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EVALUATION OF BPI (MAF-IRRI)* SMALL FARM MACHINERY INDUSTRIAL EXTENSION PROGRAM

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List of Acronyms

AAP	Accelerated Agricultural Production (Project)
AMDP	Agricultural Machinery Development Project
AMMDA	Agricultural Machinery Manufacturers and Distributors Assn.
AMTEC	Agricultural Machinery Testing Center
ASEAN	Association of South East Asian Nations
BOI	Board of Investments
BPI	Bureau of Plant Industry
BSMI	Bureau of Small and Medium Industries
CB	Central Bank
FSDC	Farm Systems Development Corporation
FSDP-EV	Farming Systems Development Project - Eastern Visayas
GOP	Government of the Philippines
IRRI	International Rice Research Institute
IBRD	International Bank for Reconstruction and Development
KKK	Kilusang Kabuhayan Sa Kaunlaran
MAF	Ministry of Agriculture and Food
MNR	Ministry of Natural Resources
MTI	Ministry of Trade and Industry
NACIDA	National Cottage Industry Development Authority
NEDA	National Economic and Development Authority
NFA	National Food Authority
OBM	Office of Budget and Management
PCARRD	Philippine Council for Agriculture and Resources Research an Development
PBSP	Philippine Business for Social Progress
PVO	Private Voluntary Organization
RIARS	Regional Integrated Agricultural Research System
RNAM	Regional Network for Agricultural Mechanization
RRDP	Rainfed Resources Development Project
SBAC	Small Busines Advisory Committee
SMED	Small and Medium Enterprise Develpment (Project)
UPISSI	Univ. of Phil. Institute for Small Scale Industries
USAID	U.S. Agency for International Development

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I. EXECUTIVE SUMMARY

The five person evaluation team conducted a quick, four day evaluation of the BPI (MAF-IRRI) Program, a component of the AID-IRRI Extension of Small Agricultural Equipment Project which is scheduled for completion in September 1985. Given the severe GOP budget crisis, additional external assistance probably will be needed to maintain the current momentum of the Program which is required to meet the new machinery needs of both MAF's promotion of new crops as well as longer term agricultural development. However, a substantial expansion of the BPI Program is not required for accelerated short term growth of either agricultural development or small farmer production/income because: a) available data indicate that farm mechanization by itself does not increase production, and b) large and small Philippine farm machinery fabricators are capable of expanding production to meet normal increases in demand. A wide variety of GOP policies and programs (including tariffs, credit, exchange rates, direct purchases of farm machinery, and perhaps most importantly pricing of agricultural products and inputs) have had a net neutral or perhaps slightly negative impact on domestic production and use of farm machinery.

The BPI Program is achieving most of its objectives and its benefits appear to definitely outweigh its costs. New equipment is being designed, evaluated, adapted, and extended to over 200 cooperator fabricators many of whom are producing the equipment as well as making their own improvements. The Program has established important communication networks both across concerned enterprises and agencies and, perhaps more importantly, between users/fabricators and equipment designers/developers. Areas of concern noted by the evaluation team include: a) ability of BPI to maintain momentum after September 1985, b) the BPI Program is not well integrated with other MAF R&D and extension efforts, c) cooperator fabricators need business/management assistance in addition to the engineering assistance they receive from BPI, and d) the BPI co-leader has not been involved in allocations of the Program's AID grant funds.

The team's primary recommendation is that the AID-IRRI Project be granted a two year, no fund extension so the the BPI Program can maintain its recently acquired momentum during the current GOP budget crisis. Other possible funding sources for sustaining the program include: existing or planned AID assisted GOP projects, AID ASEAN Program or S&T Bureau, other donors, IRRI core budget, or the GOP budget. Other recommendations include: a) better integration with other MAF activities and with the business extension efforts of other agencies, b) increased attention of GOP policy makers on the farm mechanization requirements of their recent shift to accelerated agricultural development and new priority crops, and c) officially constitute the Permanent Inter-Agency Committee for Agricultural Mechanization (PICAM), which has been delayed for four years.

II. SUMMARY OF CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

A. Farm Machinery in Philippine Agricultural Development

1. Available data suggest that use of farm machinery by itself does no increase agricultural production, but rather is used as a labor substitutin factor as farms improve water control and increase use of chemical inputs. addition, the farm machinery industry in the Philippines has developed to t point where it can meet normal increases in demand. Based on these two factors, the evaluation team concluded that while there is a need to contin support for the current Government farm machinery industrial extension program, a substantial expansion of the program is not required for either ccelerated short term agricultural growth nor short term increases in smal farm production or income. However, there is a need to focus additional sh term attention on selected post harvest machinery such as dryers, chippers hellers for the priority crops which are being promoted actively by Government.

2. In the longer term, accelerated agricultural development will requi a greater use of agricultural machinery both in terms of kinds of operation mechanized and the range of agroeconomic regions for which farm machinery i appropriate. In order to meet this longer term need, farm machinery resear and testing should continue as a joint public/private sector effort; thus a effective Government program is needed.

B. Government of the Philippines Programs and Policies Affecting the Farm Machinery Industry

1. A wide variety of Government policies and programs have had a mixed effect on farm machinery production and use. The net effect on use of farm machinery probably has been neutral or slightly negative during the last te years. Also the net impact seemed to favor imported farm equipment over lo manufacture; however, recent changes including devaluations have reduced th bias.

2. The Five Year Philippine Development Plan (1983-1987) appears to fa farm mechanization. It states that: a) Farm mechanization will be applied a selective basis and will be adopted to local conditions and available resources. b) The development and utilization of farm implements to augment the farmer's production will be encouraged. c) Mechanization will likewise b adopted as a measure to minimize post-harvest loses whenever possible.

3. Past government pricing policies for farm production and inputs discouraged agricultural growth and thus the adoption of agricultural machinery.

4. Government also affects manufacture and use of farm equipment by:

a. Exchange rates which affect the relative cost of imported versus domestically produced farm machinery.

b. Duty of about 35% placed on imported machinery.

c. Duty placed on engines, bearings, chains, plate steel and other raw materials used in domestic production of farm equipment.

d. Credit and outreach efforts to assist small industries (SBACs, NACIDA, KKK, etc.).

e. Accreditation and licensing programs.

f. Government purchases of farm machinery (by such groups as MAF, NFA, FSDC, etc.).

g. Government farmer credit programs for purchase of farm machinery.

C. The BPI (MA-IRRI) Industrial Extension Program

1. The explicit objective of the Program is to develop the capability of small farm equipment fabricators to design, adapt and produce farm machinery and implements for small farms. While the stated focus is clearly on fabricators, the evaluation indicated clearly that equipment design, development, and innovation capacity is also essential for BPI. After BPI has tested the implement in question under field conditions and mechanical defects corrected, fabricators are willing to take on the task of adapting it to their own situation, adjusting dimensions and specifications to suit local farmers' preferences, and reducing costs of production.

2. The team feels that the Program is generally well balanced; available resources appear to be allocated wisely among the various functions - extension, training, equipment development/testing, and communication/coordination with other organizations.

3. After a relatively slow start, the BPI (MAF-IRRI) Program mad signifigant progress and gained real momentum during the last year. While the evaluation team's methods of observation were somewhat less than statistically rigorous, they do suggest that the benefits of the MAF-IRRI Program most definitely outweight the costs:

a. BPI has developed its own designs, independent of IRRI, for a root crop chipper, rice thresher/corn sheller, and fertilizer-seed applicator.

b. The Program evaluted or tested over 20 types of equipment throughout the country.

c. The BPI has enlisted over 200 cooperator manufacturers most of which are small rural enterprises. As a result of encouragement, technical assistance, blueprints, and prototypes provided by the Program, many cooperators have started to produce MAF-IRRI farm machinery as well as make innovations to tailor the equipment to local conditions.

d. The Program has established important communication networks both across enterprises and agencies concerned with farm machinery and its manufacture, and, perhaps more importantly, between end users/fabricators and equipment designers/developers (such as those at IRRI, AMDP, or BPI).

4. Points of concern include the following:

a. Without continued external assistance after the September 1985 AID project completion date, the Program will have inadequate staff, budget, and expertise to sustain its current momentum. Additional institutional development and budget support for BPI are definitely needed. Without additional support, the Program probably will lose most of its momentum.

b. The Agricultural Engineering Division of BPI is relatively isolated from the rest of BPI and the overall R & D and extension efforts of MAF. Farm machinery concerns are not adequately represented in regular MAF extension efforts or MAF on-farm research trials.

c. IRRI-MAF Program focuses primarily on engineering aspects of farm machinery development and production. Better coordination is needed between BPI field extension efforts and the outreach efforts of agencies providing business support services such as costing/pricing, inventory control, marketing, financing etc. (such agencies include credit institutions, SBACs, NACIDA, small business institutions, state colleges, etc.).

d. The BPI program co-leader has indicated that he is unaware of the budget allocations of the AID-IRRI grant project funds for the BPI Program. The BPI and IRRI co-leaders should work together closely on the budgeting of such funds.

RECOMMENDATIONS

A. Recommendations for AID

1. The evaluation team's main recommendation is that the AID Asia Bureau grant a two-year extension to the current IRRI Project without adding additional funds. This would enable BPI to gain needed additional institutional capability and to the maintain its recently acquired momentum during the current GOP budget crisis.

2. The AID ASEAN Program and AID Science and Technology Bureau should consider initiating a regional industrial extension project for small-scale fabricators of farm machinery.

3. USAID/Manila Mission in collaboration with its GOP counterparts should investigate further the possibilities of assisting the BPI (MAF-IRRI) Program under one of its larger projects, either Small and Medium Enterprise Development (SMED), Rainfed Resources Development (RRD), or Accelerated Agricultural Production (AAP).

4. The USAID/Manila should encourage testing BPI (MAF-IRRI) types of farm machinery under USAID assisted, MAF farming systems projects (RRD and Farming Systems Development - Eastern Visayas).

B. Recommendations for the GOP

1. BPI should pursue efforts to obtain continued external funding either from private sources (such as AMMDA or regional industry associations), from AID, or from another donor. This last possibility can be explored with the NEDA External Assistance Staff.

2. Though the Government budget is extremely tight, efforts should be made to obtain some additional Government budget allocations to sustain the Program after September 1985. Roughly ₱300,000 to ₱500,000 per year is needed for: a) travel, training, and other extension expenses; b) costs related to equipment development and testing; c) a full time coordinator with extensive field experience and proven leadership ability to continue the excellent work initiated by the IRRI Program co-leader; and d) two or three engineers to replace those currently supported by the AID-IRRI grant.

3. The BPI and IRRI Program co-leaders should work together to utilize wisely the remaining AID-IRRI grant funds before September 1985.

4. MAF should integrate the farm machinery development work of BPI into MAF research and development (particularly through the RIARS network), farming systems, upland, and regular extension activities.

5. BPI should strengthen linkage and coordination with technology resource institutes (such as AMDP) and with other government and non-government agencies involved in industry extension activities (such as SBACs, NACIDA, private university small business institutes, and UPISSI). These agencies may be able to assist farm implements manufacturers in their business consultancy needs.

6. The evaluation team strongly recommends that Government policy makers give increased attention to the farm mechanization requirements of their current shift toward accelerated agricultural production and their focus on five priority crops: corn, azolla, rootcrops, ipil-ipil and soya beans.

7. Government agencies and credit programs should favor the purchase of locally manufactured farm equipment.

8. The Permanent Inter-Agency Committee for Agricultural Mechanization (PICAM) should be constituted officially and formulate policies on the industry's tariff and incentive structure, research and extension jurisdictions, credit schemes, and standardization, as well as monitor the impact of mechanization on small farms, landless labor, and rural industrial growth.

C. Recommendation for IRRI

1. Because the BPI Program provides IRRI with a very valuable communication channel with farmers and valuable feedback on IRRI-type equipment, IRRI should continue to support the BPI extension program with technical assistance, testing, and perhaps funding from the IRRI core budget.

2. The IRRI small farm equipment program should be coordinated closely with the IRRI cropping systems program with a goal of more fully utilizing the vast multidisciplinary expertise available at IRRI.

III. PURPOSE OF THE EVALUATION

The primary purpose of this evaluation is to assess the progress of the BPI (MAF-IRRI) Program and to make recommendations for its improvement and long term sustainability. Sustainability is a particularly important issue because the AID assistance to the program, which is provided through a grant to IRRI, is due to end in September 1985. To continue its current industrial extension activities, the Engineering Division of BPI will need additional resources after AID funded IRRI support is withdrawn. Given this situation, the evaluation team focused on: the need to continue the industrial extension activity, possible ways for improving the program, and possible sources of continued support. An important factor also investigated was the impact of the current economic crisis and Government austerity measures on both manufacturers and the MAF-IRRI Program. The five person team conducted a quick, four day, assessment which included interviews with BPI, IRRI, and AMDP personnel as well as visits to six cooperators and brief discussions with machinery end users and dealers (See Annex E. Methodology).

IV. BACKGROUND

I. Mechanization in the Philippines and Its Impact

Utilization of agricultural mechanization in the Philippines varies widely depending on farm size and crop; thus generalization is difficult. Before 1970, most mechanization was concentrated on large plantations such as sugar estates. Government credit programs contributed to the adoption of tractor mechanization. Starting in the early 1970's, small and medium rice farms started to adopt selected types of mechanization. During the decade, the use of mechanical threshers and power tillers increased rapidly, partially as a result of widespread concern about the outbreak of hoof and mouth disease. Domestic production of these types of equipment increased to meet the demand.

By 1984, about half of land preparation for rice involved mechanization and most rice was threshed using power threshers. A large proportion of mechanical land preparation and threshing are on a custom hire basis, whereby the equipment owner and his work crew hire their services to the farmer at a fixed price or percentage of the total crop. Manual methods are used for virtually all other aspects of rice production such as seeding/transplanting, fertilizing, weeding, and harvesting.

The consequences of small farm mechanization on production, employment and income have received considerable attention under the AID-IRRI project Impirical evidence presented in a December 1983 workshop on this subject indicates that:

* Mechanization of land preparation does not increase yields or cropping intensity in rice production.

* Machines reduce overall labor requirements, principally family labor. Use of hired labor has remained constant or increased.

* The incomes of landless households has not been degraded by mechanization, although there is concern that further use of machines may erode an already declining real wage.

* The use of tractors, power tillers, and threshers do not provide excess profits to their owners, still the number of machines in use has increased rapidly in the past decade.

* Credit programs for mechanization aimed at small farmers have been largely ineffective in improving equity, employment, or output objectives.

* Distortions created through an overvalued exchange rate, tariffs, and pricing policies for agricultural products and inputs have resulted in an inefficient allocation of resources in the use and ownership of agricultural equipment. The attractiveness of imported larger scale tractors and tillers in particular has been enhanced by trade policies. Furthermore, declining real incomes of small farmers has reduced effective demand for farm implements.

* Government should not participate directly in the provision of credit to farmers for farm machinery. Alternatives such as lending to manufacturers or distributors at market interest rates should be explored.

2. Philippine Manufacturers of Agricultural Machinery

The Philippine farm machinery subsector is characterized by a high degree of heterogenaity with respect to both size and primary function. Most of the companies presently involved in the local manufacture of farm implements and machinery are either operated specifically for this purpose, or initially were machine and metal working shops.

Many of the sales/distributors of foreign-made products who expanded into large scale manufacturing during the agricultural boom of the mid 1970's have since ceased production and returned to their initial sales and service functions. These enterprises appear to have faced certain common management problems: (1) over expansion - creating shortage of liquid assests necessary for profitable operations, (2) managerial problems associated with expanding operations rapidly, and (3) capital investments in relatively expensive tools and dies, the products of which compete with subsidized, more sophisticated imports.

Most of the agricultural machinery manufacturers still in existence concentrate on one or two closely related product lines; e.g., rice thresher and thresher/sheller or hand tractor and rice reapers. Several of the large firms produce several lines; power tillers, rice threshers corn shellers, rice reapers and even rice drying and milling equipment.

Firms based in Metro Manila probably are working with provincial dealers. These firms are well positioned to pursue government contracts for farm machinery (e.g., NFA, NIA, FSDC, other donor sponsored programs). Their size and volume of business enable them to cover the manpower, capital, promotion, and red tape costs necessary for securing such contracts. Those contracts, in addition to providing returns on their own, also serve an advertising function.

Most rural firms, the primary target group of the BPI Program, are family owned and operated, labor intensive enterprises. They are initially self-financed with capital mostly in inventories of raw materials or finished products. A number of firms make use of government-supported credit programs after initial start-up. While some of these small enterprises produce for inventory, most operate on a made-to-order basis.

Most manufacturers usually sell on a cash basis. However, many give credit to selected customers who they know well and trust. One fabricator visited by the team controls three rural banks which provide credit for the purchase of the farm machinery he produces. Customers often pay small fabricators 50% of the sales price at the time an order is placed so that raw materials can be purchased; the remaining 50% is paid upon delivery. Most manufacturers indicated that if customers had readily available credit, demand would increase significantly. Some indicated that if they had ample working capital, they would sell their farm machines on a credit basis.

The manufacturers visited by the evaluation team indicated that the current economic crisis was not significantly hurting their businesses. However, it must be recognized that these manufacturers are by no means representative. The six manufacturers visited said they were at the peak of the thresher demand season and were operating at full capacity. Another factor contributing to their current success could be closure of other fabricators producing similar equipment. Several mentioned that demand was increasing because remittances coming from Filipinos working in the Middle East were being invested in farm machinery. Manufacturers indicated that the price of engines, steel and other inputs had doubled during the last year; they have all passed these costs along to their final customers. While the largest manufacturers said they had no problem obtaining raw materials, some smaller fabricators indicated that both the availability and quality of raw materials was a problem. In response to this situation, fabricators in Mindanao are trying to form an association for bulk purchases of higher quality raw materials at lower prices.

V. GOVERNMENT PROGRAMS AFFECTING AGRICULTURAL MECHANIZATION

In general, Government policy is somewhat mixed toward production and use of farm machinery. Explicit statements in the Five Year Philippine Development Plan appear to favor mechanization. The Plan (which is currently

being revised for presentation to the Batasan) states that:

a). Farm mechanization will be applied on a selective basis and will be adapted to local conditions and available resources:

b). The development and utilization of farm implements to augment the farmer's production will be encouraged; and

c). Mechanization will likewise be adopted as a measure to minimize post-harvest loses whenever possible.

Government pricing and other policies affecting farm inputs and production have maintained domestic terms of trade which discriminate against the agricultural sector. This has discouraged agricultural production and thus has had a strong impact on the adoption of farm machinery.

Government minimum wage laws potentially could cause farmers to substitute machinery for labor. However, such laws have had very little impact on actual compensation received by farm workers and thus have not influenced farm mechanization. On the other hand, Government has tended to subsidize capital and thus the adoption of farm machinery.

An overvalued exchange rate has given imported machinery an unfair advantage compared to domestically manufactured machinery. However, this is somewhat offset by the duty of roughly 35% placed on imported machinery. On the other hand, import duties must also be paid on engines, bearing, chains, steel plate, and other raw materials used in domestic manufacture of farm equipment. Furthermore, manufacturers must pay significant property taxes including a stiff tax on capital equipment. Finally, Government credit programs, some with donor assistance, have tended to favor large imported farm machinery over smaller, locally produced equipment.

Accreditation and licensing programs tend to penalize small fabricators of farm machinery. Accreditation involves costs which may be substantial for small fabricators. Without accreditation, small fabricators cannot sell their products using Government supported credit programs or directly to Government agencies such as NFA, MAF, FSDC, KKK, etc. Furthermore, compared to large manufacturers, small fabricators may have more difficulty obtaining Government supported credit for investment or working capital. Thus accreditation, Government supported credit, and direct Government purchases appear to favor large manufacturers over their smaller competitors. While most evidence suggests that Government favors larger enterprises, it is interesting to note that one large manufacturer visited by the evaluation team stated that Government should "rationalize" the industry by restricting small fabricators who produce unstandardized equipment at lower cost than the big enterprises.

Government outreach efforts by BPI, SBACs, NACIDA, and KKK might appear to provide greater assistance to small fabricators than to big manufacturers; however, the team was not able to verify this.

The above policy concerns require the attention and coordination of policy making bodies such as PICAM, AMTEC, NEDA and Central Bank. A serious point of concern is the delay in constituting PICAM. The project envisioned the establishment of a high level policy making body whose functions were to include coordinating the activities of the various organizations involve in farm implement manufacturing and testing as well as formulating policies to guide the research and development of such implements. The establishment of this policy group has been delayed for four years.

The importance of establishing a policy group of the kind described above will grow in the coming years as the GOP moves upstream from extension and credit into research and design. IRRI, by virtue of its rice oriented mandate, must direct its expertise and resources to the development of rice-specific implements and machinery. Given the increasing emphasis that crops other than rice are to receive under the new Action Agenda for Agriculture, the GOP will have to rely on Philippine design and testing capabilities rather than on those originating at IRRI. Coordination of these R&D efforts will be essential to avoid wasting precious research resources and costly duplication of services.

Conclusion

While the Five Year Plan appears to favor agricultural mechanization, the net affect of a wide variety of Government policies and programs have a mixed effect on farm machinery production and use. Primarily because past Government pricing policies for farm production and inputs discouraged agricultural growth, the net impact of Government on use of farm machinery has been neutral or slightly negative during the last ten years. Also the net impact seemed to favor imported farm equipment over local manufacture; however, recent changes including devaluations have reduced this bias.

VI. THE AID - IRRI EXTENSION OF SMALL AGRICULTURAL EQUIPMENT PROJECT

A. Background

In 1965 IRRI started to work on the development of small scale agricultural equipment which could be produced in small workshops using locally available materials. This R&D effort is generally considered a success; several types of equipment were developed and refined including axial flow threshers, power tillers, weeders, seeders, and axial flow pumps. However, there was only limited success with the promotion of the equipment, particularly outside of the Philippines. As a response to this situation, the AID funded Industrial Extension of Small-Scale Agricultural Equipment Project was approved in 1975 at a total cost of $839,000. The Project covered several countries and included technical assistance to develop prototype designs and to provide business and management expertise, as well as training for manufacturers and host country personnel. IRRI provided the engineering assistance while Georgia Tech was hired to provide business/management expertise.

The project started slowly but progress has been impressive; about 30,000 IRRI type machines were produced. An evaluation in 1978 concluded that IRRI had performed very well, but that because the project was only in full operation for 18 months, ministry personnel had not been trained sufficiently to continue the project activities without additional IRRI assistance. As a result of the evaluation, AID's Asia Bureau agreed to continue the project for another two years with a grant of $1.4 million. An evaluation in 1980 evaluation concluded that the Georgia Tech input was not cost effective, that more attention should be given to explicit country outreach strategies, and that social and economic consequences of mechanization should be studied more thoroughly.

B. Existing AID-IRRI Extension of Small Scale Agricultural Equipment Project

In 1980, the AID Asia Bureau approved a five year, $4,350,000 continuation project which incorporated the recommendations of the 1980 evaluation. The stated goal of this continuation project was to increase: small farm productivity, small farm income, rural manufacturing jobs, and foreign exchange savings. Its purpose was to increase the number of fabricators, level of production, number of local designs or adaptions, and value added per machine. The project was to be implemented in several countries; the Philippines, Indonesia, Thailand, India, Pakistan, and Nepal.

VII. THE BPI (MAF - IRRI) PROGRAM

A. The MAF - IRRI Agreement

The current MAF-IRRI Agreement was signed in November 1980 and the Program actually started in 1981 as a component of the larger AID-IRRI Project. Prior to this, The MAF/BPI Engineering Division was engaged in farm machinery R&D, but did not have an outreach program. As a result, most of the equipment designs developed did not reach manufacturers and thus did not go into production.

The explicit objectives of the MA-IRRI industrial outreach effort are generally consistent with the goals and purposes of the broader AID-IRRI Project. The objectives are to:

1. Improve or establish linkages between fabricators, farmers and/or farmers' cooperatives, and public sector institutions concerned with farm machinery.

2. Develop mechanisms, procedures, and industrial capacity for planning and coordinating design, development, manufacture, distribution and utilization of small scale agricultural machines.

3. Develop a training program for personnel from manufacturing firms and from the MAF with the objectives to:

a. Develop results oriented design capabilities
b. Develop in-factory training capabilities
c. Develop extension capabilities.

4. Assist the MAF in identifying qualified candidates for advanced level educational programs.

5. Provide personnel, facilities and guidance for both advanced degree and nondegree education programs.

Under the Agreement, an Advisory Committee was formed to establish general priorities and direction to the Program.* The Agreement indicated that BPI would provide a Program co-leader, two engineers (intially, with more to be added later), a secretary, and technicians. The salaries of the BPI staff were to be paid by the GOP, with the AID project funds providing honorarium to professional staff as well as funds for necessary travel. BPI also agreed to provide office space, office equipment, and shop facilities. IRRI agreed to use AID funds to provide an expatriot Program co-leader, two research assistants, a secretary, technicians to be hired as needed, a vehicle to be used exclusively for the project, a typewriter, an air conditioner, a copy machine, and an overhead projector.

B. Progress of the BPI (MAF-IRRI) Program

The team was not able to assess accurately the contribution of the Program to the overall AID-IRRI Project goal of increased small farmer productivity, small farmer income, rural manufacturing jobs, and foreign exchange. While available secondary information suggests that the Program has had relatively little, if any, impact on this goal, the Program has been generally successful in accomplishing the purposes of the AID-IRRI Project as well as the objectives of the MAF-IRRI Agreement. The Program appears to have contributed to the AID-IRRI purpose of increasing the number of fabricators, level of farm machinery production, number of local designs or adaptations, and value added per machine production In addition, the Program seems to be achieving at least three of the initial five objectives of the MAF-IRRI Agreement. It has established and/or improved relationships with a wide variety related organizations (See Annex A). It has enhanced the institutional capability of BPI to plan and coordinate the design, development, manufacture, distribution, and utilization of farm machines. It has improved and presented training programs as well as conducted workshops. The evaluation team could not discern if the Program accomplished its final two objectives of: a) assisting MA in identifying qualified candidates for advanced level educational programs, and b) providing personnel, facilities and guidance for both advanced degree and nondegree education programs. In any case, the evaluation

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* Advisory Committee membership in October 1989 is: Chair, Asst. Sec. Nelia Gonzales, MAF; Dr. Clarence W. Bockhop, IRRI; Mr. Luis G. Bernas, AMMDA; Mr. Agapito Kalingking, Jr. BOI; Mr. Leopoldo Magpale, CB; Dr. Carlos del Rosario, AMDP; Dr. Isagani Sarmiento, AMTEC.

team judged these two objectives to be relatively unimportant to the success of the BPI Program.

There are six basic activities of the current MA-IRRI Program:

1. Define Priorities. The Program decided to focus initially on small ric and corn farmers. After visits to major rice and corn areas, the Program defined the following priority equipment: for rice - reaper, dryer, rotary weeder, broadcaster, and transplanter; for corn - planter/fertilizer, weeder/cultivator, sprayer, sheller, and dryer. While this is a relatively wide focus, the Program has devoted most of its attention to a smaller number of equipment types which showed real promise or were linked to new GOP crop priorities. For example, the Program has given attention to the "Tapak-Tapak' pump developed in Bangladesh because it shows promise. As MAF increased attention to root crops, BPI developed a new root crop chipper.

2. Develop Equipment. Though not a explicit part of the MAF-IRRI Agreement, the Program has developed or adapted five pieces of equipment: see and fertilizer applicator, heated floor dryer, root crop chipping machine, manual corn sheller, and combination rice thresher - corn sheller. The team feels it was appropriate and necessary for BPI to get involved in equipment development despite its absence from the Agreement. The equipment development record of BPI is impressive given their limited staff and shop facilities.

3. Test and Evaluate Equipment The Program has conducted on-farm tests/evaluations of 21 types of equipment (See Annex B). In addition, it has used the facilities at IRRI to conduct rather precise tests of equipment for their cooperator manufacturers. The Program appears to have performed this activity relatively well; however the team was unable to assess the extent or quality of on-farm testing of equipment.

4. Promote Equipment to Manufacturers. The Program has undertaken successfully this major industrial extension activity. At present over 200 manufacturers throughout the country have agreed to become cooperators. Cooperators agree in writing to a) refrain from starting commercial production of equipment based on MA-IRRI designs until they have manufatured a prototype which successfully passes an acceptance test by MAF-IRRI engineers, and b) provide data annually of types and numbers of equipment produced. In practice, many, if not most, cooperators do not fully comply with these requirements. Under the Agreement, the Program agrees to provide cooperators with designs for equipment as well as training and technical assistance. The cooperators range in size from small blacksmith and metal craft shops to large industries (See Table 1).

5. Technical Assistance to Manufacturers. The Program has provided a wide range of technical assistance (See Annex C). However, staff and budget limitations have restricted their outreach capability. Therefore, they are unable to meet the total demand for their assistance. An indication of this is the fact that they no longer actively pursue cooperators, but continue to add cooperators as more and more firms approach the Program and want to join.

These various sources of information indicate that the program is generally successful but suffers from some weaknesses. The evaluation team agrees with most of the Program's self-evaluation that indicates the following major weaknesses (See Annex D): a) inadequate staff and budget, b) lack of staff capability to conceptualize and innovate new designs or to conduct economic evaluations, and c) insufficient number of new equipment designs capable of achieving rapid acceptance. However, the evaluation team feels that satisfactory progress has been made on new equipment designs considering the staff and budget limitations of BPI.

6. Monitor and Evaluate the Program. The success of the Program is monitored through informal feedback mechanisms, data submitted from cooperators on numbers of units produced, special evaluation activities (such as this one) and reviews by both IRRI and the Program Advisory Committee.

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

Ranges		Cooperators (%)
CAPITAL ASSETS[b]		
Cottage Industry	: Below US$10,000	43
Small Industry	: $10,000 to $100,000	13
Medium Industry	: $100,000 to $400,000	0
Large Industry	: Above $400,000	4
LABOR (Number of employees)		
Below 6		29
6 to 15		44
16 to 50		21
Above 50		6

[a] Data as of March 1983. The team realizes that these classifications do not correspond to the Government definitions of cottage, small medium, and large enterprises.

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

C. Conclusions Concerning the Operation of the IRRI-MAF Program

1. The team feels that the Program is generally well balanced; available resources appear to be allocated wisely among the various functions - extension, training, equipment development/testing, and communication and coordination with other organizations.

2. After a relatively slow start, the BPI (MAF-IRRI) Program made signifigant progress and gained real momentum during the last year. While the evaluation team's methods of observation were somewhat less than statistically rigorous, they do suggest that the benefits of the MAF-IRRI Program most definitely outweight the costs:

a. BPI has developed its own designs, independent of IRRI, for a root crop chipper, rice thresher/corn sheller, and fertilizer-seed applicator.

b. The Program evaluted or tested over 20 types of equipment throughout the country.

c. The BPI has enlisted over 200 cooperator manufacturers most of which are small rural enterprises. As a result of encouragement, technical assistance, blueprints, and prototypes provided by the Program, many cooperators have started to produce MAF-IRRI farm machinery as well as make innovations to tailor the equipment to local conditions.

d. The Program has established important communication networks both across enterprises and agencies concerned with farm machinery and its manufacture, and, perhaps more importantly, between end users/fabricators and equipment designers/developers (such as those at IRRI, AMDP, or BPI).

3. Points of concern include the following:

a. Without continued external assistance after the September 1985 AID project completion date, the Program will have inadequate staff, budget, and expertise to sustain its current momentum. Additional institutional development and budget support for BPI are definitely needed. A factor affecting BPI capacity is the unreasonably low salary levels that BPI must pay their staff under MAF regulations.

b. The Agricultural Engineering Division of BPI is relatively isolated from the rest of BPI and the overall R & D and extension efforts of MAF. Farm machinery concerns are not adequately represented in regular MAF extension efforts or MAF on-farm research trials.

c. IRRI-MAF Program focuses primarily on engineering aspects of farm machinery development and production. Better coordination is needed between BPI field extension efforts and the outreach efforts of agencies providing business support services such as costing/pricing, inventory control, marketing, financing etc. (such agencies include credit institutions, SBACs, NACIDA, small business institutions, etc.).

d. The BPI program co-leader has indicated that he is unaware of the budget allocations of the AID-IRRI grant project funds for the BPI Program. The BPI and IRRI co-leaders should work together closely on the budgeting of such funds.

D. Recommendations for Improving the Current IRRI-MA Program

Recommendations for AID

1. The evaluation team's main recommendation is that the AID Asia Bureau grant a two-year extension to the current IRRI Project without adding additional funds. This would enable BPI to gain needed additional institutional capability and to the maintain its recently acquired momentum during the current GOP budget crisis.

2. The AID ASEAN Program and AID Science and Technology Bureau should consider initiating a regional industrial extension project for small-scale fabricators of farm machinery.

3. The USAID/Manila Mission in collaboration with its GOP counterparts should investigate further the possibilities of assisting the BPI (MAF-IRRI) Program under one of its larger projects, either Small and Medium Enterprise Development (SMED), Rainfed Resources Development (RRD), or Accelerated Agricultural Production (AAP).

4. The USAID/Manila should encourage testing BPI (MAF-IRRI) types of farm machinery under USAID assisted, MAF farming systems projects (RRD and Farming Systems Development - Eastern Visayas).

Recommendations for the GOP

1. BPI should pursue efforts to obtain continued external funding either from private sources (such as AMMDA or regional industry associations), from AID, or from another donor. This last possibility can be explored with the NEDA External Assistance Staff.

2. Though the Government budget is extremely tight, efforts should be made to obtain some additional Government budget allocations to sustain the Program after September 1985. Roughly ₱300,000 to ₱500,000 per year is needed for: a) travel, training, and other extension expenses; b) costs related to equipment development and testing; and c) a full time coordinator with extensive field experience and proven leadership ability as well as two or three engineers to replace those currently supported by the AID-IRRI grant.

3. The BPI and IRRI Program co-leaders should work together to utilize wisely the remaining AID-IRRI grant funds before September 1985.

4. MAF should integrate the farm machinery development work of BPI into MAF farming systems, research and development efforts (particularly through the RIARs network) and into the regular MAF extension activities.

5. BPI should strengthen linkage and coordination with technology resource institutes (such as AMDP) and with other government and non-government agencies involved in industry extension activities (such as SBACs, NACIDA, private university small business institutes, and UPISSI). These agencies may be able to assist farm implements manufacturers in their business consultancy needs.

6. The evaluation team strongly recommends that Government policy makers give increased attention to the farm mechanization requirements of their current shift toward accelerated agricultural production and their focus on five priority crops: corn, azolla, rootcrops, ipil-ipil and soya beans.

7. Government agencies and credit programs should favor the purchase of locally manufactured farm equipment.

8. The Permanent Inter-Agency Committee for Agricultural Mechanization (PICAM) should be constituted officially and formulate policies on the industry's tariff and incentive structure, research and extension jurisdictions, credit schemes, standardization, and the impact of mechanization on small farms, landless labor, and rural industrial growth.

Recommendations for IRRI

1. Because the BPI Program provides IRRI with a very valuable communication channel with farmers and valuable feedback on IRRI-type equipment, IRRI should continue to support the BPI extension program with technical assistance, testing, and perhaps funding from the IRRI core budget.

2. The IRRI small farm equipment program should be coordinated closely with the IRRI cropping systems program with a goal of more fully utilizing the vast multidisciplinary expertise available at IRRI.

ANNEX A. Organizations Concerned with Manufacture of Small Scale Farm Machinery

National Institutions

Design and Development

University of the Philippines at Los Baños
Technology Resource Center
Design Center of the Philippines
Metal Industry Research and Development Center
Philippine Council for Agricultural and Resource Research

Machinery Testing

Agriculture Machinery Testing Center (AMTEC)
National Grains Authority (NGA) through National Post Harvest Research and Training Center (NAPHRT)

Industrial Support

Agricultural Machinery Manufacturers and Distributors Association (AMMDA)
Technology Resource Center
Design Center of the Philippines
Metals Industry Research and Development Center (MIRDC)
Ministry of Industry (MOI)

Credit

Central Bank of the Philippines (through Rural Banking Systems)
Development Bank of the Philippines (DBP)
Philippine National Bank (PNB)

Regional Organizations

Regional Post Harvest Technical Advisory Team at SEARCA
Regional Network of Agricultural Machinery
ASEAN Agricultural Machinery Group
Asian Development Bank

International Agency

International Rice Research Institute
International Bank for Reconstruction and Development (World Bank)

ANNEX B. Equipment Considered by MAF-IRRI Program

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

ANNEX C. Assistance to Cooperators

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

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

ANNEX D. MAF-IRRI Self Evaluation

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

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

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

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

ANNEX D. MAF-IRRI Self-Evaluation

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

Best Available Document

Annex D. Continued

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

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

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

ANNEX E. Methodology

The evaluation team had only four days to complete the evaluation. A fifth day was used to present our findings to IRRI and to the Program Advisory Committee. This very short time frame meant that a rather ad hoc methodology had to be used. Fortunately, the team members had experience with agricultural machinery manufacturing in the Philippines and elsewhere as well as experience with small scale manufacturing, Philipiine agricultural programs and practices, programming of AID assistance, and GOP operations. While this experience gave the team a head start, the severe time constraint greatly limited the amount of information we could collect, analyze, and discuss among ourselves. The conclusions and recommendations presented in this report should be read with this limitation in mind. The schedule of the evaluation was as follows:

Day One: Interviews and discussions with MAF-IRRI Program (at BPI office in Manila) and with IRRI and AMDP personnel (at Los Banos). Observations of equipment demonstrations at IRRI. Visit to one cooperator in Los Banos (Los Banos Agricultural Machineries)

Day Two: Visits with three cooperators (Mechanical Factors Phils in Manila; Northern Marketing and New Tarlac Northern Cottage Industry in Tarlac; and Phil-Germa Mfg.,Inc. in Calasio, Pangasinan). Visits to two dealers (FARMACOR in Tarlac, and Chu Hardware in Dagupan).

Day Three: Visits with three cooperators (V.G. Machine Shop in Agoo, Pangasinan; C & B Crafts in Maguino, San Rafael, Bulacan; and P.I. Farms in Valenzuela). Visits with four potential or actual end users (two using power tillers, one using a peddle-type thresher, and one using a carabao).

Day Four: Team analyzed and discussed their findings, conclusions, and recommendations as well as planned their oral reports which were presented to IRRI and the Program Advisory Board the following day.

Annex F. Selected References

Rijk, A.G. "Role of Agricultural Mechanization in Asia," ADB, October, 1983.

BPI, "MAF-IRRI Industrial Extension Program For Small Farm Equipment, Annual Report and Proposed Workplan," September 1983, 1984, and 1985.

AID, Asia Bureau, "Extension of Small Scale Agricultural Equipment (IRRI) Project Paper," 1980.

IRRI ed., Consequences of Small-Farm Mechanization, IRRI & ADC, 1983.

IRRI ed., The Consequences of Small Rice Farm Mechanization in the Philippines: Workshop Papers, IRRI & NEDA, December, 1983.