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POST HARVEST RICE PROCESSING SYSTEMS IN RURAL BANGLADESH: TECHNOLOGY, ECONOMICS AND EMPLOYMENT

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ABSTRACT

Over 90 Percent of rice produced in Bangladesh is processed by women in their homesteads and in small custom mills located in the rural areas. These technologies have so far been neglected by both economists and engineers, while trying to find appropriate technology mix for rice processing in Bangladesh. This paper presents an analysis of the relative economics and employment effects of the rural processing technologies and their implications for choice of technology mix for rice processing in Bangladesh.

1. INTRODUCTION

This paper will concentrate on rural rice processing systems for two simple reasons. One is that the distribution of rice consumption in Bangladesh is over-whelmingly rural, only 9.5 percent of the population being classed as urban (BBS 1977a, p. 76-7). The major mills (with low pressure steam parboiling systems which inter alia may mill on contract to the Food Department) are usually located in or very close to urban settlements. They mill between 2 and 6 percent of rice production (GEP 1968; 1977) and are not important for rural areas. The second reason is that virtually nothing is known about the rural processing of rice, in spite of the importance of rice to the Bangladesh economy, and in spite of the fact that since all paddy has to be husked, rice processing is a basic agro-industry. Rural rice processing consists of two main bundles of techniques, those practised by women in their homesteads or baris, and those centring on the custom will, normally a number 2 or 8 huller. Neglect of the homestead technology is a manifestation of a widespread ignorance over women's' economic activity generally (W F W 1975; also see references in Adnan *et al.* 1976). Neglect of the custom mill is probably due to "urban bias" in economic monitoring (Lipton 1977) as well as the exclusion of this technology from the education of many rice processing engineers (Araullo *et ad. 1976).*

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Exactly the contribution of each of these technologies to rice processing is unknown, though it is certain that the neglected custom mills mill at the very least 3 times as much rice as the "major" mills. An estimate for 1967-8 when there were about 6,500 small hullers in the country was 17 percent of production (FAO/UNDP 1977. p. 24) and estimates for 1977 when there were 7,600 licensed, range up to 30 percent. The most recent statement, in the country paper for the Commonwealth Science Rural Technology Workshop, is 20 percent (BUET 1978, p. 13). This type of mechanised milling in no way replaces bari based pre milling processing as over 90 percent of paddy production may be soaked, parboiled and dried in the homestead, and some 64-77 percent of production is also milled there. It is with this bari technology that we shall begin. Constraints of time have restricted the field work on which this account is partly based to an expedient, non random sample of 9 homesteads (though meeting a total of about 60 women), 14 custom mills and 3 custom mills with processing facilities, in the Districts of Kushtia, Dacca and Noakhali. Fieldwork was carried out during late January and early February 1978.

II. BARI BASED TECHNOLOGIES

2:1 The Processes and Equipment Used

The imperative of purdah dictates the exclusion of women from harvesting in the fields, but they do supervise the threshing of paddy by bullocks inside the compounds. The processes of soaking, parboiling, drying, husking and winnowing are entirely in their charge. Table 1 indicates the equipment used.

Soaking

Paddy is soaked in metal vessels, or earthenware pots reserved for this purpose or in multipurpose domestic vessels. Usually 24 hours is allowed (Sattar 1975, p. 57) but up to 48 hours has been observed (Anderson and Hoberg 1974) and the present survey revealed instances ranging from 36 hours in wet weather down to 10-14 hours, including the working of shifts involving night time parboiling in order to increase processing capacity after amon, the largest harvest. During soaking, water penetrates the starchy endosperm of the paddy, forms hydrates by hydrogen bonding and results in a limited swelling.

Parboiling

Paddy is placed, in batches varying from one seer to ½ maund, into aluminium, iron or mud vessels (depending on the wealth of the family and the size of the harvest). The precise methods of parboiling show great varieties. Von Harder (1975) describes

4 different practices from within one village (Table 2). Generally the paddy at the base of the vessel is protected from burning by a lining of straw. Water is added—apparently more in Barisal than elsewhere in Bangladesh since Barisal traditionally has no problem with fuel. Paddy is then boiled and cooked on a mud stove or chula for about 30 minutes in cases when it has been soaked for 24 hours, and for up to 3 hours where it has been soaked for a shorter period. Parboiling is complete when a majority of paddy husks are split. The most that one bari can boil in one day appears to be 4 to 5 maunds on a batch basis. High yileding varieties are often double parboiled (Von Harder 1975, p. 70)

TABLE 1 EQUIPMENT FOR BARI BASED RICE PROCESSING 1978

Item	Purpose	Capacity	Price	Durability (approx. in years)
Earthenware pots	Soaking	½ maund	Tk. 7-10	<4
„ „	„	1 „	Tk. 15	<4
Metal vessel "korai"	Soaking/ Parboiling	1 maund	Tk. 50-75	<10
Almunium vessel	Parboiling	Various	Tk. 30-40	<3
Kerosene tins	Parboiling	Various	Tk. 16-20	<3
Mud oven "chula"	Parboiling			
Mats "Pati"	Drying			
Dheki	Husking	1 md/day	Tk. 120-150	<30
Winnowing basket "Kula"	Winnowing	1 seer	Tk. 3	<2
Earthenware pots	Storage	2 maund	Tk. 20	<10
		5 maund	Tk. 60	<10
Bamboo+mud stores	Storage	7-8 md 10 md	Tk. 10 labour charge	<6

Sourch : Field Survey

TABLE 2 PARBOILING METHODS, KOTWALI THANA, COMILLA

Type of paddy	Percentage by Method of Parboiling					
	Parboiling once	Parboiling Twice	Parboiling Twice in between steeped	Steeped, parboiled once	Other methods	Total
	a	b	c	d		
Fresh Paddy HYV	51	22	3	17	7	100
Tresh Paddy local	83	0	1	3	13	100
Dried Paddy HYV	3	32	24	23	18	100
Dried Taddy local	4	22	16	31	22	100

Notes :

(a) Paddy is parboiled once. Immediately after threshing the undried paddy is steamed.
(b) Paddy is parboiled twice. The freshly threshed paddy is parboiled in the afternoon for the first time, laying over night in water and is steamed again the next morning.
(c) Paddy is watered for 12-36 hours and parboiled once.
(d) Paddy is parboiled once, watered for 12-36 hours and then parboiled again.

Source : Von harder 1975; and WFW 1975, pp. 69-10.

apparently because of the thicker husks, though lack of fuel may constrain this practice. Double parboiling has also been observed during wet weather (Anderson and Hoberg 1974, p. 11) and amounts to submerged storage for up to 7 days.

Husk is used as a fuel for parboiling. Leaves, dried cowdung and wood have also been mentioned in cases where husk is used for general domestic cooking or for other purposes.

During parboiling heat weakens the starch granule by disrupting the hydrogen. The surface area exposed to hydration is increased, and the granules swell in an irreversible manner, a phenomenon known as gelatinisation (Mannan and Mahmood 1978). Parboiled paddy has the following characteristics :

(i) The split husk facilitates milling ;

(ii) Gelatinisation binds fractures in the endosperm and greatly reduces the number of brokens ;

(iii) Proteins, vitamins and minerals are absorbed ;

(iv) Being harder, it is more resistant to insect infestation during storage than is "raw" paddy ;

(v) The loss of solids to gruel during final soaking is less than with raw rice ;

(vi) Bran from parboiled rice contains approximately 15-30 percent of oil. The oil is of superior quality because it has a lower concentration of free fatty acids ;

(vii) Parboiling acts as an insurance against the vagaries of the weather.

Drying

After parboiling, paddy is dried in the sun. The courtyard is prepared by cleaning, prior to binding the dust with cow-dung-water. Drying takes from 1 to 3 days depending on temperature, day length and surface. Drying on the black tarmac surface of a road has been computed by Von Harder to take 2.3 times less time than on a mud surface (1975, p. 78). Depending on the proximity of the homestead to a tarmac road, the labour involved in drying may be female. Relatively few **baries** in Bangladesh are actually near enough to tarmac roads to take advantage of them. During drying, poultry and bird scaring is necessary and paddy is raked with a "**harpata**" or turned with the feet. From Von Harder's data from Comilla, it seems that 3 **maunds** can be dried per woman day. Most courtyards can accommodate 3-6 **maunds** and drying capacity for one family in the present survey appears to be 4-5 **maunds** per day. As with parboiling, HYVs require longer drying than does local paddy.

There is an unfortunate trade-off between increased temperature and day length which together reduce drying time, and the probability of rain which increases it. **Amon** season is coolest, thus two day's drying is usual. **Aus** drying is usually completed in one day (Von Harder 1975, p. 78; confirmed by my fieldwork). **Boro** is hot and wet and necessitates special techniques such as the spreading of husk on the courtyard floor to blot up standing water, the laying out of paddy on mats to facilitate quick removal, and even the drying of paddy on the **chula** or oven, should small quantities be needed urgently. Those interviewed in the present survey explained that paddy deteriorated unccptably if drying after parboiling was incomplete after 4 days, but the disappearance of sun behind cloud is not a disaster for paddy, since cracks (forming as a result of temperature gradients which build up inside the grain in hot sun) are less likely to form in the

shade. On sunny days in boro 6-8 hours is all that is thought necessary. Post harvest losses in aus and boro are problematic and the evidence will be reviewed elsewhere.

Husking

The dheki, a foot operated "hammer" mill, usually located in a special shelter or hut in the bari is used to remove the husk and bran by the shearing action of the paddy against the side of the hole on which the hammer plunges. Paddy is circulated manually under the hammer. The amount of paddy milled per batch varies with the size of the machines, but one seer is common. In Khushtia district the dheki is relatively short (5-6 feet long) and may be operated by one woman. Elsewhere it is longer (7-8 feet) and necessitates from 2 to 4 women (at a maximum two operating, one standing in relief and one at the hammer and stirring/clearing the grain). A daily capacity of one maund is widely reported (Sattar 1975, P.47 ; Arens and Van Beurden 1977,p.40) though the present survey found several instances of 1½ maund capabilities. This daily capacity is an important constraint on through-put of post harvest processing operations. The dheki may be worked at capacity after harvest since in many areas grain is stored as rice not paddy. Or the dheki is used twice a week to mill smaller consignments of, say 20 lbs., for immediate consumption. Rice milled by dheik is prized by rural people for its high visual and nutritional quality. Rice recovery can be up to 72 percent (GEP 1968, p.3). The Agricultural Marketing Directorate states: "Outturns from dhekhi and mechanised mills are not significantly lower than those obtained by rice mills even when rubber rollers are fitted" (ibid. p. 3).

Winnowing

Husk, bran and rice are seperated by winnowing using baskets or "kula" with the wind (capacity 40 mins per maund) or without the wind (capacity 30 minutes per maund).

By-Products

Husk is used for fuel; it may be sold within the village for this purpose, e.g. to potters for firing (see Abdulla and Zeidenstein 1977, p.3); it may be used as litter for animals, as a blotter for wet courtyards, or mixed with mud as a daub for the outside houses or for the inside of bamboo and cane grain stores.

As an ash, burnt husk is used as a washing material, as an insecticide and as a fertiliser (ibid).

Bran is fed to chicks, polutry, cattle and to fish (e.g. south of Feni). It is traded longer distances than is husk. There are economic markets for by-products in most places surveyed. Husk sells at about Tk. 3 per maund, bran at anything between Tk 6 to 22 per maund averaging Tk 15.

Existing (and broken) vessels are used for a multiplicity of purposes making their costing for rice processing problematic. Labour may be deployed on several pre-milling operations simultaneously in peak periods so that a statement of hours worked hides a widely varying intensity of application. It also hides different combinations of pre-milling processing operations and of these and other domestic activity. This generates problems for the costing of labour. However, in the months of **Ogrohayen** and **Poush** (Nov. 15th-Jan. 15th) the demands on womens' time of paddy processing are fairly unremitting, and since our brief field survey immediately followed this period we shall use this **Amon** processing as a model for the economic costing.

2.2 Economics of Bari Based Rice Processing

Nine groups of women were interviewed including an 8-woman and a 25-woman processing co-operative which, as trading enterprises will be discussed separately. Sevn **baris** gave data on the costs of processing and before these are presented, the **basis** for the calculations must be explained. Given the large number of small implements used in **bari** based processing (see Table 1), given their multiple use and their variable and often unpredictable durability, the concepts of capital costs and of maintenance and repair (whether fixed or variable costs) become some what metaphysical. A **dheki** may have a lifetime of 30 years ; it may have been purchased at a **hat** but it is commonly completely home-made on the occasion of marriage, or of family separation. A large earthenware soaking pot cum manger may last 4 years or if a cow treads in it may break on the first day. This plays havoc with costings. Here, in each instance we have taken the original cost of the item and calculated its "seasonal depreciation" according to the actual durability in years described for it by the women. This seasonal depreciation was totalled to become "fixed costs". This included the rent of a hut where relevant. So we are describing actual, not normative or simulated costs.

The throughput of paddy was either obtained from women's own statements of what the **bari** processed in a month after the **Amon** harvest, or, in two instances where the data was not given was simulated from their data on family size and the average daily calorie consumption per capita for Bangladesh converted into paddy equivalent (see Ahmed **et al.** 1977, ch, 13). With regard to variable costs, we have imputed the cost of husk at the fairly uniform market rate of Tk 3 per **maund** though we included the costs of processing without imputed costs for husk as well, simply because it is apparent that in some households it is regarded as a free good, along with leaves and cowdung.

The main variable cost is that of labour, and its costing is highly problematic. As we shall see later in the section on employment, many peasant households cannot afford to employ labour, including of course those households where female as well as male labour

is hired out. In the costings we have assumed that one female labourer is hired in for the post harvest **dheki** work, and one for the pre-milling processing which is classed by the women as general domestic work and usually, though not invariably, paid a lower wage. Several of the households acknowledged importing such labour for the post harvest peak and all households knew a wage rate for the two types of work. Invariably, household members are also involved in this work, especially on the **dheki.** However, since it is physically possible for one labourer to process 4-5 **maunds** of paddy per day over 3-4 days and for one labourer to husk one **maund** per day, the variable cost of **wage** labour alone has been used. In a majority of instances, the wages are not given as cash but in three sorts of kind ; **seers** of paddy, rice and meals. Paddy and rice has been costed at the current market price of that locality. Three meals in a day have been costed at Tk 6 and one at Tk 3.

Both **dheki** and general domestic wage rates vary substantially at the micro level, factor market imperfections possibly being due to the constraints on the flow of information engendered by **purdah** together with the vertical ties of debt discussed elsewhere (e.g. Wood 1976). These variations account for the major differences in the costs of processing and are given in Table 3. There is no evidence of kind wages being changed to cash in the manner described for male agricultural labour by Clay (1976). All the cash wages were stated to represent long standing practices and not recent change.

The cost of husking paddy by **dheki** averages Tk 11.7 per **maund** in this small and non random sample. The costs of full processing average Tk 14.7 per **maund.** But both sets of costs vary very widely about these means.

2.3 The Economics of Subsistence Trade

Two further examples not only of costs but also of the profitability of the **bari** technology have been obtained from co-operatives of women organised by the Bangladesh Rural Advancement Committee in villages within the **thana** of Manikganj. Those women are extremely poor : either widows, divorcees, wives of sick husands or wives whose landless husbands (sometimes made landless as a result of sales to buy food) cannot earn enough to provide for the family. As a result of appropriate "functional education" courses carried out by B.R.A.C. extension workers in the villages, women themselves have articulated their demand to work co-operatively on post harvest processing.

In one case B.R.A.C. has financed the building of a soaking tank, and it loans out sufficient funds to enable 15-21 **maunds** of paddy to be purchased. A male relative of one of the members buys paddy at a local **hat,** organises husking at a local mill,sells the rice and organises the transport of paddy, rice and by-products. He remits the profits to the processing co-op.

TABLE 3 COSTS OF BARI BASED RICE PROCESSING 1978

District	Total cost of husking with dheki	Total cost all processes Tk/md	Total cost all processes husk imputed Tk/md	Daily female wage rate for dheki	General domestic wage for female labour
Khushtia	10.52	14.38	16.16	2 seers rice+1 meal	Tk/5 day
Khushtia	10.51	13.2	14.89	,,	Tk 4/day
Khushtia	10.51	13.1	14.58	,,	,,
Noakhali	5.7	no data	no data	1½ seers	(Tk. 1.5–2.0 plus food)
Noakhali	15.96	no data	no data	Tk. 15 divided b/n 3 women)	(Tk. 2-3.0 plus food)
Dacca	14.42	16.4	leaves used	1 seer+3 meals	4-5 seers of paddy/3 days
Dacca	14.32	16.38	leaves+straw+ dung	1 seer+ 3 meals	1 seer+3 meals

Source : Field Survey

In another case 25 women work in small groups, themselves purchasing paddy by the **maund** from the local **hat,** carrying it home themselves, processing it by the **bari** technology and selling rice. This co-operative is for savings (Tk 0.5 per woman perweek) and for education, and with what they have saved from rice processing and earth cutting they have purchased a cow and some spades.

Some statistics about these businesses are shown in Table 4. The larger scale, newer, co-oprative will give its members on average Tk 3.68 per day, including the imputed value of bran and brokens .The second co-operative yields a women a total of Tk 1.5 per day - surely a subsistence if not a starvation trade, comparing unfavourably with the kind wage for women given by the "Food for Work" campaign, and a third the average wage for male unskilled labour (BBS 1977b).

TABLE 4 PROFITABILITY OF BARI BASED TRADE

Paddy purchase price Tk/md	Rice sale price Tk/md	Margin assuming 68·/. outturn[a]	Total costs Tk/md	Net Profits Tk/md	Net Profit 1 day Tk	Benefits
99	132	6.47	2.52	3.96	1.62	+0. 37 Tk imputed value of bran +1.5 lbs. of ? broken rice
100	150	3.0	0.01	2.9	1.25	+0.18 Tk imputed value of bran +1 lb of ? broken rice

a. The customary outturn is stated as being 27 seers of rice from 40 seers of paddy or 67.5%

Source : Field survey

Our case studies come at a time of year when prices and margins may be low. A rice price of Tk 160 per **maund** instead of Tk 132 would raise daily earnings in the first case from Tk 3.68 to Tk 6·8. Wood describes a family paddy-rice conversion business using the **dheki** which nets Tk 10 per day, from which had to be paid interest on loans (undisclosed) (1976, p. 111). Arens and Van Beurden describe the business of a widow in "Jhagrapur", she processes 40 lbs. of paddy every day to give a "profit" of one **seer**, $\frac{3}{4}$ of which she consumes and $\frac{1}{4}$ of which is bartered for oil, salt, spices, and vegetables (1977, p.40).

The I.R.D.P. Womens' Programme does not encourage specialised co-operatives for rice husking (because of its retrogressive drudgery) but is nonetheless involved in similar co-operatives to B.R.A.C. in the Moherpur and Joydevpur areas. Costs were given as follows : a new **dheki**, Tk 200 ; paddy price, Tk 100 per **maund** ; rice price, Tk 150 per **maund** ; outturn of rice sold, 66 percent ; time taken, 5 days ; loans given include

a medium term loan for the **dheki** and a weekly loan of Tk 300 for paddy purchase. Daily net earnings are thus the residual rice, brokens, bran and husk on 3 **maunds** over 5 days assuming no interest repayments on the loans (data from T. Abdullah 1978; Pers. Comm.).

The exceedingly low profits from such businesses result from the small competitive margins in petty trade in rural areas, which in turn necessitate higher outturns of rice from paddy than are usually attributed to **bari** based technology in order to break even.

2.4 Employment in Bari Based Technology

As Clay and Khan say in their study of agricultural employment (1977, p.23): "A major problem in undertaking a study of employment is our near total ignorance about many areas of activity within a largely subsistence economy... This prevents us from providing adequate measures of unemployment and therefore of the potential usefulness of different policies for acting on underemployment." They cite rural employment for women as a major "area of darkness."

This present study, because of its brevity, can shed only a little light and light at the mercy of notorisouly fickle statistics. It will be apparent from our discussion of technology and economics that formidable problems surround the estimation of employment generated by post harvest processing.

We can best demonstrate this with an example : we know that one woman can parboil and dry 4-5 **maunds** of paddy in a day, but that the physical constraint of the capacity of the **dheki** limits the "productivity" of the **bari.** The **dheki** processes one **maund** of paddy per day and usually requires the attentions of 2 to 3 women. This is roughly 5 lbs. per woman hour (B.U.E.T. 1978, p. 13 ; also Hurley 1978, Pers. Comm). Let us say that 3 women process a **maund** of paddy per day for 30 days after **Amon,** 5 after **boro** and 15 after **aus.** One woman would then process 17 **maunds** of paddy per year. The Bureau of Statistics (1977, pp. 76-84, 140-4) gives the female population above the age of 10 as 21.8 million for 1974. We know that 9.5 percent of the population is urban, which would give a rural "active" female population of 19.7 m. This population is capable of processing 335 m. **maunds** of paddy according to the assumption above. Rice production in 1976 amounted to 11.6 m. tons, equal (at a 68 percent outturn) to 455 m. **maunds** of paddy. What we have assumed that an average rural woman is likely to process in a year works out to 73 percent of production which is very probably the kind of percentage that approaches realism. The assumptions we have made about the generation of employment in **bari** based technology seem quite consistent with other estimates about rice processing. 335 m. **maunds** of production might generate employment for all able bodied rural women for 50 days of the year. By this reckoning **bari** based technology might generate "statistical" employment for 2.7 m. rural woman years in Bangladesh.

The capital labour ratio is of course extremely low. It requires only Tk 125 to generate this livelihood (part time) for one person.

Of course precisely what type and intensity of employment it actually does generate is little understood. It is easier to interview female employers than a female employee. The literature on rural society suggests it is reasonable to assume that rich peasants will hire parmanent female domestic wage labour, that peasants will hire in labour seasonally to cope with post harvest peaks, that small peasnats may exchange labour and that it is the marginal and the landless who are hired in (Wood 1976; Adnan and Islam 1977 ; Arens and Van Beurden 1977). It is only in the first group that women will not physically engage in post harvest processing, but how large is the last group for whom such employment is likely to be a major source of income ? We must search in the case study literature for answers.

Arens and Van Beurden state that 17 percent of all households hire in labour (undifferentiated by sex : 22 percent of the middle peasants and 48 per cent of rich peasants and landlords) while 50 percent of the population of Jhagrapur were landless or marginalised and eligible for hiring out their labour (1977, p. 43). Von Harder states "Only 23 percent of families never engage labour' (because of their poverty) and those with land in excess of 1.5 acres almost invariably use wage labour for processing (1975, p. 74). Wood writes that at least 50-60 percent of familes in a fairly rich village are economically very insecure and are in regular relationships of dependence upon rich peasants (1976, p. 76). Here are indications of the potential importance of rice processing to the target group of the rural poor. By contrast Adnan and Islam's data for 2 villages show that only 5 percent of economically active women hired out their labour for paddy processing. This was 1 percent of the women aged between 10 and 49 years (1977).

111. THE CUSTOM MILL TECHNOLOGY

3.1. The Process and Equipment used

Wherever sufficient capital has been accumulated in the hands of one individual, small huller mills have been installed. The process is greatly accelerated in the wake of (rural) electrification, as is recognised in the Power Development Board's Rural Electrification Feasibility Study (1977, vol. IV Annex III G2; vol. V, p. 63). From data for 1966 from the East Pakistan Small Industries Corporation and for 1977 from the Food Department, the rate of expansion in the installation of custom mills is in the region of 5 to 7 percent per year. There are 7,600 small custom mills in Bangladesh (over 1 lakh in India and about 2,000 in Sri Lanka). By and large paddy production

and the density of custom mills go hand in hand, but custom mills are disproportionately abundant in the east : Sylhet, Noakhali and Chittgong and disproporationately scarce in Comilla, Chittagong Hill Tracts and the northern districts of Mymensingh and Rangpur (Table 5).

TABLE 5 DISTIBUTION OF PADDY PRODUCTION AND CUSTOM MILLS IN BANGLADESH

Distrist	%of total production	%of total custom mllis
Dacca	5.5	4
Mymensingh	14.7	2.6
Faridpur	3.8	4.9
Barisal	8.7	5.8
Chittagong	5.5	16.3
Chittagong Hill Tracts	6.2	0.9
Noakhali	4.3	7.6
Comilla	7.6	1.3
Sylhet	8.7	11.4
Rajshahi	6.9	5.6
Dinajpur	5.0	4.7
Rangpur	8.3	4.0
Bogra	3.9	6.2
Pabna	3.1	4.0
Kushtia	2.6	3.0
Khulna	5.5	5.5
Jessore	4.8	5.8

The machinery which goes to make a huller is itemised and costed at 1978 prices in Table 6. The huller consists of a cast iron or steel rotor revolving around a horizontal axis inside a casing of perforated screens. Capacities in Bangladesh very from 10-15 **maunds** per hour (No. 8 huller) to over 35 **maunds** (No. 2 huller). In the non random sample of the field survey of 14 there were equal numbers of each type. Larger commercial enterprises run batteries of up to 5 machines working simulataneously off line-shafts. Actual throughputs are invariably less than capacity because of pauses between the small consignments of customers (who may bring in as little as 5 **seers** or as much as 4 **maunds** at a time -the latter carried by rickshow or boat). Usually consignments of $\frac{1}{4}$ to $\frac{1}{2}$ **maunds** of paddy are carried in baskets by headload, on carrying poles or by boat. Lower capacity ma y be declared because of the practice of double hulling some varieties

of paddy (especially H Y Vs), in some seasons (reportedly aus) or according to the wishes of customers. Lower capacity may also characterise old machines or poor levels of management. The field survey revealed that there is a lively market in secondhand motors and mill machinery in Bangladesh. Similar arguments as for capacity apply to the outturn of rice from paddy and to the content of the outturn. It is often reported that the huller mill produces a low outturn with a high content of brokens. This is only true for raw rice, poor quality rice and/or for mills under bad management. The available literature on South Asia has been extensively reviewed and failed to provide convincing evidence of low outturns or notably higher percentages of brokens compared with other technologies for milling parboiled rice (Harriss 1976a). It is parboiled rice that is milled in custom mills in all districts of Bangladesh save Sylhet and Chittagong (which have 28 percent of all custom mills). Hullers are easily able to achieve the 68 per cent outturn specification of the Civil Supplies Corporations in India, when milling raw or parboiled rice on contract to them (Harriss 1977a) and in the absence of scientific evidence there is no reason to suppose otherwise in Bangladesh.

As Arboleda states with reference to the Philippines : (Its popularity) "cannot be abated because of its low initial and maintenance cost, simplicity of construction and operation, capability of being locally produced" (see later for details for Bangladesh), "ability to mill small quantities" (as well as large quantities), "and the resulting by-product of ground husk-bran mixture is used as foods for backyard raised animals" (1975, p.1).

A "typical" rural mill is powered from a 15-25 h.p. electric or diesel engine. Often a wheat grinder is driven from the same prime motor by altering the flat bolts. The mills are housed in anything from a bamboo and thatch hut costing Tk 1,000 to a brick and corrugated iron building costing Tk 40,000. Customers bring consignments of dried paddy that have already been processed using bari technology. Some mills separate by-products from rice. In others products emerge unseparated. The present field survey in Khushtia, Dacca and Noakhali Districts together with that of a British Technical Assistance Team from the Tropical Products Institute covering Barisal, Dacca Comilla, Sylhet and Chittagong could find no cases apart from the 20 rather small commercial mills using scaled up bari technology on the Joydevpur road north of Dacca where husk and bran were not separated by winnowing using female labour either at the mill or in the bari (Hurley 1978, Prs. Comm.).

32. The Economics of Custom Milling

As Araullo *et al.* have remarked "There exists great variability in the economics of operation within technologies" (1976, p. 394, my emphasis). In Bangladesh this

TABLE 6 PRICES FOR MILL COMPONENTS AND SPARES, DACCA JAN. 1978. TIPU SULTAN ROAD AREA

Electric Motors

	Tk
10 HP	5,600 Chinese
	6,900 GEC Chittagong
20 HP	8,000 Chinese

Diesel engines

9 HP 12,000 DDR

No 15.20 HP diesel engines

V belts TK 1.35 per inch under 52"
0.60 - 0.85 „ over 52"

Big size Tk 2-3 per inch

Flat belts TK 13 per ft. for 4" wide belt
TK 17 „ „5" „ „

Lacing for belts TK 40 for 8 pieces

		Locally made	"Indian"
Whole steel hullers :	8	950	100
	4	700	900
	2	1300	1400
Covers :	8	85	100
	4	40	na.
	2	140	150
Rotors :	8	225	230
	4	100	na.
	2	350	350
Nets/screens	8	135	120-150
per dozen	4	120	na.
	2	140	150
Bearings	8	80	80
	4	55	na.
	2	85	85

results not only from different levels of capital investment (especially in buildings), installed capacity and capacity utilisation, types of mill enterprise and managerial expertise, but also from what will appear to be highly imperfect markets (especially for labour, bran, second hand machinery, and for the milling charge itself). We can assume that if there was any systematic distortion due to the interview with a foreigner it would be in the direction of overstimating costs and understimating profits. (The same occurs in any official, visit of course).

Operational costings were obtained for 14 custom millls. Capital costs included those of buildings, land, prime movers, mill machinery, belts and electrical installiaton where relevant. Fixed costs include licences, permanent labour and depreciation on capital costs. Wages for permanent labour were expressed in cash and food. The latter has been imputed at the same rate as for **bari** technologies (see back). Family labour was not costed and will account for some of the variation in milling costs. "Depreciation" is a somewhat notional, catch-all category. Depreciation has assumed a 25 year life span, and machinery older than this is assumed amortised. The fact that a huller machine can be assembled from spares and maintained **ad infinitum** confuses depreciation and maintenance costs. Furthermore, we did not enquire into the source of investment capital and the concept of interest on loans is also fraught with problems (rural rates varying from 12 to 500 percent per year, and 120 percent for business purposes being common). So the category "depreciation" is intended to cover these particular "areas of darkness'. Variable costs were obtained for the following items : electricity, repairs to electric motors, diesel fuel, oil, and repairs diesel engines where relevant, maintenance of flat belts to the cover, rotor, screens and bearings of the huller machine, grease and casual labour. Annual turnover was difficult to obtain since owners often have not calculated this themselves. Average actual hourly throughput was obtained ; the numer of days idle per year ; the number of busy and slack days and the average hours worked on such days. From this data a profile of approximate annual throughput may be constructed.

Table 7 gives the economics of processing paddy according to the data from these 14 interviews. The most important conclusions are as follows :

The average cost of processing is Tk 1 per **maund** but this ranges from Tk 0.5 to Tk 1.48. There is no obvious negative relationship between costs of processing and capacity utilisation. There ate no obvious economies of scale. Total net profits which include the wage element for family labour varied from Tk 700 to Tk 114,000 per year and averaged Tk 24,600. Likewise the rate of return on capital varies from 2 to 194 percent averaging 70 percent, which means that the average custom mill can pay for itself in $1\frac{1}{5}$ years. This rate of return is high and compares with those of ownership of 4 and 2 wheeled tractors, and lorries in Sri Lanka (Harriss 1976, p. 194) where there is considered to be excess or monopoly profit making. The average rate of return on capital for huller milling in South India is 15 percent and that for rice trading 25 percent (Harriss, forth coming).

We have already seen that some of the variability has to be attributed to imperfections in the factor markets. Charges vary by 150 percent ; wages for machine driving by 220 per cent (from Tk 1,400 per year for an employee in Khushtia to Tk 4,500

in Feni). Some of these variations are highly localised and suggest that employee may be bound to employer by ties ther than that of the ruling wage (the importance of debt ties inside the trading and processing firm in South India is discussed in Harriss 1977a and forthcoming).

Capacity utilisation is very low by the standards of engineering capacity (see notes for Tables 7 and 8) averaging 19 percent. The Directorate of Agricultural Marketing found an average capaciy utilisation (definition unspecified) of 32 percent for this sector in 1968 so capacity utilisation may be declining (GEP 1968, p.4.). As the Rural Electrification Feasibility Study comments: "It is unfortunate that rice miling must present such large demands and such small load factors in rural areas" (1977, vol. IV, Annex III G2). At low levels capacity utlilisation, fixed costs rise and inflate total costs to the extent of their relative importance. Here the average ratio between fixed and variable costs at 0.4 is low, however. Practically, it is not possible to approach engineering capacity, while at near this level the operating and maintenance costs often rise sharply. Also agro-industrial machinery is worked seasonally, making the concept of capacity calculated on a year round basis of spurious relevance. If instead we use the concept of economic capacity which is that level which takes into account relevant economic factors in the production environment (see notes to Tables 7 and 8) then the custom mills average 56 percent of capacity utilisation. This is on a rough per with manufacturing industry generally in Bangladesh (see Afroz and Roy 1976, p. 286) and is higher than the equivalents for South India where average engineering capacity utilisation for huller mills was 14 percent and average effective capacity 40 per cent (Harriss 1977a, p. 284).

3.3. Parboiling Firms

One attraction to an entrepreneur of rural custom milling is the possibility of incremental expansion, and on the rural fringes of towns and cities it is possible to find custom mills hiring out parboiling and drying facilities as well as milling equipment to small traders. Soaking is done either with scaled up **bari** techniques i.e. in a number of 1-2 **maunds** mud pots ; or in a soaking tank (for 15-20 **maunds**). Parboiling is either done in split 45 gallon oil drums taking 1½ **maunds** each, over a larger version of the domestic mud stove, or over an underground fire ; or it is done using steam generated from a simple boiler made of 3 welded oil drums set in a brick furnace, from which steam is led into 2 or 3 steaming vats made of 1½ welded oil drums with bottoms removed and with conical bases, which can take 4½ **maunds.** Paddy is then allowed to dry on cement covered drying yards with capacities varying from 15 to 50 **maunds.** Equipment for drying is itemised in Table 9 and consists of scaled up **bari** equipment.

TABLE 7 PROFITS FROM RURAL CUSTOM MILLING, BANGLADESH

District	Date of start	Annual through put (tonnes) (1)	Total cost per ton Tk.	T.C.per maund Tk.P (3)	Charge per maund Tk. (2)	Total net profits Tk/yr (5)	Rate of return on capital invested (3)	Capacity utilisation (eng) (4)	Capacity utilisation (effective) (4)	No. of men employed including family members	No. of women working in mill
Noakhali	1977	783	18.22	0.68	1.50	17,200	93%	12%	35%	1	—
Noakhali	1977	522	31.03	1.15	2.00	11,800	32%	17%	70%	1	1
Noakhali	1952	2216	22.38	0.84	2.75	113,800	—	25%	74%	2	2
Noakhali	1977	861	13.11	0.5	1.5	23,300	194%	11%	33%	1	1
Noakhali	1977	1874	17.92	0.68	1.5	23,900	100%	24%	72%	1	2
Noakhali	1970	297	33.8	1.26	3.0	17,600	158%	33%	89%	3	—
Dacca	1966	626	38.6	1.44	1.23	3,570	34%	24%	70%	2	3
Dacca	1974	2873	23.33	0.87	1.5	6,400	89%	31%	95%	2	—
Dacca	1966	604	22.03	0.82	1.5	10,900	35%	27%	80%	1	1
Noakhali	1973	526	23.94	0.89	1.5	8,600	49%	16%	47%	2	1
Noakhali	1973	248	29.66	1.11	1.2	700	2%	8%	28%	2	1
Noakhali	1976	410	26.5	0.99	1.5	5,600	32%	9%	28%	1	—
Khushtia	1976	447	30.7	1.48	2.5	12,200	20%	17%	50%	2	—
Khushtia	1977	188	36.03	1.34	3.0	8,300	—	6%	17%	1	—

(1) 1 ton = 26.8 maunds, 1 maund = 37.3 Kg or approx 83 lbs.

(2) Charges in : Barisal 1.50, Comilla 2, Habiganj 1.4, Chandraghona 2.0, (Hurley 1978, Pers. Comm) Nanagram 2 or 0.50 and by products retained ; Manikganj 1.5, or free if by products are retained.

(3) Not calculated on 'amortised' machinery.

(4) Engineering capacity : x maunds/hr x 20 hrs/day x 300 days/year ; effective or economic capacity : x maunds/hr x 8 hrs/day x 250 days/yr.

(5) Net profits do not exclude the consumption expenditure of the owner and family.

TABLE 8 TRADING AND MILLING FIRMS

District	Date of start	Annual through-out (tons) (1)	Total cost per ton Tk	T.C.pers maund Tk. (3)	Charge per maund Tk. (2)	Total net profits Tk/yr (5)	Rate of return con apital invested (3)	Capacity utilisa-tion (eng) (4)	Capacity utilisa-tion (effective) (4)	No.of men em-ployed including family members	No. of women working in mill
Dacca	1966	626	105.6	3.9	5	157,000	7300%	26%	70%	2	6
Dacca	1974	2900	80.6	3.0	5.5	29,300	93%	31%	95%	2	8
Dacca	1966	600	89.5	3.3	6	175,000	120%	27%	80%	2	5

(1) 1 ton=26.8 maunds, 1 maund=37.3 kg. or approx. 83 lbs.

(2) Charges in : Barisal 1.50, Comilla 2, Habiganj 1.4, Chandraghona 2.0, (Hurley 1978, Pers. Comm) Nanagram 1 or 0.50 and by products retained, Manikganj 1.5 or free if by products are retained

(3) Not calculated on 'amortised' machinery

(4) Engineering capacity : x maunds/hr x 20 hrs /day x 300 days/year : effective or economie capacity : x maunds/hr x 8 hrs/day x 250 days/year.

(5) Net profits do not exclude the consumption expenditure or 'wage' of the mill owner.

TABLE 9 SIMPLE PARBOILING TECHNOLOGIES

Item	Process	Capacity	Cost	Durability
Mud pots	Soaking	2 maunds	Tk. 25-30	?
½oil drums	Boiling	1½ maunds	Tk. 60-65	3-6months
Rake	Drying	-	Tk. 10-12	3 years
Brush	Drying	-	Tk. 3	1 year
Winnowing basket	Winnowing	-	Tk. 5-2	1 year
Soaking tank	Soaking	15-20 maunds	Tk. 1500	?
Simple boiler	Boiling	-	Tk. 2500	3 years
Basket	Drying	-	Tk. 2	
20' feet long semi-cylindrical bamboo cover	Protection during tempering	20-30 mds.	Tk. 300-400	1 year
Drying yard		50 mds	Tk. 47,000	

Source : Field survey

Three cases of parboiling firms were costed (Table 8). The average costs of parboiling and drying is Tk 2.45 and that of all processes is Tk 3.4 per **maund** of paddy. Net profits and the rate of return show high increases over the already high levels for custom milling. New installations can pay for themselves in about one year.

3.4 Employment in Custom Milling

We have already seen that most mills have an employed mill driver and in some cases an employed helper. 3 of the 14 mills used family labour alone. Male customers also help in various ancillary ways during milling. The exploitation of wage labour (or its "productivity") is higher in Bangladesh than for equivalent work in South India. On average one employee in Bangladesh supervises 570 tonnes of throughput compared which 200 tonnes in South India (Harriss 1977b). Wages are 21 percent of total costs on average and Tk 17,000 of capital creates employment for one individual.

In many rural custom mills, one or more female labourers winnow by-products on payment from farmers. The charge varies between Tk 0.25-0.5 per **maund** but averages

Tk 0.3 A woman may take home Tk 5 to 8 on an average day and is therefore capable (should male farmers so desire) of winnowing 0.9 tonne of paddy equivalent per day or 225 tonnes per year.

The parboiling-milling custom firms are more highly generative of female employment. Over and above the male labour required, one woman is employed per 75 tonnes of paddy processed per year using the scaled up **bari** technology and one per 570 tonnes using the simple boiler. Once again it would seem that Bangladeshi female wage labour is more highly exploited than in South India where a coolie of either sex is employed per 42 tonnes (Harriss 1977b, p.295). Wages to female labour are 63 percent and 31 per cent of total processing costs respectively. Women supervise soaking, parboiling, drying and post-milling-winnowing in the first case and pre-milling processing in the second. Interestingly they carry 2 **maunds** gunny bags of paddy and pile up the dried paddy, all heavy work which is done by male labour in India. Average take-home pay is Tk 4-5 per day, $\frac{2}{3}$ of what is earned by male employees in mills.

IV. SOME COMPARISONS BETWEEN THE TOTAL RURAL PROCESSING TECHNOLOGIES

Some important facts for policy makers and planners emerge from this brief piece of fieldwork.

(i) There is very large cost differential between **bari** based husking technology and huller technology - of the order of 12 to 1.

(ii) There is a lower though still large differential between the two technologies for complete post harvest processing - of the order of 4.3 to 1.

This means that it is entirely rational for an agricultural family with spare cash to switch to mechanised processing, especially milling should there be access to a mill. Access to a mill is not straight forward. Not only does a mill have to be located in the vicinity but also male family members, or girls below puberty, have to be available to transport paddy to and from the mill. Thus it is that many peasant **baris** are in a state of transition : using the mill when possible (paying with cash got from marketed surplus, or for ancillary employment such as Government service or rickshaw pulling etc.) and using the **dheki** when social access to the mill is denied, and perhaps hiring in temporary female labour to help with pre-milling processing at peak post-harvest periods. Gudrun Martius Von Harder mentions : "In 5 percent of cases during harvest time when there is a time constraint people use the mill." (1975, p. 73). However, even though the numbers of mills appear to be increasing at 5-7 percent per year, they dis-

place dhekis at a slower rate since capacity utilisation per mill is declining. Rural people have a high quality preference for dheki milled rice.

(iii) In spite of the greatly lowered costs of processing using the huller it is apparent from the data on profitability that with a 70 percent average annual rate of return, the mill charge, which averages Tk 2 per maund, allows a very high level of profits (with much less risk and/or Islamic social opprobrium) than the obvious alternative outlet for capital - in money lending. This being so, and gauging from interviews with mill manufacturers, the constraints on the expansion of mills (which might, but would not necessarily bring down the milling charge) are likely to be on the supply side- of engines and machines on the one hand and of cash with farmers to pay the mill charge on the other - rather than on the demand side from potential millers. One case study of a village in the char south of Feni revealed that inthe 10 months following electrification 5 rice mills were installed, all charging an identical rate sufficient to ensure large profits.

Even though only very approximately 1,400 out of Bangladesh's 68,000 villages have electricity (Bureau of Statistics 1977a, p. 342) one can only foresee that the process of diffusion of the custom mill will continue, even accelerate in the 42 thanas scheduled for rural electrification. Indeed in the social cost benefit analysis carried out for the Power Development Board (an analysis which gave benefit/cost ratios of at best 0.48/1 and at worst 0.36/1 (1977, vol. IV, Annex VI D)) the contribution of rice mills to total benefits from rural electrification averaged 15 percent. Rural electrification, being economically unjustified, is in fact proceeding on a grant basis to those who can benefit from it privately.

(iv) The diffusion of the huller mill results in massive displacement of female wage labour and in a limited replacement by male wage labour. It is not possible with available data to quantify this process exactly and the following represents a first attempt only.

The average mill hasa capacity of 20 maunds an hour, the average woman of 0.06 maunds per hour. The mill is some 330 times as powerful, and day for day, might be assessed as displacing the labour of 330 women.

Quite how many women it actually does displace awaits urgently needed fieldwork on female wage labour in villages undergoing changes in rice processing. The present brief survey definitely showed labour displacement in progress. In many localities the alternatives for displaced women were general domestic labour at half the dheki rate, unemployment or begging. Though mentioned last here, begging was always mentioned first where I asked about displacement. In one place women were tobacco grinding at Tk 6 per day ; elsewhere making quilts at one per two months, netting Tk 35, or cutting drainage and irrigation channels on the Food for Work campaign. Experi-

ments with poultry rearing and kitchen gardening are in progress in isolated instances. But such projects are not easily replicated. The solutions are likely to be not commensurate with the problem, for the women displaced and marginalised are from amongst the most economically vulnerable 30-40 percent of the population, precisely the target group rural development is supposed to aid.

(v) Commercial parboiling and drying using not a change in technology but a scaled up version of bari technology is 1.5 times more "productive" of female labour, year for year, than is the bari technology proper. And commercial processing using the simple boiler is some 2 times more "productive" (or labour displacing) for women, with no increase in the value of their daily wages to match the increase in productivity.

V. IMPLICATIONS

(i) With regard to rural employment generally, the conclusions from a thorough survey of the evidence for FAO/UNDP by Clay and Khan are relevant. "It is unambiguous that" the agricultural employment situation has been detertiorating and....a production oriented strategy even with the present largely non mechnised technology will not improve the situation in the foresseeable future....As the rural landless represent a large proportion of the potential market for foodgrains, the question is raised whether a production oriented strategy is feasible unless the potential consumers have a capacity to purchase" (1977, p. 39).

The present study of rural rice processing systems, concentrating as it does on processing costs and on employment, supports the above conclusion. It shows how a mill technology, dismissed by many engineers for its lack of sophistication, but most economically appropriate for the small scale milling of parboiled paddy, is diffusing into the rural areas. It results in a massive reduction in processing costs and yet at the same time permits the earning of high levels of profit for its owners at the expense of all strata of society who use it. Female labour is replaced to a small extent by male labour, but there is a large scale net social displacement. Those female wage labourers working in rice mills do not receive wages commensurate with the increase in productivity over bari employment which is forced upon them, and their level of exploitation inevitably increases. There is no evidence yet of viable alternative employment for those displaced from dheki milling. The FAO/UNDP statement with regard to agricultuial production technology that "mechanisation denies a seasonal supplement to a highly vulnerable and growing group" (1977, p.39) is even more relevant to agricultural processing technology.

(ii) As the Power Development Board itself recognises (1977, vol. V, p. 49 and 53) at the very least, rural electrification for which there is no economic justification requires supplementary programmes to generate employment for the poor female target group.

The important question is why this is not done already. Answers to this would indicate constraints on policy implementation in this area.

(iii) If the diffusion of the huller is accepted as inevitable, then improvements to the **dheki** such as the circular machine used in Teknafand Moashkhali near the Burmese border and capable of milling 15 **maunds** per day, could only be introduced into areas **not** marked for electrification, and then only after a careful examination of reasons why it has not diffused already. The reasons are likely to be economic and social. Any innovation which broke the capacity constraint on **bari** processing presently imposed by the **dheki** would simply be used domestically at lower rates of capacity utilisation than is the **dheki** presently. Fixed costs components would be relatively high. Any innovation is unlikely to be used for commercial paddy-rice conversion businesses unless its milling costs are reduced to a level approaching that of the huller.

(iv) If the diffusion of the huller is inevitable then, as Araullo *et al.* say (1975, p. 302) there is considerable scope for increasing the outturn of milled rice by improving the recovery efficiency of this technology. For parboiled rice little improvement is thought to be possible but Arboleda (1975) at I.R.R.I. shows how considerable improvements can be made in outturn even of raw rice using new components incorporable during the normal course of maintanance. Given the importance in Bangladesh of this nelgected technology, Bangladesh might pioneer such improvements.

Hullers are domestically manufactured at Bogra and casting machinery exists in two firms in Dacca, both now also making spares. One is a workers' Co-operative with 24 members sharing profits of 1½ lakhs as annual dividends. At present it is manufacturing screens and is underutilising the capacity of its machinery. Shortages of raw materials are fundamental constraints on production here.

It must also be recognised that the extension costs of incremental improvemenst are likely to be high.

(v) The Power Development Board advocates : "Where large capacity" (small huller) "mills are installed, there should be more efficient use of installed motor capabilities. Multiple purpose use of large motors which alternatively drive deep tubewell pumps and mills from one location could be achieved, thus saving transformer, service and motor investment" (1977, vol. IV, Annex III, 92) . However see blelow (ix) for comments.

(vi) This idea introduces the problem area of ownership. Since it is clear that milling is highly profitable, it is compelling to advocate co-operative ownership of these small mills so that profits can be shared amongst those whom the mill would otherwise exploit. EMPCUL, with its highly structured and profit making co-operatives has shown some interest in this possibility. The tubewell co-operatives are also obvious candidates for involvement especially given the poor performance of conventional co-operatives in 250 **thanas** under I.R.D.P. throughly analysed by, **inter alia** : Abdullah, Hossain and Nations (1976, p. 209-236) ; Bertocci (1976, p. 117-187) ; Fitting (1977, p. 54-63) ; Nowicki, (1973) ; Wood, (1976, p. 220-229, 246-7).

Co-operatively owned huller mills would best be planned in advanne of rural electrification and the installation of private mills is minimal.

(vii) Since we saw earlier that a constraint on the productivity of **bari** technology is the capacity of the **dheki** it might be quite feasible (given production increases, increases in the marketed surplus and the inevitable diffusion of the huller) to link co-operative ownership of mills with co-operative pre-milling processing using **bari** technology and co-operatives of women. As was seen earlier, processing co-operatives of women are isolated and usually confined to **dheki** milling. I.R.D.P. womens' co-operatives are most concerned with womens' agricultural production. There is yet an unexploited potential for organising premilling processing businesses in conjunction with machine milling. This would increase the productivity of women, improve their economic status and have an educative function.

(viii) For appropriate and cost effective improvements in **bari** technology we await experimentation.

(a) a possible improvement to the **dheki** has been mentioned already.

(b) B.U.E.T. is investigating the containers and furnaces for parboiling to see if the caloric efficiency of husk utilisation can be increased from its present low (an estimate of 17 percent was given by E. Hurley, 1976, pers. Comm.) ; to ascertain a combination of drying and boiling time which minimises fuel consumption ; to design more efficient parboiling containers than the pots already used and to discover the minimum quantity of water necessary (Mannan and Mahmood, 1978).

(c) B.R.A.C. and UNICEF are experimenting with black plastic lined cabine t solar driers. As yet these are only economic for vegetables. Lockwood mentions technologies using ambinet or hot aeration and several small scale mechanised driers (1975, p. 10-11) but as Andersen and Hoberg conclude : "There is no drying technology (mechanised) available for conditions under

which farmers will not mix their paddy" (1974, p. 42), i.e. for the **bari**. A team of engineers from T.P.I. and B.R.R.I. are now taking up this difficult challenge. The existence of a cost effective grain drier at the **bari** level might encourage an in crease in production because one of the important risks in the production of **boro** rice the-risk of post harvest rain and the inability to dry the crop - would be removed. The **boro** and to a lesser extent the **aus** crops are those when H.Y.Vs are grown. H.Y.Vs are conventionally supposed to be shorter duration than local crops. This being so, H.Y.Vs in **boro** might be harvested in the heat preceeding the monsoon. **Boro** rice grown largely in Sylhet also appears to be milled raw, **not** after parboiling, so the reduction of moisture is from 25-28 percent to 14, not 45 to 14. Innovations in **bari** level drying technology would not be expected to displace much labour for either sex ; perhaps even to augment male wage labour in agricultural production should the logic for the introduction of driers be correct.

(d) Village level storage structures have not been dealt with here. The best descriptions are to be found in Boxall, Greeley and Neelakantha (1976, p 11-13) and Lockwood (1975). Both papers describe exprimental improvements.

There is no reason to discourage any research on improvements to **bari** based technology. But the extension costs of diffusing cheap, minimally socially disruptive improvements are likely to be high and might even necessitate international financing, in the social interest.

(ix) Lacking in all the experiments to date has been the involvement of social scientists. This is no idle canvassing for the discipline. There is very little exact scientific measurement of the techniques of post harvest processing and the social impact of existing technological changes. It is an important priority to increase this knowledge since the new experiments, potentially affecting a large number of people and the majority of production, cannot be economically appraised or evaluated otherwise. This is another area of potential for external finance and besides supplying urgently needed information would have a beneficial training effect.

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