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RICE MACHINERY DEVELOPMENT AND INDUSTRIAL EXTENSION

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INTRODUCTION AND SUMMARY

The portable thresher with cleaning system (designated TH-7) and the multicrop upland seeder were released to manufacturers during the reporting period. The axial flow pump is in the final stages of testing and production drawings are being prepared.

The rotary tiller attachment, transplanter, and axial flow thresher continue to receive high priority. The rotary tiller and thresher projects are progressing at a good rate and should be ready for release before the end of 1979. Alternative materials are being evaluated for the metering roller of the plow sole applicator prior to release. The rice hull furnace was redesigned to reduce operator control requirements and is being evaluated. New projects initiated during this period include a multiple row liquid chemical injector, an inclined plate seeder, and product improvement of the lowland paddy seeder.

The compacted soils study was terminated after 6 years and 12 crops. Cone index profiles were obtained in each plot and indicate that the power tillers used in the study tend to develop a plow pan more readily than the 4-wheel tractor or animal tillage systems. A water use study on alternative tillage procedures indicates that the land preparation period can be shortened somewhat without adversely affecting tillage quality and increasing weed growth.

Surveys on IRRI thresher adoption, farm storage practices, and village milling systems and improved systems for the economic analysis of our machines will enhance our ability to select and evaluate new development projects and aid in determining needed product improvements in existing products.

The Consequences project has progressed to the data collection phase and efforts are also being directed to developing the data analysis systems required to process the field data.

Thresher production continues to increase in the Philippines and Thailand. The IRRI-PAK wheat and rice thresher has been released to manufacturers who are now producing prototypes. Technical assistance is being concentrated on a few firms in the Philippines, based on their ability to absorb and use the assistance as determined by a manufacturer survey. Manufacturer contact has been emphasized in Thailand and the upland seeder and vertical bin dryer are being evaluated. The axial flow pump and an amphibious tractor have been built in Indonesia and are being field tested.

Papers and Publications

1. Ebron, L., H. Takai and B. Duff. 1979. "Farm Level Paddy Storage Practices in the Philippines." Paper presented at a workshop on Grain Post-harvest Technology sponsored by Southeast Asia Cooperative and Post-harvest Research & Development Programme, Bogor, Indonesia. January 16-18. Paper #79-01.

2. Habito, C. F. and B. Duff. 1979. "A Systems Analysis of Mechanized vs. Non-mechanized Rice Harvesting in the Philippines." Paper presented at a workshop on Grain Post-harvest Research and Development Programme, Jakarta, Indonesia. January 16-18. Paper #79-02.

3. Camacho, I., R. E. Manalabe and B. Duff. 1979. "Empirical and Laboratory Evaluation of Village Level Rice Milling Systems." Paper presented at a workshop on Grain Post-harvest Technology sponsored by the Southeast Asia Cooperative Post-harvest Research and Development Programme, Bogor, Indonesia. January 16-18. Paper #79-03.

4. Lee, K. S. 1979. "An Evaluation of Water Use Efficiency and Energy Requirements for Wetland Tillage." Seminar paper. April 10.

5. Moss, C. J. 1979. "Engineering Design and Development Challenge for the Benefits of Small Farmers." Paper presented at the Annual Convention of the Philippine Society of Agricultural Engineers, Ramada Hotel, Manila, Philippines. April 27.

6. Duff, B. 1979. "Grain Losses in Small Farm Rice Post Production Systems in the Philippines." Paper presented at the 1979 Summer Meetings of ASAE and CSAE. University of Manitoba, Winnipeg, Canada. June 24-27.

PROGRESS REPORT NO. 28
January 1 to June 30, 1979

The following projects were active during the reporting period:

Design and Development (C. Moss, J. McMennamy)

6- to 8-hp tiller with steering clutches	I. Manalili, F. Cabrales
Rotary tiller attachment for the 6- to 8-hp tiller	I. Manalili, F. Cabrales
Multicrop upland seeder	M. Aban, S. Labro
Axial flow pump	G. Salazar, E. Calilung
Rice transplanter	I. Manalili, S. Labro
10-row liquid injector	G. Salazar, G. Espiritu
Wetland paddy seeder	M. Aban, G. Espiritu
Inclined plate planter	M. Aban
Portable axial flow thresher with cleaning system	J. Arboleda, R. Dayrit
Axial flow thresher	J. Arboleda, M. Diestro, R. Dayrit

Machinery Testing and Utilization (D. Kuether)

Compacted soil studies	F. Cabrales
Water use efficiency and energy requirements for wetland tillage	K. Lee
Horizontal oscillating screen performance	A. Caballes, M. Diestro

Engineering Economic Systems (B. Duff, J. Wicks)

Thresher adoption and use survey	F. Juarez
Farm storage practices	L. Ebron
Village milling systems	I. Camacho
Systems simulation modeling of post-production operations	B. Duff
Machine costing	R. Echevarria
Cost analysis of the IRRI axial flow pump	C. Maranan
Pest management practices and technology	P. Carbonell
Consequences of small farm mechanization	D. Unson, P. Moran, E. Trinidad

Industrial Extension (J. McMennamy, R. Fischer, A. Khan, V. Reddy)

Industrial extension in the Philippines	Project staff (table 4)
Industrial extension in Thailand	Project staff (table 4)
Industrial extension in Pakistan	Project staff (table 4)
Industrial extension in Indonesia	Project staff (table 4)

DESIGN AND DEVELOPMENT

6- to 8-hp tiller with steering clutches

Testing of a tiller powered by a lightweight high-speed diesel engine that is supported on a 4-coil spring mounting to reduce the transfer of vibrations continued. After 109 hours of plowing and harrowing, the two front springs failed. Both failures occurred at the center coils. The springs used were discarded automotive engine valve springs with a 4.5 mm wire diameter and 29 mm coil diameter. These were replaced with new valve springs but after about 216 hours the two rear springs failed.

Springs with a 6.5 mm wire diameter and 37 mm coil diameter, but maintaining the same 54 mm free height were installed. The test was resumed and the tiller has completed 280 hours of operation without failure. The heavier springs are as effective as the original springs in reducing the transfer of vibration from the engine to the operator. Field testing will continue until 500 hours without a failure are logged.

Rotary tiller attachment for the 6- to 8-hp tiller

The fabrication of a second prototype was initiated during this reporting period. A review of the design of the first prototype, particularly of the critical parts was made and several parts revised with experience gained from field tests.

The mounting of the countershaft, which carries the input pulley and the driving sprockets for the multi-speed primary drive, was revised. The pillow block bearings were replaced with a pivoted bearing housing resulting in a variable center distance between the engine and the countershaft. This eliminates the need for a tension pulley for engaging and disengaging the belt, and a gain in belt life. Clutching is effected by swinging the countershaft mounting about its pivot point with the clutch lever which decreases the center distance to disengage the belt drive. Speed changes are accomplished by shifting, either the belt to the appropriate sheave, or the chain to the desired sprocket ratio, or both. Four speeds, from 2 km/hour to 12 km/hour are available.

To prevent the chain from jumping off the sprockets during disengagement, a wooden braking block is provided (Fig. 1). As the driven pulley moves downward the large sheave presses against the wood block which stops its rotation.

It was reported earlier that the entry of dust and dirt, especially during dryland tillage, caused excessive wear on the primary chain drive. To prevent this, a dust-proof chain shield with provision for allowing changes in the center distance between the driving and driven members, was added to the new design.

The rotavator dog clutch was simplified by using an eccentric shifter (Fig. 2) instead of the previous fork-type, which had more moving parts. The fork-type design required installation of a coil spring inside the casing to pre-load the movable dog clutch. Only an external tension spring is used in the eccentric type.

The new prototype was completed and is being tested. Five hundred forty-one hours of endurance testing has been logged without major breakdown. The release of production drawings is planned for the last quarter of 1979.

Multicrop upland seeder

Field calibration and performance testing of the multicrop upland seeder has uncovered additional areas that need improvement. More ground clearance of the tool bar is required to prevent the tool bar from bulldozing loose soil when the furrowers are set for deep penetration. To increase the ground clearance, the bearing mount bar of the main frame was lengthened 5 cm. Incomplete stroking of the oscillating seed metering plates also occurred which affect seed and fertilizer discharge uniformity. To correct this, the loosely fitted pins that connected the plates to the oscillating frame were replaced with bolts.

Prior to the above modifications, seeder prototypes were sent to Thailand and Bangladesh for field trials. Test reports from Thailand also mentioned the need to increase tool bar ground clearance. Another unit was loaned to a college in Northern Luzon for use in field trials and demonstrations to farmers. Information from these activities will help determine the seeder's acceptance by farmers and adaptability to farmer's field conditions.

Axial flow pump

After a performance test was conducted on the first prototype, a value analysis team was formed to reduce the cost of the pump and improve its versatility. The result is the pump shown in Figure 3. The major changes included: 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 use of a power tiller to power the pump.

Tests are being conducted to determine if removal of the inlet guide vanes has an adverse effect on performance.

Rice transplanter

Following the transplanter laboratory tests reported in SAR #27, field tests were conducted. The feeder fingers described in SAR #26, which enter through slots in the feeding frame, only lifted the lower edge of the seedling mat and did not effectively push it down the tray.

Due to the location of these slots the unsupported portion of the seedlings between the feeding frame and the moving tray was excessive so the seedlings in contact with the stationary feeding frame tended to be left behind, resulting in frequent missing hills.

To correct these problems, the location of the entry of the feeder to the seedlings was changed. The lower edge profile of the tray was modified to give a slightly higher entry point for the feeder. A narrow sheet metal strip was attached to the lower end of the tray to form a slot running the entire length of the tray. This slot serves as the entry for a single narrow strip having the same length as the feeding frame (Fig. 4). This strip replaced the feeder fingers and is supported by levers at both ends, which are connected by a link to the pivot arms.

The slide guides which supported and limited the handle to straight line travel were eliminated. A U-shape handle made of lightweight pipe is now pinned at each end to the pivot arms which allows it to pivot freely as it is pulled or pushed downward during machine operation. This change provides more flexibility, simplified construction, and reduced machine weight.

These modifications produced marked improvement in the performance of the machine. Missing hills range from 2 to 5% depending on the quality of the seedlings. Field capacity was initially about .3 ha/day but this is expected to improve as the operators gain experience.

Based on the favorable results of the test of the first prototype, a second prototype was built during the reporting period. Some changes have been made in machine geometry to permit transplanting in fields with deeper standing water. The picker holders were lengthened to allow planting in water up to 15 cm deep without the picker frame immersing in the water. This required longer tubular frames which support the pivot arm hinges. Adjustable stops, mounted at both sides of the wooden skid, limit the downward travel of the pivot arms to control the depth of planting.

Due to frequent trouble with the tray indexing mechanism, a new one was designed. This consists of a pawl and ratchet wheel which rotates a sprocket (Fig. 5). The sprocket drives a roller chain supported by two rollers pinned to the main frame. A carriage bar, connected by an offset link to the roller chain, slides on a guide secured to the frame. The reciprocating movement of the bar is transmitted to the seedling tray, which is attached to the carriage bar. The distance between the rollers determines the length of tray travel.

A blade-type picker that tends to cut the soil bearing seedlings into blocks, instead of clawing them as the 3-prong type does, was developed (Fig. 6). It has three blades bolted to a square shank. The two outside blades are the same length with their ends sharpened to an S-shape cutting edge for less shearing resistance. The middle blade, which fits in a slot on the shank, is shorter and has a dull edge for pushing the block of seedlings that are cut by the two side blades. The performance of the transplanter has improved with the blade-type pickers. Seedlings per hill was reduced and release during the return stroke has also improved. Field tests under different water levels and land preparation conditions are in progress.

10-row liquid injector

The Department has investigated several designs for the deep placement of chemicals in the soil. One was a two-row, push-type liquid injector reported in SAR #21. Problems of unstable discharge rate, excessive effort necessary to push the machine in the field, clogging of the discharge nozzles, and high manhour requirements per hectare caused termination of the project.

To eliminate or reduce these problems, a pull-type, 10-row liquid injector was designed to place either insecticide or fertilizer 5-10 cm below the soil surface by spot injection. This applicator is designed to be used as a row marker for transplanting while injecting chemicals, or can be used 5-10 days after transplanting. It uses a peristaltic pump metering assembly that is attached to a wooden frame. The chemicals are pumped through 10 discharge nozzles housed in steel tubes that penetrate the soil (Fig. 7). The peristaltic pump accurately meters the correct amount of chemical and provides sufficient pressure to prevent clogging of the nozzles.

The peristaltic pump consists of ten flexible tubes that are progressively squeezed by a roller against a stationary semi-circular PVC backing. As the roller moves, it pushes the chemical toward the nozzles. A ratchet secured to the roller shaft is rotated by a pawl which is attached to a crank. The back and forth movement of the hand lever actuates the crank. The length of hand lever stroke controls the dose of chemical injected into the soil.

The total weight of the machine is 10 kg. The injector was calibrated in the laboratory and later tested in the field. It operated without difficulty even in poorly prepared soil.

The injector will be field tested to determine durability, effectiveness and field capacity.

Wetland paddy seeder

The IRRI multicrop seeder was developed several years ago but has won very limited acceptance by Asian farmers. Use of the present machine requires that the field be leveled after land preparation with no standing water prior to planting The seed is placed in furrows and no water can be applied for 4 to 6 days, when the crop is established. A heavy rain can cause premature closing of the furrows resulting in seed destruction by the anaerobic condition of the puddled soil.

The above conditions are difficult to obtain and maintain by most farmers, so it was proposed that the machine be redesigned to deposit the seed and lightly anchor it on the surface of the puddled soil to resist floating during a heavy rain. Another objective was to reduce the pull requirements of the machine so a man can pull it with moderate exertion. The machine should also operate satisfactorily in fields with good to moderate soil preparation.

An economic review of the wetland paddy seeder project showed that use of the 4-row wetland seeder would be more economical than the dry bed and wet-bed methods of transplanting, broadcasting, and use of the IRRI 6-row multihopper seeder. The study included labor cost for weeding, which is an associated problem with direct-seeding and broadcasting.

The first prototype of the seeder was a modified version of the original multihopper seeder. The skid was replaced by two lugged drive wheels. Hopper shape and position with respect to the metering roller were changed slightly for better feeding and flow of seed. The original position of the seeder hopper provided poor feeding to the seed metering pockets as the hopper emptied, resulting in non-uniform metering. The repositioning of the hopper on the first prototype gave a more uniform seed discharge. Four presswheels made of wire mesh lightly anchored the pre-germinated seeds on the surface of the puddled soil in the desired manner. The drive wheels penetrated to the hard pan depth which made the machine difficult to pull.

A second prototype was constructed to further improve seed metering and correct the drive wheel problem (Fig. 8). The metering roller with seed pockets was changed to a roller with spikes made of headless nails located at the middle portion. A groove was added to the hopper so seeds are scratched out by the spikes (Fig. 9). The ground drive wheels were increased in width and diameter for greater floatation and higher clearance. Preliminary tests produced a continuous drop of seeds in the rows. Maximum penetration of the ground wheel was approximately 10 cm which reduced the pulling effort. Field tests are being conducted to evaluate the performance of the machine.

Inclined plate planter

Establishment of an upland crop that follows a rainfed lowland rice crop is affected by the method of land preparation and availability of soil moisture. Reducing land preparation to a minimum is one way of more fully using the residual moisture as the second crop is planted earlier. If this can be done without sacrificing the proper environment for good seed germination and plant growth, considerable savings in energy and time are possible.

A project was initiated to develop a machine that opens a narrow furrow in an untilled soil, places the seed at the desired depth and spacing, closes the furrow, and firms the soil for good seed-soil contact. A first prototype consisted of a hopper with a wooden, circular metering plate inclined at 45°, seed tube, double-disc furrow opener, and an inclined presswheel which also served as a ground drive for the metering plate. The assembly was attached to a moldboard plow, which was used to cut an adjacent furrow to drain excess rain water.

Preliminary tests of the first prototype showed:

1. Uniform seed metering was obtained with the inclined plate and gravity seed cut-off.

2. The wooden metering plates wore quickly. This caused seed milling when the seed entered the clearances created between worn plate and side wall. The periphery of the metering holes was also worn. Some clogging of seed in the seed plate holes occurred, probably due to the rough surfaces of the holes.

3. In saturated and soft soil conditions, mud collected between the discs of the furrow opener which eventually clogged. Proper soil moisture content during planting is essential for good opener performance.

4. The furrow slice cut by the moldboard plow covered the path of the power tiller's wheel for the next pass, making it difficult to maintain a straight planting line.

Improvements were incorporated into a second prototype to correct the above problems (Fig. 10). This is a two-row machine consisting of two planting units attached to a tool bar. Each planting unit can be adjusted laterally on the bar for varied row spacing. The double-disc furrow opener was replaced by a single disc and which is attached to the tool bar frame by a U-bolt clamp. The metering plate is now made of metal which gave better metering performance without seed damage. Single seed metering can be attained with larger seed sizes in preliminary tests. Plant spacing in the row is controlled by the number of seed cells or metering holes in the metering plate. The planter is being evaluated by the IRRI Multiple Cropping Department in their field trials.

<u>Portable axial-flow thresher with cleaning system</u>

A general description and development progress of this machine were reported in SAR #25, 26, and 27. No major failures occurred during the 500 hour durability test in which over 200 tons of paddy were threshed. The three thin gauge metal sheets bolted together to form oscillating screen hangers passed the durability test and is now incorporated in the design.

Slight modifications to the machine were made to correct problems encountered during the tests. The sidewall of the feed tray was increased to 18 cm to accommodate more material and prevent threshed material from overflowing during operation. The blower shutter was also redesigned to provide a single lever adjustment for a wider range of airflows. Air vanes were added to the two inner rings of the open threshing cylinder to assist the axial movement of material and to suck air from the feed opening which prevents blowback and eliminates a dust hazard to operators.

Another feature of the machine not mentioned in previous reports is the easily removable feed tray, threshing cylinder, and cover. These components are connected to a single frame that rests on and is fastened to the main frame by pins and hood latches (Fig. 11). Dividing the machine in two sections provides for easier transport of the thresher over long and/or adverse field conditions. These modifications were added to the production drawings which have been released to manufacturers.

Axial flow thresher

The development of an improved version of the axial-flow thresher reported in SAR #26 and #27 was given greater emphasis during the reporting period. Although the first prototype performed satisfactorily in short tests, field testing revealed design and endurance problems. The machine was redesigned and individual components, assemblies and their interrelationships were analyzed to produce a more efficient and durable machine.

The open threshing cylinder was strengthened with thicker anchor bars and repositioned middle rings. Air vanes were added inside the threshing cylinder to assist material movement and suck air into the feed opening to eliminate blow-back and a dust hazard to operators. The pegs installed at the feed end of the cylinder were hard surfaced to reduce wear. The semi-circular round bar concave was bolted to the frame for easier removal and repair. Removable hard surfaced counter pegs were located opposite the feed opening and in the lower middle portion of the concave. The hub, spokes, and shutter of the two centrifugal blowers were redesigned and the assembly was repositioned outside the main frame for increased concave-grain chute clearance. The screen frames were redesigned for easier installation and dismantling, and minimum grain spillage. Screen oscillation was reduced to 306 cycles per minute and stroke to 31.8 mm. The screen assembly hangers, which are inclined at 25° from the vertical, and the bell crank assembly were rubber bushed to absorb shock and vibration. The auger, which conveys the clean grain to the rear of the machine was repositioned and adjusted to reduce grain damage. The 10 hp engine, semi-hexagonal louvered cover, and cylinder straw paddle designs were retained.

The redesigned machine produced good results in short performance tests conducted at IRRI. Capacities of 1.2 t/hour were obtained in paddy at 25% M.C. and .48 m.o.g. to grain ratio. Separation loss, blower loss, and grain damage were less than 1% each.

Six hundred three hours of durability and testing were logged. During this test some problems were encountered, resulting in the following design changes:

1. The rubber bushings at the pivot points between the eccentric arm and bell crank assembly and the bell crank assembly pivot to the frame failed after 3 hours of operation. After these components were redesigned and ball bearings were installed, no additional failures occurred.

2. Constant clogging of straw between the straw paddles and thrower housing, caused by inefficient discharge during operation, was corrected by redesigning the straw paddle and discharge opening. A peg-type straw paddle was installed, the discharge opening was enlarged, and a straw discharge guide was introduced (Fig. 12). These modifications eliminated clogging.

3. The .9 mm thick semi-hexagonal cover eroded rapidly at the feed end during the first 100 hours of operation. 1.2 mm thick sheet was used and a replaceable wear plate was added.

4. The 31.8 mm dia standard pipe towing bar failed at the bolted end during field transport. This was replaced by a 60 mm dia standard pipe.

The above changes were incorporated in two prototypes that were fabricated at IRRI. They were sent to ICRISAT in India and the IRRI-Pakistan project for further testing. Production drawings are being prepared, and after construction of a prototype from the drawings, as a final check of the drawings, they will be released to manufacturers.

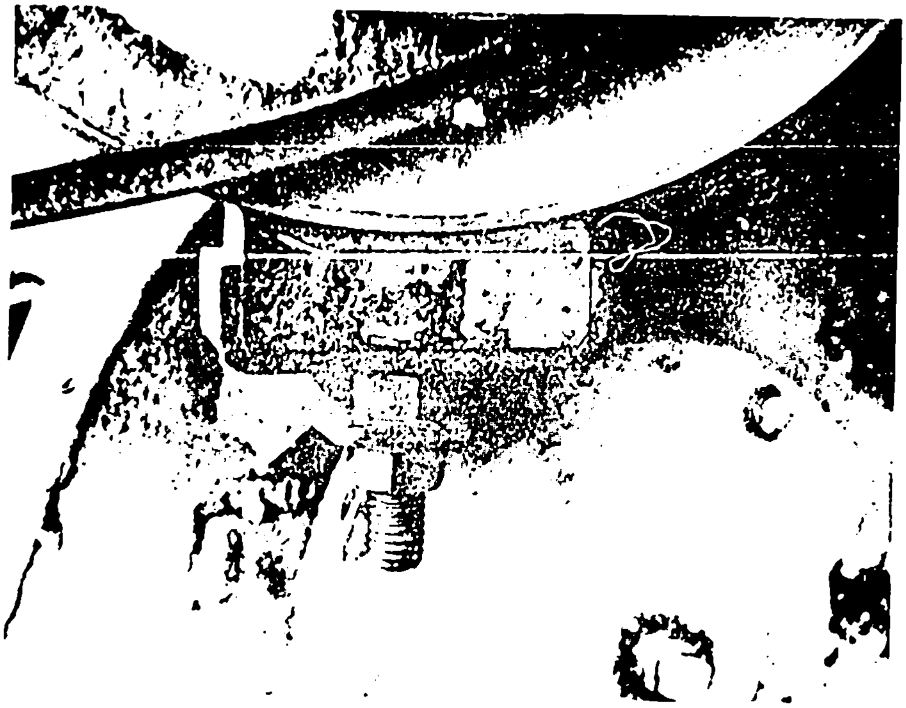

Fig. 1 Rototiller primary drive brake.

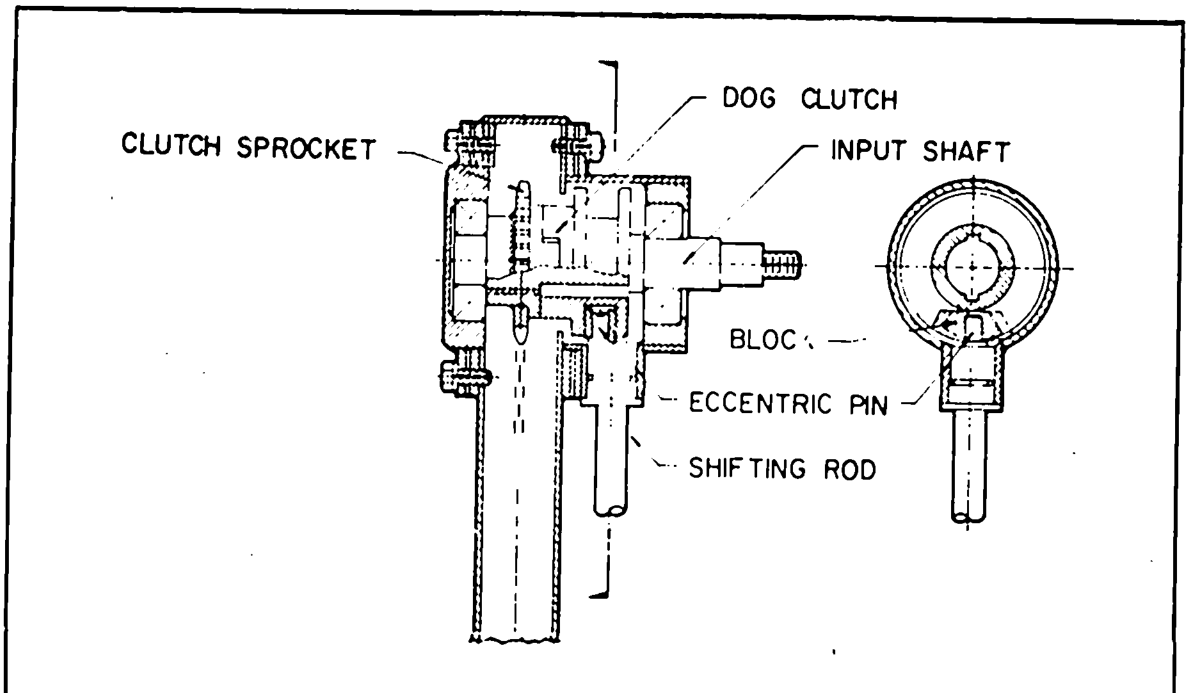

Fig. 2 Rototiller clutch.

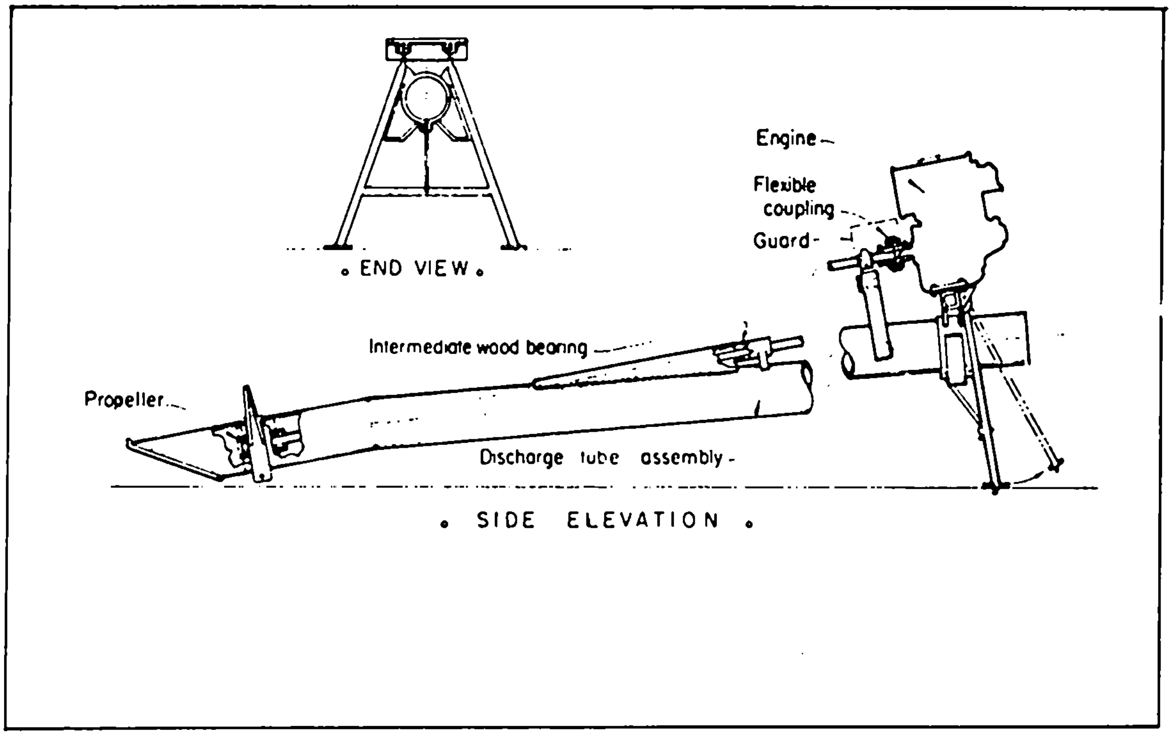

Fig. 3 Axial flow pump.

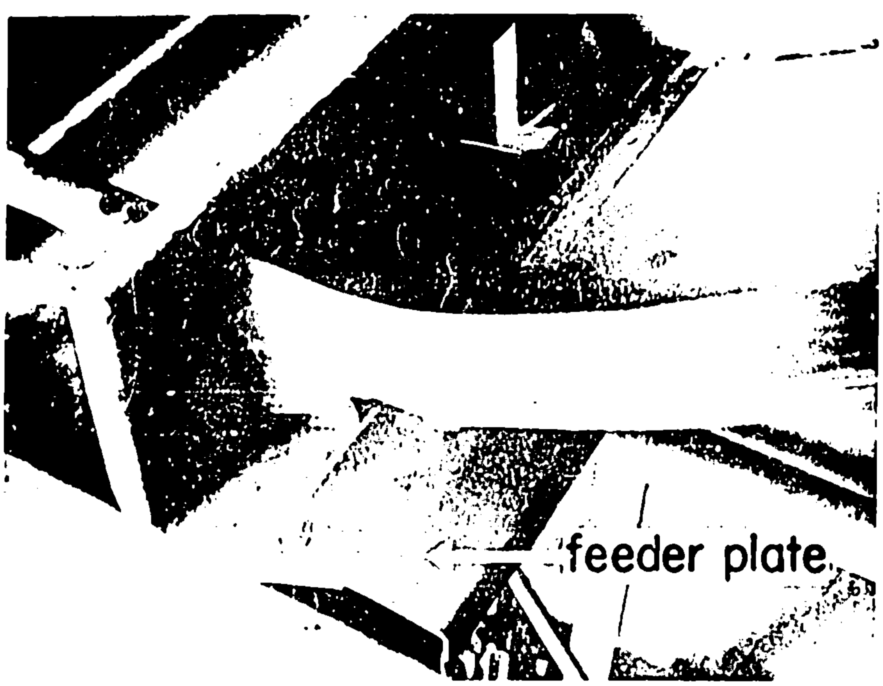

Fig. 4 Transplanter feeder strip.

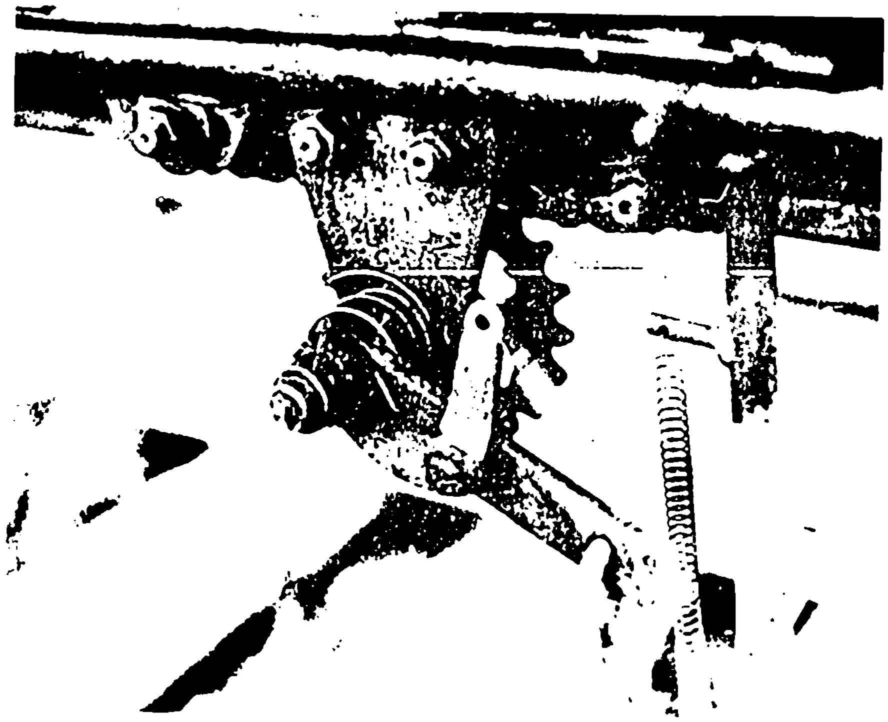

Fig. 5 Transplanter tray indexing drive.

Fig. 6 Blade-type picker.

Fig. 7 Liquid chemical injector.

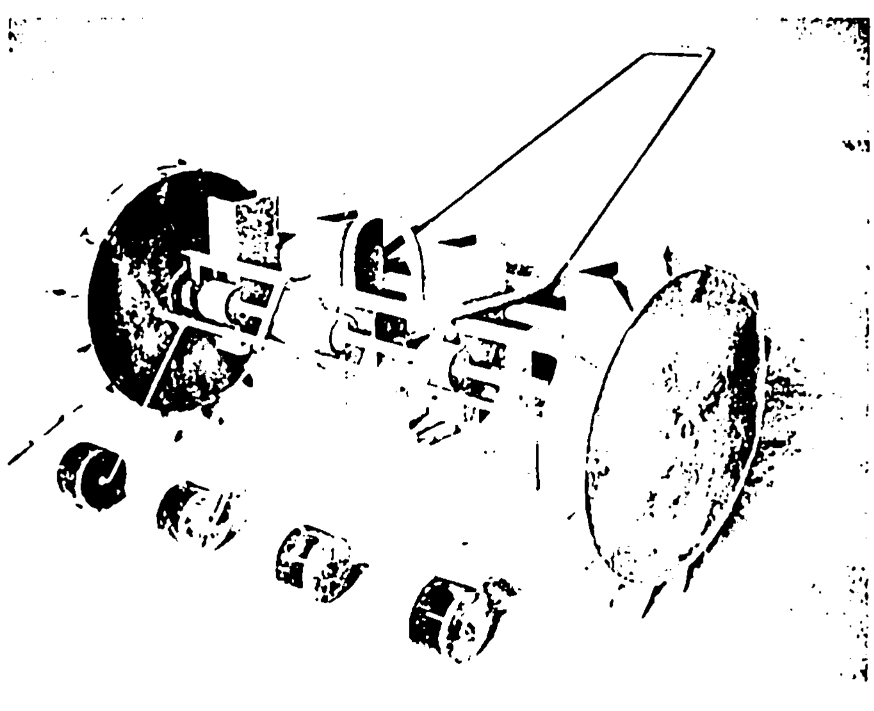

Fig. 8 Wetland paddy seeder.

Fig. 9 Wetland paddy seeder metering wheel.

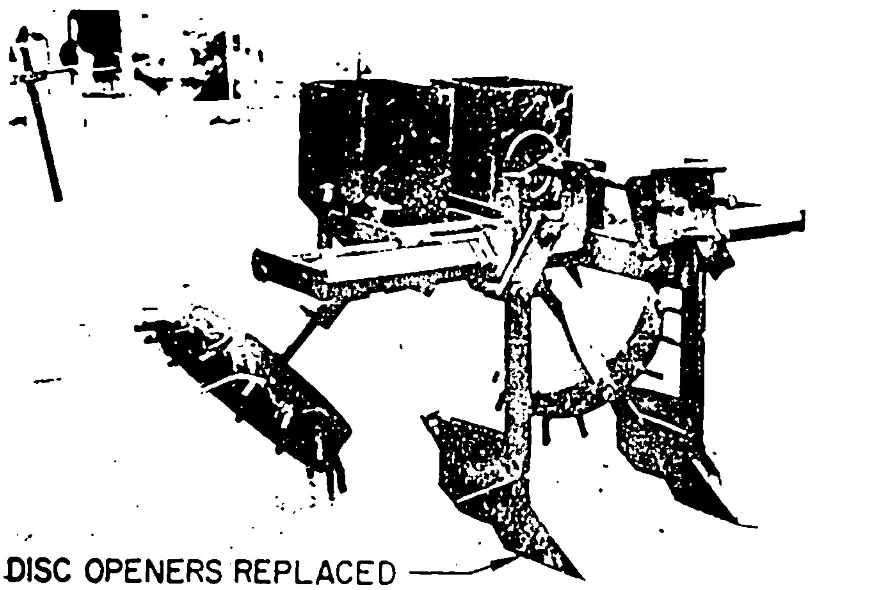

Fig. 10 Inclined plate p'anter.

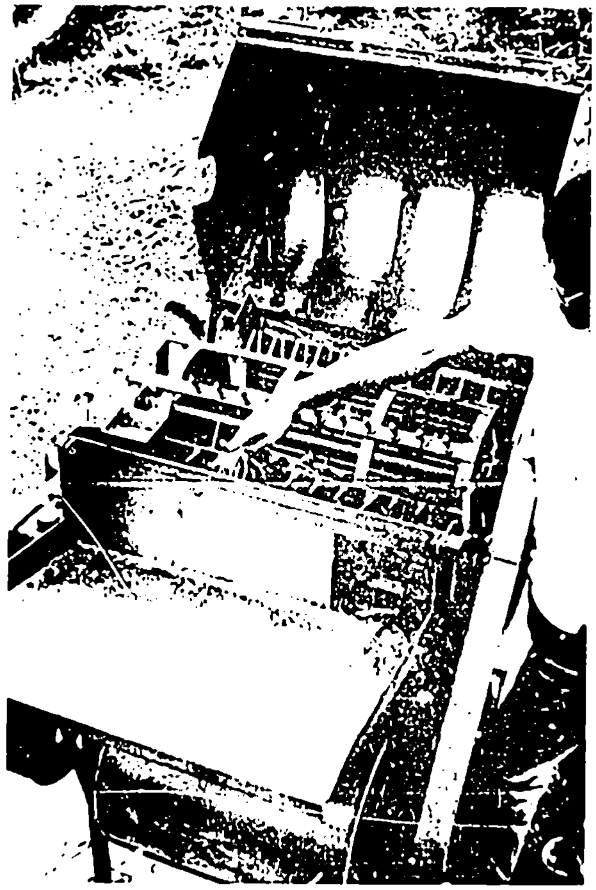

Fig. 11 Portable thresher with cleaning system.

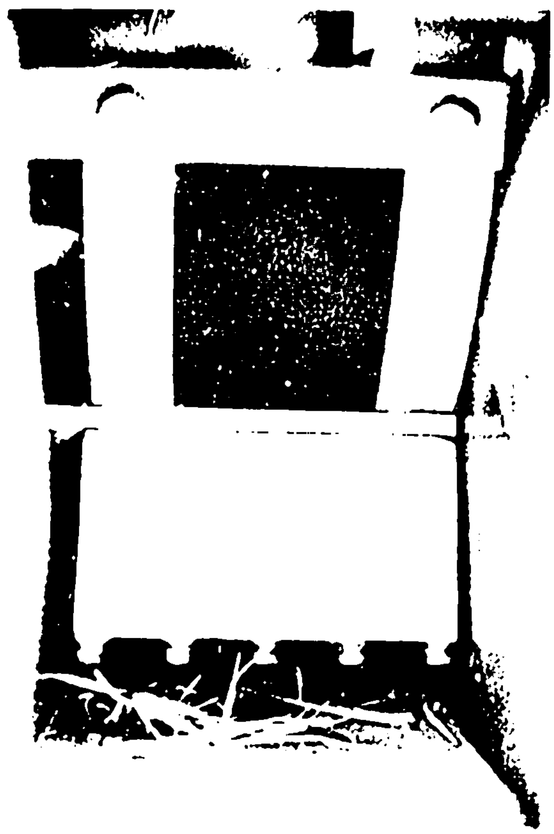

Fig. 12 Axial flow thresher straw paddle.

MACHINERY TESTING AND UTILIZATION

Compacted soil studies

A cone index vs. depth profile was obtained in each plot, before and after tillage for crop 12. The cone penetrometer was mounted in a frame that rested on the soil. Individual weights, calibrated to produce a cone index of 0.6 kg/cm^2, were placed on the penetrometer in succession and the resulting penetration depth for each increment of weight was recorded (Fig. 13). Three profiles were taken at five sites in each plot.

The cone index profiles are shown in Figures 14 and 15. The profiles for both tillers exhibit a definite point where a marked change in the slope occurs (Fig. 14). For the 7 hp tiller, this point roughly coincides with the average plowing depth and thus could be interpreted as the plow pan. These slope changes do not appear in the profiles for the water buffalo and 4-wheel tractor plots. This lack of an abrupt slope change and the less pronounced slope change in the AT water buffalo profile (Fig. 15) when compared to those of the tillers, could be caused by the tillage action of the animal's hooves. The small bearing area of the rather heavy (500-600 kg) animal's hooves results in their penetrating deeper into the soil than that of the implement drawn by the animal.

Similar profiles were obtained in plot B7 of the Institute's continuous cropping plots during land preparation for crop 51. These profiles when compared to our tillage trials plot profiles, show a substantially deeper soil with little indication of a hard pan layer in the first 30 cm of soil, even though lightweight power tillers have tilled the plots for a number of crops.

More precise profiles, taken at smaller cone index increments in a wide range of soil types and fields with known cropping and tillage histories, are required to determine the relative effectiveness of various tillage systems on creating and maintaining a hard pan.

Water use efficiency and energy requirements for wetland tillage

In the Philippines, traditional land preparation for irrigated rice usually requires about one month. Control of weeds, chemical reactions of decomposed organic matter, and water availability all contribute to this long land preparation duration. If the land preparation period can be reduced without sacrificing the quality of puddling, water saving is a possible result. A study was conducted with the objective of determining the most efficient tillage procedure for wet and dry seasons with respect to water use, energy, and time requirements, while maintaining puddling quality and weed control.

A field of 0.25 ha on the IRRI experimental farm was divided into six plots by installing additional levees and lining each plot with polyethylene film to a 70 cm depth to help control water movement between plots. This did not completely control flow between plots but water inflow to each plot was measured for the entire period by a penrecorder which was calibrated to the height of water inflow from the hydrant.

A cone penetrometer (ASAE R313.1) with cone base area of 3.2 cm^2 was used to measure soil depth at cone indexes of 2.46 and 4.92 kg/cm^2. The cone index was also measured at soil depths of 5, 10, 15 and 20 cm. Soil shearing force was measured in the laboratory by a vane shearmeter. After transplanting, sloping gauges were installed to measure water losses from the field. A 4-tube piezometer set with tube lengths of 70, 100, 130, and 160 cm was installed in the middle of each plot to monitor the water table depth. Evaporation, rainfall, piezometer water level, and sloping gauge readings were recorded daily. Except for 2 or 3 days after transplanting water depths of 3-5 cm were maintained for 22 days after transplanting to control weeds. An IRRI power tiller, with a moldboard plow and comb harrow, was used for all tillage.

Dry season experiment

The field was allowed to dry out before water was applied. Change of soil moisture content, cone index, and soil shearing force were measured daily just before irrigating in all plots during the plowing period. After plowing was completed in all plots harrowing followed, according to the schedule shown in Figure 16. Twenty-two to twenty-three-day seedlings (IR42) were used in all plots.

As soil moisture content increased during the first 1 or 2 days of irrigation, soil resistance decreased quickly. Irrigation after the second day resulted in slow changes in soil resistance and after 3 days no additional change was detected (Fig. 17). Soil resistance after 3 days of irrigation stabilized so differences in fuel consumption and machine field capacity were similar in those treatments tilled after 3 days of soaking. No significant differences in weed and plant growth were found between treatments.

Wet season experiment

The soil was fully saturated before the wet season trials started, so soil characteristics did not change after the application of more water. For this part of the study only the duration of the tillage period was varied, with all operations within the periods remaining the same (Fig. 18). Another levee was constructed without use of polyethylene to divide each of the six plots into two. The resulting 12 plots allowed a test of four treatments and three replications.

No positive relationships were found between fuel consumption, machine field capacity, and water applied, primarily because the soil was saturated before the start of land preparation. In the tillage treatment which had the shortest land preparation duration (3 days), soil shearing force and fuel consumption were a little higher in comparison to the other plots. This plot also produced a higher weed dry matter weight than other plots, with plant growth similar in other plots (Fig. 19). No differences in fuel consumption, performance, machine field capacity, plant and weed growth were found in the first three tillage treatments. Treatment 3, which involved 11 days of land preparation appears to be the most efficient tillage procedure. No advantage was apparent in land preparation of longer duration. A more detailed report on this study is available upon request.

Horizontal oscillating screen performance

Two IRRI threshers and a grain cleaner use horizontal oscillating screens for grain cleaning. These screens are expected to perform satisfactorily over a wide range of grain moisture content so a project was initiated to study the effects and relationships of the primary design parameters of an oscillating screen. These are hanger angle, crank radius (throw), and oscillation frequency.

A laboratory machine was built to provide for easily adjustable hanger angle (with respect to the vertical axis), crank radius, oscillation frequency, screen hole size, and material feed rate (Fig. 20). At present, the machine has no provisions for a cleaning fan or variable screen area.

Initial tests were conducted to determine the best method for producing grain samples with reproducible moisture and foreign matter contents. Methods were also devised to provide constant feed rates to the screen. Determining an optimum combination of parameters for cleaning wet paddy (~27% M.C.) is the first objective. A series of runs are being conducted at the ends of the parameter ranges with the aim of reducing those ranges to allow for a manageable number of required test runs.

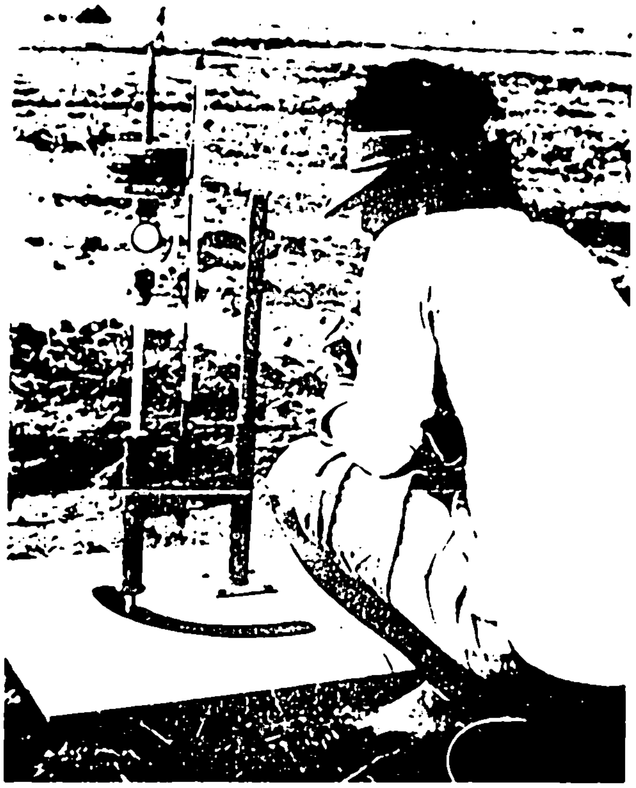

Fig. 13 Cone penetrometer and frame.

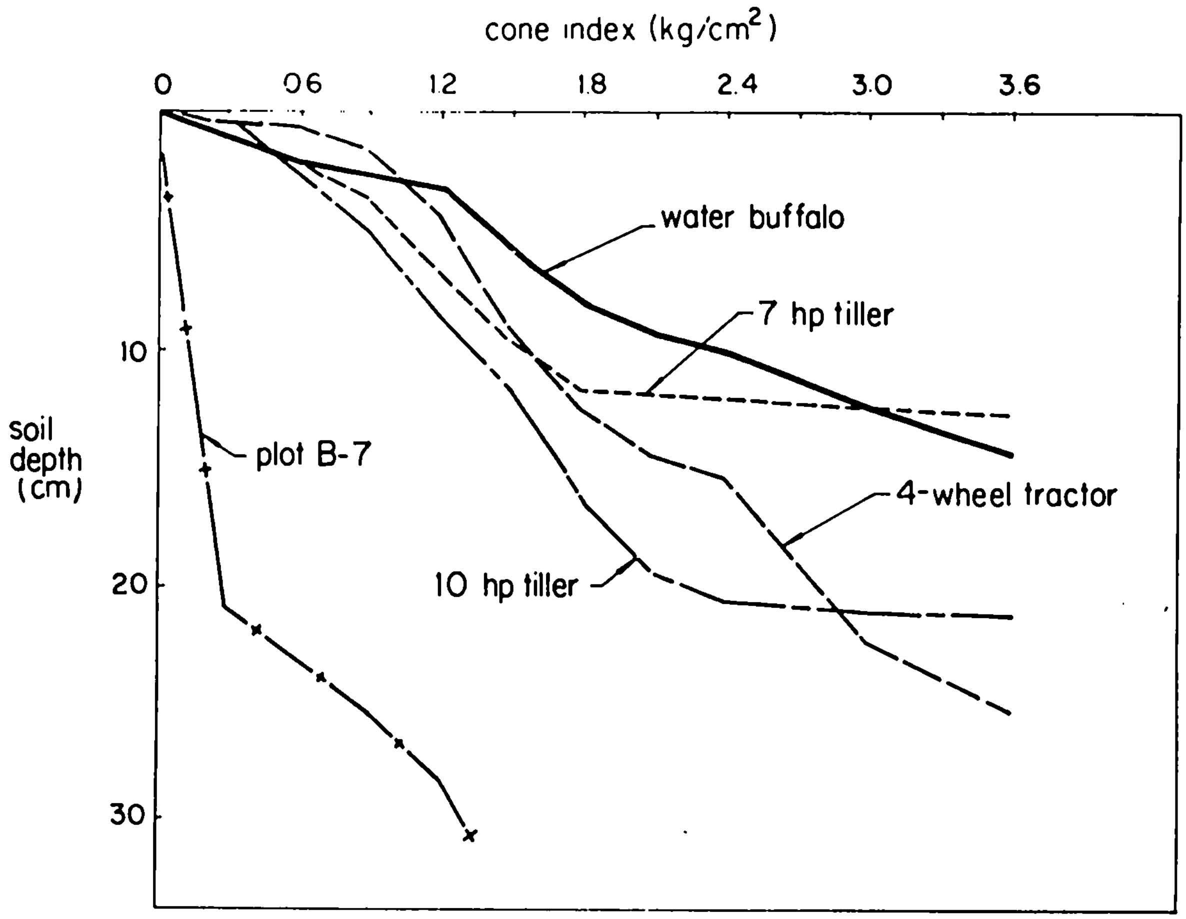

Fig. 14 Cone index profile, before tillage, crop 12, and plot B-7, before tillage, crop 51.

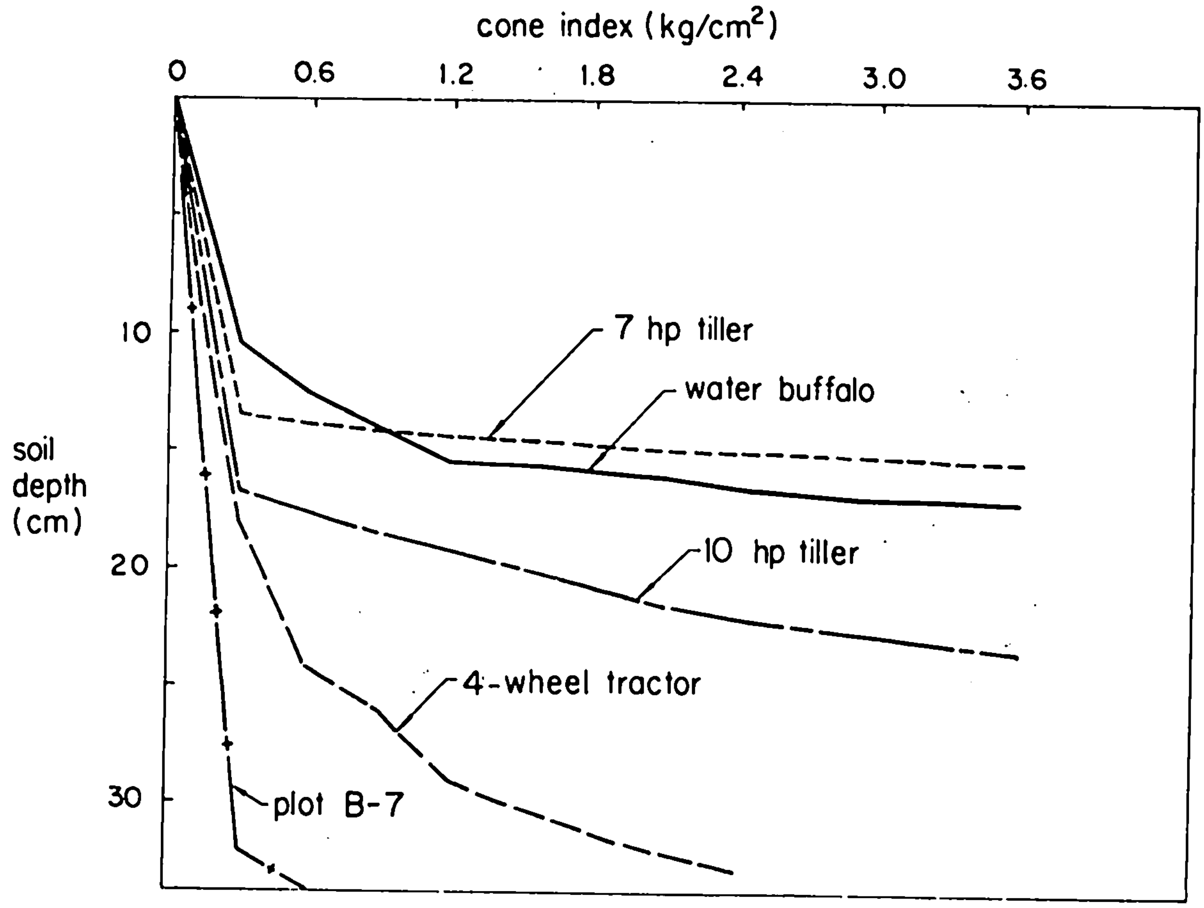

Fig.15 Cone index profile, after tillage, crop 12, and plot B-7, after tillage, crop 51.

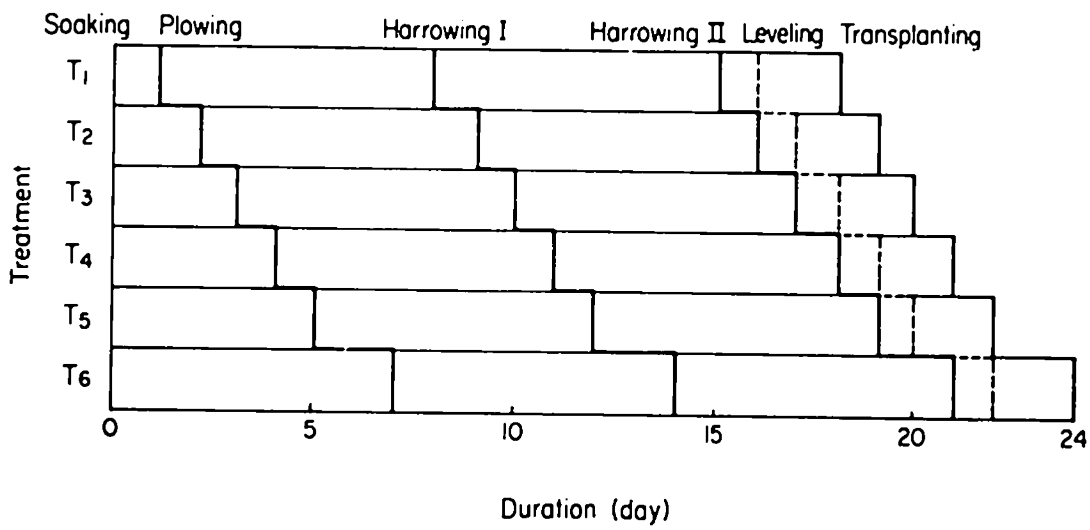

Fig. 16 Duration of land preparation. (Dry Season, 1979.)

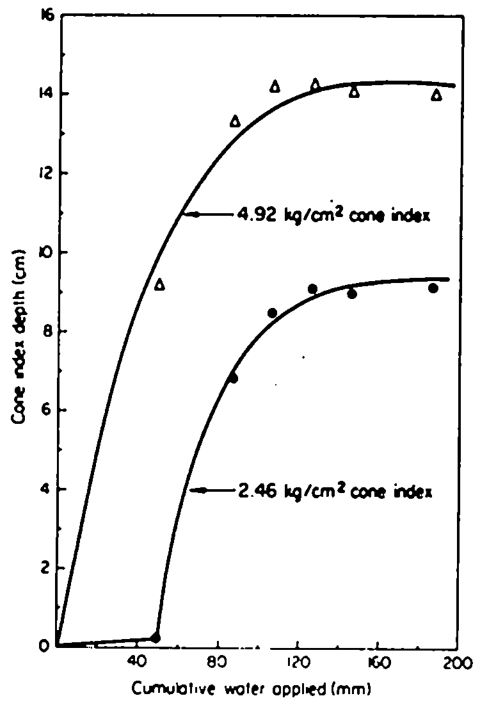

Fig.17 Changes of cumulative water applied and cone index depth, (Dry Season 1979.)

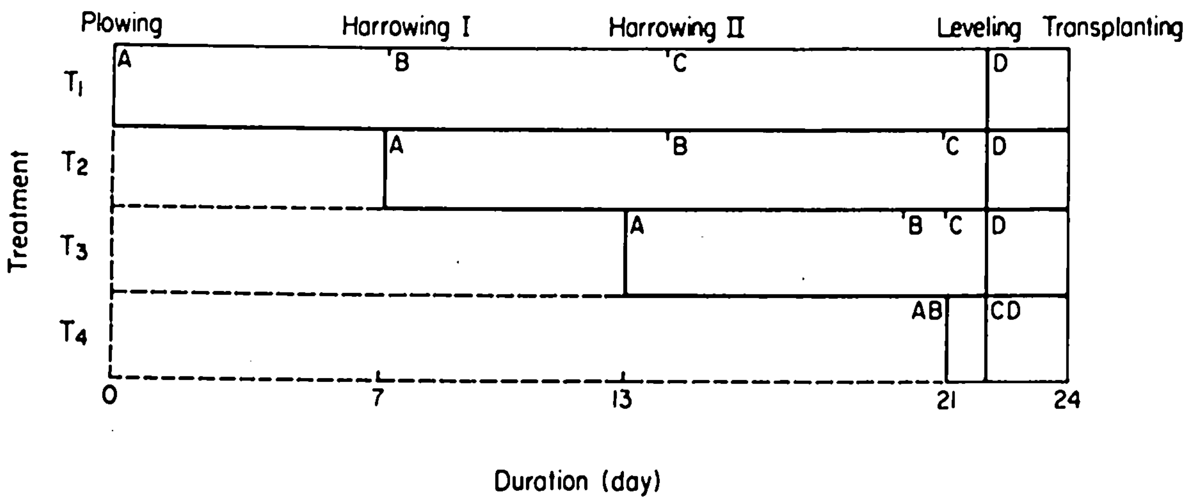

Fig. 18 Duration of land preparation. (Wet Season, 1978.)

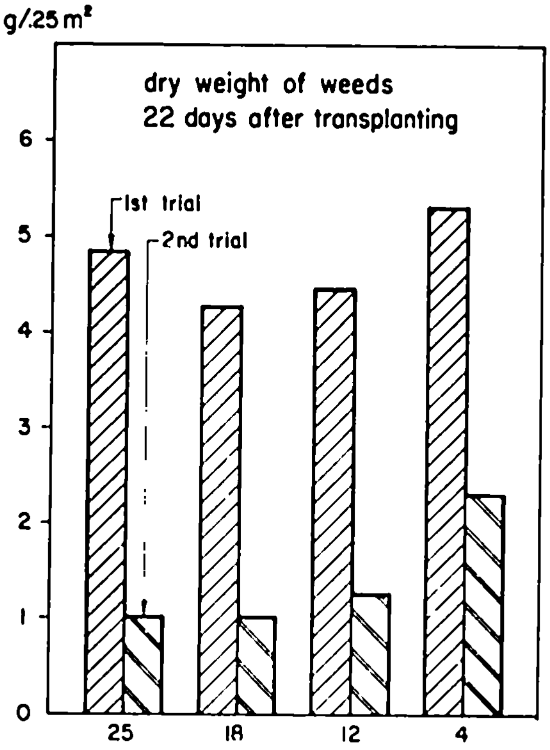

Fig. 19 tillage duration (days)

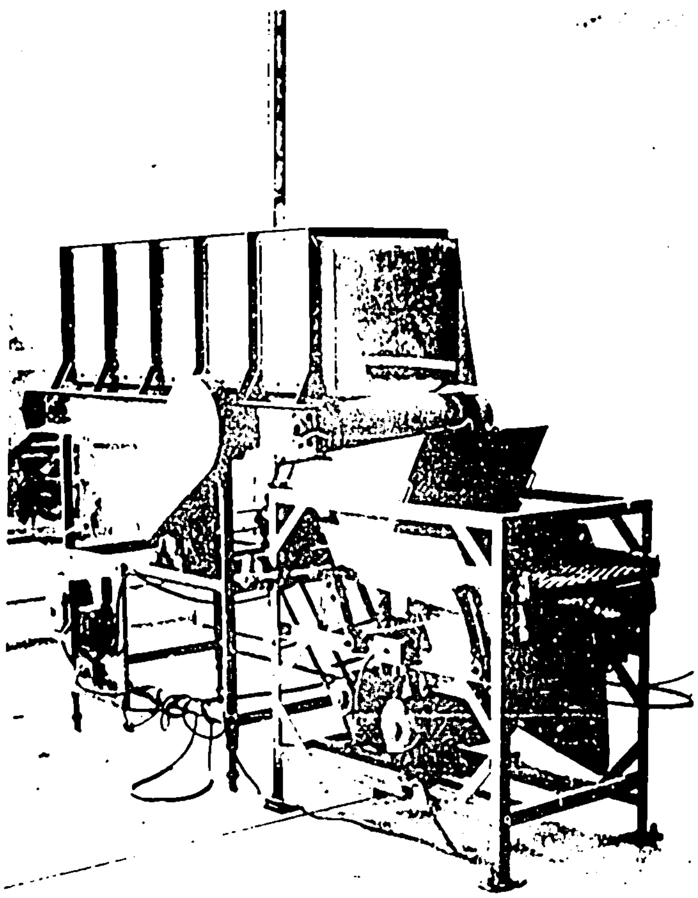

Fig. 20 Horizontal screen test unit.

ENGINEERING ECONOMIC SYSTEMS

Thresher adoption and use survey

A survey of farmers who own or use the IRRI portable thresher was conducted in late 1978 in Iloilo Province, Philippines, and two districts in Central Thailand. This was supplemented in early 1979 with a survey in Laguna Province, Philippines where there has been a very rapid introduction of both the IRRI axial flow and portable machines. The sample characteristics are given in Table 1. Use patterns are shown in Table 2. Further analysis of the data from these surveys is underway and results will be presented in subsequent reports.

Farm storage practices

Surveys of farm storage conditions in Central Luzon and Iloilo Provinces in 1978 failed to detect significant quantitative or qualitative paddy losses in grain held for periods ranging from two months to one year (Fig. 21). Additional analysis is being carried out to more completely evaluate the technical and economic factors which affect both the quantitative and temporal nature of storage equipment.

Village milling systems

Further analysis of data from field trials and surveys conducted in Central Luzon and the Bicol Region of the Philippines is underway to quantify the effects of field level operations on milling performance as well as the use of alternative milling systems. As noted in a separate report (Camacho, et. al.), milling recovery for small village mills is significantly affected by technical parameters such as rotor speed and blade clearance. Multivariate statistical techniques will be employed on these technical factors in conjunction with paddy parameters such as moisture content, purity, and variety to asses the contribution of each factor.

Work continues on the development of standardized procedures for the laboratory processing of paddy and milled rice samples. The objective is to provide simple instructions for carrying out 45 procedures commonly employed in the assessment of grain quality and milling characteristics.

Systems simulation modeling of postproduction operations

Efforts to incorporate empirical data from field experiments, technical trials, and surveys of harvesting, handling, threshing and drying operations into a systems simulation model has moved to the conceptual stage. The preliminary version of the model is described in a separate report (Habito and Duff). The second stage in development of this model is to verify the relationships against an independent data set to ensure that the technical relationships are correctly specified and results conform to actual conditions. Work on this project will be continued to examine the impact of alternative policy instruments such as price subsidies, alternative grading standards, and the availability of alternative technology on incomes, employment, and total grain production at the farm level.

Machine costing

A computerized budgeting procedure was developed for quick costing of small machine operations under varying wage costs, fuel price, initial machine cost, and annual use conditions. The package is being applied in the evaluation of alternative land preparation, reaping, and low-lift pump irrigation systems as part of an attempt to determine the economic conditions under which mechanization can be economically viable.

Cost analysis of the IRRI axial flow pump

A 5-hp diesel and 7-hp gasoline engine were used in the analysis of the axial flow pump. At normal annual use levels, the total average cost per hectare-centimeter (3 m lift) is lower for the 5-hp diesel power unit than for the 7-hp gasoline model. Shorter engine life, higher fuel consumption per unit time and higher fuel cost account for this difference. At an output of 250 hectare-cm per year, the total cost of the pump with the two alternative engines is equal (Fig. 22). The diesel engine becomes more economical at annual utilization levels above this point. Figure 23 provides cost information at lifts ranging from 1.0 to 5.0 meters. This figure also indicates the economic advantage of the diesel powered pump. The pump, with either engine, appears more economical than centrifugal pumps with similar delivery and power characteristics.

Pest management practices and technology

A reconnaisance survey of farm households in Central Luzon is planned to inventory pest managemement practices and available levels of technology. The objectives are to provide empirical information in the formulation of hypotheses pertaining to factors conditioning the use of pest management techniques. Plans are to implement the reconnaisance survey during the second half of 1979 and to prepare a preliminary report by the end of the year.

Consequences of small farm mechanization

Field activities of the Consequences Project have now begun at two sites in Indonesia, one site in Thailand, and one site in the Philippines. At each site, approximately 350 farm and landless households are included in the multi-stage, cross sectional survey (Table 3) and 50 households are participating in intensive daily recordkeeping.

Initiation of survey activities was delayed because of changes in data instruments and an attempt to synchronize starting the surveys with the beginning of main crop season.

The field activities at each site will continue for one crop year. Work is also underway to develop a data assembly and management system (DAMS) for assembly, processing, and analysis of the survey data.

A third workshop will be held at IRRI in October, 1979. The objectives of this meeting are to formulate analytical procedures for analyzing data from the farm surveys and to plan project activities for the remainder of 1979 and 1980.

Table 1. Sample design for survey of mechanical thresher

Description	Iloilo Irrigated	Iloilo Rainfed	Laguna Irrigated	Total
Thresher owner-nonuser	1	0	1	2
Thresher owner-user	10	5	6	21
Thresher nonowner-user	14	16	12	42
Thresher nonowner-nonuser	14	15	7	36
Total	39	36	26	101

Table 2. Thresher use patterns in Iloilo and Laguna Provinces, Philippines 1978-79.

Area	Initial cost	Annual use	Output	Total gross income	Total cash expenses	Net income	Payback Period
	($)	(h)	(t/yr)	($/yr)	($/yr)	($/h)	(yr)
Iloilo (irrigated)	738	214	120	965	127	387	.9
Iloilo (rainfed)	775	116	72	510	127	383	2.0
Laguna	1243	153	98	827	103	666	1.9
All	$914	173	103	$818	$120	$686	1.3

Table 3. Distribution of survey samples for the four consequences sites.

Country/site		Manual	Animal	4W & 2W tractors	Mixed	Landless labour	Total sample
Indonesia -	West Java	60	60	120	60[a]	60	360
	South Sulawesi	30	60	0[b]	162[c]	0[b]	252[d]
Philippines -	Nueva Ecija	0[b]	109	227[e]	0[b]	52	388
Thailand -	Suphanburi[f]	0[b]	60	150[g]	60[h]	50	320
	Total	90	289	517	282	162	1320

a. Combination of animal and manual.

b. Insufficient cases to permit sampling.

c. Combinations of manual and animal, manual and tractor, and manual, animal, tractor/animal and tractor.

d. Excludes 38 respondents who did not grow a crop because of irrigation improvements.

e. Two-wheel and four-wheel tractor users.

f. Provisional values as the first round of the survey is still in progress.

g. Two-wheel and four-wheel tractor owners and hirers.

h. Combination of animal and machine.

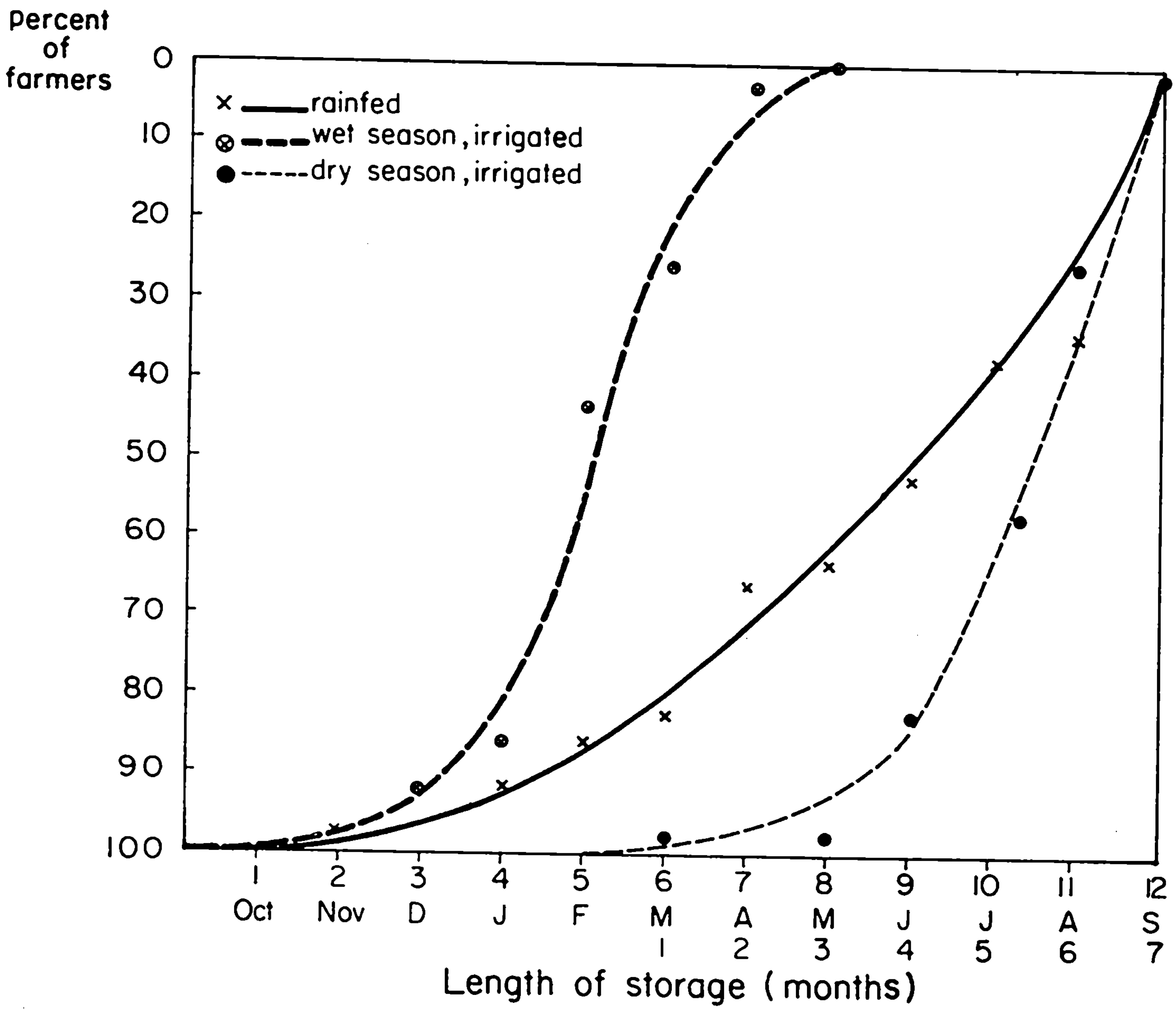

Fig. 21 Cumulative frequency distribution of time paddy is held in farm storage by farm type, Philippines, 1978.

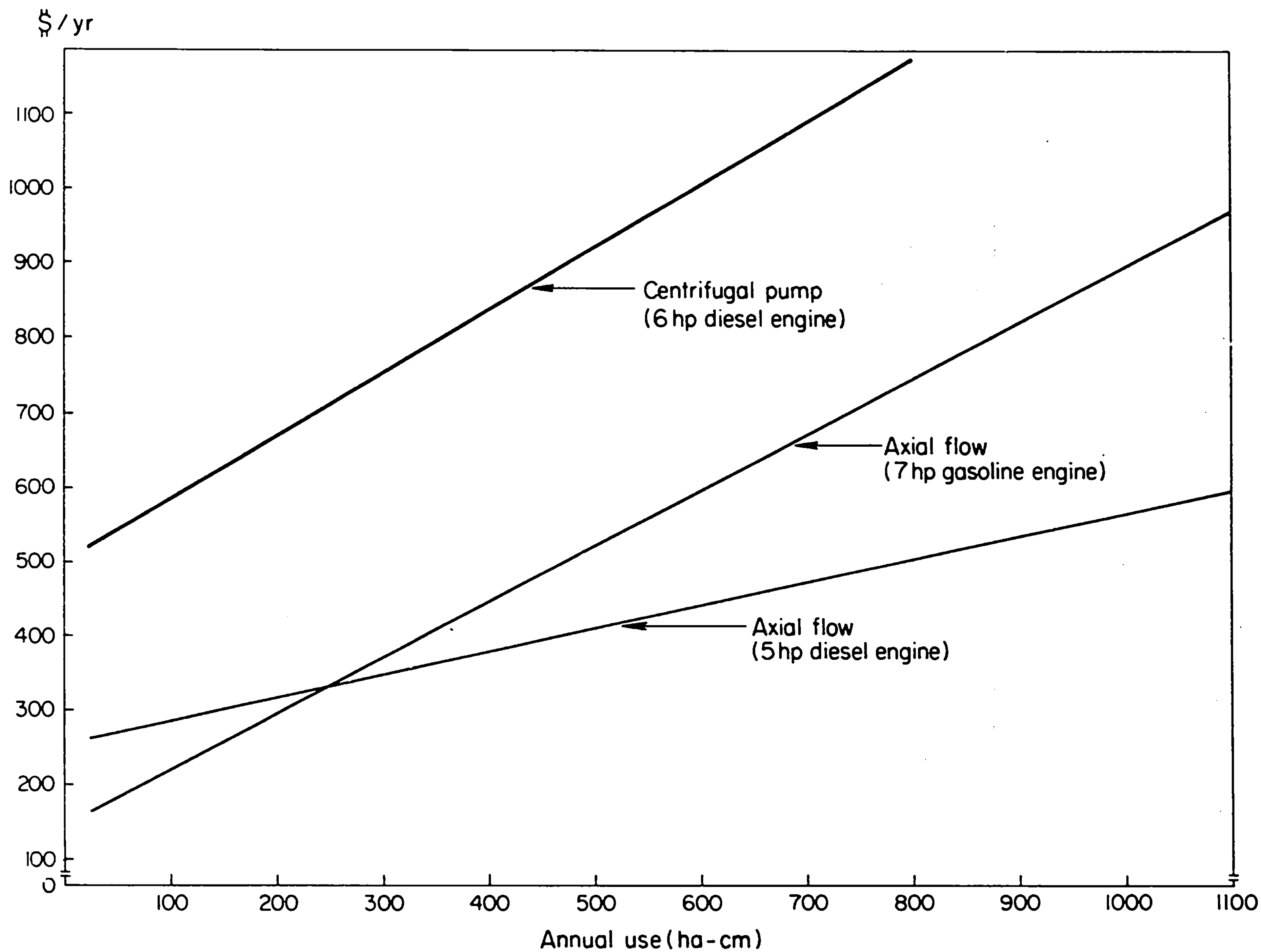

Fig 22 Total cost/year for the IRRI axial flow pump using 2 alternative prime movers and for the centrifugal pump.

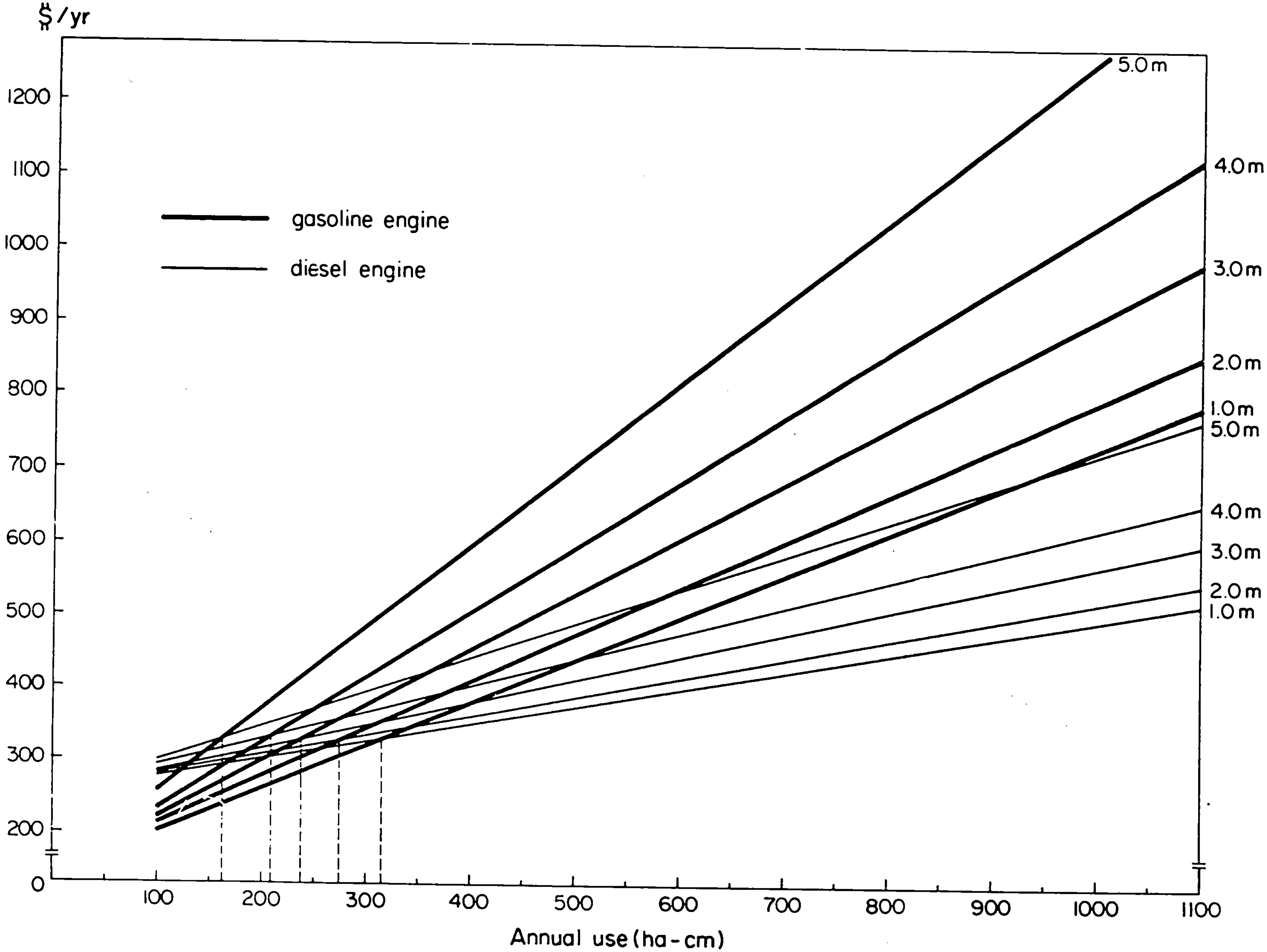

Fig.23 Effect of lift on the total cost/year: IRRI axial flow pump using 2 alternative prime movers.

INDUSTRIAL EXTENSION

Industrial extension in the Philippines

Industrial extension with cooperating manufacturers

During this reporting period, 10 new cooperators signed the "Memorandum of Agreement" to manufacture IRRI machines. Three of these manufacturers are located in the Manila area and the others are in provincial areas. All requested blueprints of the portable thresher with cleaning system. Their second preference was either the power tiller or the vertical bin batch dryer.

The project staff visited cooperators located in Metro Manila fives times and made two trips each to cooperating manufacturers in the Visayas and Mindanao regions. Technical assistance in the manufacture of threshers and power tillers was given to cooperating manufacturers as well as advice to new cooperators in the fabrication of prototype units.

The production of IRRI designed machines during the first 6 months of 1979 was about double that during the same period of 1978.

Two-week engineering training course

Primary responsibility for organizing the two-week engineering training course was transferred from the Machinery Test and Utilization group to the Industrial Extension group during this reporting period. The change was deemed appropriate since the training course is in keeping with the work objectives of the Industrial Extension section. The course was held March 26 to April 6 with 10 participants from six countries.

Manufacturers survey followup and technical assistance program

As previously reported, a survey was conducted among IRRI's cooperating manufacturers in the Philippines with the aim of increasing the effectiveness of our technical assistance program. Using survey information, cooperators were ranked based on their success in 1) the commercial production of IRRI designs, 2) production and manufacturing organization, and 3) capability to implement IRRI's recommendations for improving manufacturing efficiency. The five top manufacturers will be offered increased assistance as part of a revised technical assistance program. The new program will give technical advice to cooperators in improving their product design, production methods and controls, organization, and other aspects of manufacturing. The main objective is to reduce product cost.

The project is divided into two major phases. The first deals with product design and production problem identification, measurement of present conditions, and designing recommendations to improve present manufacturing conditions. The second phase involves assisting the cooperator in implementing the recommendations and assessing the degree of improvement as a result of implementing the recommendations.

The first manufacturer given this type of assistance is located in Davao City and is currently producing power tillers and axial flow threshers. The project staff conducted a two-week study in the cooperator's shop as part of the first phase. The study involved product design improvement, conducting time studies of all jobs, work sampling, process charting, and operation analysis. Other industrial engineering techniques were also used to identify inefficiencies, poor and costly production methods, and excessive material waste. Based on the two-week study, the project staff is preparing recommendations. These recommendations and implementation assistance will be given to the manufacturer in the second phase of the program.

Dryer burner safety valve improvement

The IRRI dryers have a built-in safety valve to stop the flow of kerosene to the burner when the blower stops due to failure of its prime mover.

The safety valve (BD-2-PD-10) consists of seven parts, one of which is a rubber gasket that serves as a diaphragm valve. Experience shows that the rubber gasket often hardens and loses its resiliency making it ineffective in closing the safety valve. An improved safety valve consisting of only four parts was designed by the project staff. The valve pin and push rod of the old design were combined into one part in the new design. The rubber gasket was eliminated by adding a tapered valve seat in the rear cover. The improved safety valve was made and tested on a prototype blower assembly. The performance was satisfactory so it will be specified on the drawings of the batch dryers.

Industrial extension in Thailand

Summary

Insufficient personnel limited activities of the IRRI-Thai Cooperative Extension program in small farm machinery during the first part of 1979. This situation improved during the last three months when Mr. Ray C. Fischer arrived to assume leadership of the project, but additional support staff can be effectively utilized to adequately pursue project work and provide assistance to manufacturers.

In addition to work on machinery testing and adaptation, considerable effort was devoted in contacting 51 manufacturers of farm machinery. Eleven of these companies produced 613 IRRI threshers and

80 IRRI power tillers during the first half of 1979. The IRRI threshers now dominate the market in Thailand. Many of the manufacturers were given help with their problems and some require further followup.

The greatest potential for IRRI-Thai activity appears to be in threshers and machines not yet introduced. Interest has been expressed in transplanters, seeders, harvesters, and land levelers.

Machinery projects

An early prototype of the upland seeder was tested in March and its performance was good in sandy soil. In heavy clay, soil stuck to the openers, so their depth was reduced which adversely affected seed coverage.

An improved seeder received limited testing near Ayudhaya on two occasions. A rubber-tired power tiller provides better traction than one equipped with steel wheels when pulling the seeder in a loose heavy clay soil. In a rough field the marker would not stay in the guides and the openers tend to accumulate clods in a cloddy seedbed. Work to adopt the seeder to Thai conditions will continue as the machine has potential for use in planting deep water rice as well as upland crops.

Construction of a 2-ton batch dryer was completed in June and it will be tested north of Bangkok in July. Two 1-ton dryers are in use. One unit is at Nan and has been used for rice, peanuts, and soybeans. The farmer using it is very enthusiastic about it. Another unit was sent to Mae Joe, Chieng Mai in June. It will be used for drying rice and for laboratory instruction. A third unit is being repaired after it was recovered from a user who unsuccessfully attempted to dry forage. It is difficult to find farmers who are interested in using dryers, even for the wet season harvest. Rice is usually sold directly after threshing so dryer acceptance appears to be very limited for the present.

Testing of a manufacturer's prototype sorghum thresher is near completion after delays caused by a lack of manpower and periodic lack of ripe sorghum. The oscillating cleaning screen speed has been reduced and stroke increased. New rubber paddles with a straight outer edge were installed on the threshing cylinder. The outer sheet of the tailings conveyor has been raised to reduce seed loss and the baffle height above the cleaning screen has been adjusted.

A buffalo plow project with the objective of reducing the draft was started in April. Three moldboards with different curvature radii were mounted on wood bases to support the moldboards at a lateral attitude 20° from standard. These will be compared with the standard plow. One limited field trial was conducted, but an improved dynamometer is required because difficulty was encountered in measuring the draft with a spring dynamometer. The brief test suggests considerable draft reduction can be obtained by modifying the lateral angle of the moldboard. Any improvement due to varied moldboard curvatures is not apparent at this time.

A Chinese transplanter has undergone trials by the Agricultural Engineering Division. Initially tested at three sites in August and September, 1978, testing continued in February and March, 1979. Results with the Chinese unit show 97% hill efficiency. Minor modifications were made and four firms are starting production. A 2-row Japanese machine was also reviewed but it was deemed too small for Thailand. As soon as the IRRI transplanter is available it will also be evaluated in Thailand.

Farm machinery survey

A survey of known manufacturers of farm machinery was conducted throughout Thailand with a total of 52 shops visited between June 7 to July 18. Twenty-seven companies are producing equipment. Their total employment is 962 people compared to 1105 at the beginning of the year, a reduction of 13%. Employment at 16 shops was unchanged. Two companies increased production and nine reported declines. Reasons given for reduced production are:

1. Difficulty in obtaining credit by dealers
2. The principle selling season is past
3. Low price of rice
4. 1979 flood damage reduced farm income
5. Low fuel availability to farmers.

Factors that may affect farm mechanization in the future, listed in order of frequency mentioned, are:

1. Irrigation
2. Credit availability
3. Land reform/consolidation
4. Education and extension programs for farmers.

Eight of the firms contacted expressed an interest in building transplanters or an opinion that they were needed. Four are starting production. Five firms exhibited a corresponding interest in a rice harvester.

Four farm accidents were reported. In two instances a power tiller ran over someone. Two people placed their hands too close to the cylinder of a thresher.

Suggestions to help solve their problems were offered to many of the manufacturers. Thresher manufacturers expressed concern on rapid cylinder tooth wear, low capacity in damp rice, high unthreshed or separation losses, fan vs. cylinder speed, fan hub breakage, axle failure, and hitch problems. A few of these items require followup. Some of the firms requested drawings, which will be provided. The ASAE category "0" hitch standard will be distributed to five 4-wheel tractor manufacturers after being translated to Thai. The importance of the problem of removing pedicels has declined because of the reduced seeding of the local hard threshing varieties.

Manufacturers visited in the Central region produce most of Thailand's farm machinery, followed by those in the Northeast and North. No production was observed in the Southern region.

A total of 26 manufacturers have signed the IRRI Memorandum of Agreement and all were contacted. Five produced IRRI threshers during the first half of 1979. Two others produce threshers during the latter half of the calendar year. Of the remaining 19 firms, four are testing a prototype. Four built one to four prototype threshers but never sold any and have abandoned the program. They were not satisfied with results at the time or were unable to sell direct to farmers. Six of them never became active because of a lack of capital or apprehension that they could not sell their product. Five of the shops are still producing machinery but never started production of IRRI designs.

Six companies that have not signed a Memorandum of Agreement produce IRRI machines also. One of them builds power tillers and the other five produce threshers. An objective is to get them officially aligned with IRRI.

Only one firm presently builds IRRI power tillers. Many of the producers started with another design long before IRRI began activity in Thailand. Although 5796 tillers were built in the last six months, only 80 of them were of the IRRI design. Twenty-three percent of all 1979 tillers were built with steering clutches.

By comparison, introduction of the IRRI thresher into Thailand was very timely. It definitely dominates production and is the highlight of IRRI achievement.

The farm machinery market is competitive, which creates a problem for some manufacturers if too many firms become active. Thresher production may expand further, but the most potential for increased mechanization appears to be through timely introduction of other small machines. Some discretion should be exercised in selecting future producers. If a company has inadequate space, equipment, capital, or lacks sales outlet, the organization probably will not help itself, the rice producer, or farm mechanization by entering the market.

Industrial extension in Pakistan

During the 1979 wheat threshing season, a program for the field testing and demonstration of the standard axial flow thresher was organized. One unit of this thresher, powered with a 12 hp diesel engine, was field tested at four locations and demonstrated at ten locations in Punjab. This machine operated for 150 hours and threshed over 37 tons of wheat. A second thresher was equipped with a 7 hp diesel engine. This machine threshed wheat and barley during demonstrations at 15 locations in the North-West Frontier Province. A third thresher was fabricated by a cooperating manufacturer, equipped with a 16 hp gasoline engine, and was demonstrated to farmers in the dryland areas of Punjab. On the basis of these tests, a number of design changes were made. Modified drawings were distributed to firms in Pakistan and neighboring countries who had previously received drawings of this thresher.

Two units of the mini thresher, one equipped with a 4 hp diesel engine and the other with a 7 hp gasoline engine were tested at the National Agricultural Research Center, Islamabad and the Punjab Agricultural Research Farm, Rawalpindi. Some design modifications were necessary to reduce sieve separation loss. Efforts are continuing to minimize choking of the aspiration duct by pieces of straw.

A new Hybrid thresher was designed by the IRRI-PAK Program which employs the axial-flow threshing principle and a simple aspiration cleaning system used on wheat threshers popular on the Indian Subcontinent. This thresher can thresh a wide variety of crops and is very simple in design. Two versions of this thresher are being developed, one is powered by a 16 hp engine and the other by the PTO of a 45 hp tractor.

Work was also initiated on the development of a simple animal drawn 3-row multicrop seeder. The seed metering mechanism has no moving parts. Different hopper shapes and seed metering slot configurations have been tested on an experimental unit in the laboratory. A prototype has been designed for mounting on conventional three-tine animal drawn cultivators that are popular in Pakistan. Development work is continuing on this project.

A 3-wheel motorized cart with a 7 hp gasoline engine was developed at IRRI in 1975. Limited production of this cart has begun in India. An improved design is being developed by the IRRI-PAK program. It has a lower center of gravity, heavier chassis, sturdier steering linkage, improved steering geometry, and a 5 hp diesel engine. A local firm in Rawalpindi is fabricating a prototype unit of the improved cart.

Limited field trials were conducted on a 4-wheel, 15 hp riding tractor being manufactured in Thailand from automotive components. If found suitable, local production can be established in Pakistan. The trials indicated a need for a number of design improvements to meet local farming requirements, so a new category I 3-point implement linkage and lift mechanism, clutch and throttle controls, seat, and front end weights were designed for this tractor. Two locally popular implements, a cultivator and levelling blade, have been adapted for use with this tractor. Further test and adaptation work is continuing.

Most of the agricultural machinery manufacturers in Pakistan have difficulty in fabricating machines from drawings. This has been a major constraint in the manufacture of new machines in the country. Almost all of the standard axial flow threshers fabricated by our cooperating manufacturers deviated from the drawings. The project staff has spent considerable time and effort during the reporting period in modifying the standard and mini axial flow threshers that were fabricated by cooperating manufacturers. The project staff gave technical assistance to six firms and assisted them in the fabrication and correction of prototypes.

A total of 22 units of the standard axial flow thresher were fabricated by three cooperating manufacturers during the reporting period.

Due to the emphasis on other projects and lack of drawings for the mini thresher, less attention was paid to its fabrication by cooperating manufacturers. A mini thresher was loaned to one company who has fabricated two units.

Two engineers from the IRRI-PAK Program, Mr. Saleem H. Zaidi and Mr. Khalid H. Uqaili, attended a two-week Agricultural Engineering Training Course at IRRI in the Philippines in March. Mr. Khalid Uqaili stopped in Thailand on the return trip and visited local manufacturers of 4-wheel tractors and power tillers. Mr. Habib-ur-Rehman, Assistant Agricultural Engineer at the Rice Research Institute, Kala Shah Kaku, was awarded an IRRI scholarship for an M.S. degree in Agricultural Engineering at the University of the Philippines, Los Baños. Three project engineers presented papers at Islamabad during the National Seminar on "RICE RESEARCH AND PRODUCTION", which was organized by the Pakistan Agricultural Research Council.

Industrial extension in Indonesia

Pilot project in West Sumatra

This project was active in the district of Agam during the reporting period. One set of IRRI equipment (tiller, thresher and dryer) was used for demonstrations in several farmers' fields and created more awareness and interest among farmers in the area. Three farmers will purchase portable threshers for cash from two local manufacturers -- one in Bukittinggi and the other in Padang. Close supervision and assistance are being given to these two manufacturers.

Many farmers in this area have shown interest in purchasing power tillers and threshers but need credit. Local banks have been involved in this extension effort and are expected to start responding to the need for financing in the near future.

In order to make a greater impact, it is felt that more machines are required for rental to farmers in the district. Farmers need to use the machines for one or two cropping seasons to be convinced that the machines are reliable and profitable. It should be remembered that most of the farmers in these areas are seeing farm machines for the first time. It is heartening to note the active involvement and full cooperation of the concerned provincial government staff in this province. If more inputs can be allocated to this pilot project the chances of making a favorable impact in this area appear good.

Low lift water pump

One 15 cm dia IRRI-designed axial flow pump was manufactured by a local company and tested with a 5 hp gasoline engine. The performance of the pump was good. The Fisheries Directorate of Indonesia and the USAID fisheries consultant who saw a demonstration felt this low cost pump has great potential for pumping water during low-tide on coastal brackish water fish farms. With available credit and some extension work a large number of these pumps are expected to be in use by Indonesian farmers in near future.

Development of small amphibious tractor

Indonesia has a large tidal swamp and deep soils area (5 million ha potential, out of which 350,000 ha of tidal rice is now being farmed in Sumatera and Kalimantan) consisting of deep fields where normal hand tractors are bogging down. There is a need for a machine suitable for these fields.

A floating type tillage machine was fabricated with a front cage wheel of 46 cm dia and 76 cm wide. The wheel rotates at 600 rpm and is driven through V-belts from the engine to a single-speed chain transmission box. A 6 hp diesel engine did not provide enough power so a 10 hp diesel engine was installed. It performed well in soils more than 30 cm deep. Extensive field trials are needed to determine parameters for cage wheel size, form, and speed. As this concept is simple in construction and operates well in deep paddy fields, its potential for adoption appears good.

The number of IRRI cooperating manufacturers has increased to seven: four in Java and three in Sumatra. Their total production in the reporting period has not gone up much, except for power tillers. Tiller production increased by 50 units over that of last year. With more extension work and liberal credit availability, to which the Indonesian Government is now giving serious attention, the demand for locally produced IRRI-type machines is likely to increase substantially in the coming year.

The Government of Indonesia has allocated a workshop building with a few machines to the project. During the next six months, this workshop will be renovated to provide a consultant-counterpart office, space for building and testing prototypes, and facilities for training.

Table 4. Industrial extension project staff.

Name	Position
Philippines	
John A. McMennamy	Industrial Liaison Engineer
Simeon Gutierrez	Senior Research Assistant
Nemelito Langam	Senior Research Assistant
Rodolfo Angco	Draftsman
Enrique Macatangay	Shop Assistant
Estrella Castro	Secretary
Thailand	
Raymond C. Fischer	Industrial Extension Engineer
Chalit Choensombat	Technician
Vacharachai Pumari[illegible]	Draftsman
Juthaporn Charo[illegible]pravat	Secretary
Pakistan	
Amir U. Khan	Industrial Extension Engineer
M. Shafiq Malik	Administrative Assistant
Saleem Haider Zaidi	Agricultural Engineer
Muhammad Ilyas	Research Assistant
Khalid Hussain Uqaili	Research Assistant
Jameel Ahmed	Draftsman
Mohammad Jameel	Shop Supervisor
Zaheer Ahmed	Bench Mechanic
Indonesia	
V. R. Reddy	Industrial Extension Engineer

Personnel List*

C. Moss	Agricultural Engineer & Department Head
B. Duff	Associate Agricultural Economist
D. Kuether	Associate Agricultural Engineer
J. Wicks	Associate Agricultural Economist
I. Manalili	Assistant Engineer
E. Almario	Research Scholar
M. Baqui	Research Scholar
A. Haque	Research Scholar
M. Ilyas	Research Scholar
K. Lee	Research Scholar
V. Monge	Research Scholar
L. Roa	Research Scholar
J. Singh	Research Scholar
G. Thapa	Research Scholar
J. Arboleda	Senior Research Assistant
P. Carbonell	Senior Research Assistant
R. Echevarria	Senior Research Assistant
S. Labro	Senior Research Assistant
M. Aban	Research Assistant
A. Caballes	Research Assistant
F. Cabrales	Research Assistant
E. Calilung	Research Assistant
E. Casillan	Research Assistant
I. Camacho	Research Assistant
R. Dayrit	Research Assistant
M. Diestro	Research Assistant
L. Ebron	Research Assistant
G. Espiritu	Research Assistant
F. Juarez	Research Assistant
L. Kiamco	Research Assistant
H. Manaligod	Research Assistant
C. Maranan	Research Assistant
P. Moran	Research Assistant
G. Salazar	Research Assistant
M. Sumiran	Research Assistant
E. Trinidad	Research Assistant
D. Unson	Research Assistant
F. Jalotjot	Drafting Supervisor
D. Catahan	Draftsman
R. Pabustan	Draftsman
N. Rivera	Office Assistant
J. Reyno	Office Aide

*See Table 4 for Industrial Extension staff.

N. Jose	Senior Secretary
M. Dolores	Secretary
H. Rada	Secretary
E. Suñaz	Secretary
L. Bañez	Clerk-typist
E. Dungo	Shop Supervisor
A. Barot	Shop Assistant
Z. Borja	Shop Assistant
A. Camacho	Shop Assistant
M. Castro	Shop Assistant
R. Dignadice	Shop Assistant
A. Dizon	Shop Assistant
M. Fabellar	Shop Assistant
C. Flojo	Shop Assistant
M. Macatangay	Shop Assistant
D. Manalo	Shop Assistant
P. de Mesa	Shop Assistant
M. Salac	Shop Assistant
R. Santos	Shop Assistant
G. Ladra	Field Assistant
F. de Leon	Field Assistant
L. Villegas	Field Assistant
I Barredo	Field Aide
N. Ongkiko	Field Aide
E. Principe	Field Aide
R. Tobias	Laboratory Aide
P. Aldemita	Laborer
T. Balba	Laborer
R. Capule	Laborer
E. Diaz	Laborer