RESEARCH REPORT

Appropriate Technology for Improving Women's Welfare: A Case Study of Farmer Participatory Evaluation of a Micro Rice Mill in Central Luzon, Philippines

CATALINA P. DIAZ, MAHABUB HOSSAIN, AND THELMA R. PARIS

Rural women in Asia play important roles in the production of rice and the preparation of rice products. These tasks require considerable time and energy and involve drudgery. Small engineering technologies that reduce drudgery, increase labor productivity and augment family incomes are needed for improving welfare. The challenge lies in developing intermediate engineering technologies which can improve the working conditions of women and at the same time generate income for their families and their communities.

This study aims to test and evaluate the micro rice mill, an intermediate mechanical technology suitable for women, in terms of technical performance, economic viability and social acceptability.

THE MICRO RICE MILL

Large scale commercial rice mills are most often located in towns, as they require large volume of business for capacity utilization at profit making levels. Meanwhile, milling paddy for home consumption in some remote areas is still done by handpounding methods because of the high cost of transporting the palay to the mills, the need for milling small amounts, and the availability of surplus female labor. The techniques used are strenuous, labor-intensive, time consuming and have low productivity. Based on the women's need for a small capacity rice mill which can reduce drudgery and increase labor productivity, the Agricultural Engineering Division, in collaboration with the Social Sciences Division of the International Rice Research Institute (IRRI) and PhilRice, started field testing of a prototype micro rice mill from China in 1991.

The mill weighs 40 kgs, has a capacity of 50 to 70 kgs. paddy per hour, 60 to 65 percent milling recovery (MR) and 50 to 70 percent head rice recovery (HR). It is powered by either a 1.0 to 1.5 hp electric motor or 3 hp gasoline engine with energy requirement ranging from 0.012 to 0.016 kw-hr/kg paddy input.

The micro rice mill was field tested in Tampac II-III, Guimba in Nueva Ecija, a major rice producing province in the Philippines.

A farmer participatory approach was used in this study. There was an agreement that IRRI would allow the women to use the machine free of charge

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in exchange for the information needed for the evaluation study.

When the machine was introduced in the village, there was no existing women's association that could manage the machine's operations. It was thus agreed that the operators who were trained in its use would charge P0.65/kilogram of milled rice, which was close to the prevailing milling fee charged by the commercial mills. Initially, the three operators neither charged for the electricity used nor fees for their labor. However, due to the increasing number of users of the machine, especially after harvesting season, the operators strongly felt the burden of paying for the machine's power consumption. Time spent as operators of the machine also conflicted with their work on the farm as laborers. Owing to these, the women thought it was time for them to organize themselves (with the help of the social scientist). And from then on, the women's association that was formed managed the machine's operations, charging a milling fee of P0.65 per kilogram of milled rice, which was divided into labor cost (40 percent), power consumption (20 percent) and share of the women's association (40 percent).

Regular visits were made by the social scientist assigned to the village to monitor the actual field performance of the micro rice mill. During the peak months of the milling season, the social scientist had to travel to Nueva Ecija every week to closely supervise the recording of information on the monitoring sheets. The social scientist was also responsible in relaying to the agricultural engineers the feedback and suggestions of the women on how to improve and modify the design of the machine. On many occasions, when the micro rice mill broke down, the social scientist patiently facilitated its repair at PhilRice.

In assessing the potential demand for the services of the micro rice mill, a survey was conducted in 1995 using a structured questionnaire to collect information on production, disposal and marketing of paddy rice for all households in the village.

THE SETTING

The village is seven kilometers from the town proper. Transportation is by means of motorized tricycles and hand tractors (power tiller) with trailer locally known as "kuliglig." Due to poor road condition, the trips in and out of the village are limited, particularly during the wet season. The village has 125 households with a total population of 650 people. Ninety percent of the population are involved in rice farming. The average farm size is 1.50 ha. Of the total rice area of 187 hectares, 134 hectares are planted during the wet season, while only 53.0 hectares are planted during the dry season. Sixty two percent of farmers are landowners, while 38 percent are tenants. Sixteen percent of the total number of households in the village are landless.

The average age of the women members of the association is 39 years and majority of them has had some formal elementary education. They are engaged in livelihood activities such as swine production, goat and poultry raising and in off-farm employment, such as hiring out

of labor for transplanting from which they earn about P1,000 to P1,200 per season. Some of them also earn income from the gleaning of palay from the rice field after the harvest. They can gather from 3 to 5 cavans of paddy, which is equivalent to between P600 and P1,000 per cropping season. Although more men than women are involved in rice production activities, women have a greater role in household decision-making because they have greater control over family resources than their husbands. They borrow from informal private lenders, relatives, and friends when the household is in need. Thus, they carry the responsibility of repaying their debts. This exerts pressure on them to take advantage of whatever earning opportunities are available in the village. They say that they are not inclined to be confined primarily to household activities. They have to work because poverty is prevalent. However, mothers usually wait until children are weaned before they participate in economic activities outside the home. When they take up employment outside the home, their husbands, older children and other relatives help with the domestic chores such as cooking, cleaning, feeding the animals, and taking care of the children.

The women in the village were observed to be highly motivated, receptive to new ideas, and eager to learn new skills. They were willing to share their experiences and interests and discuss their domestic problems. They were sociable and were not culturally prevailed from working with men. In fact, they were also observed to be more active, curious, aggressive, and were more willing to accept challenges in adopting new ideas than their male partners. They consider the children as the means of achieving upward social mobility. They want their children to finish at least secondary education. Generally, they do not want their children to depend on rice farming alone for their livelihood. But, they refuse to abandon their rice field because this is where they grew up. As far as the social position of the family in society is concerned, majority of the women are hopeful that their present conditions will still improve, while only a few are pessimistic about their future. Others believe that their living conditions can still be improved if they have greater access to livelihood opportunities, and through hard work and the grace of God.

THE WOMEN'S ASSOCIATION

The micro rice mill was not identified as one of the technology needs of the women during the early stage of the research process due to the availability of large scale commercial mills in the town. However, a group of women in the village saw a micro rice mill loaded in an IRRI vehicle for transport to Bontoc, Mountain Province for testing. Out of curiosity, they requested a demonstration on its operation. Fascinated with the performance and the ease in operating the mill, the women took the initiative of writing a request for one unit from the coordinators (Ms. Thelma Paris) of the Women in Rice Farming Systems Program of IRRI.

The women disclosed that they are mainly responsible for bringing the paddy to the commercial mill and also in buying the farm inputs and household supplies.

They spend about half a day for the milling of even just small amounts of paddy because they have to wait for their turn as well as for transportation. They do not handpound paddy, unlike women in the upland areas, but farming families usually store about 20% of their total harvest which they have milled in small amounts (50 kgs.) at a time. Having access to a mill within the village would reduce transport cost and give women more flexibility particularly during the peak crop season when they work as hired laborers in other farms. One unit of the machine was provided for testing and later, monitored for further evaluation.

The women realized the potential benefits of managing the use of the micro rice mill as a group, in terms of the income derived from the milling fees and access to milling services in the village itself. On June 8, 1992, with the assistance of Thelma Paris of IRRI, 15 women of the village formed an association which would have full control of the management of the income generated from the mill. The members of the association elected seven officers. The wife of the village head was elected as adviser of the association. The membership fee was fixed at P10.0 per year. Regular meetings were held to discuss problems related to the rice mill. Later, the women also discussed problems related to their children, as well as income earning opportunities, at these meetings.

During the first few months of operating the mill, there was no formal policies regarding its use. It was only agreed that the operators charge P0.65/ kilogram of milled rice. Subsequently, the women agreed that the milling fee of P0.65 of milled rice be divided into labor cost (40 percent), power consumption (20 percent), and share of the women's association (40 percent) to be accumulated in a fund for use as loans to members.

WOMEN'S EVALUATION OF THE MACHINE

After two months of using the machine, the women offered suggestions and feedback to the researchers, who in turn relayed these to the agricultural engineer. The modifications suggested were: (a) installation of a wire screen in the hopper to separate foreign particles (i.e. stones) which can damage the screen of milling chamber; (b) installation of a bigger hopper to reduce the frequency of filling paddy during milling; (c) installation of wheel and pulley so that the mill could be transported from one place to another; (d) installation of wire screen and longer bran chute to separate the hull from the bran because the women wanted more fine bran for swine feeds; (e) modification of the aspiration chamber for better hull separation from the bran since separating the rice bran from the rice hull bran by sieving it manually was tedious and time consuming; (f) installation of a larger rice hull outlet (with extension) to protect the motor from accumulating rice hull; (g) providing the fan belt with a cover to avoid accident; and (h) installation of an adjustable (swinging) discharge weight for better and easier polishing control. The experience demonstrated the usefulness of user participatory evaluation of technologies.

TECHNICAL EFFICIENCY

The performance of the micro rice mill was evaluated from July 1992 to July 1993 in terms of milling recovery (MR), milling capacity (MC), power consumption and quality of milled rice and rice bran (Table 1).

per hour. In remote areas, like Kalinga Apayao and Matalon, Leyte, the women practice the traditional method of handpounding using mortal and pestle. Usually, a person can process 2 kilograms of paddy per hour. Obviously, the micro mill is an intermediate technology that

Table 1. Field performance of micro rice mill, Guimba, Nueva Ecija, Philippines, wet and dry seasons, 1992 -1993

Rice Variety	Paddy Weight (tons)	Milled Rice Weight (tons)	Milling Recovery MR (%)	Milling Capacity (kg/h)	Power Consumption (kw-hr/kg)
IR42	1.21	0.76	62.8	43.4	0.02
C4	0.58	0.36	62.1	64.0	0.03
IR65	1.28	0.79	61.7	50.0	0.02
IR64	2.87	1.88	66.0	50.0	0.02
Mixed	1.03	0.65	63.1	45.0	0.04
PSB-RC2	1.30	0.89	68.5	56.5	0.02
IR60	1.01	0.68	67.3	47.3	0.02
Total	9.25	6.01			
Average	-	-	64.5	50.9	0.02

*Data from micro rice mill monitoring sheets; 196 entries/observations.

Based on field testing, milling recovery for all rice varieties ranged from 61 to 68.4 percent with an average of 64.5 percent. This is marginally higher than the milling recovery of commercial mills in Guimba, Nueva Ecija, which ranges from 58 percent to 67 percent.

The milling capacity of the micro rice mill varies from 43.4 to 64 kg/hr, with an average of 50 kgs/hr, depending upon the purity and moisture content of rice paddy. On the other hand, the milling capacity of the commercial rice mill is 500 kilograms

requires more labor and electric power per unit of output than the modern larger scale rice mills but more appropriate for labor surplus economies.

The head rice is up to 70 percent (depending on paddy quality, moisture content and variety) and is comparable with the quality of milled rice from the commercial town mill which is quite satisfactory. The quality of the rice bran produced by the micro rice mill is also as fine as the rice bran produced by the commercial rice mill, after adjustments in the micro mill were made.

EVALUATION OF IMPACT

Demand for milling service. To assess the potential demand for services of the micro mill, we carried out a survey on the production, disposal, and marketing of paddy rice in the village. The information was collected by administering a structured questionnaire to all households in the village. The findings of the survey are reported in Table 2. The average rice land cropped per household is 1.5 ha; 72 percent in the wet season and 28 percent during the dry season. Rice farming in the dry season is practiced with ground water irrigation using privately owned shallow tubewells. The average rice yield was 3.67 tons/ha for the wet season, and 4.37 tons/ha for the dry season. Total paddy rice production was 725 tons (5.8 tons/household), 63 percent of which was sold to traders immediately after the harvest. Only 3.4 percent of the production was kept for seeds. The labor for harvesting and threshing was paid in kind, claiming 7.1 percent of the paddy produced. Agricultural workers, especially the women, prefer payment of harvest work in the form of paddy (locally known as "hunusan") rather than in cash. The reasons for their preference for payment in kind were: (a) paddy can be used immediately for home consumption (they consider paddy more valueable than cash) and, (b) paddy can be stored and provide food security even for a shorter period while there is compulsion to use cash immediately for nonfood items due to subsistence pressure. During the wet season, more land is planted to rice, so the demand for labor is high. Thus, agricultural workers have the opportunity to be paid in kind. However, during the dry season, when the demand for labor is low since the

Table 2. Total area, production and disposal of paddy, Guimba, Nueva Ecija, wet and dry seasons, 1994-1995

	Wet Season	Dry Season	Total	
Rice area (ha)	134.20	53.0	187.20	
Area irrigated (ha)	71.0	53.0	124.00	
Production (tons)	493.0	231.5	724.50	
Rent paid to land owner (tons)	21.27	6.47	27.74	(3.8)[1]
Harvester and thresher share (tons)	35.05	16.48	51.57	(7.1)
Rent paid for irrigation (tons)	-	11.84	11.84	(1.6)
Repayment of loan	24.0	7.27	31.27	(4.3)
Amount kept for seeds (tons)	15.19	9.85	25.04	(3.4)
Amount sold to traders (tons)	313.0	146.63	459.63	(63.4)
Given to friends/relatives (tons)	2.15	1.1	3.25	(0.4)
Amount kept for household consumption (tons)[2]	82.34	31.86	114.20	(16.)
Capacity of the micro rice mill (tons)[3]	58	58	116	

[1]Figures in parentheses are percentages of total production.

[2]Available amount of paddy for milling.

[3]The estimated capacity of the machine was based on 50 kgs/hour (capacity of machine); 8 hours/day operation; 24 days/month; 6 months/season; 2 seasons/year.

area is planted to rice, they are paid in cash. Many poor farm households take out loans from local money lenders for financing production expenses and for meeting consumption deficits before the harvest. The in-kind repayment of such loans accounted for 4.3 percent of the produce. Aside from the cooperative, farmers obtain loans from other sources within and outside the village in the form of food items like pork and milled rice. A 2.5 kilogram of pork obtained on credit is repaid with from one (1) cavan of paddy to one (1) cavan of milled rice depending on the source of credit. Hired laborers usually take advance wages as loans in the form of rice. This is one of the reasons why they prefer their share of the harvest in kind. They need the paddy for the repayment of loans. Many farm households also borrow irrigation water to grow rice during the dry season for which they pay pump owners 10 percent of the harvest. The irrigation fee accounts for 5.1 percent of the dry season harvest, 1.6 percent of total production during the year. Thus, only 16 percent of the production is kept for household consumption, amounting to 114 tons for the whole year, excluding paddy received as wage by the agricultural workers (with and without land).

If the micro rice mill operates for 8 hours a day, 24 days a month, the capacity of the mill would be 116 tons of paddy rice. Thus, if all the paddy set aside for family consumption were milled in the village, there would be sufficient paddy for only one micro rice mill. If some households the micro mill decide to have part of their paddy milled in the commercial mills, the mill will be underutilized, assuming that the machine is new and its design perfected for uninterrupted operations.

The production and disposal of paddy by farm size for wet and dry seasons 1994–1995 are reported in Table 3, showing that if the services of the machine is limited to the 31.5 tons of paddy per year that small farmers reserve for household consumption, the mill would face underutilization of capacity. However, the utilization of the machine can be increased if it also mills the paddy for consumption of the medium farmers (69.4 tons/year). Even if the larger farmers are excluded, since they usually mill in bulk using large commercial mills, the micro rice mill can run full operation capacity. It should also be noted that it can, as well, mill paddy received as wages by the landless and marginal farmers who must work for others to supplement their meager household incomes (Table 4). The amount of paddy to be milled from the agricultural laborers is about 22 tons.

POTENTIAL BENEFITS TO THE WOMEN'S COOPERATIVE

With 65 percent milling recovery and a milling charge of P0.65 per kg of milled rice, the gross revenue of the machine operating at the full capacity is estimated at P48,295. The cooperative sets aside 20 percent of the gross revenue for operating expenses, now largely consisting of utilities but could later cover repair and maintenance expenses. The net potential income is estimated at P38,636. If there is enough demand so that it operates at a full capacity, the operation of the mill will be highly profitable. The association can easily recover the initial investment on the mill estimated at P10,000 within a year. Investment on the micro rice mill is thus a good business proposition.

Table 3. Production and Disposal of Paddy Farm Size, Wet and Dry Seasons, 1994-1995

	Farm Size[1]		
	Small	Medium	Large
Production (tons)	143.20	488.25	93.0
Rent paid to land owner (tons)	5.72	18.82	3.2
Harvester and thresher share	9.02	34.40	8.16
Rent paid for irrigation	2.82	6.17	3.0
Repayment of loan	8.72	21.31	1.10
Amount kept for seeds	4.23	17.94	3.0
Amount sold to traders	81.03	317.18	61.02
Given to friends/relatives	0.20	3.05	-
Amount kept for household Consumption (tons)[2]	31.46	69.38	13.48
Capacity of the microrice mill For one year = 116 tons[3]			

[1]Small -less than 1.0 ha; Medium - equal and greater than 1.0 ha and less than 3.0 ha; Large - equal and greater than 3.0 ha.
[2]Available paddy for milling.
[3]Based on: 50 kgs/hr (capacity of machine); 8 hours/day operation; 24 days/month; 6 months/season, 2 seasons/year.

Table 4. Disposal of palay received as wage in kind of agricultural laborers, wet and dry seasons, 1994-1995

	Agricultural Laborers		
	Farmers with Land	Landless	Total
Palay received as wage in kind (tons)	15.26	17.05	32.31
Amount sold in palay form (tons)	5.52	4.80	10.32
Amount kept for home consumption (tons)[1]	9.74	12.25	22.00

[1]available paddy for milling.

Currently, the mill is operated by three members of the group who devote 2 to 3 hours of their time to this job each day. Since they perform this duty during their spare time, opportunity cost is minimal. The women's association pays 40 percent of the gross revenue from milling to these members. Thus, if the mill could operate at full capacity, the potential income for each of these members is estimated at P6,439 per year (P22 per day, or P8.38 per hour). If one of the members takes up the operation of the mill as full-time job, her daily earning would be P67, almost equivalent to the market wage rate for agricultural workers.

The association keeps 40 percent of the gross revenue. The amount accumulated is used as credit fund to loan to the members to finance capital requirements of micro enterprises such as growing vegetables, raising swine, goat or poultry, or for meeting emergencies such as medical expenses or children's school fees. The amount that the association can accumulate from the operation of the micro mill for financing such activities of its members is estimated at P19,318 provided the mill operates at full capacity. Borrowing from the association would save women from paying the usurious rates that informal lending sources charge for loans.

FIELD PERFORMANCE

Actual field performance of the micro rice mill in 1992–1993 showed that there was wide variation in the utilization of the machine. One important factor in this was the supply of paddy in the village. There was greater demand for the service of the mill during the harvesting seasons. The quantity of paddy milled from October to November accounted for more than 60 percent of the total amount milled during the year. Although the period from March to May was the peak of the second crop harvesting season, the amount of paddy processed was relatively smaller because smaller number of farmers grow rice during the dry season.

The economic analyses of the micro rice mill from 1992 to 1995 is reported in Table 5. The economic importance of the machine can be assessed in terms of capacity utilization as it is an important determinant of the income of the operators of the machine and of the members of the women's association. Increasing the capacity utilization of the machine will also increase the income of the women in the village.

Table 5. Economic analyses of micro rice mill, Guimba, Nueva Ecija, Philippines, wet and dry seasons, 1992–1995

	1992–1993	1993–1994	1994–1995		
			Dry	Wet	Total
Quantity of paddy (tons)	9.25	7.4	16.75	8.50	25.25
Quantity of milled rice (tons)	6.01	4.81	10.89	5.52	16.41
Cost of milling (P/kg)	0.65	0.65	0.50	0.65	-
Gross income (P)	3,906.50	3,126.50	5,445.00	3,588.00	9,033.00
Operator's share (P[1]	1,562.60	1,250.60	2,178.00	1,435.20	3,613.20
Cost of electricity[2]	781.30	625.30	1,089.00	717.60	1,806.60
Net income to the association[3]	1,562.60	1,250.60	2,178.00	1,435.20	3,613.20

Capacity of the micro rice mill - 116 tons/year
Total available amount of paddy for milling - 114.3 tons/year

[1]40% of gross income
[2]20% of gross income
[3]share of women's association (40% of gross income)

Analysis of the actual field performance of the machine indicates that the amount of paddy milled during the wet and dry seasons of 1992–1993 was 9.25 tons, representing only 8 percent of the capacity of the mill. With a recovery rate of 65 percent, the 9.25 tons yielded 6.01 tons of milled rice. As the association charged P0.65 per kilogram of milled rice, which is similar to the rate of the commercial mill, the gross income amounted to P3,906.5. The operators' share was P1,653 while the income of the women's association was also P1,563, an amount too meager to sustain the interest of the association in the micro rice mill. At this rate of return, it would take 10 years for the Association to recover its investment if it had purchased the machine. During 1993–1994 (wet and dry seasons), the amount of paddy milled (7.4 tons) further declined by 20 percent. The decline was due to the frequent breakdowns suffered by the machine, preference for commercial mills, and a lack of interest shown by the women in running the mills as a business enterprise because of the marginal income.

The micro rice mill, an original Chinese model, was *not* new when it was brought to the village. Thus, during the second year of the study, it started breaking down frequently. The women operators usually asked assistance from the agricultural engineers of PHILRICE for its repair. Efforts were exerted by the engineers of IRRI to develop an improved model of the Chinese prototype.

During 1995 dry season, on the advice of the social scientists from IRRI, the milling fee was reduced from P0.65 to P0.50 per kilogram of milled rice to attract more customers. The intention was to increase the capacity utilization of the machine by making it more competitive. The reduction in the cost of milling, with the strong cooperation of the women's group, increased the volume of the business. The amount of paddy milled increased to 16.7 tons during the dry season in 1995, compared to 9.25 tons per year in 1992 and 1993. The income of the operators and the Association increased substantially in 1994 and 1995 due to higher capacity utilization. The three operators received an average of P1,204 for their labor, while P3,613 accrued to the association's loan fund.

During the 1995 wet season, the milling fee was again raised from P0.50 to P0.65 per kilogram of milled rice, in response to the increase charged by the commercial mill in town, from P0.65 to P0.75 per kilogram. However, the effect of milling rate on the capacity utilization of the machine could not be evaluated because of the frequent breakdowns suffered by the micro mill. The amount of paddy milled during the wet season was only 8.5 tons, far below the amount of business expected from the main wet season crop.

SOCIAL ACCEPTABILITY

The women's perceptions of benefits on the use of micro rice mill are reported in Table 6. During harvesting season, the commercial rice mills are tied up. More time is spent in waiting and traveling to get the paddy milled. The time saved in using the micro machine is devoted to caring for the children, looking after the animals, and doing household chores.

Other women cited that having a mill within the village gave them flexibility since they can have the paddy milled at their convenience, particularly during the peak cropping season.

Although the women reported that the milling recovery is dependent on the variety, presence of impurities, and moisture content of paddy, they consider the use of micro rice mill beneficial because of its higher milling recovery compared to the commercial mill in town.

One important consideration in the acceptance of the micro rice mill is the quality and quantity of rice bran which is used as feeds for swine. Some users of the machine wanted to have finer rice bran, while others are more concerned with the quantity (larger amount but coarser output). Realizing that not everybody can be pleased, a wire screen was installed to adjust the quality of rice bran produced.

One of the perceived benefits in using the micro rice mill is milling on credit, as fees can be paid during the harvesting season. In the commercial mill, they have to pay in cash or they have to leave the rice bran valued at P2.50/kg with the mill owner. If they ran out of rice bran as feeds for swine, they are forced to buy from the commercial mill at P3.0/kg.

The machine was instrumental in improving the status of women through the establishment of a small enterprise managed and controlled by women. The women in the village also learned to

Table 6. Comparison of benefits derived from the use of micro rice mill and commercial mill, Guimba, Nueva Ecija, Philippines, 1993

	Milling Method	
	Micro Rice Mill	Commercial Mill[1]
Cost of milling (P/kg milled rice)	0.65	0.65
Transportation cost (P/person)	0	10.0
Time spent in milling/waiting (hr/cavan)	1.0	3.0
Milling recovery (MR)	61-68.5%[2]	58-67[3]
Milling capacity (MC)	50 kg/hr	500 kgs/hr
Quality of milled rice	satisfactory	satisfactory
Quality of rice bran	coarse (not acceptable)	fine (acceptable)
Quantity of rice bran	satisfactory	satisfactory
Cooking and eating quality	satisfactory	satisfactory
Milling on credit basis	yes	no
Strengthened Women's Association	yes	no

[1]Single pass rubber roll
[2]Based on women's field evaluation of microrice mill
[3]Based on data gathered from the operator of the town mill
[4]Since the micro rice mill is an Engelbert type, the bran and ground hull were discharged together. It was later modified by separating the coarse and the fine ground hull using an inclined screen just beneath the milling chamber to produce acceptable combination to be used as animal feeds.

formally organize and collectively manage the income from the mill. The machine, too, strengthened the support systems among the poor women by contributing to the efficient management of the milling operations. The members of the association were given more opportunities to develop their skills, knowledge and leadership capabilities. These are crucial in developing women's self-reliance and self-esteem in changing their aspirations, beliefs, and attitudes to create a better life for themselves and their children. The family relationships also improved for husbands were very supportive of the activities of their wives. They did not interfere in the milling operations of the machine. The operators' husbands assisted only when they (women) needed help on minor repairs of the machine, in caring for their children, and in doing household chores.

CONCLUSIONS

The micro rice mill would be an ideal livelihood project for women in remote areas if it could be operated at full capacity.

Despite the positive features of the micro rice mill which the women perceived as beneficial to their welfare, further research must be done on the sustainability of the machine, and on how to make the mill competitive with other investment opportunities in the village. Determining the appropriate milling charge is an important issue, as the capacity utilization of machine and benefits to members of the Association critically depend on this factor.

The new micro rice mill designed by IRRI still needs improvement. Thus, the idea of replacing the old Chinese model did not materialize. Despite the technical constraints, the capacity utilization of the mill increased from 8 percent to 22 percent when the milling charge was set somewhat lower than the rate charged in the commercial mill. The milling charge is a critical variable affecting the demand for services of the micro mill.

The appropriateness of a small engineering technology like the micro rice mill has to be assessed not only in terms of economic viability but also in terms of technical and social acceptability. Therefore, it is necessary to consider the characteristics and attitudes of the end-users of technology. It is important to know how the women organize themselves and interact with one another. A technology is appropriate if it is relevant to the needs of the end-users. Thus, in addition to the economic benefit, social benefits that cannot be measured quantitatively must be considered in developing appropriate technologies for the disadvantaged groups in the society.

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