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UTILIZATION AND MARKETING REVIEW OF SELECTED COUNTRIES
EVALUATION AND RECOMMENDATIONS FOR THE AGRICULTURAL EQUIPMENT
DEVELOPMENT RESEARCH FOR TROPICAL RICE CULTIVATION PROJECT
AID/csd-2541
INTERNATIONAL RICE RESEARCH INSTITUTE
SEPTEMBER, 1973

by

Don E. Davis
and
Judson M. Harper

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Technical Assistance Bureau, AID

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IRRI Agricultural Mechanization Research Results

INTRODUCTION

by

Omer J. Kelley, Director
Office of Agriculture
Technical Assistance Bureau, AID

The problem of how to realize measurable payoff from centrally funded research programs is one that deserves the attention of administrator and technician alike. During the past year, the Office of Agriculture has selected the project "Agricultural Equipment Development Research for Tropical Rice Cultivation" for intensive review. This review is proposed to serve as a prototype example for measurement of payoff and as a basis for improvement of goals, management and funding of research projects administered by this office.

As a part of the planned intensive review, consultants Mr. Don E. Davis and Dr. Judson M. Harper carried out an on-site and selected country review of the Agricultural Equipment Research program carried out under contract with the International Rice Research Institute at Los Banos, Philippines. The consultants further carried out in-depth review and evaluation as to the status of utilization and marketing prospects of the IRRI contract-developed machines. They paid special attention to the capacity for manufacture of the machines by local industries using available components and technical skills within the selected countries. Their findings are included in the attached reports.

I find these reports highly informative and of value toward better management of the contract for which TA/AGR is responsible. Not only do the reports bring out some weakness in the operation of the contract, they also serve to bring administrators up to date as to the status of equipment use and development in a rapidly changing agricultural situation in the

developing countries. The reviews further point out the need for more intensive effort toward outreach aspects of the research programs and the need for constant evaluation on our part to insure that research is modern in concept, meet specific problems and make a definite contribution to the developing countries.

Your participation in the Seminar and review procedure for this particular project is appreciated, your comments welcomed and any further assistance you may wish to offer toward improvement of our efforts is welcomed.

UTILIZATION AND MARKETING REVIEW OF SELECTED COUNTRIES,
EVALUATION AND RECOMMENDATIONS FOR THE AGRICULTURAL
EQUIPMENT DEVELOPMENT RESEARCH AND TROPICAL RICE
CULTIVATION PROJECT, AID/csd-2541, INTERNATIONAL RICE
RESEARCH INSTITUTE, SEPTEMBER, 1973

by Don E. Davis and Judson M. Harper

I. PHILIPPINE PROJECT SITE AND ACTIVITIES REVIEW

A four-day review of the IRRI Agricultural Equipment Development Project was undertaken by Don E. Davis and Judson M. Harper starting Aug. 19, 1973 with a site visit. This review covered the current status of the project, project management, and discussions with individuals having concern and knowledge about the project.

A. Current Status of Project

The project staff of Dr. Bart Duff, acting project leader, Mr. Fred Nichols and Mr. Joseph Campbell was consulted extensively to obtain an understanding of the project status. At the present time, the following machines were ready for evaluation, prototype construction and manufacture by local companies: 1. Power tiller, 2. Lowland seeder (selected areas), 3. Axial flow thresher, 4. Batch dryer, and 5. Bellows pump.

Under the constraints of time and manpower it was felt the above developments were significant accomplishment which would have impact as they are adopted and manufactured by local industry.

In review of drawings, test data, economic evaluations and projected market size certain deficiencies were noted. Correction of these would help the potential manufacturer decide to manufacture the IRRI designed equipment. Specifically they were:

1. Machine drawings were not entirely up-to-date. Dimensions were in inches and fractions which will cause problems in most of Asian countries which are metric.
2. Testing and evaluation procedures need to be more specific. Quality control procedures for equipment manufacture needs to be further emphasized.
3. Subcontract agreements need some revision to reflect the operational realities of releasing designs as well as protecting IRRI's needs to maintain a limited degree of control.
4. Economic evaluations should place more emphasis of mechanization impact on total crop production due to timeless, etc. In other words, the economic analysis should consider the impact of mechanization on the entire rice production system.

It is felt that incorporation of these suggestions into the project efforts to develop acceptable machinery would help as it moves to transfer the machine designs to manufacturers.

B. Outreach of the Project

The project has used subcontracts as a means of formalizing working relationships with potential users and manufacturers. A listing of the current subcontracts follows:

<u>Country</u>	<u>Cooperating Agency</u>	<u>Address</u>
India	Krishi Engines Ltd. Mr. V. R. Reddy, Managing Director	A-7 Unit, Industrial Estate, Sanath Nager, Hyderabad
Indonesia	Directorate of Agri- cultural Techniques Ir. Soedharso Rawidjo, Director	Pasar Minggu, Djakarta
Korea	Institute of Agricul- tural Engineering and Utilization Dr. Sung Kum Han, Director	Suwon
Malaysia	Malaysian Agricultural Research and Develop- ment Institute (MARDI) Dr. Anuwar bin Mahmud, Director	Jalan Swettenham, Kuala Lumpur
Pakistan	Lahore Engineering and Foundry Limited Mr. D. M. Khan, Managing Director	Ambassador Hotel, Davis Road, Lahore
Philippines	Nueva Ecija Land Reform Integrated Development Project Dr. Basilio de los Reyes, Director	Bitas, Cabanatuan City
Sri Lanka	Browns Group Industries Limited Mr. S.N.N. Perera, Manager, Landmaster Dept.	481 Darley Road, Colombo 10

<u>Country</u>	<u>Cooperating Agency</u>	<u>Address</u>
Taiwan	Joint Commission on Rural Reconstruction (JCRR) Dr. T. H. Shen, Chairman	37 Nan Hai Road, Taipei 107
Thailand	Engineering Division, Rice Department, Ministry of Agriculture Dr. Bhakdi Lusananda, Director-General	Bangkok 9
Vietnam	Vietnam Agricultural Machinery Company Mr. Vo Van Nhung, General Manager	422 Tran Hung Dao, Saigon

Several things should be noted about this list. First, many of the subcontracts are with governmental or educational agencies within countries which may adopt the equipment. Although these represent valuable contacts through which outreach of the project can occur, they are not contacts which will take on the manufacture. Secondly, not all the companies currently manufacturing equipment have signed subcontracts with the IRRI project. This has occurred because no specific outreach plan exists within the project and because some manufacturing companies object to certain provisions in the subcontract form.

The above comments point to a project need to formalize their outreach program and proceed with a plan to meet predetermined goals.

A more specific outreach criterion for the project is the extent of acceptance of the equipment. This can be measured by the numbers of manufacturers evaluating and manufacturing the IRRI designs as shown below:

PHILIPPINES

1. Prototype stage
 - a. Axial flow thresher -- 4 companies building
 - b. Batch dryer -- 4 companies building, 30 built
2. Production stage
 - a. Power tiller -- 6 authorized companies producing 300 to 500 total per month. Six other companies copying and producing 3 to 4 per company per month.
 - b. 4 and 6 row seeders -- 2 companies are producing 40 to 50 per month.
 - c. Seed cleaners -- 2 companies have produced 30 machines to date.

d. Misc. -- Plot threshers, bellows pumps, propeller pump: 6 companies in limited or pre-sale production.

3. Comments

All machines produced are generally pre sold and on a cash sale basis. There are no formalized market studies. However, producers of the tiller estimate a demand of some 8,000 per year. Other machines will probably be produced on an order basis.

THAILAND

One company has produced 15 power tillers to date.

KOREA

The power tiller and the batch dryer are under production by two companies producing up to 15 prototypes each. The Korean Government has requested assistance in developing production for the batch dryer locally for use in drying farm crops harvested in the wet season.

TAIWAN

One company has produced 10 seeders. The tiller and table thresher are under test.

BURMA

Presently testing two power tillers and seeders.

SRI LANKA

One company has produced four power tillers as models. The government plans to produce 2000 of this design in 1973.

INDIA

There have been prototypes of the tiller produced in Bombay. Krishi Engines Co. is testing the tiller for production.

BANGLADASH

Christian Relief Group has requested and received plans and drawings for local production of the bellows pump. The Minister of Agriculture in a visit to IRRI stated that he wanted the tiller produced locally.

PAKISTAN

One company has produced 20 seeders. The tiller is under evaluation and the grain cleaner is being redesigned by a local company.

VIETNAM

Two companies have prototype tiller for study.

The tabular data above shows a wide range of outreach activities and significant acceptance of the IRRI designs. With the relatively small staff of the project, the current range of activity may be too broad. Many of the manufacturers need more attention by the project staff than they will be able to provide, which may lead to problems in equipment manufacture, quality control and modifications required to make a design entirely suitable to the local environment.

Harper visited three manufacturers of the power tiller in the Manila area. They were: Oberly Co. Inc., Marsteel Corp. and IGRI Industrial Sales Corp.

Oberly is a very small manufacturer having only limited facilities with a maximum capability of 50 power tiller per month. Marsteel is a large concern (estimated 800-1000 employees) which casts and machines metal parts and rolls steel shapes. They are manufacturing 100 power tillers per month and have developed a new version with a gear transmission of their own design and manufacture. IGRI (estimated 100-200 employees) is manufacturing 100 power tillers per month. None of these concerns has a subcontract with IRRI.

In talking to the representatives of these firms it was clear that the IRRI project was the key element leading to their involvement in manufacturing small scale farm machinery. IRRI had provided the design and a prototype, tested and suggested revisions for the firms equipment and generally been available for consultation during the outreach process. This involvement had been greatest with Oberly, the smallest and least capable of the manufacturers. As the outreach program of the IRRI project expands, it may be necessary for the project to limit its attention to firms having some demonstrated manufacturing capacity if maximum potential is to be reached.

One limitation which the manufacturing concerns appear to have is the lack of working capital to buy raw materials and to hold inventory.

C. Current Project Management

The productivity of the IRRI equipment project has been significant. The reviewers were impressed by the level of activity and accomplishments. The following are observations which the reviewers feel would improve the productivity of the project and increase its potential for substantial impact.

1. Develop an overall plan and strategy of equipment development and outreach. No obvious thread of continuity is apparent in the major thrust of the project.

2. Systems analysis should be used to measure the impact of proposed equipment developments on the entire crop production system to provide a rationale for future developments and to focus project activities.

3. Focus current project on developments which appear to have significant local interest and potential. Work currently is progressing on the stripper harvester in lieu of working out final development details on the axial flow thresher, a machine believed to have much greater potential.

The project is moving from activities which have been primarily research and development to those involved in outreach. This expansion of orientation is viewed as being very desirable.

D. Operational Plan

The IRRI Equipment Development contract team has been concerned about the outreach of the project. They have begun to think of ways to focus their efforts and meaningfully enhance the adoption and manufacture of machines outside the Philippines. These thoughts include the machines for which developed prototypes exist. We encourage further refinements of these plans using the items in section C and the data which will be gathered by the review team in Vietnam, Thailand and Korea.

In discussions with Dr. Nyle S. Brady and Dr. D. S. Athwal, it is apparent that IRRI's goals and objectives are being considered in terms of the entire cropping systems involving rice. They see machinery as an integral part of these systems along with plant breeding, fertilization, pest control, weed control, harvesting, etc. In this context the research and extension programs of IRRI should involve all these aspects in a systems approach. To what extent these thoughts will effect the direction of the equipment project is unknown. Indications are that IRRI has the long-range potential to draw all these aspects together.

It appears to the review team that the equipment development project needs to work out a model which will increase its outreach capability. At this time, we see no reason why the model can't be part of the existing IRRI program. The model must consider that equipment adoption requires acceptance and manufacture by an indigenous firm as well as acceptance by the farmers who will purchase and utilize the equipment.

Considering the manpower limitations of the current project team, it appears wise for the model to include some full-time outreach engineers located in the target countries. These individuals would be IRRI employees and would have spent at least three months at IRRI to thoroughly familiarize themselves with the machines, testing, economic analysis and manufacture.

Once in the country, these individuals will serve as the contacts for the outreach program. They would contact manufacturers, demonstrate prototype equipment, test and evaluate manufactured equipment, work with farmers who will purchase and use the equipment, etc. In this job they will act as contact agents to disseminate information from IRRI, establish subcontractual arrangements, maintain liaison with the local manufacturers to assure quality, and collect and feed back manufacture's and user's impressions and experience. Currently IRRI's program has only a limited and informal feed back mechanism which must be an essential part of any successful project.

E. Other Contacts

The project was discussed with Dr. Sam C. Hsieh of the Asian Development Bank in Manila. Dr. Hsieh pointed out his interest in mechanization but only in the context that it would beneficially effect the entire agricultural production system. He stressed the need to view the effectiveness of mechanization in terms of the output of the system and value to the farmer rather than the increased productivity of the individual as is done in developed countries. These comments emphasize the need for the IRRI Equipment Programs outreach to effectively document its impact on the entire economic system so that the program can serve as a model for large bank-funded projects where mechanization would be a component.

Discussions with Mr. Thomas Niblock, AID Mission Director and Dr. Frank Sheppard emphasized their satisfaction with the project. They are contemplating meaningful ways in which the machinery developments can be a part of the planned agricultural projects in the Philippines. Also, Mr. Niblock suggested that the Industrial Development Division may be a mechanism to provide working capital to the manufacturing companies in the Philippines.

SUMMARY

The progress on the IRRI Machinery Development Project has been substantial. It appears the project has the potential to significantly improve rice production both through increased yields and prevention of loss to those yields. Because of limitations on project resources, the review suggests that it focus its efforts on the most promising developments in an outreach program. A systems approach which documents the impact of mechanization on the entire crop production system would be most desirable in establishing the rationale for this focus.

The review suggested that the project could improve the informational package on their machinery developments as provided to potential manufactures. Improvements in drawings, test data, test procedures, economic analysis and market data were sited.

To adequately expand the outreach of the equipment development, it is suggested that additional funds be added to the IRRI project to provide salary and logistic support to engineers who will be hired and trained for location in proposed outreach countries. These individuals would work with

local manufactures to manufacture the machinery as well as with the farmers who will be applying them to the crop production system. It appears that this suggested outreach model of machinery development could be integrated into the existing IRRI extension activities.

II. AGRICULTURAL MACHINERY AND EQUIPMENT REVIEW IN KOREA

Davis and Harper spent four days reviewing the agricultural mechanization situation in Korea. The objectives of the review were to determine:

1. The current status of agricultural mechanization in Korea.
2. The status of the testing, evaluation, adaptation and manufacture of the IRRI designed equipment.
3. The capability of the Korean industry to manufacture agricultural equipment.
4. The history of the development of the Dae Dong Co.

ITINERARY

The following itinerary was developed to fulfill the above objectives:

September 7, 1973 - Meet with Mr. Francis Jones, Food and Agriculture Officer, USOM/Seoul. Travel to Institute of Agricultural Engineering and Utilization, Office of Rural Development (ORD) Suwon to meet with Dr. Han, Director, Mr. Soung Rai Kim and Mr. Yong Kook Lee. Meet Mr. Sam M. Johnson, Agriculture Engineer, Korea United Kingdom Farm Machinery training project.

September 8, 1973 - Meet with Dae Dong officials Mr. Young Choe and Mr. Yong Ju Kim, Vice President to discuss operations and the developmental history of the Company. Also visit Mr. Yup Shin, Manufacturer of drying and forage producing equipment.

September 10, 1973 - Travel to Taegon to visit thresher manufacturers.

OBSERVATIONS

Mechanization Situation

The Exotech Systems, Inc. carried out an extensive project on farm mechanization in Korea. Their findings and recommendations are found in a report entitled "Farm Mechanization Programs for Korea" dated August 1972. This report was reviewed carefully by the review team. Because of the need for timeliness, the projected shortages of labor, mechanization is well started in Korea and will undoubtedly continue.

Currently power tillers of the Dae Dong manufacture have been well accepted by the Korean farmer. The Dae Dong tiller (8-10HP) with plow, harrow, roto tiller, steering clutches, six speed transmission and wagon currently sells for \$1,000 and represents a well made versatile machine. There are approximately 24,000 power tillers in the country, which in addition to their agricultural functions, also serve as a source of transportation for the farmer. In 1973 13,700 of the tillers will be manufactured and sold.

Non-tillage operations have been mechanized to a lesser extent than have the tillage ones associated with the power tiller. The Institute of Agricultural Engineering and Utilization has been working on mechanization of transplanting machinery with their own design. They have also designed power sprayers, upland seeders, threshers and driers. Of particular interest was the transplanter which fed and planted 14-day old seedlings which were started in one by two foot beds. A four-row corn and sorghum seeder to be pulled by the power tiller also looked very good. Seed metering was accomplished by using cupped wheels.

The Agricultural Engineering and Utilization Institute was also looking at machinery associated with rice milling and polishing operations. They recognized the important fact that much rice was lost using current technology. On short-grained varieties with equipment of Korean design and manufacture they were able to obtain a 72% head rice extraction.

The IRRI contract has been working with the Agricultural Engineering and Utilization Institute to test and evaluate their designs. This relationship is very important in Korea because the Institute must certify all equipment before it is sold in Korea. To date the following equipment has been imported for testing:

1. Bellows pump - although fabric failed in 20 hours of use, concept was well liked and felt to have a definite place in the practices in the south.
2. Seed cleaner - not tested.
3. Table thresher - tested and modified with loops replacing the thresher teeth on original model. Modification improved operation but machine was still felt to be inferior.
4. Batch drier - will be tested during this harvest season. Similar models are already being manufactured in Korea. Korea drying technology has already moved to recirculating batch driers.
5. Seeders - tested. Requirement of very good seed bed preparation was felt to be a disadvantage.
6. Power tiller - undergoing some testing. AEU is trying to interest a Korean manufacturer of sprockets and chain in manufacturing the IRRI unit. To date, this has not been successful. Because the price, quality and capability of the Dae Dong tiller is superior, it seems unlikely that the IRRI design will have much impact in Korea.

AEU is particularly interested in IRRI's axial flow thresher. This machine appears to offer some design advantages over Korean design and available equipment. Efforts should be made to get a prototype into Korea as soon as possible.

Four wheeled tractors have only seen limited use (less than 200 in country working). Their small level of usage is associated with the small fields in Korea making their operation difficult. Dae Dong is manufacturing, in cooperation with Ford, four-wheel tractors at the present rate of about 30 per year.

The United Kingdom has a tractor operators training program located at Suwon. It is concentrating on preventative maintenance, tune ups and machine operation training for teachers who will be sent to the various provinces.

MANUFACTURING CAPABILITY

Korea has a sophisticated manufacturing capability. It can easily manufacture all of IRRI's designs. In most cases, the IRRI designs represent the generation of equipment proceeding the current status of the Korean designs.

With the exception of modernization and expansion of current manufacturing facilities, no assistance in the way of machine tools is required for Korea. Currently, government regulations require the use of locally fabricated engines which are being fabricated by Dae Dong. Dae Dong is going to build a small two cycle engine, suitable to power the weeder, shortly which will eliminate this one obstacle. Most engines burn kerosene because of the tax structure levied on fuels.

The story of the Dae Dong Co. represents an interesting history of how A.I.D. loans have helped a developing industry. This narrative is attached as an appendix to this report.

SUMMARY

The Korean Government has encouraged mechanization with a five-year plan which provides subsidies and loan policies to encourage farmers to purchase tillers. The emphasis on mechanization has resulted because of the rapid shift of labor from the farm to industry, (12% GNP increase/year) and the need for timeliness to enhance double cropping activities.

Korea is well along the road to mechanization and has developed an extensive manufacturing capability for indigenous machines. IRRI may provide some help in simplifying designs, lowering cost and making machine adaptations. In this respect, IRRI could also learn and profit from the Korean developments and progress.

Improvement in yield capacity of new rice varieties requires an improved handling technology. The new varieties shatter badly under traditional methods of harvest and drying so that loss is excessive. This makes the design and adoption of a high moisture content thresher and subsequent drying a necessity. The dryer manufacture visited had done considerable development on recirculating types of a sophisticated design. Last year he produced 100 driers and was unable to fill the requirement of 300 as specified by the Government. Manager Mr. Shin made the point that his Company had received no Governmental assistance which made it difficult for him to expand to fill the increased need for drying equipment.

RECOMMENDATIONS

1. IRRI should provide prototype axial flow thresher and design drawings as soon as possible.
2. IRRI should not push designs of their equipment too hard but should assist the Koreans in simplification, lowering cost and adaptation of existing farm equipment.
3. IRRI should look carefully at Korean transplanters and seeders for possible additions to their line of equipment.
4. A.I.D. should consider ways of helping Due Dong take a more aggressive role in looking for export markets for their line of tillers.

II a. HISTORY AND DEVELOPMENT OF DAE DONG INDUSTRIAL CO., LTD.

The Dae Dong Industrial Co. is expanding production capacity for the eighth time in its 16-year history. This latest expansion has been made possible through the securing of an Agency for International Development loan of \$1,000,000.

The loan is being utilized for the purchase of a new Ajax 2,500 ton forging press and modern forging equipment. The new equipment will occupy a new forging shop built by local capital. This shop allows the Company to produce higher grade precision made component parts for machines being manufactured. Previously, component parts were produced through casting and milling and trip hammer shaping of steel billets. Thus the Company has advanced its capacity to produce high quality machinery, increase plant capacity and lower cost of production.

The Company was founded in 1947 with a capital equivalent of \$2,500,000. They originally produced small threshers, one, two and three-inch pumps and low speed diesel stationary engines. Today the Company produces eight different machines with various power ratings. These are:

1. Power tillers - 5-10 HP
2. Water pumps - one, two and three-inch
3. Rice combines - 6-8-10 HP
4. Land use diesel engines - 12-64 HP
5. Air cooled engines - 5-7 HP
6. Marine deisel engines - 7-250 HP
7. Outboard motors - 7-25 HP
8. Four-wheel tractors - 39-77 HP

Except for the four-wheel tractor, Dae Dong will now have the ability to produce some 95% of all component parts of the above machines.

One other significant landmark in the Company's history occurred in 1958. That year the Company received a \$338,000 ICA (A.I.D. predecessor Agency) loan. This loan was utilized for purchase of machine tools and forging equipment. These new additions to the factory allowed the Company to make other machine tools and gave the plant the capacity to go into power tiller production.

In 1962, under a technical tie-up and licensing procedure with Mitsubishi, they started actual production of a 5 HP tiller. This was later expanded to produce 6, 8 and 10 HP machines. In 1973, the Company will produce and sell to Korean farmers approximately 15,000 of these tillers complete with roto tiller, mold board plow, harrow and trailer. The tiller can provide a power source for pumps, threshing machines, forage cutters and off-farm transportation. Of special interest is the selling price of the lower HP tiller to the Korean farmer of 400,000 won (approximately \$1,000). This can be compared to the cost of a comparable imported machine of approximately 500,000 yen (approximately \$1,900). With the new forging plant, the Company has an annual production capacity of 30,000 of various HP tillers at comparable price savings advantage to the Korean farmers.

In 1964, again under a licensing agreement with Mitsubishi, the Company began production of marine diesel engines of 7-250 HP. Production capacity of these engines is 8,000 various sized motors per year. This production, coupled with a production capacity of 3,000 outboard motors of 7 to 25 HP (started in 1969) powers most of the Korean tug and coastal fishing and transport fleet.

In order to train Korean technicians for work in the plant and related ventures, the Company started a vocational training institute in 1967. In 1970 they started a business school. In these institutions, young Koreans are learning the skills necessary to operate and maintain the machines used in manufacture as well as the production output. They also attain the business know-how and skills necessary to manage the distribution end of the Company.

The Company has 120 distributors throughout Korea. These distributors maintain mechanics, tractor services and ample supply of spare parts.

Present plans call for introduction of increased production of four-wheel tractors. Size and terrain of Korean paddies generally prevent the use of four-wheel tractors. However, plans call for expansion of upland use for forage and feed grain crops. Here four-wheel tractors will be needed.

The Company produces small numbers of transplanter and combines. Acceptance of these machines is slow and will continue so until out-movement of farm labor becomes a more pressing problem. However, the present rural farm population is under 50% of total population. This, coupled with a limited arable land resource, a marginal climate, new high yield technology and varietal improvement, plus increasing demand through growing population and increased affluence, has and will increase the pressure on the remaining farmers to increase farm production to the point where mechanization becomes a necessity. Fortunately, the Dae Dong Company is growing to a capacity to meet much of the required machinery demand. The assistance loans have played and will continue to play no small part in this expanding capacity. Most of all, the loans embellish the chance for operation of an indigenous capacity to produce the needed machines. This, we believe, is a prerequisite for a successful developing country mechanization effort.

III. AGRICULTURAL MACHINERY AND EQUIPMENT REVIEW IN VIETNAM

Davis and Harper spent eight days reviewing the agricultural mechanization situation in Vietnam. The objectives of the review were to determine: (1) The current state of agricultural mechanization within the various areas of the country, (2) The suitability of the IRRI-designed machines for various local conditions found in the country, and (3) The capability of the Vietnamese machinery industry to manufacture, maintain and repair the machines.

ITINERARY

Mr. Lewis E. Swanson, Chief, Agricultural Engineering Branch, had arranged an excellent itinerary which provided the background and contacts needed to fulfill the objectives of the review. Travel was as follows:

August 27 - Saigon -- visit agricultural machinery directorate (AMD), Mr. Bach Van Bai, Director.

August 28 - Nha Trang -- visit local fabricating and repair shops and to Ben Me Thout to visit a peanut threshing and drying operation and a local maker of threshers.

August 29 - Bien Hoa -- visit two large manufactures and dealers in farm equipment, Vikyno -- an authorized dealer for Kubota engines and manufacturer of double drum thresher, and Vinappro, a company partially owned by Yanmar, a Japanese manufacturer of power tillers and threshers.

August 30 - Cantho with stops at repair shops, farm machinery factory and water pump factory at Long Xuyen, two machine shops at Chau Doc and a rice and sorghum grain depot and mill.

August 31 - Cantho to visit the manufacturer of a small thresher (similar to U.S. Turner design) and farm equipment dealer.

September 1 - Saigon with visits to Muller and Phipps (Mr. Richard Dennison) industrial sale representative for Briggs and Stratton engines who is currently sponsoring the building of the IRRI power tiller, the International Harvester Corporation, Vietnam sales office and a manufacturer of coffee bean cleaning and drying equipment.

OBSERVATIONS

Manufacturing Capability

At all stops we found the capability to manufacture the small IRRI designed equipment. Outside of the manufacturing concerns located in Bien Hoa, most shops were small and primarily involved in equipment and engine repair of all kinds. The small shops had lathes, grinders, drill presses, welding equipment and milling machines. Sheet metal working equipment was not commonly seen because it is not a normal part of their primary repair function. Many had made one or two agricultural machines for various purposes but were not actively engaged in any real manufacture.

The two firms visited at Bien Hoa were medium-sized manufacturing concerns having extensive capability. In all cases their facilities were new and well equipped. It appeared that neither was working up to capability. Vikyno, the Kubota dealer, had an IRRI designed power tiller made in the Philippines which they were intending to test. We had understood that they were making a prototype of the IRRI tiller of their own manufacture but the visit determined this was not the case and it was unlikely they would be doing so for some time in the future. They were interested in using the Kubota engine on the tiller which was too large for the current design of the chain transmission.

Both Vikyno and Vinapro/Yanmar were manufacturing double and single drum threshers which were copies of the Yanmar Model DD 900. Between the two manufacturers, 50+ threshers were visible in their shops indicating the demand for the equipment in Vietnam. Their sales price was 40,000 to 60,000 VN without an engine. Currently Vinapro was acting as sales agent for the Yanmar 12-14 HP Kubota power deisel tillers manufactured in Japan. Several hundred of these machines have been sold. Their selling price is approximately 800,000 VN.

Agricultural Situation

Agricultural crops and practices varied widely with the location. In the Nha Trang-Saigon area, paddy production was in small field making application of the IRRI power tiller practical. In the Delta, south of the Mekong River, extensive rice production in large fields was viewed. These were being plowed with 40-100 HP four wheel tractors using single disc plows. Individual land holders had plots within

these large fields. It appeared to us that the practice of using the four wheel tractor would probably continue and expand in this situation. It would have to be said that mechanization is well along its way in the Delta with over 10,000 such tractors being sold.

A very serious spare parts shortage has resulted from the GVN requiring the deposit of 1 dollar VN for each \$1 of the import license. Since this added cost cannot be passed along to the purchaser, it has almost completely stopped the inflow of spare parts. Many tractors are being cannibalized for parts which may cause a shortage of equipment in the coming season.

The general under utilization of the four wheeled tractors, poor preventative maintenance and the lack of a developed service organization and parts points to the need to formalize some type of dealers/owners/operators association to address these problems. This association could direct its activities toward these problems as well as promote new machinery and practices such as land levelling.

Threshing using the small throw in type thresher of the Yanmar DD 900 type was very prevalent in the Delta. Double cropping of rice with harvest in the wet season causes certain problems with the handling of wet straw. Improved threshers would find a ready market in this situation.

Double cropping in small irrigated paddies along the channels is becoming more extensive. These practices appear to be more suited to the use of the IRRI type power tiller and represents a potential market. The effect of land reform which has created more smaller land holdings may possibly also enhance the market for the small tiller. IRRI designs may have too small a capacity to be suitable for the application but need evaluation.

Irrigation used in paddies requires pumps of simple design and manufacture -- perhaps utilizing the long propeller sanpan drives which are very common in the Delta.

The expansion of rice production in the dry season which is harvested in the wet season points to the need for rice drying capabilities. During the trip through the Delta, rice was being dried in the sun by spreading it along the black topped roads. The IRRI one-ton batch design may have application here and it needs to be tested to determine if

it is suitably sized and will produce dried product without excessive cracking. Millers visited stated that their extraction of head rice was 58 to 60% and that they could adjust their machines to obtain a higher extraction rate if the conditions of the paddy were better and not so cracked under local drying and handling practices.

The agricultural production in the highlands was viewed to be greatly expanding. It is very diverse and includes the field cropping of peanuts, soybeans, rice, corn and sorghum. These crops all use and need improved threshing and drying technology for the highlands situation. The power tillers may also find application in their cultural practices and should be tested. Tillage of the lighter highland soils under dry or moist conditions may be possible with the auger wheel attachment.

To date, only a few tillers of the IRRI design have been brought into Vietnam for testing and evaluation. Our review shows that very little actual testing here has been accomplished. Muller and Phipps, sales agents for Briggs and Stratton are sponsoring the building of a IRRI design tiller. This has been accomplished using only the blueprints without the availability of a prototype machine. Although this construction has gone along well, it has pointed up some difficulties in the blueprints including omissions, lack of metric units and too many details on each drawing. Other IRRI designed equipment needs to be made and tested in Vietnam. This program should include a suitable feedback mechanism so that the machines can be altered to fit local conditions and capabilities, and provide additional information necessary for IRRI to improve and extend their line of designs.

The Agricultural Machinery Directorate (AMD) has extensive shop facilities for repair and fabrication. Its current facilities appeared under utilized because they are restricted by civil service pay scales which are not high enough to maintain a trained staff. The equipment available at AMD is primarily the large earth-moving type which may be helpful in land clearing and levelling. Mr. Bai was very interested in the IRRI designed equipment and may be helpful in prototype contracting and training.

SUMMARY

Mechanization is well advanced in Vietnam and will undoubtedly expand in the future. The small indigenously manufactured equipment of the IRRI design has potential in selected applications. Particularly applicable are the axial flow thresher, batch drier, seed cleaner and weeder. To a more

limited extent, the power tiller will have potential application to the smaller irrigated paddies in the Delta and other regions of Vietnam.

The capability of the local Vietnam industry to fabricate the IRRI designs was established. Many small to large well equipped facilities exist and would manufacture if given the incentive and a demonstrated market.

The specific suitability of the IRRI designed equipment needs to be established. A program administered by IRRI which would seed prototype equipment into Vietnam appears to be a workable approach for this testing and adaptation. The program would provide for IRRI hiring Vietnamese technicians who would be trained to work in the area of manufacturing, testing and adapting the prototypes in the private sector. This work can best be done with back stopping of the effort by the Mission through logistic support, advice and council, contacts and general support. Not only will this approach provide an outreach program for the IRRI project, it will create the necessary feedback mechanism to help direct the project's research efforts. Such a program has been outlined for USAID support, left with the Mission and is attached as a part of this report.

RECOMMENDATIONS

Vietnam is a priority country for every aspect of development. US investment of AID and manpower resources demands that this priority be continued. Even through the rapid adoption and expansion of the use of IRRI developed machine designs is not as promising as in some of the other countries of the region, this priority demands a concerted effort to establish the suitability, usefulness and place in the agricultural economy of the relatively cheap, efficient and indigenously manufactured (which makes possible ownership by the 2 to 10 ha farm owner) IRRI designed machines.

Thus, it is recommended that prototypes of the following IRRI designed machines be brought into Vietnam for testing, evaluation and manufacture. The machines are listed in preceived order of greatest suitability and need:

1. Thresher -- The multipurpose axial flow thresher appears to fit a developing demand. Its suitability on the variety of crop needs to be demonstrated as well as its ability to handle wet straw. The availability of larger tractors (although many do not have PTOs) may mean the PTO version would have some application.

2. Drier -- Drying methodology is needed particularly for harvesting done in the wet season. Drying may be most suitably accomplished by a grain depot which would require the capacity of 20-50 T/day. It will also be necessary to determine the drying techniques which yield a high quality dried product.
3. Irrigation pumps -- Power pumps of various designs are needed. Current IRRI designs may have smaller than required capacity.
4. Seed cleaner -- the large quantities of rice and the quality consciousness of the Vietnamese may mean a market through proper demonstration.
5. Power tiller -- the power tiller appears to have less widespread suitability in Vietnam than it does in the Philippines due to the large rice fields. However, it needs to be tested and evaluated in the smaller irrigated paddies in all sections of the country. To expand its acceptability, implements for the power tiller to pump water, seed and aid in the harvesting process should be examined as part of the research portion of the IRRI project.
6. Seeder -- the desire for a good row seeding device was clearly felt. The current IRRI design probably does not have sufficient flexibility to fulfill the ranges of conditions which will be encountered. Perhaps a seeder attachment for the tiller is a solution.
7. Weeder -- The shortage of manpower in the Delta and the expense of herbicides makes a practical weeder desirable.

It is further recommended that every effort be made to keep the development of the local manufacture of farm machinery in the hands of the private sector. Since one of the goals of the present development plan is to encourage the indigenous manufacture of machinery by the private sector, this should be followed. Government should encourage but not direct or enter into direct competition with the private sector.

III. a. A PROPOSAL FOR A METHOD TO DEVELOP AN INDIGENOUS FARM MACHINERY INDUSTRY IN VIETNAM

THE SITUATION

Mechanization of the farming industry in Vietnam is advancing at a rate which is difficult to imagine for a developing country still under questionable internal security. In the highlands and in the Delta area, new lands are being brought under production and formerly unused paddy lands are being plowed and planted. In the Delta area, there are vast areas of paddy land being levelled for better water control. Price of agricultural commodities is apparently sufficient to provide the farmer an incentive to produce. Probably most of the clearing and development of new lands, levelling and even the land preparation for cropping of old paddies is being encouraged or brought about by the availability of power machinery which can accomplish rather rapidly what would be most difficult or impossible under traditional use of human and animal power.

While the above picture is encouraging from the standpoint of overall production, there are elements in the developmental method and picture which experience has shown to be troublesome in future years. Firstly, the mechanization taking place is based on the import of foreign made machines. This brings with it the ever present problem of spare parts. There is a drain on foreign exchange. Tractors are sold by dealers--not serviced. Preventative maintenance is limited. All this adds up to inefficient use of the machines and adds to the cost of the operations they perform. Discussions with repair shop managers and owners and with knowledgeable people in the area indicate that as many as 4 out of 10 machines are down for repair at any one time. It is our belief that successful mechanization over the long haul must be based on the indigenous capacity to produce and maintain machines from locally available materials and within the skill capacity of the local people. Secondly, the machines being imported and used are generally beyond the means of the local farmer to purchase and operate. Most all the machines found in the production cycle were owned and operated by jobbers. There is nothing basically wrong with a jobber operation except that in times of stress from price or other causes, the farmer can ill afford to pay the jobbers prices with a resultant fall in overall production. The better system of jobber operation is for local farmers to own machines with which to till their own lands and then job out to their neighbors. Thirdly, an indigenous machine industry provides labor opportunities and the development of a capital forming industry essential to long range development.

One other facet of the picture is the capability of indigenous companies to produce machines and to repair them. Insofar as machine tooling and skilled manpower to operate them and to repair machines, Vietnam is far

ahead of most of the developing countries in the region. There are large shops in the Saigon area which are tooled up to the point to where if proper materials were available, they could produce most of the more sophisticated machines. In fact, most of the shops in the area are overtooled for the work they are now doing. There is a rather large force of skilled machine tool operators and mechanics left over from the war effort. The securing of proper steel material is a problem but should not be insurmountable if isolated out to what is needed. At the present time most of the basic steel and metal being used is scrap left over from the war and from parts salvaged from other machines.

THE PROPOSAL

AID has had a small research contract with IRRI since 1965 for the research and development of machinery required in the rice production cycle. This contract has matured to the point where they have developed machines capable of doing most of the work required in the production cycle. These machines are developed on the basis that they can generally be produced using available material. True, some parts must be imported. However, these parts are generally available in all countries. These are such parts as Honda sprockets, V belts, etc. Bearings requiring import are kept to a minimum and fabrication is labor-intensive requiring a minimum of machine tools. (Every village visited has the capacity to fabricate and produce the machines in local repair or manufacturing shops.)

The designs and prototype models of all machines are available from the IRRI project on a no cost, license basis. These machines, while basically sound and relatively inexpensive, do need testing and adapting to meet local conditions in the different countries and regions of the countries. Further, they need introduction to the other countries outside the Philippines so that farmer and producer acceptance can be gained and local production started. Further, the machines can not and should not be produced and dumped on the market without arrangements for follow up so that necessary adaptations can be incorporated into the original design. Cost of production factors need to be determined and a distribution system studied and developed.

At the present time, it is believed that the following machines developed can be adapted to and manufactured or fabricated in Vietnam:

1. A one-ton batch dryer. With diversification of farming going on through such crops as corn, peanuts, soybeans and sorghum, generally produced in the dry season and harvested in the rainy season as well as

the dry season rice crop drying, becomes a pressing factor in the success of the venture. The batch dryer could be most useful to the small miller and buyer.

2. A two row and four row mechanical weeder. This machine has been further refined and is under production by the Japanese. It is simple to produce, relatively cheap and badly needed in the Delta area for weed control in corn and sorghum as well as rice.

3. A one ton per hour axial flow thresher. This may have problems with the very wet rice and sorghum. However, for the main rice crop it should be an improvement over most of the machines seen to date.

4. A one ton per hour seed cleaner. This can be very useful to the small mill.

5. A walking tractor for tillage of the smaller paddies and for the tillage of lighter soils. This is presently being developed to be used as a variable power source for pumping, threshing, etc. It also can be equipped with a 1/4 ton trailer for transport of produce to market and the movement of farm inputs.

These machines need to be seeded into the country on a planned basis. They need to be introduced to prospective manufacturers and encouragement given to these private businessmen to produce and test prototypes under local fabrication. They further need to be followed through to their end use by the farmer so that refinements and proper use can be attained.

It is proposed that to accomplish the above, the USAID Mission enter into a contract with IRRI as an extension of its present technician contract to provide for the:

1. Purchase through IRRI of 4 each of the above listed machines. These to be distributed to prospective manufacturers for testing, adaptation and copying.

2. Provide for the purchase of 10 each of the locally fabricated machines from the prospective producers selected to build prototypes. These machines in turn to be distributed to selected areas in the country for demonstration and copying by selected village producers.

3. Provide in the contract for the hire of 2 Vietnamese employees and for their training at IRRI at Los Banos in the contract machine shop in the production and operation of the machines. These men to be IRRI contract employees who would follow-up with the local producers, distribution of the machines, demonstrations and training in proper use and end use work with the farmer users.

4. Provide on an unofficial and informal basis logistic backstopping for the two Vietnamese trainees.

BUDGET

Purchase from Philippine producers 4 each machines of the 5 listed.	\$12,000
Contract cost of 10 each of the 5 listed machines produced by selected local shops	30,000
Salaries for hire of two Vietnamese technicians and their training costs at IRRI	
Salaries for one year	6,000
Training at IRRI	2,000
Total	<u>\$50,000</u>

IV. AGRICULTURAL MACHINERY AND EQUIPMENT REVIEW IN THAILAND

Davis and Harper spent three days in Bangkok and vicinity reviewing the agricultural machinery situation. The specific objectives of the review were to determine:

1. The status of ECAFE Regional Agricultural Mechanization Institute.
2. The review of progress Thailand manufactures were making toward adopting, testing and manufacturing IRRI designed machines.
3. The capability of the Thailand manufactures for manufacturing simple machines. Mr. Joseph Cambell of IRRI accompanied consultants on the trip.

ITINERARY

Contacts made were as follows:

September 3, 1973 - Farm Machinery Training Center, Engineering Div. Department of Agricultural Engineering, Ministry of Agriculture to see Mr. Paitoon Nogalakshana, Director and Mr. Chalermchai Saksre.
2. Dr. Ben Jackson, Plant Breeder, Rockefeller foundation.
3. Dr. D. L. Umali, FAO Asst. Director General and Dr. Sallah Dasonondes, FAO.

September 4, 1973 - RED to see Mr. David Steinberg, Mr. William Tonesk and Mr. Phil Ruppert.
ECAFE to see Mr. U Tun Thein, Small Industry Development Director.

September 5, 1973 - Mr. Paitoon set up meeting with the Juck Kol Co., Klongsie, Tanyaburi District, Pratumdhani, Thailand who manufactures two-wheel power tillers and a four-wheel-drive tractor. Also with the Winner Mfg. Co., manufactures of two cycle engines ranging in HP from 6 to 15.

OBSERVATIONS

ECAFE SITUATION

ECAFE has a specific proposal for the development of an agricultural machinery Institute (Copy attached) which has received enthusiastic support from AIDC (Asian Industrial Development Council) (copy attached). Apparently the proposal is being strongly pushed by the Japanese, Indians and to a lesser extent by the Philippines. India has offered informally to host the Institute. The plan calls for

6-8 experts and 4.9 million dollar budget over the first five years.

To firm up the proposal, ECAFE is having a study group make an area study to be completed by December 4, 1973. As of today, study party will have three members from Japan, two from India and have asked for help from the Philippines and USA (specifically Dr. Giles who resides in Raleigh, N.C.). This study team is to have a specific proposal for ECAFE to review at a meeting to be held on the subject in Bangkok on December 4-7. The proposal would then be submitted to UNDP for funding.

Although this all sounds like the plans and funding for the Institute are well along the way, most observers feel that chances of funding through UNDP were slim and could not be completed before 1975 or 76. (If then).

Mr. U Tun Thein discussed a more likely proposal that ECAFE might attempt if the plans for the Institute seemed futile. ECAFE might attempt to sponsor a central coordinating group consisting of 2 or 3 staff which would coordinate, disseminate information and encourage agriculture machinery manufacture.

It appears to us that this is the most likely eventuality. Building on the current farm equipment activities within the region which encompass both research and outreach seems a far wiser approach than building from scratch a whole new Institute that would have to build this capability. If this is the case, IRRI and the Agricultural Machinery Project would have a particularly important role to play. This conclusion is shared by Dr. Umali who envisioned IRRI fielding a mobile team to advise and help set policy in the areas of economics, sociological implications, technology, finance and service.

THAILAND MANUFACTURE

One manufacture is currently producing the tiller and has made four. He made them from the IRRI blueprints and had considerable difficulty because of too little explanation on the prints, lack of meter units and too much information condensed in each print.

The Agricultural Engineering Division has received prototypes of the tiller, cleaner and table thresher. They have tested the tiller extensively with more than 1000 operating hours. The major difficulty the Agricultural Engineering Division found to be in keeping the chains adjusted.

The Agricultural Engineering Division is most interested in obtaining, testing, and promoting the axial flow thresher, the drier, the larger tiller and pump. They are also interested in procedures which would allow the handling of wet harvested rice.

Mr. Panya has quit his post as the IRRI representative and taken a more permanent job with Massey Ferguson. This leaves a serious vacancy in the IRRI Thailand outreach program which will be filled by Mr. Chalermchai, a civil servant. It appears Mr. Panya was making progress in the IRRI outreach program and all effort should be made to fill the position. If possible the new position should have increased logistic support, particularly transportation.

One difficulty mentioned in the acceptance of the IRRI designs by the Thais is that they are not built as heavily as other machines being built in Thailand. Although they may be just as adequate and have cost and weight advantages, this will have to be demonstrated.

THAILAND CAPABILITY

The shop of the Juck Kot Co. was manufacturing power tillers of their design at the rate of 4/day. They manufactured all parts except chains, bearings and motor. The two wheeled version sold for \$200 wholesale for fixed drive and \$300 with steering clutches (without motor). Dealer will add 10% to price. Machine weighed 230 Kg. and was very sturdy, well built and rigid. The firm also was manufacturing a 4 wheel drive machine powered by a 10-15 HP engine which will sell for \$1350 to \$1400 and weighs 500+ kg without the motor. We were much impressed by the capability of the shop.

Not seen but reported that another shop in the Utiea area is manufacturing the tiller from the IRRI design and has an order for ten of them from a dealer. This dealer is making the investment for the ten machines in order to demonstrate them to local farmers and test the potential market.

Thailand has the advantage of having an indigenously manufactured engine with the Winner two cycle engine. The company has extensive manufacturing capability.

SUMMARY

Although the ECAFE proposal has progressed considerably and received official blessings within the organization, it appears unlikely that it will receive UNDP funding. Even if it does, it will not become an effective force in the Agricultural machinery area for 3 to 4 years. This makes the current and extended role for IRRI very important. We feel that the IRRI contract could contribute to the Thailand machinery development by obtaining models of the Thai designed machines and proposing improvements such as lesser weight, etc. The Thai tiller and some of the other designs made by the Thai designers have been in production and use for many years, are well accepted by the Thai farmers and comparable to IRRI designs and local cost.

Thailand has the need and interest in the thresher, drier, pumps and the larger power tiller. Manufacturing capability clearly exists but IRRI needs to have a well trained and logistically supported representative in Thailand to make the necessary steps required for adoption to local manufacture.

V. SUMMARY REVIEW AND RECOMMENDATIONS FOR THE UTILIZATION OF IRRI AGRICULTURAL MECHANIZATION RESEARCH RESULTS

INTRODUCTION

TA/AGR/W has had a contract with IRRI entitled "Agricultural Equipment Development Research for Tropical Rice Cultivation". This project has been in operation since 1965 and has been developing equipment which 1) meets the functional requirements of rice culture for a sizable segment of tropical farmers and 2) is suitable for local manufacture with the available manufacturing technology of the region.

As a result of this contract, a number of pieces of agricultural equipment have been developed including a power tiller, weeder, seeder, thresher, and batch drier. The power tiller is being manufactured by four companies in the Philippines and has found wide acceptance with the farmers there. The power weeder has been manufactured by a Japanese concern and is widely used in Japan. The evaluation and testing of the developed equipment is being done through a subcontract arrangement with manufactures and governmental agencies in ten Asian countries.

OBJECTIVES

An extensive review was undertaken to fulfill the following objectives:

1. To obtain the current status of the IRRI project in the areas of machine development, testing, evaluation, and outreach.
2. To determine the suitability of the IRRI designs to local situations using the Philippines, Vietnam, Thailand and Korea as examples. (Indonesia was to be included but travel clearances could not be arranged in time). IRRI project will follow up there later in September, 1973.
3. To explore the capability and capacity of the local industries in these countries to manufacture and adapt the IRRI designs.
4. To determine the feasibility of providing technical assistance and training to locally owned and operated machinery production enterprises.
5. To determine the status of the ECAFE mechanization institute for the Asia region.

ITINERARY

August 13-18 - Briefing in Washington

August 19-25 - Review of IRRI program and Philippines situation.

August 26-September 1 - Review of Vietnam situation.

September 2-6 - Review of Thailand situation and meet with ECAFE

September 7-11 - Review of Korean Situation.

Mr. Joseph Campbell, Agric. Engineer with IRRI project, accompanied the review team in the Philippines, Vietnam, Thailand and Korea. He provided valuable information on the outreach of the IRRI projects in these countries. The trip provided Mr. Campbell with many new contacts as well as a first hand appreciation of the status of each countries agricultural mechanization and the place for the IRRI designs.

SUMMARY

In each of the countries visited, the AID mission, local manufactures, governmental agencies and officials were contacted to obtain relevant information pertinent to the objectives of the review. The detailed findings and appropriate recommendations were written at the conclusion of each country visit. These are attached and have been left with each Mission of the countries visited.

The IRRI project has been very benefically engaged in the research and development of 16 types of agricultural equipment oriented to tropical rice cultures. These developments have occurred primarily in the past three years and have been most specifically oriented to the needs of the Philippines. In the last year, attention has been focused on the need for utilization of the research accomplishments of the project. Outreach to date has consisted of establishing contracts with ten Asian countries for the testing, evaluation and manufacture of the IRRI designs.

The Project program of outreach has pointed to certain limitations. One is due to the small staff associated with the project which has made it difficult to adequately cover and provide assistance to the countries being contacted. Another is the necessity for future research work to be done considering the broader priority needs of the region which are different for each of the end user countries. This can be effectively accomplished by an expanded activity of testing and evaluation programs in the user countries which will provide needed feed back information to the program. In addition, the project needs to develop and establish clearer priorities and goals in their research efforts backed by data rather than the intuitive approach for selecting priorities currently used.

In all the countries visited, agricultural mechanization was moving ahead rapidly. In each, circumstances pointed toward the suitability of certain IRRI designs, the inadequacy of others and the need for further developments. These will be summarized briefly on a country by country basis.

Philippines

The IRRI designs have been most readily accepted here. The power tiller is being manufactured by four manufactures at a maximum rate of approximately 300 per mo. Threshing and drying developments appear to be needed and suitable for the country situation.

Vietnam

Large four wheeled tractors are an important part of the Delta tillage operation which means that the IRRI tiller will probably find only limited use in the area of small paddies. Improved threshers are needed although they must handle wet materials which may be difficult for IRRI axial flow design. Driers are needed but large capacity designs appear most appropriate. Operable seeders and weeders should find a ready market.

Thailand

The power tiller has a definite place but IRRI design may find stiff competition from a rugged heavy model being produced there. Threshers, seeders, and weeders can find a place in Thailand's mechanization program. Pumps which can lift water 2-3 meters using simple equipment appear needed.

Korea

The mechanization of Korean agriculture is well developed. IRRI's thresher was of particular interest. Pumps, seeders, transplanters and driers seem to be in most need. With Dae Dong manufacturing a well accepted and moderately sophisticated tiller, the IRRI design will probably not find a significant place. Improved rice milling equipment and procedures would be accepted. It is possible that present Korean design on driers of from .7 to 2.3 MT capacity are superior to IRRI design and should be studied as to their adaptability in other countries.

In all countries visited, the capability exists for manufacturing the IRRI designs. Because of the limitations of manpower in the IRRI project, their greatest outreach impact has resulted when they have worked with firms having some previous manufacturing experience. These firms are able to better adapt the IRRI designs, provide the quality control measures required for satisfactory manufacture and sell and service the equipment they produce.

At this time, it does not appear that AID would have to provide any assistance to potential manufactures in the form of machine tools or other manufacturing equipment. The firms appear to be in the greatest need of technical assistance that might be provided by an IRRI employee located in the country to work with the potential manufacturing firms

in testing, manufacturing and equipment demonstrations. The other major need of the firms was to obtain working capital required to buy materials used in the manufacture of equipment and to carry an inventory of machines and spare parts.

ECAFE is moving ahead with plans for a regional Agricultural Equipment Institute to be funded by UNDP. Japan, India and the Philippines are most actively participating in the proposal.

At this time, the probability that the ECAFE Agricultural Institute will become a reality is very low and should not be considered as a significant factor when considering the future of the IRRI project.

RECOMMENDATIONS

1. To increase the effectiveness of the IRRI agricultural mechanization project, the following changes need to be made.
 - a) Formulate a 2-3 year plan of equipment research, development and outreach. This plan will serve as a coordinating theme for all future activities and should concentrate on those objectives which will have the greatest demonstrated payoff.
 - b) Collect pertinent information on designs including specifications, economic justification, sales potential, blueprints (with metric units) and develop unified outreach material.
 - c) Evaluate the possibilities of expanding the utility of the power tiller with added implements and or uses as a power source, new methods for pumping water and improved rice milling and processing machines and technology.
 - d) Develop a new subcontract format that will more clearly define all parties responsibilities, ownership of ideas and operating rules for IRRI and manufacturer evaluation relationships.
 - e) Assure that prototype machines are available for testing and assistance in their manufacture of prototype, testing and demonstration. (See seeding of equipment plan developed for Vietnam).
2. To develop a viable outreach for the IRRI contract, it is recommended that consideration be given to:
 - a) The contract be extended for 4 years with a new set of objectives which will clearly describe the outreach functions. It is recommended that consideration be given to turning the outreach function over to IRRI and keeping the machinery contract as a core technical group to develop new designs, adapt or improve other country developments in machinery for the construction of a more efficient, cheaper and reliable machine. To further study, in cooperation with AID missions and IRRI, activities in target countries to design or adapt under the contract, machines to fit the specific conditions of the country or region within the country. This will require consultation with IRRI and may require additional funding in the major grant.
 - b) Funds be provided to hire liaison engineers from the various target countries who will be IRRI employees, trained in the specifics of the designs, their manufacture and testing. They will reside in outreach countries and work closely with manufactures in testing, adapting and building equipment. These

- individuals will serve as focal points for the outreach in the countries which have been selected for a concentrated outreach effort for the project.
- c) The outreach programs be oriented to the greatest extent possible to the developing of machine manufacturing by the private sector of the recipient countries.
 - d) The outreach program be informally coordinated with AID Mission people in all countries where a Mission exists.
3. To broaden the effectiveness of the program to:
- a) Start design, testing and evaluation work to machines for upland rice growing as well as for rain fed paddies and for a tillage machine usable in tropical countries for general purpose tillage for multicropping.
 - b) To pay greater attention to the milling process, especially to the small mill in the ten to twenty ton/day range.
 - c) To develop and encourage greater participation in short term training programs for developing country participants. This may be possible by including machinery training in the curriculum of the IRRI agronomic training programs.
 - d) To sponsor and lead short workshops in the developing countries in the design, evaluation, operation and place of machinery in the agricultural sector.