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THE CONSEQUENCES OF SMALL RICE FARM MECHANIZATION PROJECT

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LABOUR USE PATTERN AND MECHANIZATION OF PADDY POSTHARVEST PROCESSING IN BANGLADESH

By

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ABSTRACT

In Bangladesh, the economic necessity for small-scale mechanization of paddy processing at farm level does not appear to be strong. This may be attributed to the already low labor requirement in mostof the traditional methods of paddy processing, extensive use of low-cost female family labor, and the existing low level of postharvest loss. As a particular case, the analysis reveals that the average of food loss per farm due to wet season drying constraints was much below the level at which the costs of using small-scale driers would equal the gains from saving food by supplementary mechanical drying. Contrarily, custom hullers enjoy commercial demand among farmer users mainly due to their high labor productivity. The custom hullers, however, were found to have caused some employment and income imbalances among the rural poor which may be alleviated by pro-poor development programmes.

INTRODUCTION

Paddy is the principal foodgrain crop in Bangladesh accounting for three-fourths of total crop land. As of 1979-80, Bangladesh produced 12.5 million tons of rice (Bangladesh 1980). Total wheat production was 0.8 million tons. With current requirements estimated at 14.7 million tons domestic production of foodgrains would cover approximately 90 percent of the total requirement. This leaves a deficit of 1.4 million tons (computed from Bangladesh 1980; Rahman et al 1980). As in the case of other crops in Bangladesh, the production of paddy is fragmented into small, family farms with an average size of 2.7 acres (Bangladesh 1979). The most important features underlying the paddy postharvest system are the low proportion of marketed surplus, ranging between 10 and 15 percent (Farruk 1970; Greeley 1980a) at the farm level and the dominance of traditional processing methods with extremely low capital-labor ratios.

Discussions held so far at various levels (BCSIR 1980; CIRDAP 1981) may be divided into two opposing views on the necessity of mechanization of paddy postharvest processing at farm level. According to one view, advanced by technologists and development assistance groups of doner countries, postharvest mechanization may help reduce the foodgrain deficit in Bangladesh by bringing down the level of postharvest loss which is claimed to ve very high - the range being 20 percent as estimated by Wimberly (1974) to 50-100 percent "quality loss" as reported by Farim (1979). These estimates are, however, mostly based on guesswork rather than scientific assessment.[1/] They also argue that mechanization may release labor for more profitable employment outside of the postharvest sector.

The second view which has arisen recently, following some scientific loss assessment surveys by field monitoring, is that postharvest loss of paddy in Bangladesh does not appear to be high enough to force the farmers to demand and use loss reducing technologies (Huq and Greeley 1980; Ahmed 1981b; see also Tables in Appendix I and Appendix II). Moreover, it has been further argued that improved postharvest technologies may create an adverse impact on rural employment and income distribution (Ahmed 1981a).

These two views, however, agree that one major source of private income stream from using improved postharvest technologies may be their labor saving potential. The fied surveys so far on postharvest processing of paddy largely emphasized the loss assessment aspect, labor use patterns

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[1/] The round figures of 20, 50 and 100 may indicate that they were based on gross estimates of the reporting sources and/or farmers.

under alternative technologies remained relatively unexamined. This makes it difficult to draw inferences on the labor saving potential of improved postharvest technologies.

The main objective of this paper is to argue that in Bangladesh where labor is relatively abundant and the labour requirement of most of the traditional methods of paddy processing is already low, and the postharvest loss of paddy is not high (see Tables in Appendix I and Appendix II), the opportunity for small-scale mechanization with a view to saving labor and reducing food loss seems to be restricted. However, in case of rural custom milling, the superior labor productivity of the huller technology, compared to that of traditional husking, seems to have provided a source of profit and attracted a substantial amount of private capital for expansion on a commercial scale. The paper seeks to examine the imbalances in rural employment and income distribution caused by such technological expansion.

While the analysis in this paper has covered the entire paddy processing system in general, three operations, where the level of labor requirement and use of hired labor were supposed to differ considerably, have been examined with particular emphasis. These are threshing, drying and husking. The hypothesis was that the rate of expansion and adoption of modern labor saving technologies in these operations would be high or low according to the level of labor requirement, and the use of purchased labor in these operations. The consequences of postharvest mechanization on the employment and income distribution patterns were investigated with particular reference to the expansion of the huller mills, the only commercial level technology in the rural postharvest sector in Bangladesh.

The data for this paper were from a field survey of 76 randomly selected households in the vicinities of two huller mills in the villages of Shimla and Padurbari in Mymensingh District. The huller mills were commissioned in 1979 when the area came under the rural electrification programme. Final year undergraduate students of the Faculty of Agricultural Economics and Rural Sociology at the Bangladesh Agricultural University were asked to interview the 76 sample farmers as part of a practical assignment in Research Methodology. Each student collected data from one or two households after closely observing the individual paddy processing operations. Additional data were also available from an earlier survey conducted in 1980 in the villages Boyra and Sutiakhali in Mymensingh district. This latter survey covered 80 farms selected purposively by keeping the weights of various size groups at par with the distribution pattern at national level. The purpose of this survey was to investigate the problems of postharvest processing of *aus* paddy, a wet season crop generally faced with drying problems due to insufficient sunshine.

INFLOW OF PADDY AND ITS DISPOSAL IN THE SAMPLE HOUSEHOLDS

The type and sequence of postharvest operations are largely influenced by the intended end use of paddy produced by farmers. However, emergencies like the need for immediate consumption, forced sale or postharvest technology constraints may eventually force farmers to change the type and sequence of operations or the originally intended end use. Before anlaysing the mode of disposal of paddy, it is perhaps appropriate to present briefly some socio-economic characteristics of the sample households, since they have also considerable influence upon the pattern of paddy disposal.

As Table 1 reveals, farming in the study area is characterized by small land-holdings and tiny operational area as in most parts of Bangladesh. If we characterize those households which hired out labor as poor, 49 percent of the sample households in Shimla and Padurbari could be classified as poor. The relative depth of poverty in the poor households may be gauged by the size of land-holding, dominance of rented land in the total operational area, extent of hiring out of permanent labor and female labor and the proportion of family income derived from female labor. By all of these criteria, the category of poor who are employed by the producer farmers had the lowest socio-economic status (Table 1).

Considerable differences were also found amongst the various categories of the sample families with respect to their sources of inflow of paddy and its disposal pattern (Tables 2 and 3). In the whole sample, own production was the largest source (52.52 percent) of inflow of paddy. The next major source was purchase (22.31 percent). Paddy received as wage had also a substantial share (11.36 percent) of the total paddy inflow. In addition to selling of labor, one further dividing criterion between the poor/poorest and non-poor households could be the share of purchase and paddy-wage in the total paddy inflow which was only 0.48 percent in the non-poor, 25 percent in the poor and 87 percent in the poorest households (selling labor to farmers).

On the disposal side, 68.70 percent of the total paddy inflow was consumed at home, 16.69 percent was sold and 6.23 percent was kept as seed. There were huge variations amongst the different categories of the households with respect to marketed surplus. In-kind payment to laborers and barter against household goods together accounted for 5.10 percent of the total disposable paddy. Usually low quality paddy/rice is offered to the laborers or bartered away. Thus a considerable part of the low quality paddy/rice seems to be transfered to the users with lower per capita availability of grains. These derive higher marginal utility from the low quality grains than their producers probably could. A loss assessment survey indicates that the proportion

of paddy qualitatively deteriorated by moulding and germination was only 1.06 percent of the total gross yield in a sample of 80 households in the villages Boyra and Sutiakhali (Ahmed 1981b). Similarly, a very low level of qualitative loss of paddy under small farming conditions has been also reported in Greeley (1981a). This implies that the farmers seem to be able to eliminate entirely or partly the burden of qualitative loss by disposing of affected grains in the form of in-kind payment or barter.

Postharvest processing of paddy in Bangladesh mainly consists of physical handling of the crop from field to farm, stacking, threshing, winnowing, soaking, parboiling, drying, storage, husking, polishing, cooking and/or other forms of final processing before consumption.

The actual combination and the sequence of the operations varies widely depending on the nature of end use of the grains, crop season and, to a certain extent, on the resource endowment of individual farms. The field survey on *aus* paddy conducted in Boyra and Sutiakhali identifies 14 major kinds of sequence combinations (Table 4). Amongst them, cutting, carrying, threshing I + II, parboiling, drying and husking for immediate consumption (within two months of harvest) was the major sequence, accounting for 36.34 percent of the total *aus* crop. The next major combination was cutting, carrying, threshing I + II, parboiling, drying and storing for future husking and consumption which accounted for 24.02 percent of the *aus* paddy. Most of the paddy meant for consumption was parboiled.

Sale, barter and in-kind payment of paddy was mostly done in unparboiled dried form (sequence combinations 3 and 4 in Table 4). Husking (including polishing) was not always done immediately after drying the parboiled paddy. More than one-third of the parboiled dried paddy was kept in storage for future husking mainly due to shortage of labor. Some farmers also considered it to be a positive factor influencing the milling quality. Drying of unparboiled paddy meant for future consumption accounted for 11.54 percent of the entire *aus* crop. Drying of unparboiled paddy for storage was done due to shortage of fuel and also due to the belief that paddy, particularly HYV, yields quality rice when it is parboiled after storing for some weeks.

The sequence combinations and disposal pattern varied according to farm size and variety of paddy grown. This was evident in the higher proportion of marketed surplus in the relatively large farms. The proportion of grains sold or given away in repayment of loan, advancement of loans, in-kind payment to laborers or as barter, was higher in case of HYV paddy compared to LV paddy (Ahmed et al 1980).

LABOR REQUIREMENT IN POSTHARVEST PROCESSING OF PADDY BY TRADITIONAL METHODS

The labor requirement of postharvest processing of paddy in Bangladesh is from 41 to 49 percent of total man-days required for preharvest production (Ahmed 1981a) and one-fourth of all agricultural employment (Greeley 1980b). Information on labor use in individual postharvest operations is, however, scanty. The only sources of information in this regard, viz. Abdullah and Zeidenstein (1977), Arrens and Van Beurden (1977), Harriss (1979), Sattar (1975), and Von Harder (1975), suffer from a major drawback that the labor requirements in their estimates were mainly based on personal communication rather than on sample survey and, therefore, seem to be uniformly "standardized" without reflecting the actual requirements (Ahmed 1981a).

Table 5 provides detailed data on the labor requirement in paddy processing on the basis of the survey conducted in Shimla and Padurbari. The average labor requirement in the postharvest processing of paddy by traditional methods was 1.37 man-days per maund (=37.3 kg). The requirement was higher in the *aus* and *boro* season than *aman* largely due to postharvest problems caused by rains during *aus* and *boro* season. The lower labor requirement in threshing *aman* paddy is mainly due to dryness of the plants. The labor required for husking, which is almost entirely a female's job, formed 52 percent of the total postharvest employment. Threshing, which is almost exclusively done by males, accounted for 14 percent of the total postharvest labor requirement. Assuming that winnowing, soaking, parboiling, drying, and husking are done by female labor, women's contribution to paddy processing was 86 percent.

The labor requirement for each of the pre-husking operations was, therefore, very small. These are also the operations in which use of family labor was higher compared to husking (Table 5). Future research and development programmes aimed at reducing labor cost by modernization of the pre-husking operations under small-scale farming may, therefore, have limited scope since the labor required for these operations under the currently available traditional technology is already low and the opportunity cost of the female family labor engaged in these operations is also very low. Contrarily, due to the higher labor requirement in the traditional *dheki* husking, the expansion of the labor saving huller technology has gained momentum as a profitable alternative to *dheki* husking in rural Bangladesh. The existing number of these hullers is estimated at 10,000 (Ahmed 1981a) which is growing at the rate of 380 per annum (Salahuddin 1980). The proportion of total paddy husked by mills and hullers is currently estimated at 23 to 36 percent (Bangladesh 1979).

Also viewing from the proportion of total number of families hiring in labor, the potential for improved technologies aimed at reducing hired labor cost in the postharvest operations may seem to be limited. The survey in Shimla and Padurbari reveals that although 46 percent of all the 76 sample families hired in labor for farm work, only 28 percent hired in female labor for postharvest processing of paddy (calculated after Table 1).

FARM LEVEL DEMAND FOR MODERN POSTHARVEST TECHNOLOGIES

As of today, rice hullers represent the only mechanized postharvest technology enjoying substantial degree of commercial demand among rural users in Bangladesh.[2/] Next are the Comilla-type pedal threshers of which about 4,000 pieces are in use (communication with Comilla Karkhana and BRRI Rice Technology Division). As regards small-scale crop driers, it seems that the driers so far designed - natural draft, bellows-powered and solar - have very negligible or no advantage of labor productivity over the traditional technologies. Given also the non-conducive nature of the wet season drying problem, these small-scale driers cannot be expected to be economically viable (Ahmed 1981b; Greeley 1981b). This is also evidenced by the reluctance of the farmers to use the natural draft driers in the trial sites of Boyra and Keyotkhali. An opinion survey in the study area reveals that the weather conditions during the *aus* postharvest period did not significantly vary in the last five years (Ahmed 1981b).

While looking for the determinants of the degree of extension of the three modernized postharvest technologies at farm level - thresher, drier and huller -, one may conclude that the labor productivity of the technologies has been the prime factor in influencing the degree of farm level extension of the improved technologies (Table 6). Evidently, the rural custom hullers in Bangladesh, due to their huge labor productivity, provided a significant source of profit for private capital. The annual rate of profit and return on investment per custom mill are roughly estimated to be Taka 18,847.00 and 69.83 percent respectively (calculated from data on 14 custom mills gathered from Harriss (1979)). Due to the drudgeries involved in traditional husking, the use of hired labor in this operation is larger than in other processing operation (Table 5). This is why the availability of custom milling, as is discussed later, has replaced a large part of the hired labor in husking and thus strengthened the demand for the custom mills.

[2/] In Bangladesh, there are two types of use of rice hullers. custom milling for customer service to farmers and trade milling for direct trading by purchasing raw paddy and disposing of polished rice.

The use of pedal threshers is generally confined to the big farmers with a labor constraint. Group interviews with users in the Bangladesh Agricultural University Extension Project area revealed that farmers use them because of the higher labor productivity and suitability for use under special circumstances. For example, when it rains outside they can be used in a small area inside the farm house.

While custom milling services are being used by farmers in general, direct ownership of huller mills by farmers is practically absent. Given the present scale of production, direct ownership of hullers for individual use would mean over-investment. Although the small-scale natural draft driers under trial in the project area entail relatively low investment cost, these three preconditions for effective demand among farmers. These are:

(1) lowering of cost by increasing efficiency;
(2) high degree of threat of moulding and sprouting due to bad weather; and
(3) availability of fuel for the driers.

This may be illustrated with the help of a graph showing different break-even points between costs and gains of using small-scale driers under various conditions (Figure 1). The graph is based on the results of a postharvest loss assessment survey with *aus* paddy in the trial site of the driers (details in Ahmed 1981b). The survey shows a value loss of Taka 16.00 approximately per maund of paddy affected by moulding and sprouting due to drying constraints. Presumably, this loss could be saved by using mechanical driers.

The graph (Figure 1) assumes that mechanical drying will supplement open sun-drying only when a drying constraint, such as rain for more than three continuous days, arises. It also assumes a conservatively estimated fixed cost of Taka 60 per year due to the construction and installation of the drier, i.e., the total cost of Taka 600 being spread over a period of ten years without considering the opportunity cost of investment. Fuel cost for the drier has been estimated at Taka 2 per maund (Table 6). Since family labour can operate the drier, the labor cost has been excluded. The break-even point between cost and gain due to saving of food loss by using the drier was thus fixed at B_1. This indicates that at least 4.3 maunds of paddy threatened with moulding and sprouting would have to be dried in order to make the gains due to saving the food loss equal the costs. If the opportunity cost of capital is calculated by a compounding factor of 10 to 15 percent, the breakeven point would be at a still higher level.

In the study area an average of only 0.41 maunds of *aus* paddy (1.06 percent of the *aus* harvest) was affected per farm by moulding

and germination due to bad weather. If this amount is doubled to include also the potentially threatened grains, the maximum risk limit would be 0.82 maunds per farm which is far below the break-even level of B_1. This answers partly why farmers were reluctant to own and use the driers.

The break-even point can be, however, pushed leftwards by shifting the cost line from TC_1 to TC_2 through increasing the drier efficiency and/or by moving the total gain curve from TG_1 to TG_2 in case of greater threat of food loss. Also, if similar food loss occurs with *boro* paddy, part of which is harvested during wet season, the amount needed to be mechanically dried will tend to near the break-even point.

It is, therefore, evident that uder the prevailing small-farming conditions in Bangladesh, the commercial scope for mechanical driers does not seem to be at the farm level, rather at secondary levels like government procurement depots and milling centres where the scale of operation and risk of loss may be higher. However, if drier efficiency is increased, some large farmers may find it economic to use mechanical driers in times of extremely bad weather.

EMPLOYMENT AND INCOME EFFECT OF MODERNIZED POSTHARVEST TECHNOLOGY

Changes in the employment and income distribution due to a new postharvest technology may be examined by taking the case of custom hullers since, as mentioned earlier, they represent the only mechanized postharvest technology enjoying commercial scope in rural Bangladesh. Data from the Shimla-Padurbari household survey seem to indicate that the introduction of hullers did not significantly reduce the number of users of hired labor in husking (Table 7). Although 37 percent of the sample households used the huller mills, only 29 percent of their total paddy was husked at the mills, which means a displacement of husking labor by that percentage. The proportion of paddy husked by hired labor dropped from 32 percent to 16 percent and that by family labor from 68 percent to 55 percent after commissioning of the mills.

It will be evident from Table 8 that the employment and income distribution impacts of the huller mills are different for the three categories of rural poor engaged in paddy processing, namely those employed by producer farmers, those engaged in independent small-scale paddy processing business as *Kutias* and *Barkiwalas*, and those employed at the mills. Most of the labour displacing effect has been upon those formerly employed by the farmers. Contrarily, two-thirds of the *Kutias* and *Barkiwalas* reported that employment-wise they were not affected by the hullers (reasons discussed later).

As regards terms of employment, the field survey reveals that about two-thirds of the rural poor employed by farmers in husking changed from casual laborers to permanent laborers on terms of more than three months (Tables 8 and 9). This could have been a positive impact in terms of size and security of employment, but this was also associated with a decrease in wage rate on per hour basis since the length of daily work under the traditional arrangement of a permanent employer is almost double the length of casual labor employed on per day basis.

The impact of custom hullers on the income of the poor comes into force both by its influence on size of employment as well as wage rate (Tables 8 and 9).

Three different wage rates for female husking labor could be collected during the field survey: (1) rate for permanent labor per year, (2) rate for daily labor and (3) rate for per maund contract labor. The comparisons of yearly rates between areas and between periods may be vulnerable because they varied widely according to the capacity of the laborer concerned, the privileges enjoyed by him or her as well as the generosity of the employer. On the average, however, the range of the yearly rates in the study area during the post-mill period (1980) was less compared to the rates of pre-mill period (1979) and those existing in the area without mills (Table 9). Considering a 19 percent increase in the cost of living index of the rural population of Bangladesh from 1978/79 to 1979/80 (calculated after Bangladesh 1980), the fall in the real wage should be larger than it apparently seems. The differences in the wages were more evident in the cash rates rather than in the privileges. The same holds true for the daily and per maund contract rates too.

There was no significant difference in the daily wage rate for female husking labor in the area with mills and that without. But the daily rates have slightly decreased in the mill areas after commissioning of the mills. Most visible was, however, the decline in the per maund contract rates after commissioning of the mills. Apparently, the rates for permanent husking labor as shown in Table 9 may seem higher (including meals and other privileges). But if these are computed on per hour basis the casual or contract rates will be higher because permanently hired laborers work almost twice as long per day as casual laborers.

The only category of rural poor deriving spectacular benefit from the introduction of custom milling are those who operate small-scale paddy processing business (Table 10). Before introduction of huller mills in the study area a paddy processing *Barkiwala* or *Kutia* family with one working woman could husk one maund dried paddy per day and simultaneously parboil and dry another maund to be husked the next day. After the introduction of the huller mills all the *Barkiwala* families changed from traditional *Dhekiing* to custom hulling and utilized the

labor thus saved in parboiling and drying more paddy. Thus they increased their volume of business two to three times. Using *Dheki* technology, the return to family labor in paddy processing was 22 percent to 34 percent higher compared to the daily wage rate for husking. Using custom hulling service, the return to family labor was 139 percent to 163 percent higher than the daily wage rate (Table 10). This shows that with some operating capital for purchasing paddy many of the rural poor displaced by the custom mills could probably earn even a larger income by operating independent paddy processing business and using the services of the mills. This may be useful for policy making aimed at rehabilitating a part of the labor force displaced by the mills. In addition to paddy processing, other activities such as beef fattening, milk cow rearing and poultry keeping may be also promoted amongst the displaced labourers by means of extension and credit programme.

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Table 1. Characteristics of the sample households in Shimla and Padurbari

Characteristics/information	Category of families interviewed			
	Poor			
	Employed by producer farmers (n = 24)	Paddy processing groups[c/] (n = 11)	Permanent laborer in rice mills (n = 2)	Non-poor (n = 39)
% of total number of sample families	31.58	14.47	2.63	51.32
Area owned per family (acres)	0.16	0.34	0.21	2.97
Area mortgaged in per family (acres)	b/	b/	b/	0.01
Area rented in per family (acres)	0.09	0.33	b/	0.28
Area mortgaged out per family (acres)	0.01	0.03	b/	0.01
Area rented out per family (acres)	b/	0.08	0.07	0.39
Area operated[a/] per family (acres)	0.24	0.56	0.14	2.86
% families hiring in labor	b/	b/	b/	89.74[d/]
% families hiring out labor	100.00	100.00	100.00	b/
% families hiring out permanent labor	62.50	9.52	100.00	b/
% families hiring out female labor	70.83	38.10	50.00	b/
% earnings from female labor	32.94	5.81	11.32	b/

a/ Operated area = own + mortaged in + rented in - mortgaged out - rented out.

b/ None.

c/ They are functioning as *Kutias* and *Barkiwalas* (Bengali terms for paddy processing people).

d/ Amongst non-poor, 35 families, i.e., 46% of all families in the three categories and 89.74% of the non-poor, hired labor for some farm work. However, only 21 of them, i.e., 28% of all families, 54% of non-poor, reported hiring of female labor for postharvest processing.

Source: Field survey in villages Shimla and Padurbari.

Table 2. Inflow of paddy by source, per family, 1979-80.

Source of supply	Category of families[a/]						
	Employed by farmers (poorest)[a/]		Paddy progessing groups (poor)		Non-poor		All groups
	Maunds[e/]	Percent	Maunds	Percent	Maunds	Percent	Percent
Carry over	0.24	1.09	0.36	0.99	1.05	0.96	1.01
Own production	5.17	9.86	13.57	37.40	92.75	85.22	52.52
As tenant's share	b/	b/	9.90	27.29	5.51	5.06	6.55
As landlord's share	b/	b/	2.40	6.62	7.98	7.33	4.72
Puchase[c/]	12.80	58.16	5.42	14.94	0.52	0.48	22.31
Borrowed or received back	0.17	0.77	0.38	1.05	0.29	0.27	0.55
Wage	6.38	28.99	3.61	9.95	b/	b/	11.36
Gift	0.25	1.14	0.64	1.76	0.73	0.67	0.98
Total inflow	25.01	100.00	36.28	100.00	108.83	100.00	100.00
Meals taken at employer's house[d/]	14.35	-	3.66	-	b/	b/	b/

a/ Data on the two respondents working as permanent laborer at the mills are included in the category "employed by farmers".

b/ None/not applicable.

c/ Excludes paddy purchased for processing business.

d/ Assuming 12 ounces paddy (8 ounces rice) per meal.

e/ 1 maund = 37.3 kg.

Source: Field survey in villages Shimla and Padurbari.

Table 3. Disposal of paddy by provenance, per family, 1979-80.

Nature of disposal	Category of families[a/]						
	Employed by farmers (poorest)[a/]		Paddy processing groups (poor)		Non-poor		All groups
	Maunds	Percent	Maunds	Percent	Maunds	Percent	Percent
Seed	0.23	1.09	2.50	6.89	10.31	9.47	6.23
Sale[b/]	0.22	1.00	0.78	2.15	34.02	31.26	16.69
Payment in kind for:							
a. postharvest labor	c/	c/	c/	c/	3.25	2.99	1.53
b. other labor	c/	c/	c/	c/	4.23	3.89	2.00
Barter in goods	0.11	0.45	0.14	0.39	2.88	2.65	1.57
Lent/repaid	0.17	0.77	0.37	1.02	0.29	0.27	0.55
Gift	c/	c/	0.11	0.30	0.66	0.61	0.36
Consumption at home[d/]	24.09	95.82	31.57	87.02	49.47	45.46	68.70
Carry over	0.19	0.86	0.81	2.23	3.72	3.42	2.37
Total	25.01	100.00	36.28	100.00	108.83	100.00	100.00

a/ See footnote (a), Table 2.

b/ Other than those related to paddy processing business.

c/ None.

d/ Includes meals taken by laborers.

Source: Field survey in villages Shimla and Padurbari.

Table 4. Distribution of *aus* paddy output by use and sequence of post-production operations vis-a-vis farm size.

Categories of use/sequence combination[a]	Farm size: Small (Below 2.50 acres)	Medium (2.50 to 4.99 acres	Large (5.00 acres and above	All farms
	Percent of paddy produced			
1	7.29	11.78	8.45	9.37
2	12.01	11.60	11.12	11.54
3	0.35	5.31	18.80	8.70
4	0.41	4.24	1.08	2.07
5	58.95	31.14	24.22	36.34
6	15.38	26.34	28.29	24.02
7	1.27	0.47	b/	0.53
8	b/	b/	2.53	0.89
9	1.79	0.34	0.36	0.75
10	0.12	1.54	1.49	1.13
11	0.23	0.13	b/	0.11
12	0.17	4.66	1.49	2.31
13	2.03	2.36	2.17	2.20
14	b/	0.09	b/	0.03
Total	100.00	100.00	100.00	100.00

a/ For explanation of these use and sequence numbers see next page.

b/ None.

Source: Ahmed 1981b.

Key to Table 4

Type of sequence combination/use	
1	Cutting-carrying-threshing I+II - drying-storage for seed.
2	" " " " " " consumption.
3	" " " " " " sale.
4	" " " sale/repayment of loan/advancement of loan/ payment to laborers.
5	" " " - parboiling-drying-husking for immediate consumption.
6	" " " " " -storage for future husking operation.
7	" " " " " -husked for immediate sale.
8	" " " " " -husked for future sale.
9	" " -threshing II - drying barter for household utensils and in-kind payment for labor, other services.
10	" " " - parboiling-drying-husking for consumption.
11	" " " " " " " sale.
12	Received as rent-drying-storage for future consumption.
13	" -parboiling-drying-husking-consumption.
14	" " " " -sale.

Note: Cutting includes field staking while carrying and threshing include farm-yard stacking and winnowing as and when necessary. Husking includes polishing. Soaking was not always necessary because *aus* is a wet season paddy.

Table 5. Labor requirement for postharvest processing of one maund paddy by traditional methods (1 man-day = 8 hours).

Operation	Labor requirement (man-day/maund)				Percent done by hired labor[a/]
	Aman season	Boro season	Aus season	All seasons	
Threshing	0.17 (13)	0.20 (14)	0.22 (15)	0.19 (14)	25
Winnowing[b/] (3 times)	0.15 (12)	0.15 (11)	0.15 (10)	0.15 (11)	14
Soaking	0.03 (2)	0.03 (2)	0.03 (2)	0.03 (2)	c/
Parboiling	0.14 (11)	0.14 (10)	0.14 (10)	0.14 (10)	14
Drying	0.11 (8)	0.19 (13)	0.10 (13)	0.15 (11)	14
Husking and polishing	0.71 (54)	0.71 (50)	0.71 (49)	0.71 (52)	32[d/]
All operations	1.31 (100)	1.42 (100)	1.44 (100)	1.37 (100)	25

*Figures in parentheses indicate percent of total labor requirement.

a/ Average of all seasons has been computed by using the percentages of total area under aman, boro and aus as respective weights.

b/ One winnowing after threshing and two during husking and polishing.

c/ Not available.

d/ This is the 1978 figure when there was no huller mill in the area. The percentage dropped to 16 percent after commissioning of two huller mills in 1979.

Source: Field survey in Shimla and Padurbari.

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Table 6. Cost and performance comparison of some alternative postharvest technologies.

Kind of technology	Ownership or extension status of the technology	Rate of energy input per maund	Purchase/ construction cost (Taka)	Operational cost/maund: Labor: Man-day	Operational cost/maund: Labor: (Taka)	Operational cost/maund: Fuel/ Elec. (Taka)	Maintenance cost (Taka/ year)	Labor productivity (mds/ day)	Food loss
Threshing:									
1. Pedal thresher (Comilla Model)	Individual or group, not commony used	.10 man-day of labor	1,200	.10	1.20	a/	20	10.00	.43 (% unthr.)
2. Manual and/or animal threshing	Most commonly practiced at farm level	.19 man-day + .76 animal dayb/	-	.19[b]	2.28	a/	a/	5.26	.60-3.64 (% unthr.)
Drying:									
1. Natural draft drier (small)	Still experimental	.25 maund rice husk	600	.50	6.00	2.00	10	Less than 1.00	NA
2. Concrete floor (400 sft)	Private entrepreneur(s) or cooperative, very seldom	(solar heat) NA	3,200	.09	1.08	a/	15	11.00	NA
3. Kutcha yard (400 sft)	Family-based, most common	(solar heat) NA	-	.15	1.80	a/	a/	6.67	NA
Husking & polishing:									
1. Steel huller (20 HP)	Private entrepreneur(s) commonly used	Diesel or electric	20,000[d/]	c/	.15	.20	500	150.00	31 (% broken)
2. Traditional *Dheki*	Family owned, most common	.72 man-day	300	.71	8.50	a/	c/	1.41	28 (% broken)

a/ None. b/ Mutual borrowing of animal labor is free of cost. Therefore, only human labor has been considered in the costs. c/ Insignificant. d/ Including building and installation.

Source: Compiled after Ahmed (1981a); Greeley (1981a); Harriss (1979); Shahriar (1980).

Table 7. Employment pattern in husking paddy.

Information	Area without rice mill[b/]	Area with huller mill[c/]	
		Before huller mill	After huller mill
Number of sample farms	80	76	76
Percent farms hiring labor	41	53	46
Percent farms reporting husking by hired labor	41	49	46
Percent paddy[a/] husked by hired labor	24	32	16
Percent farms using mill	d/	d/	37
Percent paddy[a/] husked at mill	d/	d/	29
Percent paddy[a/] husked by family labor	76	68	55
Percent farms reporting use of male labor in husking	19	21	9

a/ This excludes the paddy for processing business.

b/ Villages Boyra and Sutiakhali.

c/ Villages Shimla and Padurbari.

d/ None.

Source: Field survey.

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Table 8. Effect of rice mill on different categoreis of rural poor.

Effects of rice mill	Category of the poor interviewed in mill area[a]		
	Employed by producer farmers (n = 24)	Engaged as paddy processing group[b] (n = 11)	Engaged in the rice mills (n = 2)
1. On size of employment			
Percent reporting increase	13	9	100
Percent reporting decrease	83	27	c/
Percent uneffected	4	64	c/
2. On term of employment			
Changing from daily/ contract labor to permanent labor	63	c/	c/
Changing from permanent to daily/contract labor	13	27	c/
Uneffected	25	73	100
3. On wage rate			
Percent reporting increase	c/	c/	100
Percent reporting decrease	79	18	c/
Percent uneffected	21	82	c/
4. On net income			
Percent reporting increase	c/	100	100
Percent reporting decrease	88	c/	c/
Percent uneffected	13	c/	c/

a/ Of the 76 farmers interviewed in the supply hinterland of the mills in Shimla and Padurbari, 37 were classified as poor who were employed by others.

b/ As *Kutias* and *Barkiwalas* (Bengali words for paddy processing people).

c/ None.

Source: Field survey in villages Shimla and Padurbari.

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Table 9. Terms of employment and wage rates of female labor employed in husking paddy.

Study area	No. of farms hiring in husking labor	Percent of employer farms hiring in		Wage rates quoted[a/]						
				Permanent labor per year			Casual labor/day			Per maund con tract (Tk)
		Perma-nent labor	Casual labor	Cash (Tk)	Meal (Nos./ day)	Kind[b/] (Tk)	Cash and kind[c/] (Tk)	Meal (No.)	Total (Tk)	
Area without rice mill	33 (41)	39	61	2000 to 3000	2.5	40 to 60	5 to 6	2.5	10 to 11[d/]	9 to 10 + husk
Area with rice mill:										
i. Before mill	37 (49)	54	46	1900 to 2500	2.5	40	5 to 7	2.5	10 to 12[d/]	8 to 9 + husk
ii. After mill	35 (46)	63	37	1800 to 2300	2.5	40	5 to 6	2.5	10 to 11[d/]	7e + husk

*Figures in parentheses indicate percent of total number of farms interviewed.

a/"Guesstimates" based on rates quoted by employers and laborers; not averages.

b/Mainly clothes or paddy/rice of poor quality.

c/Sometimes a portion is paid in cash and the rest in rice.

d/Each meal was priced at the rate of Tk 2.00.

e/This rate is slightly higher than the rate charged by the mills which is Tk 6.00 per maund.

Source: Field survey.

Table 10. Return to family labor in small-scale paddy processing business of the rural poor under alternative milling technologies (December 1980).

Cost/return	Techology	
	Husked *dheki* method (1 md paddy/woman-day) (Taka)	Husked at custom mill (3 mds paddy/woman-day) (Taka)
A. Costs		
1. Purchase cost of paddy (Tk 105.00/md)	105.00	315.00
2. Fuel for parboiling	2.00	4.00
3. Transport	2.00	4.00
4. Husking/milling	a/	18.00
5. Interest on operating capital	1.00	3.00
Total (A):	110.00	344.00
B. Returns		
1. Sales price of rice (Tk 184.00/ md, 66% rice per maund paddy)	121.44	364.32
2. Price of husk, bran and broken rice	2.00	6.00
Total (B):	123.44	370.32
C. Return to family labor (A-B)	13.44	26.32

a/ No husking cost because paddy is husked by family members.

Source: Group interviews with professional paddy processing women in Keyotkhali.

APPENDIX I

Extent of loss of aus paddy by moulding and germination.

Farm size	Unit of extent of damage	Time: Farm-yard stack-ing I	Thresh-ing I to drying	Farm-yard stack-ing II	Threshing II to drying	Percent of total yield affected
Small	Percent of farmers	2.5	a/	15.0	5.0	b/
	Percent of plots	0.7	a/	4.1	1.4	b/
	Percent of area	1.0	a/	4.6	1.0	b/
	Percent of gross yield c/	0.17	a/	0.81	0.23	1.21
Medium	Percent of farmers	12.0	4.0	24.0	a/	b/
	Percent of plots	3.2	0.8	5.0	a/	b/
	Percent of area	3.6	0.2	4.1	a/	b/
	Percent of gross yield c/	0.60	0.03	0.60	a/	1.13
Large	Percent of farmers	a/	a/	6.6	20.0	b/
	Percent of plots	a/	a/	0.9	2.9	b/
	Percent of area	a/	a/	1.0	3.2	b/
	Percent of gross yield c/	a/	a/	0.27	0.50	0.77
All farms	Percent of farmers	5.0	1.3	16.3	6.2	b/
	Percent of plots	1.4	0.2	3.5	1.4	b/
	Percent of area	1.63	0.07	3.12	1.43	b/
	Percent of gross yield c/	0.27	0.01	0.54	0.24	1.06
		(25)	(1)	(51)	(23)	(100)

*Figures in parentheses indicate percentage along horizontal line.

a/ None.

b/ Not applicable.

c/ Not deducting physical loss of grains in the immediate postharvest operations.

Source: Field survey in Boyra and Sutiakhali.

APPENDIX II

Extent of loss of aus paddy by missing of grains

Farm size/unit	Extent of loss during					Total loss
	Farm-yard stacking I	Threshing I + II	Farm-yard stacking II	Parboiling	Drying	
Small						
% farms	2.5	57.5	2.5	5.0	90.0	b/
% plots	0.7	33.2	0.7	1.4	82.7	b/
% area	1.2	40.6	0.2	1.4	88.2	b/
% gross yield	0.00	0.17	0.00	0.01	0.31	0.49c/
Medium						
% farms	8.0	64.0	8.0	28.0	100.0	b/
% plots	1.6	30.3	3.2	5.7	96.0	b/
% area	1.4	32.0	5.1	5.5	98.5	b/
% gross yield	0.02	0.15	0.05	0.01	0.40	0.63c/
Large						
% farms	20.0	86.7	a/	26.7	100.0	b/
% plots	3.9	39.8	a/	3.9	93.2	b/
% area	3.0	38.1	a/	6.5	95.4	b/
% gross yield	0.06	0.24	a/	0.02	0.62	0.94c/
All farms						
% farms	7.5	65.0	3.8	16.2	95.0	b/
% plots	1.9	35.7	1.4	3.5	90.0	b/
% area	2.0	36.5	2.0	4.7	94.6	b/
% gross yield	0.03	0.19	0.02	0.01	0.44	0.069c/

a/ None. b/ Not applicable. c/ T-tests indicate that the loss difference between small and medium farms was not significant but the loss was significantly higher in large farms compared to both small and medium farms at 0.01 level.

Source: Field survey in Boyra and Sutiakhali.

APPENDIX III

Glossary

Aman	:	Paddy planted before or during moonsoon and harvested in November and December.
Aus	:	Wet season paddy planted from mid-March through early May and harvested in July and August; generally known for its postharvest problems due to rain.
Barkiwala	:	Traditional paddy processing people, mainly women.
Boro	:	Paddy planted in December and January and harvested from April to June; harvesting of late *boro*, usually HYV, is done partly in the wet season and it is, therefore, sometimes faced with processing problems.
Dheki	:	Indigenous pedal powered husking devise.
Kutia	:	Synonym for Barkiwala; Kutias operate relatively smaller business.
Maund	:	Forty *seers*, equivalent to 82.3 lbs or 37.3 kg.
Taka (Tk)	:	Unit of local currency, approximately equivalent to 0.06 US dollar (March 1981).

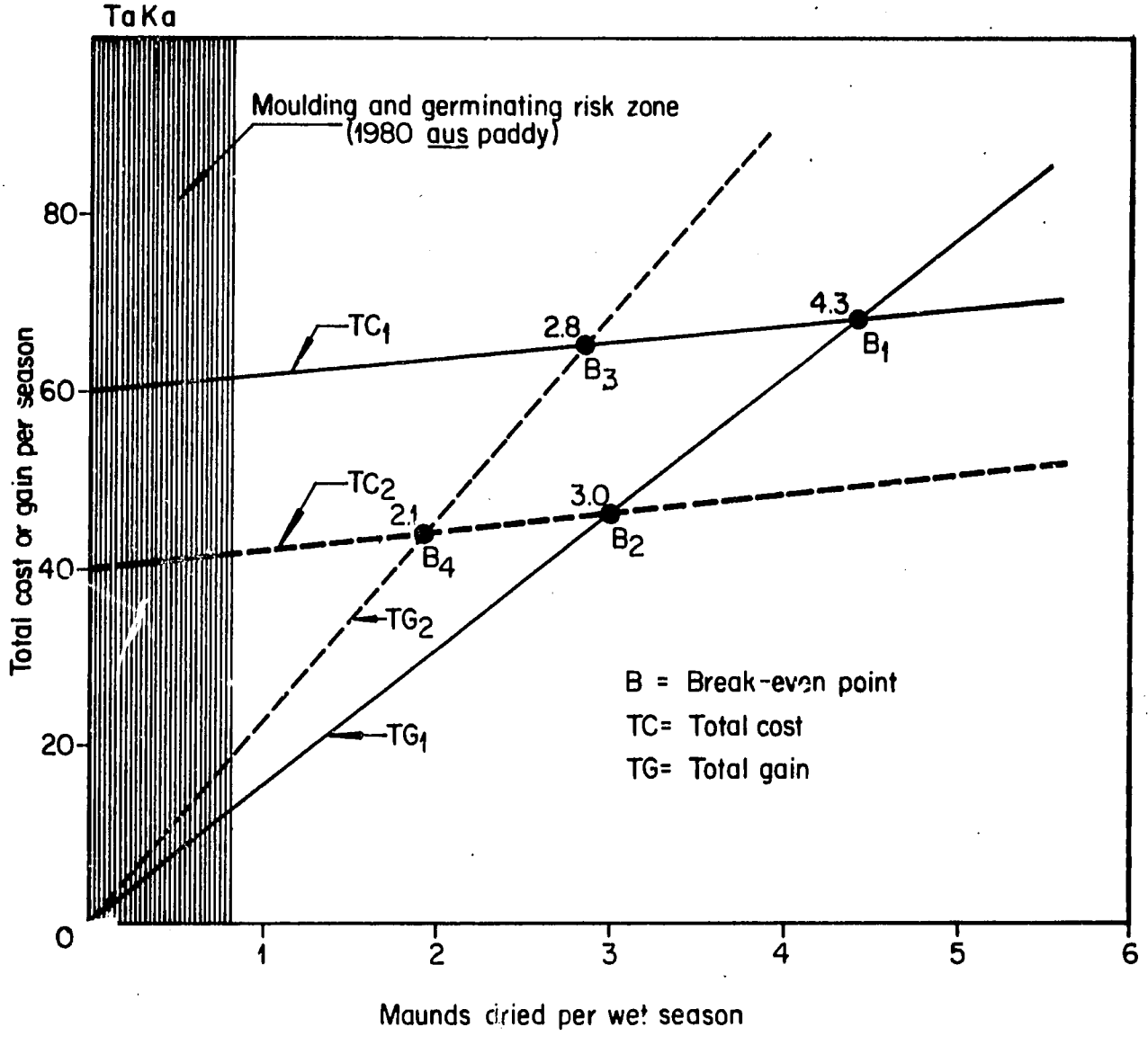

Fig. 1 Break-even points between costs and gains of using small-scale natural draft driers under trial in Bangladesh.

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