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POSTHARVEST PADDY PROCESSING IN BANGLADESH: IS MECHANIZATION NEEDED AT FARM LEVEL?

Jasim U. Ahmed*

ABSTRACT

The analysis in this paper provides indicative evidences of low foodgrain loss and labour requirement in postharvest processing of aus paddy by traditional methods in some selected farms of Bangladesh. The reasons for low food loss lie in the relative efficiency of small-scale farming in managing the postharvest operations. This tends to limit the scope for probable modernized loss reducing technologies at farm level. Possibilities for saving labour by modernized postharvest technologies too do not appear to be substantial since the labour requirement in all the operations, except husking, is already low under the existing traditional technologies and the use of zero-or low-cost family labour is also high. Failures to popularize the natural draught dries in the study area may be attributed mainly to higher costs of labour, fuel and fixed capital. Contrarily, the increasing expansion of the rice huller technology, the only commercial type modernized technology in the rural postharvest sector in Bangladesh, is mainly due to the higher labour requirement in the alternative traditional husking technologies. Development programmes should be undertaken to alleviate the adverse effects of labour displacing technologies, such as rice hullers, on the employment and income of the rural poor.

I. INTRODUCTION

The economic rationale behind mechanization of postharvest processing of paddy is to increase labour productivity and or reduce food loss. However, under conditions of labour-abundant small-scale farming, as in Bangladesh, this two-fold rationale may become inoperative due to scale of operation lagging behind need for mechanization or may come into conflict with the equity issue in rural income distribution due to eviction of hired labour caused by mechanization of paddy processing (Ahmed 1981a). The present paper seeks to examine the need for mechanizing paddy postharvest operations

*The author is an Assistant Professor at the Department of Cooperation and Marketing, Bangladesh Agricultural University (BAU), Mymensingh. This paper has been drawn from a larger report he submitted to the Agricultural Development Council, Inc. (A D C), New York, on conclusion of a study conducted in 1980. The A D C deserves appreciation for financing the study. The views expressed in the paper are not, however, necessarily identical with those of BAU or A D C.

at farm level from the view-point of its potential for saving food and labour as well as possible socio-economic imbalances caused by such mechanization.

The data used in this paper have been obtained from two separate field surveys in two areas under Mymensingh district in 1980. In one survey in the villages Boyra and Sutiakhali, data on postharvest loss of aus paddy-a wet season crop known for its postharvest problems-were collected from a sample of 80 farms selected purposively allowing proportionate representation of all size groups. In another survey in the villages Shimla and Padhurbari, where two huller mills were commissioned in 1979, postharvest employment data for a whole crop year were collected from a random sample of 76 households within the supply hinterland of the huller mills. (Methodological details on the two field surveys have been prodvided in Ahmed (1981b).

The analysis of the results of the aus paddy loss assessment survey has been presented in Part II of this paper. The labour requirement in paddy processing at farm level has been examined in Part III and the question of farm level demand for modern postharvest technologies has been discussed in Part IV. The consequences of mechanization of paddy processing on the rural poor have been examined in Part V with the example of the expansion of rural huller mills. Some policy conclusions on the basis of the findings of this study have been provided in Part VI.

II. POSTHARVEST LOSS OF AUS PADDY

Postharvest food loss occurs due to a multitude of factors during various handling and processing operations after cutting in the field upto final consumption. Due to obvious technical and time limitations, the emphasis of the 1980 aus postharvest monitoring in the study area was placed on the collection of data on only some selected sources of loss, namely : (i) physical loss by missing of grains during immediate posthervest operations such as farm-yard stacking, threshing, parboiling and drying, and (ii) physical and qualitative loss of paddy by moulding and germination due to drying constraints.

There may be many types of sequences of postharvest operations for paddy processing at farm level. In case of aus, the most common sequence was cutting, carrying threshing, parboiling, drying and husking for immediate consumption (within two months after harvest) which accounted for 36.34 percent of the total harvest (Ahmed 1981b). The next most important combination of operations was cutting, carrying, threshing, parboiling, drying and storage for future consumption which acconted for 24 percent of the aus paddy. Additionally, some other operations like on-field and farm-yard stacking and winnowing are also done in between the operations in the afore-mentioned sequence combinations.

Postharvest loss of aus paddy was analyzed both by operations as well as by sources in all the opertions under study taken together. Data on physical loss due to missing of grains were ollected by conducting "test gleanings" in sample cases and using the results of these test gleanings as measuring scale for verifying and, if necessary, correcting the estimates given by the sample farmers after close observation of each operation. The same procedure was also applied for estimating unthreshed loss. Rodent loss estimates were based on figures given by farmers. But the occurrence of rodent loss was very rare so that it may not have caused any bias to the total estimate. For loss due to birds, farmers' estimates were taken after thoroughly checking the figures with number of birds and possible rate of eating and length of time of eating.

For measuring physical and qualitative loss of grains by moulding and germination, samples of affected grains were collected from those farmers in the sample who reported such loss, and then milling yields of affected grains weie compared with those of unaffected samples collected from the same farmers. Milling tests were conducted at the Bangladesh Council of Scientific and Industrial Research (BCSIR) Laboratories in Dacca by using Satake laboratory huller and Gariboldi disc polisher. Before hulling, the moisture content of the samples was brought to 14 percent.

Loss by Missing of Grains

As Table 1 indicates, on an average, only 0.69 percent of the total aus yield was lost by missing of grains during the six operations, namely farm-yard stacking I and II, threshing I and II, parboiling and drying. This is a small figure and seems to sugest that farmers' estimates of physical loss of grains are not as high as generally presumed. Contrarily, farmers - particularly the poor try to keep the missing loss to a minimum by gleaning, and even hand-stripping in case of unthreshed grains, Also the most recent loss assessment survey by Huq and Greeley (1980) suggests a low level of loss in these operations.

Drying has been found to be the most dominant source of physical loss (0.44 percent of yield) followed by threshing I and II combined (0.19) percent). Amongst the individual loss causing factors, birds - mostly poultiy - caused the greatest part (58 percent) of the total loss reported for the six operations while unthreshed grains accounted for 25 percent of the loss (Table 2).

Most remarkable is, however, the pattern of physical loss variations with respect to farm size. Between small and medium farm size there was no significant variation in the extent of physical loss ; but the loss in large farms was significantly higher compared to medium and small farms - t values being significant at 0.01 level in both cases (Table 1).

TABLE 1 PHYSICAL LOSS OF AUS PADDY BY MISSING OF GRAINS

Farm size	Operations					
	Farm-yard stacking I	Threshing I+II	Farm-yard stacking II	Parboiling	Drying	All operations
	Percent of gross yield lost					
Small (Less than 2.50 acres)	a	0.17	a	0.01	0.31	0.49[b]
Medium (2.50 to 4.99 acres)	0.02	0.15	0.05	0.01	0.40	0.63[b]
Large (5.00 acres and above)	0.06	0.24	a	0.02	0.62	0.94[b]
All size groups	0.03	0.19	0.02	0.01	0.44	0.69

a. Less than 0.01.
b. 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.

The reasons for the variations of physical loss among farm size categories cannot be explained by differences in postharvest technology endowments of each size group alone. The availability of fixed man-units of post-production labour, threshing animal, threshing yard and implements per acre of aus paddy decreased almost uniformly with increase in farm size except in case of threshing yard which is used also for stacking and drying (details in Ahmed et al. 1980). That is why the insignificant loss variation between small and medium farms and significantly higher loss in large farms

TABLE 2 EXTENT OF PHYSICAL LOSS BY MISSING OF GRAINS

Farm size	Sources of loss				
	Unthreshed	Stuck to floor	Bird	Rodent	Total
	------ Percent of output- -------------				
Small[a]	0.11	0.06	0.26	0.06	0.49
Medium[a]	0.15	0.08	0.37	0.03	0.63
Large[a]	0.24	0.06	0.56	0.08	0.94
All farms	0.17 (24.64)	0.07 (10.14)	0.40 (57.97)	0.05 (7.25)	0.69 (100)

Figures in parentheses indicate percentage in total loss.

a. As in Table 1.

Source : Field survey in Boyra and Sutiakhali.

should be explained by some other factors, One possible explanation may be that as farm size rises above certain level the marginal utility of unthreshed grains, grains lost due to birds, soft floor and other factors tends to diminish. It has been reported that in larger farms house wives are generally liberal about poultry birds feeding on grains. This is evident in high proportion of loss caused by birds particularly in the large farms (Table 2).

Loss Due to Moulding and Germination

The incidence of moulding and germination of 1980 aus paddy was very rare in the sample farms mainly due to very favourale weather conditions. This is evident from the figures on percentage of farmers, plots, aus area and yield affected (Table 3). Only 1.06 percent of the total gross yield in the sample farms was affected by moulding and germination, and the biggest proportion of this loss (51 percent) happened during the period of farm-yard stacking II i.e., inside the stacks of the plants after threshing I.

Percentage of gross yield affected by moulding and germination was significantly lower in large farms (0.77 percent) compared to small and medium farms. One explanation to this may be the higher availability of labour employed for difficult postharvest operations by the large farmers (Table 4). During the aus harvest, large farmers hire workers for transplanting aman paddy and simultaneously use them for aus postharvest operations to utilize fair weather. One further explanation may be the relative shortage of fuel for parboiling in the small and medium farms which delayed parboiling and increased the risks of moulding and germination (Table 4).

Loss of grains due to moulding and germination was, then, determined by comparing milling yields of deteriorated and not-deteriorated grains. In total, 21 samples of deteriorated grains and 38 samples of not-deteriorated grains were collected from the farmers under study. Milling yields of the deteriorated and not-deteriorated samples were compared separately for parboiled and not-parboiled paddy. Milling yield of parboiled paddy was predictably better than that of not-parboiled paddy in both deteriorated and not-deteriorated samples (Table 5). The estimation of loss of value was, however, based on the parboiled samples since about two-thirds of the aus paddy is parboiled at farm immediately after threshing (Ahmed 1981b).

Both in terms of percent polished rice and percent broken rice, the milling yields of parboiled deteriorated grains were lower compared to parboiled not-deteriorated grains. Physical loss of grains due to moulding and germination is evident in the lower yield of polished rice in the deteriorated samples which was 6.08 percent less than that of not-deteriorated samples. Qualitative loss due the moulding and germination was also evident in the higher degree broken rice content, bad colour and smell in the rice obtained from deteriorated samples. The broken rice content in deteriorated samples was about 140 percent higher compared to not-deteriorated samples. The loss of economic value in the dteriorated paddy has been determined on the basis of both physical and qualitative loss whereby physical loss was assumed to be inherentin the rate of milling out-turn and the qualitative loss due to higher proportion of broken rice and bad colour and smell was supposed to be reflected in the price differentials.

TABLE 3. EXTENT OF LOSS OF AUS PADDY BY MOULDING AND GERMINATION

Farm size	Unit of extent of damage	Time				Percent of total yield affected
		Farm-yard stacking I	Threshing I to drying	Farm-yard stacking II	Threshing II to drying	
Small	% farmers	2.5	b	15.0	5.0	c
	% plots	0.7	b	4.1	1.4	c
	% area	1.0	b	4.6	1.0	c
	% yield	0.17	b	0.81	0.23	1.1
Medium	% farmers	12.0	4.0	24.0	b	c
	% plots	3.2	0.8	5.0	b	c
	% area	3.6	0.2	4.1	b	c
	% yield	0.60	0.03	0.60	b	1.13
Large	% farmers	b	b	6.6	20.0	c
	% plots	b	b	0.9	2.9	c
	% area	b	b	1.0	3.2	c
	% yield	b	b	0.27	0.50	0.77
All sizes	% farmers	5.0	1.3	16.3	6.2	c
	% plots	1.4	0.2	3.5	1.4	c
	% area	1.6	0.1	3.1	1.4	c
	% yield	0.27	0.01	0.54	0.24	1.06
		(25)	(1)	(51)	(23)	(100)

Figures in parentheses indicate percentage along horizontal line.
a. Same as in Table 1. b. None.. c. Not applicable.

Source : Field survey in Boyra and Sutiakhali.

TABLE 4 EXTENT OF LOSS VIS-A-VIS POSTHARVEST PROBLEMS

Farm size	Kind of information	Operations		
		Thresh-ing	Parboil-ing	Dry-ing
Small (Below 2.50 acres)	% plots having postharvest problems	48	25	87
	% plots having loss	33	1	83
	% problem plots facing labour shortage	21	a	a
	% problem plots using more labour	11	11	21
	% problem plots facing fuel shortage	6	75	a
	% problem plots using more fuel	b	8	a
Medium (2.50 to 4.99 acres)	% plots having postharvest problems	41	14	99
	% plots having loss	30	6	96
	% problem plots facing labour shortage	16	a	1
	% problem plots using more labour	2	a	13
	% problem plots facing fuel shortage	b	65	a
	% problem plots using more fuel	b	a	1
Large (5.00 acres and above)	% plots having postharvest problems	44	13	98
	% plots having loss	40	4	93
	% problem plots facing labour shortage	2	a	a
	% problem plots using more labour	60	a	5
	% problem plots facing fuel shortage	b	2	a
	% problem plots using more fuel	b	31	a
All sizes	% plots having postharvest problems	45	18	94
	% plots having loss	34	3	90
	% problems plots facing labour shortage	15	a	.29
	% problem plots using more labour	22	6	14
	% problem plots facing fuel shortage	b	58	a
	% problem plots using more fuel	b	11	.29

a. None.
b. Not applicable.

Source : Field survey in Boyra and Sutiakhali

TABLE 5. MILLING YIELD COMPARISONS OF DETERIORATED AND NOT-DETERIORATED GRAINS

Kind of paddy	Not-deteriorated grains		Deteriorated grains	
	No. of samples	Mean yield	No. of samples	Mean yield
	---- percent polished rice -------			
Not-parboiled	30	67.31	13	64.27
Parboiled	8	70.59	8	66.30
	----- percent broken rice ------			
Not-parboiled	30	8.74	13	15.47*
Parboiled	8	5.52	8	13.23*

*Milling yield differences between deteriorated and not-dereriorated samples were statistically significant at 0.05 level.

a. $\text{Percent polished rice} = \frac{\text{weight of polished rice}}{\text{weight of paddy}} \times 100.$

b. $\text{Percent broken rice} = \frac{\text{weight of broken rice}}{\text{weight of polished rice}} \times 100.$

Source : Field survey in Boyra and Suitakhali.

Loss of value due to moulding and germination was determined by using the formula:

$$Lv = Pn \times Mn - Pd \times Md$$

where Lv stands for loss of value per maund of deteriorated grains ; Pn and Pd are prices of not-deteriorated and deteriorated rice per maund respectively ; Mn and Md are rates of polished rice-out-turn per maund of not-deteriorated and deteriorated paddy respectively.

As of December 1980, prices of good and bad quality rice - corresponding to the qualities of the sample rice - were Taka 186.00 and Taka 175.85 per maund respectively. And according to Table 5, Mn and Md were 0.71 and 0.66 maund respectively. Accordingly, loss of value was Taka 16.00 per maund of deteriorated grains.

The proportion of grains affected by moulding and germination was 1.06 per-cent of gross yield which comes to 33.23 maunds for the whole sample of farms. By extrapolating, the total value of loss by mouldinga and germination was found to be Taka 531.68 for the whole sample i.e., Taka 6.65 per farm. And the average per farm value loss was Taka 33.23 for those households ($n=16$) which reported moulding and germinating loss (Ahmed 1981*b*).

Three conclusions on the basis of the above loss estimates may be that : (1) the loss figures are not high enough to force the farmers to seek for loss reducing technologies, (2) the operational costs of any loss reducing technology should be low enough so that the benefit of loss reduction is not offset by high costs, and or such technology should be maintained and used collectively in order to minimize at least fixed costs, and (3) unless enough private profit is generated by means of labour saving, new postharvest technologies may not be able to create an effective demand at farm level only by dint of their limited loss-reducing potential.

Postharvest Lossess Vs Postharvest Problems

The low level of postharvest loss does not, however, fully depict the size of postharvest problems of farmers. The proportion of aus plots facing postharvest problems was larger than the proportion of plots for which losses during threshing, parboiling and drying were reported (Table 4). Some extent of postharvest problem is also evident in the increased use of labour and fuel, particularly by large farms, in order to prevent loss. Shortage of labour and fuel was a problem for small and medium size farms. This has probably made timely cutting, threshing and parboiling of grains difficult for them as evident in the higher degree of loss due to moulding and germination in small and medium farms compared to large farmers.

Small-scale Farming Vs Postharvest Problems

Small-scale farming seems to provide for some built-in mechanism to reduce the chances of postharvest loss. It was found that farmers deliberately scattered their planting dates in order to avoid peak period labour and draft power shortage which permitted also reasonable average gaps between successive harvesting dates. Since aus is a wet season crop, it also permits some flexibility in the harvesting date by two to three days. In this way farmers can considerably avoid management problems concerning postharvest operation. The average distance between two successive harvesting dates of aus was 6.58 days. New HYV seeds, which are late varieties of aus, have made it yet easier to scatter out the harvesting dates (Ahmed 1981b).

Moreover, the extent of drying problem due to non-availability of solar heat for two three days together did not seem to cause much panic among the farmers. Over 90 percent of the respondents said that they even preferred drying paddy over two three days (except in case of unparboiled uses like seed-purpose grains) in order to improve milling quality. Sunshine records from the Bangladesh Agricultural University Weather Yard also suggest that occasions of continuous non-availability of sunshine over three days were extremely rare in the aus postharvest period under study (Ahmed et al. 1980).

Farmers' opinions on the extent of aus postharvest problems in 1980 are also revealing in this regard. About 61 percent of the respondents did not consider the postharvest problems due to inconvenient weather as extremely difficult to overcome, only 19 percent said these were extremely difficult, while 20 percent said the problems were not at all difficult.

It is not, however, realistic to presume that the respondents' low assessment of aus postharvest problem in 1980 was due to the exceptionally favourable weather in that year. Because, 79 percent of the farmers reported that over the past five years there was no significant negative deviation in the extent of aus postharvest problems compared to the level of the study year.

One further strength of small-scale farming in tackling postharvest problems lies in the subsistence nature of disposal of its produces. Since the grains are mostly consumed at home, the value loss in deteriorated grains, if measured in terms of utility, may not seem to be very high to the consumers most of whom live on a subsistence level. That is why in the event of small amount of deteriorated grains (1.06 perecent of yield in this sample), farmers do not feel much concerned. Nevertheless, change of end use of deteriorated grains may represent a source of economic value loss to the farmers. However, the major part of the deteriorated grains in the sample farms was used for purposes as originally intended by the farmers (Table 6).

TABLE 6 MODE OF DISPOSAL OF DETERIORATED GRAINS

Mode of use	Quantity (maunds	Percent deviation from originally intended use
Own consumption	25.87 (77.85)	18.34
Sale	5.61 (16.88)	6.57
Barter for goods and services	1.52 (4.57)	100.00
Cattle and poultry feed	0.23 (.0.69)	100.00
Completely unusable for consumption	a (a)	a
Total	33.23 (100.00)	20.64

Figures in parentheses indicate percentage of total.

a. None.

Source : Field survey in Boyra and Sutiakhali.

III. Labour Requirement of Paddy Processing at Farm Level

The labour requirement of postharvest processing of paddy runs to the tune of 41 percent to 49 percent of total man-days rquired for its production upto harvest (Ahmed 1981*a*) and about one-fourth of all agricultural employment (Greeley 1980). Detailed operation-wise data on labour reqirement for paddy processing in Bangladesh are scanty. It has been attempted in Table 7 to provide operation-wise data on labour requirement for paddy processing at farm level. The average labour requirement for 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 in aman perhaps due to postharvest problems caused by rains during aus and boro seasons. Labour requirement 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 labour requirement. Assuming that winnowing, soaking, parboiling, drying, and husking are done exclusively by female labour, women's contribution to postharvest paddy processing stood at 86 percent.

The labour requirement for each of the pre-husking operations was, therefore, very small. These are also the operations in which use of family labour was higher compared to husking (Table 7). Future research and development activities aimed at reducing labour cost by modernization of the pre-husking operations under small-scale farming like that of Bangladesh may, therefore, have limited scope since the labour requirement of these operations under the currently available traditional techonology is already low and the opportunity cost of female family labour engaged in these operations is also very low. Contrarily, due to the high labour reqirement in husking, the expansion of the labour saving huller mills in rural Bangladesh has gained momentum. The existing number of these hullers is estimated at 10,000 (Ahmed 1981*a*) which is growing at the rate of 380 per annum (Salahuddin 1980).

Also viewing from the proportion of total number of families hiring in labour, the potentials for technologies aimed at reducing hired labour cost in the postharvest operations were found to be limited. The survey in Shimla and Padurbari reveals that although 46 percent of all the 76 sample families hired in labour for farm work, only 28 percent hired in female labour for postharvest operations.

IV. Farm Level Demand for Mechanized Postharvest Technologies

As of today, rice hullers represent the only mechanized postharvest technology enjoying substantial amount of commercial demand among rural users in Bangladesh. The proportion of total paddy husked by mills and hullers in Bangladesh is currently estimated at 23 to 46 percent (Salahuddin 1980). Next in ranking with respect to farm level-demand are pedal threshers of which about 4000 pieces are in use by farmers in Bangladesh (personal communication with BRRI Rice Technology Division). Small-scale driers under trial in the study area of Boyra (and Keyotkhali), however, seem to be more labour and capital intensive compared to the open sun-drying technology. With the non-conductive nature of the wet season drying problem added to it, these driers may not have much economic prospect at farm level (Ahmed 1981b ; Greeley 1981).

TABLE 7 LABOUR REQUIREMENT FOR PADDY PROCESSING

Operation	Labour requirement (man-day/md)				All seasons
	Aman season	Boro season	Aus season	Man-day/md	% done by hired labour
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)	0.19 (13)	0.15 (11)	14
Husking	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)	1.36 (100)	25

Figures in parentheses indicate percent of total labour requirement.

a. Average of all varieties 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.

c. Not available.

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

Source : Field survey in Shimla and Padurbari.

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 be convinced that the labour saving potential and comparative cost advantage of a mechanized technology (over the traditional method) rather than its food saving potential have been the prime factors influencing the demand for that technology. This will be evident from a careful examination of the loss figres in Part II, the labour requirement data in Part III as well as the cost and performance comparisons of some selected alternative processing technologies presented in Table 8.

Although the small-scale natural draft driers under trial in the project area entail relatively low investment cost, they must be met with three preconditions in order to be able to create effective demand among farmers. They are : (i) lowering of cost by increasing efficiency, and or (ii) high degree of threat of moulding and sprouting due to bad weather, and or (iii) availability of fuel.

This may be illustrated graphically by fixing break-even points between costs and gains of using small-scale driers under various conditions (Figure 1). The graph is based on the figure on value loss of Taka 16.0 per maund of paddy affected by moulding and germination due to drying constraints (see Part II). The graph assumes that mechanical drying will supplement sun-drying only when drying constraint arises. It also assumes a crudely estimated fixed cost of Taka 60.00 per year due to the construction of the drier, i.e., the total cost of Taka 600.00 being spread over a period for ten years without considering the opportunity cost of investment. Fuel cost has been estimated at Taka 2.00 per maund (Table 8). Since female family labour can operate the drier, labour 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 . This indicates that at least 4.3 maunds of paddy threatened by moulding and germination would have to be dried in order to make the gains equal the costs. If the opportunity cost of capital is calculated by a compounding factor of 10 to 15 percent, the break-even point would be at a still higher level.

In the study area, on the average, only 0.41 maunds of aus paddy (1.06 percent of the yield) was affected by moulding and germination. 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. 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

TABLE 8 COST AND PERFORMANCE COMPARISON OF SOME ALTERNATIVE POSTHARVEST TECHNOLOGIES :

Technology	Energy need per maund	Purchase/ construction cost (Taka)	Operational cost per maund: Labour Manday	Operational cost per maund: Labour Taka	Fuel/ elec. Taka	Maintenance cost (Taka/ Year)	Labour productivity (Mds/ day)	Food loss
1. **Threshing :**								
Pedal thresher	.10 man-day of labour	1.200	0.10	1.20	a	20	10.00	.43 (% unthr.)
Manual and or animal threshing	.19 man-day+ .76 animal day	a	.19[b]	2.28[b]	a	a	5.26	.60-3.64 (% unthr.)
2. **Drying :**								
Small natural draft drier	.25 maund rice husk	600	.50	6.00	2.00	10	less than 1.00	NA
Sun-drying (Kutcha floor 400 sft.)	(Solar heat) NA	a	.15	1.80	a	a	6.67	NA
3. **Husking** ·								
Steel huller (20 HP)	NA	20,000	c	.15	.20	500	150.00	31 (% broken)
Traditional **dheki**	.71 man-day	300	.71	8.50	a	c	1.41	28 (% broken)

a. None.

b. Mutual borrowing of animal for threshing is free of cost. Therefore, only human labour cost has been considered.

c. Insignificant.

Source : Computed after Ahmed 1981a ; Greeley 1981, Harriss 1979 ; Shahriar 1980.

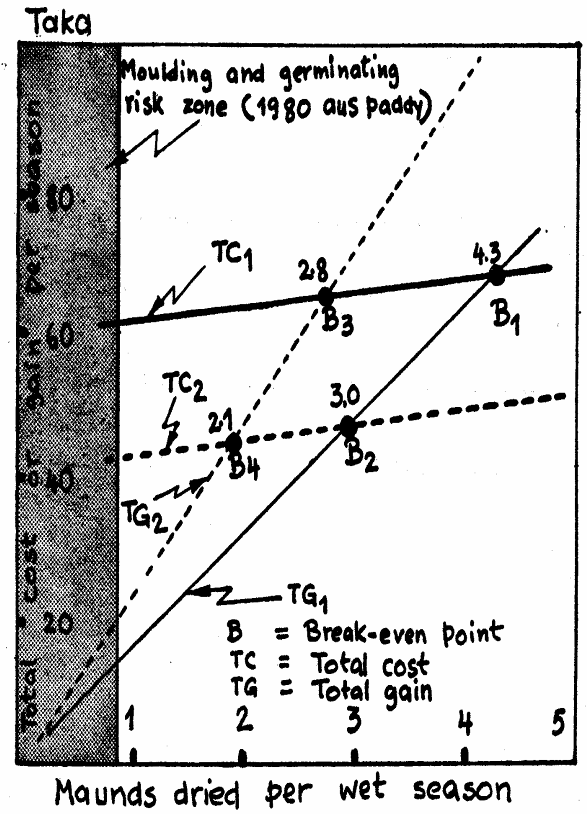

Figure 1. Break-even points between costs and gains of using small-scale natural draft driers under trial in Bangladesh.

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 from the preceding postharvest loss figures and the data on labour requirement under alternative processing methods that under the prevailing small farming conditions in Bangladesh, the commercial scope for mechanization of drying and other pre-husking operations does not seem to be high at the farm level. The scope for mechanical drying, however, may be greater at secondary levels like govern ment procurement depots and milling centres where the scale of operation and risk of food loss may be higher. Also, if the drier efficiency is increased, some very large farmers may reach the economy of scale by using mechanical driers in times of extremely bad weather.

It is also evident from the example of the custom hullers that the possibility of private profit due to labour saving potential may attract petty capitalists to invest in mechanized processing devices. Given the present scale of farming, however, individual ownership of such devices by the vast majority of farmers in Bangladesh would mean over-investment.

V. Consequences of Postharvest Mechanization for the Rural Poor

The case of rural hullers seems to indicate that large-scale mechanization of paddy processing at farm level may create employment and income imbalances for the rural poor. Data from the Shimla-Padurbari survey suggest that 37 percent of the sample households in the supply hinterland of the custom hullers used the huller mills for husking and polishing 29 percent of their paddy. The proportion of paddy husked by hired labour dropped from 32 percent to 16 percent and that by family labour from 68 percent to 55 percent after the introduction of hullers (Table 9).

It will be evident from Table 10 that the employment and income distribution impacts of the hullers mills are different for the three categories of rural poor engaged in paddy processing, namely those employed by producer farmers, those engaged in 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, the **Kutias** and **Barkiwalas** were not significantly affected by the custom hullers in respect of employment.

As regards terms of employment, the field survey reveals that about two-thirds of the rural poor employed by farmers in husking were converted from casual labourer to permanent labourer on terms of more than three months (Table 10). This could have

TABLE 9 EMPLOYMENT PATTERN IN HUSKING PADDY

Information	Area without huller mill[b]	Area with huller mill[c]	
		Before rice mill	After rice mill
Number of sample farms	80	76	76
Percent farms hiring labour	41	53	46
Percent farms reporting husking by hired labour	41	49	46
Percent paddy[a] husked by hired labour	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 labour	76	68	55
Percent farms reporting use of male labour 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 10 EFFECT OF CUSTOM HULLERS ON RURAL POOR

Effects of rice mill	Category of the poor interviewed in mill area		
	Employed by producer farmers ($n = 24$)	Engaged as paddy processing group ($n = 11$)	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 unaffected	4	64	c
2. On term of employment			
Changing from daily contract labour to permanent labour	63	c	c
Changing from permanent to daily contract labour	13	27	c
Unaffected	25	73	100
3. On wage rate			
Percent reporting increase	c	c	100
Percent reporting decrease	79	18	c
Percent unaffected	21	82	c
4. On net income			
Percent reporting increase	c	100	100
Percent reporting decrease	88	c	c
Percent unaffected	13	c	c

a. Of the 76 farmers interviewed in the supply hinterland of the huller mills in Shimla and Padurbari, 37 were classified as poor.

b. As kutias and barkiwalas (Bengali words for paddy processing people).

c. None.

Source : Field survey in Shimla and Padurbari.

been a positive impact in terms of size of employment, but this was also associated with a decrease in the 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 labour employed on per day basis. The rural poor employed by the farmers in husking were also the worst affected group in consideration of the wage depressing effect of the custom hullers.

The only category of rural poor deriving spectacular benefit from the introduction of custom milling are the **Kutias** and **Barkiwalas** (Tables 10 and 11). They save their husking labour by switching from traditional dheki husking to custom milling and used it for intensifying the pre-husking operations. This enabled them to increase their volume of business three times and return to family labour in paddy processing almost two times (Table 11).

TABLE 11 INCOME OF A KUTIA OR BARKIWALA FAMILY UNDER ALTERNATIVE TECHNOLOGIES

Cost/return	Technology: Husked by **dheki** method (1 md paddy/woman-day) Taka	Technology: Husked at custom mill (3 mds paddy/woman-day) Taka
1. **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 labour (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.

VI. Conclusions

Possibilities of reducing food loss and labour requirement are the major factors influencing the level of demand for mechanized paddy processing devices at farm level. The present loss assessment survey in Mymensingh, Bangladesh, however, seems to indicate a low level of loss of aus paddy, a wet season crop, under the existing traditional processing methods. This possibly reduces the necessity for postharvest mechanization aimed at minimizing food loss due to wet season problems. Small-scale and fragmented type of farming, as in the study area seems to permit efficient planning and management of postharvest operations in order to prevent food loss and also reduce utility loss of affected grains by subsistence mode of disposal.

Moreover, the labour requirements of all pre-husking operations by indigenous methods are already low and the use of low-cost female family labour is high so that the scope for generating profit by reducing labour cost through mechanization of these operations is rather limited. Rice huller mills, however, made their way into the rural postharvest sector in Bangladesh by dint of their labour saving potential. This seems to have caused imbalances in employment and income of the rural poor employed by farmers in husking. One possible programme to re-employ them may be to help them with credit and extension facilities for undertaking small-scale paddy processing business of their own as well as other activities like beef fattening, milch cow rearing and poultry raising.

The small-scale natural draft driers under trial in the study area do not seem to have effective demand among farmers because of non-occurrence or extremely low frequency of drying crisis as well as higher labour, capital and fuel costs compared against the traditional sun drying technology. This proves the necessity of in-depth study into the economics of the existing traditional technologies before undertaking research and development programmes aimed at promoting mechanization at farm level.

REFERENCES

Ahmed J. U. Ahmed: *"Impact of New Paddy Postharvest Technology on the Rural Poor in Bangladesh,* paper presented at the seminar on "Rural Technology, Rural Institutions and the Rural Poorest" sponsored by the CIRDAP and IDS Sussex, February 2-5, 1981, Comilla (Bangladesh).

Ahmed J. U. Ahmed: *Economics of Traditional Postharvest Technology under Small-scale Farming, The Case of Paddy in a Selected Area of Bangladesh,* a report for the A D C, New York.

Ahmed et al	J.U. Ahmed, et al : *Effects of Farm Size and Tenancy on Post-production Loss as Estimated by Farmers*, *The Case of Aus Paddy,* paper presented at the "Post-production Workshop on Food Grains" sponsored by the BCSIR and Ford Foundation, December 12-14, 1980, Dacca.
Greeley	M. Greeley, : *Farm Level Post-harvest Food Losses*, *The Myth of the Soft Third Option,* paper presented at the "Post-production Workshop on Food Grains" sponsored by the BCSIR and Ford Foundation, December 12-14, 1980, Dacca.
Greeley	M. Greeley, : "Wet Season Post-harvest Food Losses," *The Agricultural Development Agencies in Bangladesh News* (The ABAB News), 8, 1 (Jan,- Feb. 1981) : 33-41.
Harriss	B. Hariss, : "Post-Harvest Rice Processing Systems in Rural Bangladesh : Technology, Economics and Employment" *The Bangladesh Journal of Agricultural Economics,* 2, 1 (June 1979) : 23-50.
Huq and Greeley 1980	A.K.F. Huq, and M. Greeley : *"Rice in Bangladesh*, *An Empirical Analysis of Farm Level Food Losses in Five Post-production operations,"* paper presented at the "Grains Post-harvest Workshop, "SEARCA , Kuala Lumpur.
Salahuddin 1980	K. Salahuddin, : "Post-harvest Paddy Processing and Rural Women of Bangladesh," *The ADAB News,* 7, 1 (November 1980) : 8-10
Shahriar 1980	M. L. Shahriar, : "Food Losses During Rice Husking," *The ADAB News,* 7, 11 November 1980) : 16-17.