SOCIO-ECONOMIC IMPACTS OF FLOODS AND FLOOD PROTECTION: A BANGLADESH CASE STUDY

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ABSTRACT

Bangladesh ranks as one of the world's most flood prone countries. In 1988 perhaps half its population was affected by exceptional floods, which have led to renewed pressure for major investment in flood protection embankments. A case study in both flood prone and flood protected areas immediately before this event indicates that in moderate floods, losses may be less severe than media reports would indicate, but that they are nevertheless serious for poorer households. Reductions in the depth and duration of normal flooding following flood protection result in greater agricultural production, but the benefits of this are unevenly distributed. Moreover, within flood protection projects the vulnerability to losses and low incomes still remains in years of unusual floods, due to higher input costs for agriculture (resulting in higher losses if output is lost), drainage congestion, and the risk of embankment breaches.

THE CONTEXT TO FLOOD ISSUES IN BANGLADESH

Bangladesh is located at the north end of the Bay of Bengal, and approximately 80% of the country comprises the combined delta of the Ganges, Brahmaputra and Meghna rivers with a catchment of 1.76 million km^2 (92% outside Bangladesh) (Rogers *et al.*, 1989). Mean annual discharge of these rivers is, together, second only to the Amazon (Meybeck, 1976); monsoon rainfall over Bangladesh and the nearby hills is particularly high, and hence river flows are very seasonal. About 50% of Bangladesh is below 12.5m above sea level (Master Plan Organisation, 1986). Hence flooding in some form or another is an annual occurrence.

However, in most years much of the 'flooding' which occurs is within the range of locations and depths which are expected, and to which agriculture and rural life are adjusted, whereas in years of exceptional floods much of the country can be affected by severe floods. There is a long history of such damaging floods, but it appears that within recent records the floods in 1987 and 1988 have affected the greatest areas and involved some of the highest flood stages on record (Choudhury, 1988). It is not surprising that economic losses were also at record levels in 1987 and 1988, since population growth continues (and is now around 110 millions) and inevitably more intensive use of the flood plain increases potential flood losses.

After a series of reviews following severe floods in 1954 and 1955, a Master Plan for water development was devised which emphasised flood control through a series of large embankment projects (East Pakistan Water and Power Development Authority, 1964). Subsequently a large part of water development investment has been for flood control and drainage both in the form of large projects and, when the long gestation periods of these projects became apparent, through smaller projects. However, the justifications for these investments have been agricultural gains resulting from changed cropping patterns as a result of changed and more stable normal monsoon water levels, rather than preventing flood damages. Yet the larger part of the agricultural output increases due to water management improvements since independence have been from small scale irrigation development.

Because of its location there are limited opportunities for structural flood mitigation measures within Bangladesh - embankment projects of various types are the norm - and few serious attempts have been made directly to improve the resilience of the existing infrastructure and economy to flooding. Apart from the many polders of the Coastal Embankment Project (protecting against saltwater inundation and cyclonic tidal waves) the embankment development so far has been piecemeal and rather uncoordinated.

The response to the floods of 1988 has been a renewed emphasis on flood protection. A series of studies of 'the Bangladesh flood problem' culminated in a Flood Action Plan (World Bank, 1989) involving some 26 component studies covering a wide range of issues. However, Boyce (1990) points to a number of criticisms, and particularly that the emphasis is towards major engineering works and a large scale, phased, embankment programme along the main rivers. Both the Bangladesh Agricultural Research Council (1989) and Boyce (1990) point to the adverse environmental impacts of existing embankment projects in Bangladesh, and the latter quotes from a World Bank audit on the remarkable lack of formal evaluations of flood control works, despite the building of over 6000 km of embankments (Master Plan Organisation, 1986).

THE AIMS OF THE CASE STUDY

This paper addresses part of this lack of studies by examining the impacts on households of a major flood control drainage and irrigation (FCDI) project, compared with conditions in a flood prone area. A wider economic evaluation of the same project is reported in Thompson (1990), but further evaluations encompassing a wider range of flood impact mitigation measures are clearly needed to guide the choice of future measures.

It seems likely that in flood prone areas unusual floods will cause loss of agricultural production and other damages, thus reducing incomes, and that poorer households will be more vulnerable to this becoming a disaster, for example resulting in sales of assets including land. Embankments are a public response to the hazard rather than an individual one, and the public good created ought to benefit households equally to the extent that their land and property was flood prone before. Furthermore, a more stable environment with lower monsoon water levels should encourage changes to more productive crops, and hence higher incomes and employment, as well as reducing flood losses. These hypotheses are examined below.

THE STUDY AREA

The Chandpur Irrigation Project (CIP) is a major FCDI project located south-east of Dhaka on the east bank of the Lower Meghna river. The CIP was selected for study because it had been completed for ten years, and therefore long term adjustments and impacts should be apparent, and also because it has not breached or suffered flooding from outside, and thus has been technically relatively effective.

A project for this area was first drawn up in 1961 and was included in the 1964 Master Plan. Work started in 1963 but was halted in 1967 due to problems with land acquisition and erosion. Work on a redesigned project restarted after the 1970 War of Independence, and flood control was provided from 1976/7, whereas irrigation development was only completed in 1980. The project protects from flooding about 850,000 people in area of 53,822 ha (net cultivated area 29,224 ha) with an encircling embankment, with a regulator and a reversible pumping station linked to existing rivers and channels for drainage (see Figure 1 for the project layout). Irrigation is provided by maintaining a relatively high water level in the dry season in the rivers and channels in the area, and then lifting this water on to cultivated land through approximately 1200-1300 low lift pumps, each serving an area of about 13ha (Thompson, 1990).

The study extended to an area approximately twice the size of CIP (see Figure 1). The outside area is mostly flood prone, to a similar degree to CIP prior to the project, with the exception of the Meghna-Dhonagoda Irrigation Project (MDIP) which is another FCDI project whose embankment was closed in 1987. These outside areas formed a 'control' area with which to assess conditions without flood protection, including the impacts of floods, to provide an estimate of what socio-economic conditions might have been like without CIP.

METHODS

The underlying assumption in the study was that to evaluate the impact of the project a "with-without" comparison between project and comparable control areas was necessary, rather than a "before-after" comparison which would ignore trends and changes which would have happened anyway and would rely on memories and recall. The method has the advantage of involving an assessment of conditions and vulnerability in the flood prone areas. This was further helped by fieldwork taking place during 1987/8 - as a result data was collected for 1986 which was a 'normal' year and 1987 which represented a 1-in-6 to 1-in-30 year flood in the study area. Unfortunately data on the impacts of the 1988 flood (approximately a 1-in-30 to 1-in-100 year event (UNDP, 1989)) could not be collected although impacts in the control area were certainly more severe.

Land levels are the main feature causing differences in the impacts of floods and flood protection since crop choice and yields are directly related to these. Villages in the study area were characterised according to their general level or land elevation, and one was selected at random from each of the following categories: 'low', 'medium' and 'high' inside CIP, low and 'medium' outside CIP, and MDIP. In each village 100 households were selected at random for an interview concentrating on agriculture, economic activities and status, and flood impacts; most of these interviews took place soon after the 1987 floods. Additionally, group discussions were held in 61 villages distributed on a randomly aligned grid throughout the study area just before and during the 1988 flood season (the locations of the villages are shown on Figure 1); these helped to confirm the pattern found in the main study villages.

A SUMMARY OF AGRICULTURAL-ENVIRONMENTAL CHANGES AND DIFFERENCES

The agricultural differences between project and control areas underlie the socio-economic impacts of floods, hence a brief summary is necessary here. Data were collected on all agricultural plots cultivated by the respondents. Cultivated holdings are small (mean of 0.23

ha) and fragmented (means of 0.08-0.14 ha per plot) and were found to be fairly well matched between project and control areas, in terms of previous cropping patterns, tenure, and past normal monsoon water levels. The CIP has considerably reduced the normal monsoon water level and duration of 'flooding' on 92% of plots surveyed, whereas conditions changed on only 8% of control plots during the same period.

The result has been a widespread change in cropping pattern: a transplanted Aman (monsoon season) paddy crop, often of short stemmed high yielding varieties (HYVs), is now possible throughout CIP. In unprotected areas (and in the CIP area without flood protection) cultivation of local transplanted varieties is only possible on the higher land, with most of the flood prone area growing low yielding local broadcast Aman varieties. Yields under normal conditions do not differ greatly for a given crop between project and control areas, but, rather, different types of paddy are suitable for different water regimes. With no unusual flood broadcast Aman varieties yield 1.4 tonnes/ha, compared with 2.7 tonnes/ha for local transplanted varieties and 3.4 tonnes/ha for HYVs. To adjust these figures for flood risk, expected or annual average yields were calculated based on the risks of flooding and reported losses from floods of different severity and probability within the study area. In addition the majority of CIP now receives irrigation so that a winter crop of HYV Boro paddy is possible, replacing a variety of non-irrigated crops.

Based on survey data, aggregate paddy output was estimated to be 1.9 times what it would have been without the project, although almost half of this gain is due to irrigation rather than flood protection. The gain is considerably less than the 2.5 times increase which had been predicted (World Bank, 1981), although there is clearly an overall benefit under normal conditions. However, this ignores the distribution of gains and the impacts of flood years.

SOCIO-ECONOMIC CHARACTERISTICS OF HOUSEHOLDS

The occupational structures of households in flood prone and protected areas did not differ significantly - both areas are predominantly agricultural with approximately 45% households dependent mainly on cultivating, and 20% dependent on agricultural labouring, yet in the six villages means of only 0.059-0.03 ha are cultivated per person. Population pressure on land is very high and many households have several sources of income and/or no land, yet flooding and protection from floods could be just as important for them.

Many previous studies in Bangladesh have categorised households by landholding size, either because this is a readily available indicator of economic position, or because social relations were found to be correlated with landholding classes. This type of classification did not appear appropriate in this study since a landless or marginal cultivating household could have a salary or other secure income not vulnerable to flooding. Instead household incomes were imputed from their landholdings and other occupations based on survey data, and this was compared with basic household needs.

There appeared to be no systematic association between size of holding and the levels of plots, so average cropping patterns and yields from each village were used for all households in that village. Cropping pattern depended largely on the general land level of the village and the availability of irrigation. Relative production costs were much lower if a household owned a plough team, and were higher on sharecropped land since input costs are not shared (Table 1 and Figures 2, 3 and 4 show the wide variations in gross returns per ha). For other income sources the mean numbers of days worked and wage rates were used, coupled with the numbers of people in a household engaged in each occupation category. These income estimates are largely based on normal, non-flood, conditions in 1986/7.

Household needs were estimated based on the number of people in a household and the costs of a minimum diet based on 2020 calories per day (Knudsen and Scanizzo, 1979), which is 32% greater than actual consumption among poor Bangladeshi households found by Hossain (1987), plus 19% for weekly non-food expenditure (Hossain, 1987). This translated for the study area in 1987 prices to Tk 2532 per person per year for basic needs, and Tk 2051 per person per year for food (approximately US$ 65 at official exchange rates).

A majority of female 'household heads' had husbands working away from home and remitting income and were thus insulated from flooding; those without outside support (often destitute widows) were treated separately. Male headed households were divided into three categories: *mainly cultivating* (divided between surplus (larger landowners) and deficit households, based on imputed income compared with household needs); *mainly with 'secure' incomes* such as salaries, remittances and business (generally with better incomes and little affected by floods); and *mainly with 'insecure' incomes* such as labouring. Each of the last two categories was further divided according to whether any *subsidiary income* came from cultivation.

Table 2 breaks down households, incomes and landholding by these categories. Although the percentages of households in each category are comparable in the flood prone and protected areas (that is flood protection compared with flooding has not altered social structure), cultivated holdings tend to be larger in the flood prone areas (where per ha yields average less), and overall incomes are significantly higher in the flood protected area ($t=2.39$, $df=597$, $p<.05$) (Figure 5). This suggests that flood protection has brought economic benefits.

Closer analysis shows that the distribution of gains from CIP under normal conditions is uneven - incomes appear only to be higher among larger landowners, and households with 'secure' incomes such as outside remittances. The explanations would appear to be that larger landowners receive greater gains from agriculture because they own plough teams (saving hire costs), do not take in sharecropped land, have had preferential and earlier access to irrigation, and are not limited so severely by credit.

In addition, the greater productivity of land in CIP resulted in increased land prices - some larger landowners have been able to diversify into business (which also provides extra security against climatic risks to agriculture), and some smaller landowners could sell land and invest in business or send wage-earners abroad (to the Middle East); these activities may be seen as less risky than agriculture even with flood protection (see below). There have also been some increased opportunities for trade associated with higher input use and production in CIP.

However, labourers' real wages have remained roughly constant and do not differ between the two areas, so poorer households are no better off in terms of incomes because of flood protection. The reason appears to be that extra work created by changed cropping patterns (with flood protection) has not compensated for population growth since 1976 and labourers from adjacent (control) areas can find some work in CIP in peak seasons.

Hence from a static viewpoint under normal conditions the combined flood control and irrigation project has at least benefited some households through increased agricultural production, but about half of this change appears to be due to irrigation rather than flood protection (although separating the impacts is complex), and the gains have not gone to marginal farmers or landless labourers.

THE 1987 FLOOD IMPACTS

Hydrological analysis indicated that the water levels in 1987 at main gauging stations near the study area reached approximately 1-in-6 year levels for flood prone areas north of CIP. However, the level for the areas south of CIP was approximately a 1-in-30 year event reflecting heavy rainfall over this area, and the rainfall pattern over CIP (particularly the southern half) was probably of a similar order of magnitude. Farmers' reports of the difference in flood level on different land levels compared with 'normal' appeared to agree with the official records - flood levels in the northern part of the study area were only slightly higher than the normal range of depths.

The greatest flood losses in the study area in 1987 were to agriculture, with aman paddy the main crop affected. Table 3 shows the percentages of 'normal' (1986) yields achieved in 1987 in each of the villages studied based on mean yields per variety type weighted by the sample areas under each type (see also Figure 6). Broadcast Aman is tolerant of deep water provided it rises gradually and is grown in lower flood prone areas where flooding was not so severe (1-in-6 years) and it was not too badly affected. Transplanted Aman is grown in relatively higher flood prone areas but was destroyed by relatively more severe (1-in-30 year) flooding. All Aman paddy in the Meghna-Dhonagoda Irrigation Project sample was virtually destroyed because the embankment breached despite only a 1-in-6 year event -even broadcast varieties could not survive the sudden onrush of water.

However, despite flood protection (resulting in only transplanted Aman being grown) there were drainage problems within CIP which indicate that agriculture is still risky in the monsoon. On higher land there were only small losses, but in lower areas, particularly in poorly drained basins within the project, yields were reportedly more than halved - this is despite farmers re-transplanting paddy to avoid a complete loss - because the consequent late planting results in lower yields. However, some of the losses may be made up if post-flood crops are better than normal because of residual moisture.

Table 4 shows the relative gross margins (financial returns) for average cropping patterns in 1987 compared with 1986 (see also Figure 7). Farmers with irrigation are somewhat sheltered by the higher proportion of their annual crop income which comes from the unaffected winter season, while farmers without a plough team are disadvantaged because they incur land preparation costs but yields are flood-affected. Clearly, shortfalls of about 50% and negative financial returns are serious, particularly for marginal farmers. Associated with these flood impacts, agricultural labourers - one of the poorest groups and dependent on daily work - reported obtaining less work than normal for that time of year.

Direct damages to property are a risk faced by all households, but homesteads are raised above normal monsoon water levels and the evidence of this survey indicated that most are above the flood levels experienced in 1987 in this area. Only on medium land in CIP (CIPM) and in flood prone areas (OutM), where an approximately 1-in-30 year rainfall pattern and flood was experienced, did over 50% of homestead areas suffer flooding. However, very few buildings were damaged: only 20 homes in the flood prone sample and five in the CIP sample. Estimates of losses to buildings (no damage to household possessions was encountered due to the low level of flooding) and to livestock were obtained. Building repair costs averaged between Tk 430 and Tk 1400 for those buildings damaged. These relatively low figures reflect construction of bamboo or jute-stick walls and a flood which did not demolish the main structures but only led to early replacement of materials which have short lives in any case (housing damages may be much higher where flooding is very unusual and earth-built houses are common).

Based on all these sources of loss, Table 5 estimates household incomes in 1987 and losses due to flooding compared with normal incomes (see also Figure 8). As might be expected losses were relatively higher for cultivating households and those dependent on non-secure incomes (daily-paid work). The main conclusions are that even in a 'moderate' flood deficit cultivators and households dependent on cultivation and daily-paid work in flood prone areas suffered most. This must be seen in the context that deficit cultivators are by definition under normal conditions unable to meet their basic needs, as are 71% of 'insecure cultivators', hence even in normal conditions such households are barely surviving. However, in CIP despite flood protection these same categories of household (along with some surplus cultivators able to met their basic needs) suffered similar percentage losses on their normal 'incomes' because of drainage problems - since their normal incomes are no higher this means that the project has neither raised or stabilised the incomes of one of the most vulnerable groups (marginal farmers).

Relative losses in MDIP did not appear to be greater, despite the embankment breach, but this is because the flood level was not in itself so severe: virtually all homesteads in the sample were above the 1-in-6 year flood in 1987. The same was not true of MDIP in 1988 when approximately 1-in-30 to 1-in-100 year flood levels were reached (UNDP, 1989) and another embankment breach occurred. Stewart (1989) reported higher damages inside MDIP than in areas outside that project; although damages would have been significant without the project, a sudden breach and slow drainage can worsen losses when projects fail.

Information on outstanding credit among the households surveyed may indicate the extent of flood distress. Before 1987 in both the flood prone areas and CIP more outstanding credit had been taken during the dry season than in the monsoon and immediate post-monsoon season - 62% and 74% respectively in CIP and control areas. In 1987 the pattern was reversed - only 31% and 20% respectively of loans were taken in the dry season with the majority taken in the monsoon period (the differences are significant in X^2 tests at $p < .001$). Hence it may be that flood losses imply increased indebtedness, which eventually results in more permanent falls in household welfare.

LONG TERM IMPACTS OF FLOODS AND FLOOD CONTROL

The survey results for the 1987 flood season give a picture of losses in a moderate flood. However, the continued risk and incidence of unusual floods in flood prone areas, compared with the hoped-for protection from unusual floods in flood protected areas, could result in cumulated long-term differences. Cain (1981) suggested that higher mobility in landholding size, which he found among a sample of households in Bangladesh compared with an Indian sample, reflected distress sales due to environmental risks (mainly floods) in Bangladesh. This hypothesis was tested for those households which had the same household head in 1976, when CIP began operation, by reconstructing their landholdings then (based on recall of land sales and losses over the intervening period).

A classification of households by landholding size is necessary since the socio-economic categories used for the static 1986-7 analysis could not be reconstructed for 1976. One approach is to use the same landholding categories as used by Cain (1981); mobility matrices for changes in landholding category over time are then compiled for both flood prone and CIP areas. This indicated that only a small difference in overall mobility has occurred (10.3% in CIP compared with 12.8% in flood prone areas), although losses of land are slightly more among households not changing category in the flood prone areas.

Because CIP changed the viability of households for a given landholding, by increasing total foodgrain production and returns per hectare, it is more appropriate to categorise households according to landholding sizes which reflect different 'carrying capacities'. Assuming an average household size of six people, and that 70% of land is cultivated (based on survey data), then 0.5-0.77 ha is the minimum landholding needed in CIP to maintain a household by agriculture alone, compared with a holding of 0.8-1.59 ha in the flood prone areas and prior to CIP. Table 6 and Figure 9 show the changes in landholding category for CIP and control areas allowing for the jump in viability (or effective landholding-output) provided by CIP. This indicates a general but small slide of households into the deficit categories in the flood prone areas, but a polarisation in CIP where a sizeable minority of those households with a deficit landholding in 1976 moved into the viable categories. As a consequence of CIP there were by 1987 more rather than fewer (than in 1976) households able to meet their basic needs from their landholdings compared with the flood prone areas.

The results are not statistically conclusive but indicate a long-term trend which benefits households with larger landholdings. However, the effects of flood protection cannot be separated from those of irrigation, and it is perhaps surprising that greater changes have not occurred in CIP given the major agricultural changes brought about. One explanation may be that the 1976-1987 period did not include any particularly severe floods which could have caused distress sales of land in the flood prone areas (although there was a noticeable peak in reported land transactions in 1984-5 in the flood prone areas when there was an unusual flood, which was not reported from inside CIP).

CONCLUSIONS

The study confirms that agricultural losses occur even in a moderate flood, but that they are proportionately more in areas normally less deeply flooded and where consequently transplanted Aman paddy is grown rather than deep-water broadcast varieties. Property damage was low in the study area in 1987. Overall the proportion of income lost was higher for larger landowners, but smaller losses for marginal cultivators and landless households are socially and economically more serious since even in normal times these households fall short of 'minimum' food requirements.

However, the overall gains from flood control through the CIP embankment have not been evenly distributed. Although agricultural production increased substantially it was less than had been expected and was equally due to irrigation and flood control. Marginal farmers and landless labourers have gained little, since employment for landless agricultural labourers has only grown in proportion to population growth. Moreover, even with a flood protection project which remained intact during the 1987 floods, internal drainage problems led to sizeable losses of agricultural production in low-lying areas - hence monsoon season risks are not eliminated - and there is still the risk of embankments failing.

The evidence of MDIP in 1987 and 1988 also indicates that if embankments breach then agricultural losses may be greater than they might have been without a project. It remains to be seen over time whether in that case expected agricultural returns will be greater with the project. However, household security is not so far higher, even if in good conditions crop production is increased, since variability in agricultural production and thereby in welfare appears not to be reduced by flood protection.

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Table 1. **Gross returns per hectare of cultivated land (1987 Taka)**

Land category	Location					
	CIPH	CIPM	CIPL	OutM	OutL	MDIP
With plough						
own irrigated	38705	26483	32695	36203	na	na
sharecrop irrigated	17575	11650	14683	16587	na	na
own non-irrigated	29344	17231	21443	27886	20246	17900
sharecrop non-irrigated	12721	7499	9603	12180	8429	7153
Without plough						
own irrigated	33614	21653	27889	31445	na	na
sharecrop irrigated	12484	6819	9877	11829	na	na
own non-irrigated	22010	12575	16288	20942	12454	10498
sharecrop non-irrigated	5387	2843	4447	5236	638	-248
Mean rental income per ha	14587	8296	15504	7562	6318	7073

Notes: Returns to cultivating household exclude irrigation charges and hired labour

Locations are surveyed villages categorised respectively as 'high', 'medium' and 'low' in CIP, as 'medium' and 'low' outside CIP, and from MDIP.

Table 2. **Breakdown of income and land by household classes**

Item	Male head surplus cult	Male head deficit cult	Male head secure+cult	Male head insec+cult	Male head sec no cult	Male head insec no cult	Female head suported	Female head no support	Total
Households									
CIP no	30	22	85	43	29	48	40	2	299
percent	10.0	7.4	28.4	14.4	9.7	16.1	13.4	0.7	
Out no	28	27	74	53	29	40	40	9	300
percent	9.3	9.0	24.7	17.7	9.7	13.3	13.3	3.0	
Per capita total income per annum (Tk)									
CIP mean	5935.1	1273.6	4871.0	2117.2	3411.3	1912.2	4492.6	1441.7	3626.9
s.d.	7209	326	6711	894	2130	1131	3571	1638	4744
Out mean	4025.3	1201.6	3893.9	1961.8	3485.1	2163.7	3459.6	792.1	2901.4
s.d.	1402	535	3141	1138	2552	1125	1960	378	2275
Area owned in (ha)									
CIP mean	1.191	0.444	0.454	0.078	0.201	0.033	0.198	0.012	0.344
s.d.	1.43	0.32	0.51	0 07	0.39	0.58	0.21	0.01	0.64
Out mean	1.148	0.468	0.366	0.129	0.258	0.018	0.225	0.039	0.321
s.d.	0.54	0.27	0.32	0.14	0.50	0.02	0.34	0.09	0.44
Area cultivated (ha)									
CIP mean	0.822	0.325	0.283	0.135	0.000	0.000	0.080	0.000	0.217
s.d.	.59	.12	.27	.10			.14		.34
Out mean	1.044	0.423	0.298	0.170	0.000	0.000	0.087	0.032	0.251
s.d.	.54	.23	.19	.16			.27	.06	.37

Table 3. 1987 Aman yields as a percentage of 1986 ("normal") yield by location

Crop	CIP	Control	Village CIPH	CIPM	CIPL	OutM	OutL	MDIP
1987 mean as % of 1986 mean								
B.Aman	-	63	-	-	-	0	72	26
T.L.Aman	42	7	72	18	29	5	91	21
T.Paijam	48	2	-	41	50	0	-	2
T.HYV Aman	61	0	81	34	38	0	-	-

Note: B. Aman are Broadcast Aman varieties (most water tolerant),
T.L. Aman are Transplanted Local Aman varieties (fairly long stemmed but not long enough with flood water
T. Paijam is an 'improved' variety intermediate in height between T.L. and HYV varities
T.HYV Aman are high-yielding varieties of Aman which generally have shot terms.