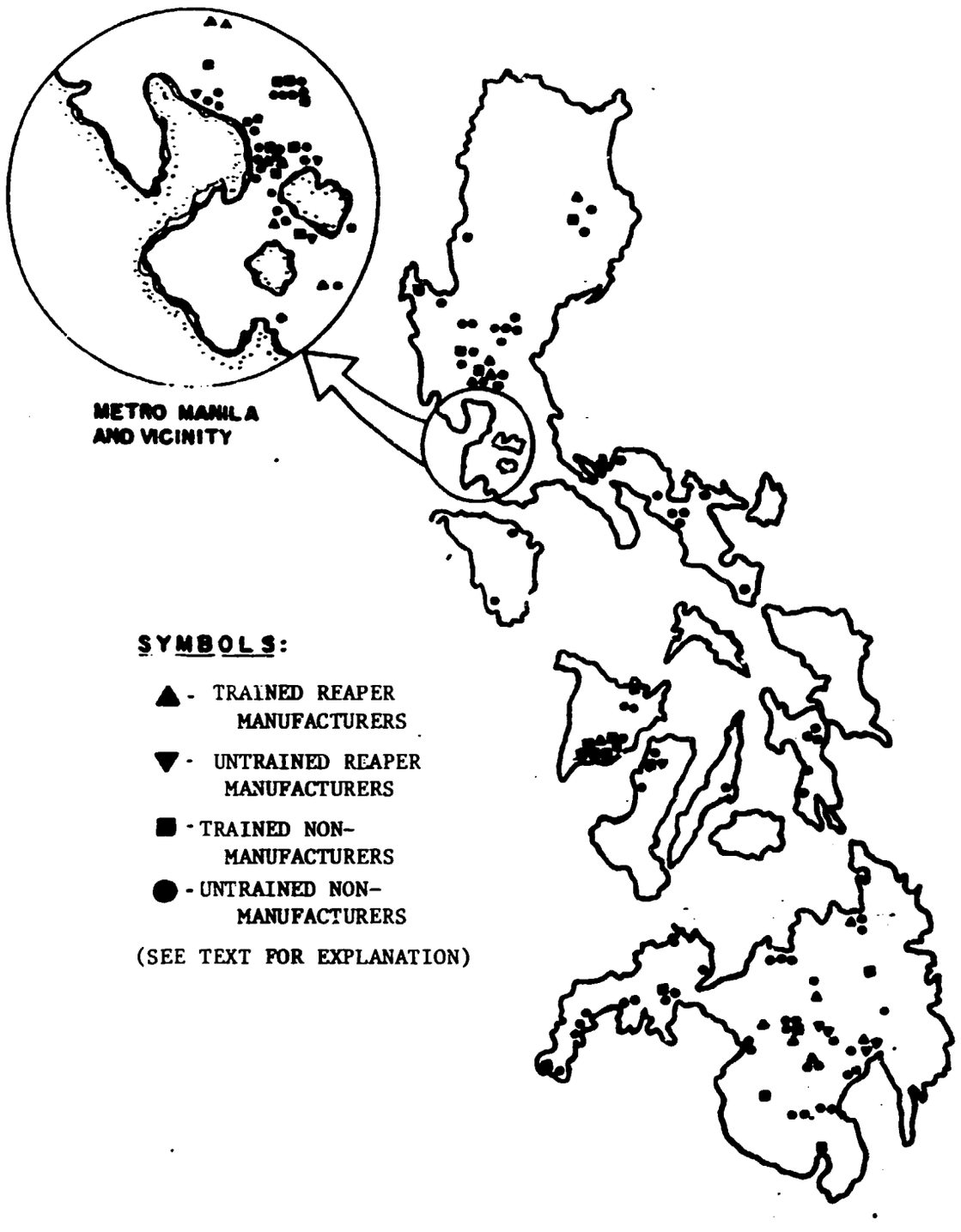


Figure 1. Geographical Location of Cooperating Manufacturers of the MA-IRRI Industrial Extension Program for Small Farm Equipment.