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Research Note

ADOPTION OF MODERN RICE VARIETIES IN BANGLADESH

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ABSTRACT

This paper reviewed the farm level adoption rate and yield of modern rice varieties. This study used both primary and secondary data. The analysis shows that 46 percent of the total rice area were devoted to grow modern rice varieties in 1990. Among all MVs, BR 11 was the predominant variety which covered 63.03 percent of the total MV area and gave the highest yield in T. Aman season. Purbachi covered 21.1 and 34.08 percent of the MV areas in Boro and Aus season respectively while BR3 ranked the highest position in terms of yield both in Boro and Aus season of 1990. Per hectare use of nitrogen, triple super phosphate and potash in Aman and Aus season was much lower than the recommended rate but in Boro season, application of urea and TSP fertilizers at the sample farms were almost close to the recommended rate. Subsistence pressure, land unsuitability, timing and inadequate extension contact were important constraints to the adoption of' MVs in Arnan season.

1. INTRODUCTION

Rice, the principal food crop of Bangladesh occupies about 80 percent of the total cropped area (BBS, 1990) and it alone contributes about 28% to the GDP of the country. In fact Bangladesh is critically dependent on rice both in the past, present and will remain so in the foreseeable future. Considering these, modern varieties (MV) of rice were introduced to meet the urgent food problems in Bangladesh. The Bangladesh Rice Research Institute (BRRI) has so far developed as many as 26 modern rice varieties suitable for growing in three different seasons. MVs are well suited to some areas where they give four to five times higher yield than LVs. But they are not adopted equally to all rice growing areas of the country. Moreover, there are drastic variations in the rate of adoption of modern rice varieties among three rice growing seasons (Aus, Aman and Boro) through the efforts made in the past, the MVs became popular for Boro season rice because of high yields associated with irrigation water. But the scope of increasing MV adoption in Boro cultivation is becoming costly as it is mainly dependent on high cost investment on irrigation. Moreover the crop diversification program is getting importance now-a-days to meet up the nutritional status of our people in one hand and on the other hand, the crop diversification programme is replacing the Boro area to other crops. The scope of increasing MV adoption in Aus season is risky as Aus crop is often

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affected by natural hazards like drought in growing period and early flood during harvesting time. Therefore, the only scope remains is to increase rice production through devoting more area under MV rice cultivation in T. Aman season. The cultivation of MV rice in Aman season is less cost effective since T. Aman is grown mainly under rainfed condition. Although there are serveral modern T. Aman varieties available in the field, but their adoption is very slow and patchy. It is not expected that MV adoption rates in the Aman season will show an exponential curve but a step-like progression as new varieties expand to fill a particular niche in the system. Certainly it is a debateable issue to the researchers as well as to the planners and they are to search for the reasons for this slow and patchy adoption of MVs in Aman season. It is therefore, imperative to investigate why the adoption of MVs in the Aman season has not expanded as rapidly as in other crop seasons. The present study was therefore undertaken with a view to determine:

- Zone-wise adoption rate and yield of different MV rice in different seasons of Bangladesh.
- Fertilizer use rate and the causes of using higher/lower dose at the farm level.
- How relative changes in the market price of fertilizer and paddy affect MV adoption and, finally.
- To determine the relative importance of socio-economic, environmental, and varietal constraints on adoption rates; and to suggest appropriate policy measure to accelerate adoption of MV T.Aman.

II. METHODOLOGY

Sampling Procedure:

A multi-stage stratified random sampling procedure was used to collect required information. In the first stage of sampling procedure, thanas were selected from 7 different agro-ecological zones as provided by Islam (1986). The zones are as follows:

I. Comparatively non-flood and non-drought.
II. Flood prone.
III. Drought prone.
IV. Drought and flood prone.
V. Salinity and tidal submergence.
VI. Flash flood areas, and
VII. Hilly areas.

Sample Selection in T. Aman Season:

Out of 464 thanas, T. Aman was grown in 445 thanas during 1990. In order to select a number of representative thanas from the total population the following methodology was used.

The sample thanas were distributed proportionately among seven zones by using the formula derived by Kish (1965 and Cochran 1977):

$$n_i = \frac{N_i S_i}{\Sigma N_i S_i} \times n \text{ ----------------- } (1)$$

Where, n_i = no. of sample thanas in the i'th zone,

i = 1, 2, 3,......................................,7.

n = no. of total sample thanas

Ni = no. of total thanas in the ith zone.

S_i = std. dev. of MV adoption in the ith zone.

The number of sample thanas were 11, 8, 3, 5, 2, 1, and 1 in zone I, II, III, IV, V, VI and VII respectively. Since only 1 thana was selected from each of two zones (zone 6 and 7) we added two more thanas to those zones in order to make the sample representative and thus total sample size became 33.

For identifying the constraints to MV adoption in the T. Aman season, a different survey was done during 1990 Aman season in 8 different thanas. Four villages were selected from each thana. A total of 574 T. Aman growing farms were selected randomly from these villages.

Sample Selection in the Aus Season:

Out of 464 thanas Aus rice was grown in 363 thanas during 1990. Cochran (1977) suggested that, for a positively skewed distribution, 95% confidence probability statement will not be wrong in more than 6% of the time, if the following rule is applied in selecting sample.

$$n > 25 \quad G^2 \text{ .... } (2)$$

where, n = sample thanas,

G = Fisher's measure of skewness (Fisher, 1932)

According to equation (2) a suggested minimum n is;

$$n = (25) \quad (0.97)^2 = 24.$$

We selected 30 thanas (adding 6 more thanas in order to make sample representative as was done in T. Aman sample selection) which were distibuted in 7 zones applying equation (1) as stated above. The number of sample thanas were 8, 5, 5, 5, 3, 2, and 2 in zones I, II, III, IV, V, VI, and VII respectively.

Sample Selection in the Boro Season:

The variability of MV adoption between thanas was very low in Boro season. Forty-three thanas were selected at random which were distributed within the zones using equation (1). The number of sample thanas were 13, 11, 7, 6, 2, 2 and 2 in zones I, II,.. and VII respectively.

Village and Farmer Selection:

One village from each selected thana and 15 farmers from each village were selected at random. The distribution of these 15 farmers were 3, 4 and 8 as large, medium and small farm size groups respectively.

Data Collection and Analysis:

Data were collected for all three rice growing seasons of 1990. Adoption constraints have been measured using multivariate regresion analysis (Tobit Model).

The Tobit Model

According to Maddala (1983), Amemiya (1981) and Calzolari & Fiorentini (1990) the Tobit model specifies a functional relation between the probability of adoption and various explanatory variables. The probability of adoption is specified as:

$I = b_o + b_1x_1 .... b_nx_n = f(xi_i)$ ....(3)

and $Y = g(I)$ .... (4)

Where, $Y = 1$ if $I >= I^*$ (4a)

$Y = 0$ if $I < I^*$ (4b)

I is the index reflecting the combined effect of $x_1 .... x_n$ factors that determine adoption. This index level, I, is not observed. What is observed is whether the farmer is an adopter (Y> 0) when I exceeds some threshold level I*, (4a). If I is less than the critical value I*, the farmer is a non-adopter so y = 0 (equation 4b).

The Tobit model assumes that I is a normally distributed random variable so the probability that I is greater than I* (i.e. the farmer is an adopter) can be computed from the cumulative normal probability function:

Prob. (y) > sigma I) = Prob. (I > = I* / I) + F (I/sigma) where F (z) is the value of the standard normal cumulative distribution at (I/sigma).

The Tobit model also estimates the expected value of Y for adopters, defined as:

E (y / I) = I [F (I/sigma) + sigma (f (I/sigma) .... (5) where,

E (y/ 1) = expected amount (eg. adoption intensity) at a given stimulus level I;

sigma = standard error of the estimate;

I/sigma = standardised index level;

F (I/sigma) = Tobit probability of choosing the event, calculated from the cumulative normal distribution.

f (I/sigma) = normal density function of the index at Z = (I/sigma).

Mean values of continuous variables included in the MV T. Aman adoption and hypothesised signs are listed in Table 1. The price variable represents the ratio of the price of urea to the wholesale price of MV Aman paddy in the two months August-September, 1990. This data were available for the survey thanas from the monthly price monitoring surveys conducted by IFDC. The model in equation (3) was estimated using the LIMDEP software package (Greene, 1981).

III. FINDINGS OF THE STUDY

Adoption of Modern Varieties:

Variety-wise adoption of modern rice under seven agro-ecological zones are presented in Table 2. It was found that, BR11 covered 63.03 percent of the total T. Aman areas while

Pajam and BR4 respectively covered the second and third highest (14.53% and 8.56%) area of the total MV area during T. Aman season of 1990 (Table 2).

Adoption of different MV Boro rice by zone in Bangladesh during 1990 have been shown in Table 3. It appears that Purbachi, a short duration variety, covered 21.1 percent of the total Boro area followed by BR3 which covered 19.3 percent. IR8 is still popular at the field level as a short duration variety compared to BR3 and this variety (IR8) occupied 11.7 percent of the total Boro area during 1990.

Table 4 reveals the variety-wise adoption of MV rice during Aus season of 1990. The table shows that, Purbachi covered the highest area (34.08%) also in Aus season followed by BR1 which covered 20.15 percent of the MV Aus areas. BR14 as an early maturing variety occupied the third position covering 8.84 percent of the total MV areas during Aus season of 1990.

Yield:

Variety-wise yields of MV paddy have been shown in Table 5. Among all modern varieties BR11 gave the highest yield (4110 kg/ha) during T. Aman season of 1990. The average yield of modern, Pajam and local varieties were 3920, 2790 and 1890 kg per hectare respectively in T. Aman season, 1990 (Table 5). Among all the modern varieties BR3 gave the highest yield (4820 kg/ha) during Boro season of 1990. On an average, modern varieties gave the yield of 3920 kg per hectare during 1990 Boro season (Table 5).

BR3 occupiedd the highest position in terms of yield also in Aus season of 1990. Considering all the zones as a whole this variety (BR3) yielded 3830 kg/ha. The average yield of modern varieties and Pajam were 3070 and 2070 kg per hectare respectively during the Aus season of 1990 (Table 5).

The level of MV adoption in the country by zones and by seasons have been presented in Table 6. High yielding varieties were adopted to 37, 38 and 25 percent areas in Aman, Boro and Aus seasons respectively. But on an average of all seasons and all zones MVs were adopted to 46 percent of the rice area (Table 6).

Fertilizer use:

The per hectare use of Nitrogen, Phosphorus and Potash both in Aman and Aus seasons were much lower than the recommended rate. In Boro season the average use of Nitrogen and Phosphorus were almost close to the recommended rate. But the use of Potash in Boro season was much lower than the recommended rate (Table 7).

Factor Affecting Fertilizer Use:

Table 8 shows the socio-economic factors that were hindering the use of chemical fertilizers in growing rice. It appears from Table 8 that the economic insolvency of the paddy growers and high market price of fertilizers were the common factors in all three rice growing seasons. The real price of urea has been increasing continuously in comparison to the paddy price (Table 9). In order to encourage the paddy growers the real price of urea should have been kept colse to the real price.

Determinants of Adoption (MV T. Aman):

The estimated co-efficients of the Tobit model on MV T. Aman adoption are shown in Table 10. The R^2 value implies that only 34% of the variance in actual adoption intensity of the farmers in the sample. Obviously, other factors affected adoption intensity, such as ecological variation among of the eight survey sites. The log-likelihood ratio of the Tobit model was significant at the 1% level, however, the model correctly predicted 58% of the variance in adoption intensity.

Table 10 shows that, in the Tobit model, 10 out of 11 explanatory variables were significant at the 10% level or better. The credit variable was not significant. The sign suggests that dependence on non-institutional credit has a negative effect on the area farmers plan for MV T. Aman. All the other variables displayed the expected signs.

The coefficient of owned land per household member (Lochula) was negative and significant at the 1% level, indicating that the more land owned per member of the household, the less is the intensity of adoption. This indicates that larger farmers with less subsistence pressure have a lower proportion of their land under MVs. The coefficient of the education variable (EDUC) had the expected positive sign and was significant at 10% level. The coefficient of the percentage of sharecropped land (TNC) was negative and significant at 1% level, indicating that sharecropping was a disincentive to intensity of adoption.

The coefficient of the percentage of lowland (LOWLAND) was negative and significant at 1% level, indicating that deeply flooded land was unsuitable for short-stemmed MVs. The coefficient of the percent area left fallow in the Aus season (AUSFALL) was positive and significant at 1% level. Farmers who grew MV T. Aman typically left the plot fallow in the Aus season to ensure timely transplanting of photoperiod sensitive MVs.

The coefficient of the percentage area under irrigation (IRRIG) was positively related to MV adoption and was significant at 1% level. Since few farmers used irrigation for MV T. Aman reflecting that farmers could transplant Aman earlier on irrigated plots after the harvest of MV Boro. This is an important advantage for photoperiod-sensitive MVs.

The coefficient of the risk variable (CVMV AMAN) had the expected negative sign and was also significant at 1% level. Thanas with greater variability in MV yields (as measured by the coefficient of variation) had lower adoption intensities.

The coefficient of the price ratio of fertiliser/paddy (PP/PRICE) was significant at 1% level and had the expected negative sign. This coefficient had the highest t-value of any explanatory variable in the model.

The extension exposure variable (DPLOT) was positive and significant at 1% level, indicating the importance of demonstration plots in increasing awareness of the yield increase possible with MVs. Lastly, the infrastructure variable (ROAD) was positive and significant at 1% level. This result underlines the importance of good communication for exposure to new rice technology and for access to markets.

Varietal Constraints:

Timing : MVs for T. Aman season are non-sensitive (weakly sensitive) to photoperiod whereas LIVs and LV are strongly sensitive (Recently, BRRI released BR22 and BR23 which are strongly photoperiod-sensitive; these have not yet been widely adopted). This means that farmes must transplant MVs earlier than LVs to ensure flowering before mid-November after which cold night temperature may severely reduce yields. The recommended cutoff date for transplanting BR11 is 31 August.

Eighty-five percent of MV Aman was transplanted by the second week of Srabon (before 15 August). By contrast, only 54% of LV Aman was transplanted by this date. The peak transplanting period for LV Aman was the first and second week of Bhadro (1-15 September). This was two weeks later than the recommended cut-off date for transplanting BR11.

Fallow-MV T. Aman: The need to transplant MVs early is an important adoption constaint. Although BRRI has recommended the pattern BR1-BR11 for the rainfed lowland favourable rice environment, few farmers have followed this advice. Out of 240 ha under MV T. Aman, 17 ha (7%) was preceded by MV Aus; 51 ha (21%) by LV Aus; and 172 ha (72%) by fallow. Thus, farmers who grow MV T. Aman normally keep their plots fallow in the Aus season to ensure timely transplanting.

The correlation between the percent area under MV T. Aman and the percent of land fallow in Aus season was extremely close ($r = 0.697$ for 574 cases). The exception was Patuakhali, where high salinity levels limited rice cultivation in the Aus season. On an average, 45% of the Aman area was under MV and the proportion kept fallow in the Aus season was 48% Thus, farmers who wish to grow MV T. Aman must keep their land fallow in the Aus season.

Farmers Perceptions: Farmers were asked why they grew LV T. Aman. Because of the difficulty in interpreting answers from this type of open-ended question, the results should be treated cautiously. But they give useful insights into farmers view on problems associated with adoption of MVs.

Out of the five most important reasons given for growing LV T. Aman the low cost involvement ranked the top in farmers adoption decision. They reveal the primary importance of input costs in farmers adoption decisions. Other reasons for growing LV T. Aman confirmed our previous findings: lowland, timing, water problems, and custom (indicating lack of extension contact).

Policy Options

The impact of changing five determinants of adoption intensity are shown in Table 11. Without knowing the costs of each intervention it is difficult to say which is the most economic way to reduce adoption constraints. However, the technology impact of these policy options can be easily visualized.

The socio-economic policies of increasing farmers exposure of extension and land reform had the smallest impact of the five policy options. The most effective socio-economic policy is reducing the real price of fertilizer, as measured by the urea/paddy price ratio had the greatest impact. This increased the number of farmers adopting by 12 percent and increased adoption intensity by 59 percent (Table 11). Falling fertilizer prices over the period 1986-90 have encouraged farmers to use more fertilizer in the T. Aman season, and this has been accompanied by a rise in adoption of MVs.

The technical ploicy of breeding taller MVs had only a slight impact on the number of farmers adopting but a significant impact on adoption intensity. Taller MVs would have shown a greater impact if the sample had included areas with deeper floodings.

The physical ploicy of supplementary irrigation had the second biggest impact in terms of number of adopters and adoption intensity. Irrigation permits early transplanting which favours the adoption of photoperiod-sensitive MVs. The irrigation variable really represents a time constraint on date of transplanting.

V. CONCLUSIONS

Among all the modern varieties cultivated in T. Aman season, BR11 is the predominant variety which covered about 63.03 percent of the total MV area of T. Aman in 1990. Among all the modern varieties, BR11 gave the highest yield in T. Aman season of 1990. BR3 was the highest yielder both in Boro and Aus seasons giving yield of 4820 and 3830 kg/ha respectively. Modern rice varieties have been adopted to 51 percent of the total rice area in all three rice growing seasons of 1990. But excluding Pajam, 46 percent of the total area were devoted to MVs.

The variations in the level of chemical fertilizer use among different zones are very high in all the three rice growing seasons. The use of Nitrogen, Phosphorus and Potash per hectare both in T. Aman and Aus seasons were much lower than the recommended rate. The real price of urea fertilizer has been increasing continuously in comparison to that of paddy. Subsistence pressure, land unsuitability, timing and inadequate extension contact were the important constraints to MV T. Aman adoption.

The need to transplant MVs early, is an important adoption constraint in the T. Aman season. The findgings support BRRI's current breeding objectives of greater plant height and photoperiod sensitivity for MVs in the T. Aman season. The important reasons to the farmers for growing LV T. Aman were: low cost involvement, land suitability, timing, water problems and better taste.

Adoption rate of MV Aman can be enhanced substantially if supplemental irrigation is provided to ensure early transplantation of photoperiod sensitive modern varieties.

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Table 1. Characteristics of Sampled Farmers Used in the Analysis of MV T. Aman Adoption in Bangladesh, 1990.

Xi	Variable	Unit	Mean value	Expected sign
1.	Continuous variables :			
X1	Land owned/member of household	Decimals/person	27.03	< 0
X2	Education of household head	Years	3.57	> 0
X3	Area sharecropped	Percent	22.75	< 0
X4	Lowland	Percent	27.87	< 0
X5	Aus fallow	Percent	49.99	> 0
X6	Area irrigated	Percent	13.52	> 0
X7	CV of MV Aman yield	Percent	23.09	< 0
X8	Prices urea/rice	Ratio	0.52	< 0
X9	Credit/MV Aman area	Taka/decimal	6.71	> 0
2.	Dummy variables :			
X10	Extension contact	Yes = 1		> 0
		No = 0		
X11	Road	Mud = 1		> 0
		Brick = 2		
		Metalled = 3		
	Sample size (n) = 574			

Table 2. Zone-wise Adoption of Different MV T. Aman Rice in Bangladesh, 1990.

Varieties	Varieties as % of total MV T. Aman areas of all zones*							
	I	II	III	IV	V	VI	VII	ALL
BR2 & 3	0.60	0.89	-	-	-	-	0.08	1.57
BR4	5.14	2.14	-	-	-	1.05	0.23	8.56
BR5	-	0.64	-	-	-	0.17	-	0.81
BR8 &9	-	0.45	-	0.56	-	0.01	-	1.02
BR10	1.50	1.38	2.20	0.08	-	-	0.17	5.33
BR11	25.05	6.88	6.22	11.78	3.67	1.29	8.14	63.03
BR14	0.47	-	0.12	1.91	-	-	-	2.50
BR22 & 23	-	-	0.09	-	-	0.03	-	0.12
IR5	1.25	-	-	-	-	-	-	1.25
IR20	0.78	-	-	-	-	-	-	0.78
Pajam	4.70	3.74	1.49	0.15	1.14	1.87	1.36	14.53
Indian	0.30	-	0.07	-	-	-	0.13	0.50
All	39.87	16.12	10.19	14.48	4.81	4.42	10.11	100.00

* Zone I = Non-flood and non-drought, II= flood prone, III= Drought prone, IV= Drought and flood prone, V= Salinity and tidal submergence, VI= Flash flood areas, and VII= Hilly Areas.

Table 3. Zone-wise Adoption of Different MV Boro Rice in Bangladesh, 1990.

Varieties	Varieties as % of total MV Boro areas of all zones							
	I	II	III	IV	V	VI	VII	ALL
BR1 & 2	2.3	0.3	0.8	0.4	-	-	0.2	5.0
BR3	9.7	1.9	2.7	0.7	1.5	2.2	0.6	19.3
BR6, 7 & 8	-	-	-	0.2	0.5	-	2.0	2.7
RB9	1.4	2.5	0.1	1.0	-	-	-	5.0
BR10 & 11	0.4	5.9	1.1	0.1	0.2	-	-	7.7
BR14	3.0	5.0	0.2	0.6	-	-	-	8.8
BR16 & 17	-	0.2	-	-	-	-	-	0.2
BR18 & 19	0.1	0.6	-	-	-	-	-	0.7
IR8	2.7	3.4	0.1	0.9	1.8	2.2	0.6	11.7
IR50	-	-	-	1.4	-	0.4	0.4	2.2
Purbachi	7.4	8.5	-	4.5	0.5	-	0.2	21.1
BAU63	-	0.2	-	-	-	-	-	0.2
Pajam	1.5	1.0	0.5	1.2	0.3	0.2	0.1	4.8
Indian *	0.9	-	3.9	0.5	0.6	-	-	5.9
Iratom	1.7	-	0.4	1.7	0.2	-	-	4.0
Others **	-	-	-	0.3	0.4	-	-	0.7
All	31.1	29.5	11.2	13.1	6.4	5.0	3.7	100.00

* Lata, Parijat, Panchabati, Balaka, Usha, Joya, Kallayani, CRP, Ratna.

** Japanee, CM25, Unknown.

Table 4. Zone-wise Adoption of Different MV Aus Rice in Bangladesh, 1990.

Varieties	Varieties as % of total MV Aus Areas of all zones							
	I	II	III	IV	V	VI	VII	ALL
BR1	6.51	-	4.94	-	3.82	4.19	0.69	20.15
BR2,3 & 4	1.86	0.73	-	0.24	3.55	1.20	0.33	7.91
BR8 & 9	3.67	9.58	-	-	-	-	-	13.25
BR11	-	-	-	0.14	0.26	-	-	0.40
BR14	4.95	1.63	-	2.18	0.08	-	-	8.84
BR20	0.05	0.05	-	-	-	0.87	-	0.97
IR8	1.58	-	-	1.61	1.87	-	-	5.06
IR20 & 50	-	-	0.65	0.28	-	-	-	0.93
Purbachi	17.36	0.08	11.50	0.25	4.18	0.71	-	34.08
Pajam	0.13	-	-	-	-	-	-	0.13
Indian	-	-	2.62	4.00	-	-	-	6.62
Iratom	-	-	-	-	0.79	-	-	0.79
Others	0.40	-	0.22	-	-	-	0.25	0.87
All	36.51	12.07	19.93	8.70	14.55	6.97	1.27	100.00

Table 5. Average Yield of Paddy (kg/ha) by Variety and by Seasons of all Zones, Bangladesh, 1990.

Varieties	T. Aman	Boro	Aus
BR1	-	3850	3010
BR2	3970	3870	3130
BR3	3470	4820	3830
BR4	3790	-	2950
BR5	2610	-	-
BR6	-	3890	-
BR7	-	3310	-
BR8	3720	3270	3120
BR9	3020	3840	3110
BR10	3880	3300	-
BR11	4110	3410	2970
BR14	3750	4100	3500
BR16	-	3990	-
BR17	-	3890	-
BR18	-	3000	-
BR19	-	3310	-
BR20	-	-	2600
BR22	3690	-	-
BR23	3490	-	-
IR5	4000	-	-
IR8	-	3900	3120
IR20	3320	-	3070
IR50	-	3560	3260
IR76	-	3940	-
Purbachi	-	3730	3180
BAU63	-	2300	-
Indian	3490	3790	2380
Iratom	-	3470	3190
Others	-	3400	2240
All MV	3920	3920	3070
Pajam	2790	2670	2070
Local	1890	1970	1320

Table 6. Adoption of MV Rice in Different Seasons, Bangladesh, 1990.

Variety %	Zones							
	1	2	3	4	5	6	7	Average
			Aman[a]:					
HYV	43	26	53	34	21	58	44	37
Pajam	10	06	02	01	02	10	06	06
			Boro :					
HYV	85	77	96	86	88	82	84	83
Pajam	06	05	01	01	01	03	07	04
			Aus:					
HYV	31	17	29	08	30	52	33	25
Pajam	01	-	-	-	-	-	-	-
			All:					
HYV	49	43	57	42	27	62	54	46
Pajam	07	05	02	01	02	06	05	05

a HYV adoption percentage of total Aman area (including B. Aman)

Table 7. Average Use of Chemical Fertilizer (kg/ha) in Rice cultivation by Season in Bangladesh, 1990.

Zones	MV T. Aman			MV Boro			MV Aus		
	Urea	TSP	MP	Urea	TSP	MP	Urea	TSP	MP
I	118	69	33	151	126	53	109	84	46
II	95	50	26	155	122	37	59	47	23
III	84	80	35	224	140	62	81	52	19
IV	116	77	39	213	98	31	32	18	06
V	84	51	06	216	77	18	75	53	25
VI	79	53	19	44	37	18	55	68	02
VII	66	51	26	246	219	86	28	19	04
All	102	64	30	174	118	44	66	48	22
N-P_2O_5-K_2O	(46)	(31)	(18)	(78)	(56)	(26)	(30)	(23)	(13)
Recommended Rate	(60)	(40)	(40)	(80)	(60)	(40)	(60)	(40)	(40)
F-ratio for difference between zones	14.1*	10.4*	11.5*	16.4*	12.3*	14.4*	10.4*	11.1*	11.4*

* significant at 1% level.

Table 8. Socio-economic Factors Responsible for Lower Use of Chemical Fertilizer in Different Rice Growing Seasons; 1990.

Causes	Frequency of respondents by season & fert. type								
	Aman			Boro			Aus		
	Urea	TSP	MP	Urea	TSP	MP	Urea	TSP	MP
1. Lack of capital & higher price	83 (40)	69 (32)	64 (30)	80 (67)	70 (58)	62 (42)	92 (38)	86 (37)	72 (27)
2. Lack of Knowledge	45 (21)	47 (21)	37 (18)	20 (17)	15 (13)	25 (17)	50 (21)	43 (19)	41 (16)
3. Do not get direct effect	-	6 (3)	68 (32)	-	10 (8)	44 (30)	35 (15)	59 (26)	107 (40)
4. Water instability*	51 (24)	74 (34)	28 (13)	20 (16)	25 (21)	16 (11)	63 (26)	42 (18)	46 (17)
5. Applied less considering residual effect of manur	32 (15)	23 (10)	15 (7)	-	-	-	-	-	-
Total respodent	211	219	212	120	120	147	240	230	266

* Includes both excessive water and draought.

Figures in the parentheses indicate the percent of sample respondents.

Table 9. Relative Prices of Paddy and Urea in Bangladesh, 1972-90.

Year	Harvest price of paddy (Tk/Kg)	Price of Urea (Tk/Kg)	Real Price of Urea (against paddy)
1972-73	1.10	0.54	0.49
1973-74	1.55	0.80	0.52
1974-75	3.27	1.37	0.42
1975-76	1.96	1.37	0.70
1976-77	1.74	1.63	0.94
1977-78	2.06	1.63	0.79
1978-79	2.57	1.90	0.74
1979-80	2.71	2.97	1.10
1980-81	2.81	3.62	1.28
1981-82	3.16	4.02	1.27
1982-83	3.59	4.02	1.12
1983-84	4.10	4.42	1.08
1984-85	4.72	4.98	1.06
1985-86	4.37	4.80	1.10
1986-87	5.39	4.50	0.48
1987-88	5.57	4.56	0.82
1988-89	5.89	5.36	0.91
1989-90	6.70	5.36	0.80

Table 10. Determinants of Adoption MV T. Aman 1989/90.

Variable			Tobit estimate	
	CONSTANT		719.942	
			(8.560)	
X1	LOCHULA		-0.2804	
			(-3.869)	***
X2	EDUC		0.9916	
			(1.665)	*
X3	TNC		-0.2053	
			(-3.515)	***
X4	LOWLAND		-0.3918	
			(-6.733)	***
X5	AUSFALL		0.2379	
			(4.336)	***
X6	IRRIG		0.28918	
			(4.157)	***
X7	CVAMAMAN		-2.0499	
			(-3.451)	***
X8	PF/PRICE		-1239.71	
			(-7.601)	***
X9	NICR/MV		-0.1113	
			(-0.736)NS	
X10	DPLOT		15.8644	
			(3.537)	***
Sigma			43.9924	
			(25.493)	***
X11	ROAD		10.6600	
			(4.472)	***
Adjusted R2 : 0.34		Log of likelihood function:	-2034.4	
		Log of likelihood function, constant only :	-2157.2	
		-2 times log of likelihood ratio :	245.6	***
Percent of cases predicated correctly :			58	

Notes : Figures in the parentheses are t-value, *** = significant at 1% Lavel : ** = 5%; * = 10%;
NS = not significant.

Table 11. Effects of Policy Options on Adoption of MV. T. Aman in Bangladesh, 1989/90.

Policy	Estimated No. of adopters	Percent change	Est. Adoption intensity (%)	Percent change
No. Change	494	-	55	-
Land reform	511	+ 3	59	+ 9
More extenstion contact	511	+ 3	59	+ 9
Taller MVs	522	+ 6	66	+ 22
Irrigation	545	+ 10	81	+ 50
Lower fertilizer price[a]	551	+ 12	86	+ 59

a Urea/Paddy Price ratio reduced from 0.52 (1989/90 level) to 0.5.