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Mechanization of rice production in the Philippines: trends and perspectives

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ABSTRACT

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The present level of rice mechanization in the Philippines is still insufficient to significantly reduce the cost of rice production and for farmers to attain high level of competitiveness relative to those of neighboring rice-producing countries. Sustained support and a consistent mechanization policy of the government are needed for agricultural modernization through mechanization of farm operations to take off. Aside from increasing the efficiency of production and reducing postharvest losses, farm mechanization can serve as a catalyst for the implementation of integrated rural and agricultural development programs of the government.

Keywords: agriculture. development. mechanization. rice.

INTRODUCTION

Rice is the most important crop in the Philippines. It is the country's staple food and some 48 million Filipinos depend on it for a living (Philippine Rice Research Institute, 1999). Inspite of this, production has not been able to consistently meet our rice needs. The ever-growing population continues to exert tremendous pressure on our rice farmers to produce more.

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Much effort is presently given by the Philippine government to modernize rice production and to improve the living condition of Filipino farmers. One of the means of promoting agricultural modernization is to encourage and train farmers in the use of modern farm machinery and equipment. The *Gintong Ani* Program of the Department of Agriculture under the past administration included a farm equipment supply subcomponent that aimed to assist farmer-cooperatives in acquiring the needed farm machinery through interest-free loans payable in 5 years. At present, the program is continued and even enhanced under the new banner, the Department of Agriculture – *Agrikulturang MakaMASA*. This government support is expected to encourage local manufacturing, training, and extensive use of farm machinery by individual farmers and farmer-cooperatives.

This paper reviews the current state of rice mechanization in the country. It also discusses problems besetting mechanization as well as the various government interventions aimed to alleviate these problems.

Present state of rice mechanization

The use of agricultural machinery in Asian countries including the Philippines, has been increasing since the early 1970s. Compared with the other Asian countries (Table 1), the Philippines still needs to improve its mechanization program as it is still classified by the Regional Network for Agricultural machinery (RNAM) under "low mechanization countries" (Rahman, 1994). In these countries, 50% of crop production operations are already mechanized with major impediments to mechanization such as: low buying power of farmers; abundance of rural labor and, hence, low wages; very small land holdings; high cost of imported machines; substandard quality of locally manufactured machines; and government policies not conducive to mechanizing agriculture (Rahman, 1994).

Table 2 shows the relative capability of Filipino rice farmers to buy a piece of equipment compared with other Asian farmers (Hossain, 1999). Hand tractor is used for comparison since it is commonly used as a source of power in the rice lands of Asia. In Japan, a farmer needs to sell only one ton of paddy rice to buy a hand tractor. A Filipino farmer, on the other hand, has to sell 10.6 tons to buy the same piece of equipment. In Vietnam, the figure shoots up to 13 tons. In contrast, Japanese and Korean farmers can easily afford even the

Table 1. Average yearly percentage increase in the use of agricultural machinery for selected Asian countries

Machinery	Period	India	Indonesia	Pakistan	Philippines	Korea	Sri Lanka	Thailand
4-W tractor	1971-1980	19	170	11	10	60	30	22
	1981-1990	10	15	18	26	64	2	10
Power tiller	1971-1980	11	30	90	25	70	na	14
	1981-1990	17	10	9	66	13	na	14
Pumps	1971-1980	15	25	6	33	12	30	8
	1981-1990	17	na	6	21	15	16	7
Sprayers	1971-1980	9	74	95	27	17	24	2
	1981-1990	36	11	60	86	227	36	4
Reapers/	1971-1980	30	–	50	–	na	na	na
Harvesters	1981-1990	26	–	33	12	na	na	na
Threshers/	1971-1980	14	75	106	28	38	na	30
Shellers	1981-1990	23	23	19	4	5	na	13

Source: Rahman (1994)
- = no data
na = not applicable

Table 2. Amount of paddy which must be sold to purchase a hand tractor (7 hp) in selected Asian countries (Domestic rice prices and cost of production are based on 1989 figures)

Country	Paddy yield (t/ha)	Cost of production (US$/t)	Domestic farm gate price of paddy (US$/t)	Amount of paddy to be sold to purchase one hand tractor (t)
Bangladesh	4.6	138	180	9.4
Indonesia	5.8	118	132	12.9
Japan	6.5	1,987	1,730	1.0
Korea	6.6	939	957	1.8
Philippines	2.6	124	160	10.6
Thailand	1.8	120	141	12.1
Vietnam	4.6	100	130	13.1

Source: Hossain (1999)

most sophisticated machinery. Since the average size of landholding in many Asian countries does not vary very much, it can be seen that the main reason for the lack of mechanization in agriculture in these countries is not small farm size, but small farm income (Gee-Clough, 1984).

Table 3 presents the actual sales of farm equipment in the Philippines by the Agricultural Machinery Manufacturers and Distributors Association (AMMDA) during the past two decades. The picture has not been well defined because of erratic performance of the market. This may indicate that the country still has to increase its efforts in promoting farm mechanization and modern farming techniques for the next decade if it hopes to catch up with its neighboring countries (Bautista, 2000).

Table 4 shows the percentage distribution of rice farms in the country. It shows that most landholdings are less than 5 ha (Gimenez, 1993). This partly explains why rice mechanization has focused on the use of small farm equipment with engine primemovers seldom exceeding 20 hp. There is also a proliferation of lightweight equipment which can be transported from one paddy field to another. There is strong emphasis on mobility on soft and deep soils which are common in rice fields during wet seasons. Since most farmers have less financial resources, there is a heavy bias for equipment that are low cost and easy-to-manufacture or service.

Table 3. Number of units of farm equipment sold by Agricultural Machinery Manufacturers and Dealers Association (AMMDA) from 1978 to 1998

Year	Engines	Tractors	Power tillers	Threshers	Irrigation pumps	Rice mills	Others
1978-79	87914	2490	13182	5226	8437	1062	795
1980-81	69043	1395	5894	3538	1968	1739	1342
1982-83	53147	1178	3792	725	2820	582	311
1984-85	16808	326	2088	1073	—	506	294
1986-87	28032	101	485	389	—	570	91
1988-89	58899	315	2012	520	—	420	86
1990-91	101241	305	2634	661	1208	906	109
1992-93	101182	253	1035	382	9128	836	93
1994-95	173171	301	873	584	12506	711	651
1996-97	220661	430	3368	934	12636	133	737
1998	80631	114	294	288	10137	27	15

Source: Bautista (2000) — = no data

Table 4. Distribution of rice farms by size in the Philippines in 1993

Area (ha)	No. of Farms	% Share of Total
Less than 1	146,826	14.90
1 to <3	531,526	53.97
3 to <5	211,529	21.48
5 to <10	71,412	7.25
10 to <25	21,218	2.15
25 to <50	1,582	0.16
Over 50	821	0.09
TOTAL	984,914	100.00

Source: Gimenez (1993)

Agencies involved in rice mechanization

Several agencies and programs were established with the end view of implementing the needed changes in mechanization research and development, technology transfer, manufacturing, infrastructure, as well as institutional arrangements for developing suitable and better quality machines, and popularizing the adoption of appropriate mechanization technologies. These agencies include the following :

a. Bureau of Postharvest Research and Extension (BPRE), formerly the NAPHIRE - develops and promotes technologies to improve the postharvest industry of the country. BPRE has previously developed the NAPHIRE Mobile Flash Dryer, the In-Bin Drying System for rice and corn, a low-cost grain moisture meter, as well as other improved systems for rice and corn postharvest operations. It is the main implementing arm of the Department of Agriculture for the promotion of postharvest equipment and facilities in the country.

b.College of Engineering and Agro-industrial Technology (CEAT), University of the Philippines Los Baños (UPLB) - implements the Agricultural Mechanization Development Program (AMDP) and the Agricultural Machinery Testing and Evaluation Center (AMTEC). The former is involved with RNAM in the adaptation and exchange of designs with other member countries while the latter evaluates commercial prototypes from local manufacturers needing government assistance for production and marketing operations. AMTEC also spearheads the setting up of farm machinery standards under the Department of Agriculture.

c. Agricultural Engineering Division of the International Rice Research Institute - has a strong program focused on developing rice equipment for Asian conditions. The designs are sent to other countries for testing and adaptation. IRRI has been responsible for the development and popularization of the axial-flow thresher design in the Philippines and the rest of Southeast Asia. In 1981-86, it collaborated with the Department of Agriculture-Bureau of Plant Industry in the development and extension of small farm equipment, like axial-flow pump, foot-treadle pump, IRRI reaper, and the hydrotiller which is an adaptation of a local invention. Starting in 1990, however, it shifted its focus to equipment design and development, leaving the extension of the IRRI-designed machines to the national agricultural research systems of interested countries.

d. National Agriculture and Fishery Council (NAFC) - this is an agency of the Department of Agriculture tasked to monitor and implement special projects with funding coming from foreign donors. Since 1990, NAFC has been implementing the Committee on Agricultural Mechanization which formulates and implements mechanization policies and strategies. Recently, the committee was expanded to include the fishery sector.

e. State Colleges and Universities - aside from UPLB, several state colleges and universities with strong agricultural engineering departments in the country are also involved in rice mechanization. Involvements are mostly in the development and testing of farm machinery through graduate and undergraduate thesis of agricultural engineering students. Examples are the Mariano Marcos State University and the Central Luzon State University in Luzon, the Visayas State College of Agriculture in the Visayas (now Leyte State University), and the Mindanao State University in Mindanao.

f. Philippine Rice Research Institute (PhilRice) – PhilRice is the lead agency of the Department of Agriculture that formulates and implements the National Rice Research and Development Agenda. Its Rice Engineering and Mechanization Division has been developing engineering technologies which are geared towards improving efficiency of farm operations and reducing field and postharvest losses. PhilRice has been able to perform its mission through its strong linkages and collaboration with IRRI, attached agencies of the Department of Agriculture and the Department of Science and Technology with strong engineering units and with its local research development and extension network composed of stations of the Department of Agriculture and state colleges and universities.

Apart from collaboration with IRRI, the Rice Engineering and Mechanization Division of PhilRice was the coordinating body of the Collaborative Program on Rice Mechanization among various institutes involved in rice mechanization from 1987 to 1994. It also had previous collaborations with IRRI on the local adaptation of the rice stripper and other IRRI designs, with the University of Agriculture and Forestry in Vietnam on the local adaptation of a rice batch dryer, and with local agencies on some specific concerns. It is also an active member of the newly-formed Philippine Rice Post-Production

Consortium together with BPRE, IRRI, CEAT-UPLB and the National Food Authority. This collaboration is formed specifically to address the problems of the rice post-production industry in the country.

With increased technical and facility support both from the government and foreign sources such as the Japan International Cooperation Agency (JICA), PhilRice, with the help of the Network, has now a strong capability to effectively promote mechanization of our rice farms. Since 1992, the Rice Engineering and Mechanization Division has developed 14 rice engineering technologies, 9 of which have already been commercialized (see Bautista, 2000).

The role of the private sector in rice mechanization

The significant contribution of the private sector to rice mechanization lies in the fact that private manufacturers are the ones supplying the needed machines and equipment to the farmers. The Philippine machinery industry is characterized by a mixture of imported and locally manufactured tools, implements, machines and equipment. At present, there are more than 460 manufacturers and distributors of agricultural machinery scattered all over the country. AMMDA, which is composed of more than 30 big and medium-sized companies, serves as the spokesman of the industry and as an active partner of the government in its efforts to modernize Philippine agriculture. It is trying to fulfill its noble mission of maintaining high standards in supplying agricultural machinery to its customers and to help Philippine agriculture attain greater efficiency and productivity (Canapi, 1999).

Factors affecting rice mechanization

a. Irrigation, high yielding varieties, government's program to increase rice production (provision of credit for fertilizer and chemical inputs). The introduction of modern high-yielding varieties, the provision of irrigation facilities in the major rice areas, and the continued emphasis of the government on increasing the production of rice for food sufficiency, have provided the impetus for the continuous adoption by the farmers of rice machinery and equipment. Farmers in irrigated areas, for instance, produce two (in some cases up to three) crops a year. In contrast, farmers in rainfed areas usually have only one crop a year. With traditional practices and implements, it is impossible to prepare the land and to thresh the harvested paddy of the first season and still plant the second crop at too short turnaround time.

b. Local machine development and manufacturing. The most popular equipment are those that are locally developed and manufactured (i.e. hand tractors, threshers), for reasons like adaptability to local conditions, ease of repair and maintenance, availability of service and parts with the manufacturers, and cheaper cost (although manufacturers still rely heavily on imported parts like engine, bearings, and other transmission elements).

c. Formation of farmer cooperatives/foundations. More than 80% of the rice farms are actually less than five hectares (Table 4). It is only when majority of these farmers, including the smaller ones, are organized into a cooperatives that the ownership of farm equipment is made possible and their use is economically attractive. Custom use allows smaller farmers to benefit from farm equipment.

d. Increased farmer incentives and income generation. Although other incentives provided to the farmers are not directly given, some incentives in the form of subsidized fertilizers and slightly higher government prices for paddy (compared to private traders) are provided on a limited scale. A significant number of farmers are actually operating their equipment on custom basis for income generation purposes and to optimize the use of the equipment.

Problems besetting mechanization

Figure 1 indicates the problem tree on the low level of mechanization in the country. The major problems that cause the low level of mechanization in the Philippines are the lack of farmers' awareness of new mechanization technologies, the unfavorable attitudes and orientation of farmers caused by risks in adapting locally manufactured equipment, the lack of financial capability to acquire the needed equipment, as well as the labor displacement effect of mechanization (Bautista, 2000). Strengthening promotion programs for new technologies will help in increasing the awareness of farmers towards modernmechanized methods.

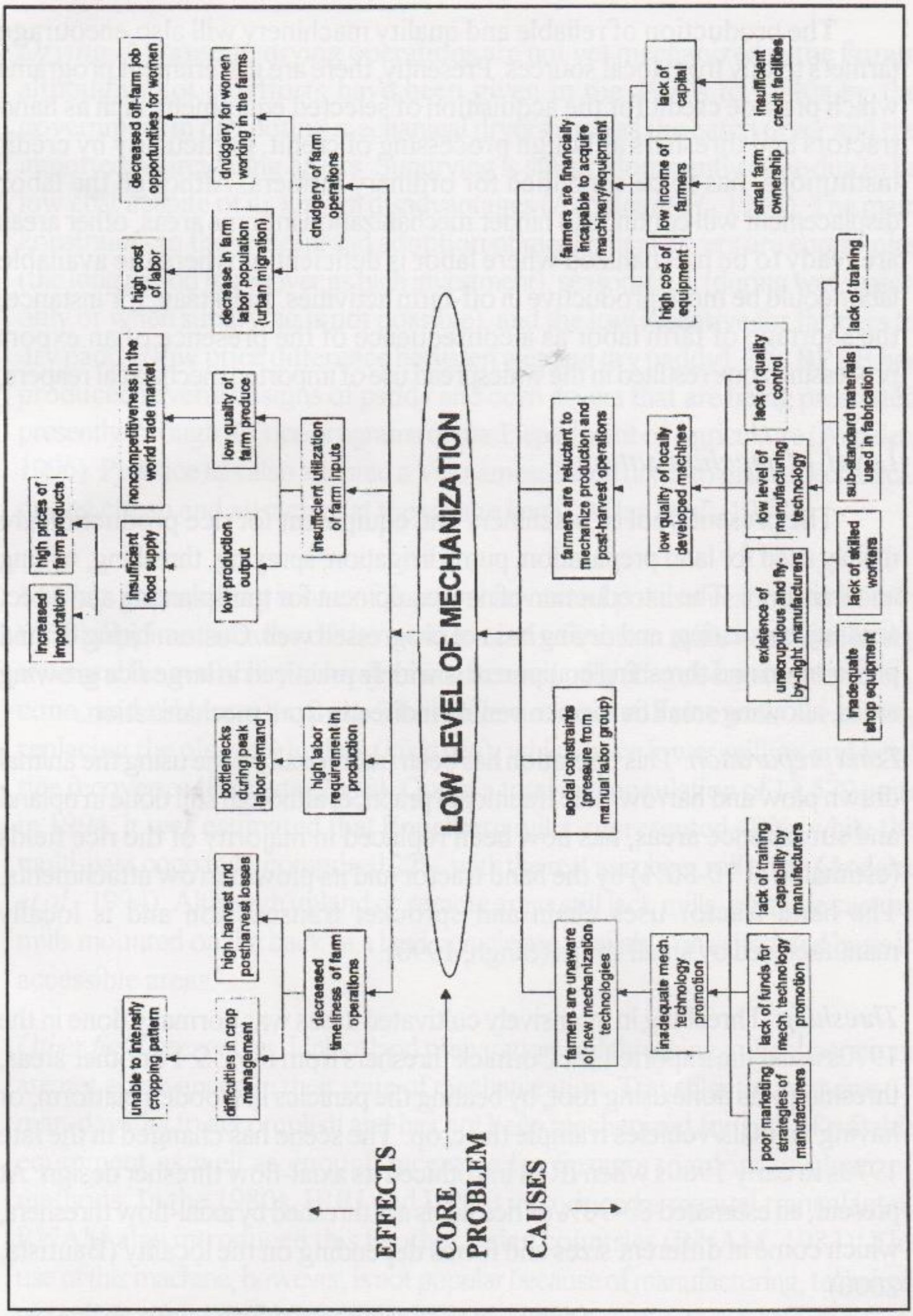

Figure 1. Problem tree on mechanization in the Philippines (Bautista, 2000).

The production of reliable and quality machinery will also encourage farmers to buy from local sources. Presently, there are government programs which provide credit for the acquisition of selected equipment such as hand tractors and threshers although processing of credit, particularly by credit institutions, has to be simplified for ordinary farmers. Although the labor displacement will continue to hinder mechanization in some areas, other areas are ready to be mechanized where labor is deficient or where the available labor could be more productive in off-farm activities. In Bataan, for instance, the shortage of farm labor as a consequence of the presence of an export processing zone resulted in the widespread use of imported mechanical reapers.

Level of mechanization

The present pool of machinery and equipment for rice production are mainly used for land preparation, pump irrigation, spraying, threshing, milling and transport . The introduction of new equipment for transplanting and direct seeding, harvesting, and drying has not progressed well. Custom hiring of land preparation and threshing equipment is widely practiced in large rice growing areas, allowing small farmers to benefit indirectly from mechanization .

Land preparation. This operation has been traditionally done using the animal drawn plow and harrow. The traditional practice, although still done in upland and subsistence areas, has now been replaced in majority of the rice fields (estimated at 70-80%) by the hand tractor and its plow/harrow attachments. The hand tractor uses chain and sprocket transmission and is locally manufactured by small shops (Singh, 1990).

Threshing. Threshing in intensively cultivated areas was normally done in the 1970s using the imported McCormick threshers from the US. For other areas, threshing was done using foot, by beating the panicles in wooden platform, or having animals/vehicles trample the crop. The scene has changed in the late 1970s to early 1980s when IRRI introduced its axial-flow thresher design. At present, an estimated 80-90% of rice fields are threshed by axial-flow threshers, which come in different sizes and forms depending on the locality (Bautista, 2000).

Drying. At present, drying operations are not yet mechanized in the farmm although a lot of efforts have been given in the 1970s to 1980s by the government in promoting mechanical dryers such as the batch dryer and the imported recirculating dryers. Sundrying is still predominantly done due to its low cost despite of its known disadvantages (Andales *et al*., 1994). The main constraints to the widespread adoption of mechanical dryers are economics (the long period to recover its high investment), seasonal use (during wet season only or when sundrying is not possible), and the low incentive for farmers to dry paddy (low price difference between wet and dry paddy). The BPRE has produced several designs of paddy and corn dryers that are being promoted presently through the rice programs of the Department of Agriculture (Andales, 1996). PhilRice has also adapted a Vietnamese batch dryer to make mechanical drying cheap and attractive at the village level (Aldas *et al*., 1996).

Milling. Rice milling is one of the most advanced postharvest operations in the Philippines because of the proliferation of custom mills in almost every town and the availability of locally manufactured mills (Engelberg steel dehullers, cono, and rubber roll types). The modern rubber roll rice mills are slowly replacing the old steel hullers (*kiskisan*), which have lower milling and head rice recoveries (Bautista, 2000). Out of a total mill population of 13,579 units in 1994, it was estimated that Engelberg mills represented 40%, while the multi-pass cono mills comprised 22% with the rest as rubber roll types (Andales *et al*., 1994). Although upland or remote areas still lack mills, portable custom mills mounted on the back of a land vehicle are available on scheduled basis in accessible areas.

Other field operations. Unlike land preparation and threshing, other operations are not as advanced in their state of mechanization. Transplanting requires 15 man-days/ha to accomplish and has not been mechanized for lack of suitable equipment as well as enough incentive for farmers to adopt mechanized methods. In the 1980s, IRRI and UPLB introduced a manual transplanter; RNAM also introduced this in other Asian countries (RNAM, 1983). The use of this machine, however, is not popular because of manufacturing, technical, as well as social problems (Salazar *et al*., 1986).

Thus, to minimize labor and cost, an increasing number of farmers resort to direct-seeding of pre-germinated seeds on puddled soils. PhilRice and IRRI are presently promoting the use of manual row seeders to allow seeding in rows at lesser seeding rate. PhilRice, in collaboration with JICA, has recently developed a hand tractor-mounted direct row seeder with a capacity of 3-5 ha/day but this is still being verified in farmers' fields (Damian *et al.*, 1999).

Fertilizer application is done by broadcast. Chemicals are applied using the lever-operated knapsack sprayer which is imported from Taiwan or China. For weed control, few farmers adopt the manually pushed rotary weeders since herbicide is commonly applied in combination with manual spot weeding (Bautista, 2000).

In terms of harvesting, most farmers still use the sickle to harvest paddy. This practice requires 10-15 man-days/ha, with around 5% losses due to shattering, over-mature crop, and excessive infield handling prior to threshing. Around 2% now uses the imported Japanese rice reaper and the IRRI-designed rice stripper. Despite its high cost (about P150,000/unit), the use of the imported reaper is increasing near urban areas where harvesting labor is deficient. PhilRice has recently released for commercial manufacture the PhilRice-JICA rotary reaper with similar performance but at less than half the price of the imported model (Regalado *et al.*, 1997).

Future prospects

The ever-increasing population coupled with the degradation and shrinking of our prime rice lands as a result of industrialization necessitates an increase in rice production through the expansion of irrigated areas and the promotion of modern rice technologies. Cropping intensity and yield per unit area have to be increased in order to lessen dependence on rice imports and attain the food production targets of the government. With the growing scarcity of farm labor in many areas of the country, mechanization of farm operations is increasingly seen as a solution to improve production efficiency, reduce harvest and postharvest losses and allow full utilization of farm products and by-products. Due to the scarcity of research and development on mechanization there is a need for it to be prioritized. On the production side, priorities may be the labor intensive operations such as land preparation, crop establishment and harvesting. Among them, research and development on crop establishment lags behind.

On the postharvest side, drying accounts for the biggest losses among the different operations, shooting up to 8.7% in 1995 (Maranan *et al.*, 1999). There is therefore an urgent need for the development of cost-efficient mechanical dryers.

However, mechanization has to be done in such a way that it does not degrade the environment. Because of the increasing global awareness on the negative impacts of new technologies on the environment, environmental preservation has become necessary in the development and adoption of new technologies. The development of environment-friendly farm machinery which uses renewable energy sources on the farm may help usher in agricultural modernization into the new millennium.

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