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FERTILIZING BEHAVIOUR OF A SAMPLE OF BANGLADESH FARMS

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ABSTRACT

In a sample of 384 farms, 79 per cent applied some fertilizer in the survey year 1976/77, rate of adoption varied from 95 per cent in case of Boro HYV to 41 per cent in case of Jute. Only 37 per cent of recommended doze was applied in Boro HYV compared to 66 per cent for Boro LYV, 76 per cent for Jute, 37 per cent for T. Aman and 30 per cent for Aus. Proper mix was applied to around 60 per cent of Boro LYV and HYV areas and around 20 per cent in case of Aus, Jute and Tobacco. Fertilizing experience, size of farm, tenurial status, availability of institutional credit and purchase of fertilizer from government licensed dealers has significant influence on the rate and mix of fertilizer application.

INTRODUCTION

In a recent note, Quasem (1978) integrated information on farm level utilization of chemical fertilizers from various case studies and reports and then tried to relate variation in application rates to a number of factors. He concluded that (1) fertilizer use is mainly dependent on the crops grown and their productivity, (2) farm size does not have much effect on the use of fertilizers even under unfavourable tenurial system because of serious scarcity of land. He considered his conclusions tentative and recommended more careful study on this aspect.

Data available from a survey conducted in 1976/77 provided opportunity to verify the conclusions of Quasem as well as make more detailed analysis of fertilizing behaviour of the farmers. This was not a planned fertilizer survey but information on fertilizer utilization constituted an important component of the survey. The survey was part of a practical exercise for students taking course on Farm Management given by the author. Data were collected by 20 students from 20 clusters of 20 farms each, the centre of each cluster being the student's own farm family. The 20 clusters are distributed across 10 out of the 20 districts of Bangladesh. Final analysis is based on 384 farms, information from 16 farms being incomplete.

In section II, pattern of fertilizer application is described. In section III, factors influencing the rate and mix of application are identified. A summary is presented at the end.

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PATTERN OF FERTILIZER APPLICATION

Major cropping characteristics of the sample farms are presented in Table 1. Information on minor crops were not collected. It is assumed that exclusion of minor crops will not affect the general pattern of the results.

Table 2 summarizes what in extension terminology may be said to measure 'degree of fertilizer adoption in the aggregate'. It appears that 21.4 per cent of the sample farms did not use any fertilizer and 78.6 per cent farms achieved varying degrees of fertilizer adoption measured by the proportion of the total number of produced crops fertilized and proportion of the total produced crop area fertilized.

TABLE 1. CROPPING CHARACTERISTICS OF THE SAMPLE FARMS

Crop	No. of producers	% of sample farms producing	Hectares produced par producer	% of total cropped area
T. Aman	376	98	1.11	53.7
Aus	260	68	0.80	26.8
Jute	200	52	0.38	9.8
Boro HYV	127	33	0.48	7.8
Boro LYV	45	12	0.28	1.6
Tobacco	20	6	0.11	0.3
All crops	384	100	2.20	100.0

Source; Field survey 1976/77.

TABLE 2. DISTRIBITION OF FARMS ACCORDING TO PROPORTION OF CROPS AND PROPORTION OF CROP FERTILIZED

% of crops fertilized	% of crop area fertilized						
	0	1-29	30-49	50-69	70-89	90-100	All farms
	% of farms						
0	21.4	-	-	-	-	-	21.4
1 – 29	-	2.9	1.1	-	-	-	4.0
30 – 49	-	3.4	3.4	2.3	0.3	-	9.4
50 – 69	-	3.6	5.7	6.5	3.9	1.1	20.8
70 – 89	-	-	-	1.6	3.1	1.6	6.3
90 – 100	-	-	0.8	0.8	2.6	33.9	38.1
All farms	21.4	9.9	11.0	11.0	9.9	36.6	100.0

Source: Field survey 1976/77

It appears that only 33.9 per cent of the farms fertilized 90-100 per cent of the crops as well as crop area produced by them. These 33.9 per cent farms were the Boro HYV producers.

Table 3 presents degree of fertilizer adoption with respect to the selected crops. It appears that 95 per cent of the Boro HYV producers used fertilizer in the crop. Among other crops, degree of adoption was generally low in case of the cash crops. Fifty one per cent of the total crop area under the six crops was fertilized in that year. Taken the crops separately, 98.6 per cent of HYV Boro area was fertilized compared to 33.2 per cent of Jute area.

Column 3 of Table 3 indicates that some of those who reported using fertilizer did not do so on all the plots. Lower adoption rate of fertilizer in case of T. Aman, Jute and Tobacco in spite of specialized extension-credit-fertilizer programme in operation for theses crops should be noted. Probably only those receiving credit under these programmes have used fertilizers in these crops (this will be verified below). The degree of adoption achieved indicates that still there are vast areas where fertilizer was not used. However, the unfertilized areas were under traditional crops having low fertilizer response.

TABLE 3. DEGREE OF FERTILIZER ADOPTION IN SELECTED CROPS

Crop	% producers using fertilizer	% crop area fertilized		% of total fertilized area
		of producers	of users	
T. Aman	47	52.1	92.3	54.6
Aus	51	42.3	82.6	22.1
Jute	41	33.2	94.5	6.4
Boro HYV	95	98.6	100.0	15.0
Boro LYV	67	48.4	93.6	1.6
Tobacco	45	60.3	100.0	0.3
All crops	79	51.2	94.6	100.0

Source: Field survey 1976/77

Table 4 presents the proportion of users and fertilized area with respect to fertilizer mixes applied to selected crops. If a mix of Urea, TSP and MP is considered ‘proper’ or ‘ideal’ then it appears that vast majority of the users for all crops including HYV Boro did not apply a ‘proper’mix. However, the proportion of fertilized area covered by proper mix is relatively high compared to the proportion of users applying a proper mix. This suggests that users of proper mix are relatively large farmers (this is verified below).

Table 5 presents the application rate and the degree of adequacy, measured by adequacy index, achieved in fertilizer application to different crops except Tobacco for which calculations were made but details are not shown. Adequacy index Ai for fertilizer mix i applied to a particular crop is measured thus:

$$A_i = \frac{\Sigma \text{ Quantity of fertilizer } j \text{ in mix } i \text{ applied per hectare}}{\Sigma \text{ Quantity of fertilizer } j \text{ in mix } i \text{ recommended per hectare}} \times 100; \; j = 1,\ldots,k.$$

Thus, adequacy index for a mix of Urea and TSP applied to T. Aman is measured as:

(Quantities of Urea & TSP applied Per treated hectare) / Quantities of Urea & TSP Recommended per hectare) x 100

TABLE 4. PROPORTION OF USERS AND FERTILIZED AREA ACCORDING TO MIXES OF FERTILIZERS USED IN SELECTED CROPS

Crops	Mix of fertilizers					
	OnlyUrea	Urea, TSP	Urea, MP	TSP	Urea, TSP, MP	All mixes
T. Aman						
% Users	35.8	28.4	1.7	-	34.1	100.0
% Area	29.8	19.6	1.7	-	48.9	100.0
Aus						
% Users	63.6	24.2	1.7	-	11.4	100.0
% Area	64.1	23.2	0.1	-	12.6	100.0
Jute						
% Users	60.5	12.3	13.6	2.5	11.1	100.0
% Area	57.0	9.0	14.3	0.5	19.2	100.0
Boro HYV						
% Users	18.3	32.2	1.5	-	47.9	100.0
% Area	9.6	28.0	2.7	-	59.7	100.0
Boro LYV						
5 Users	40.0	20.0	-	-	40.0	100.0
% AArea	31.4	6.0	-	-	62.6	100.0
Tobacco						
% Users	66.7	-	11.1	-	22.2	100.0
% Area	68.5	-	11.9	-	19.6	100.0

Source: Field survey 1976/77

TABLE 5 QUANTITIES OF DIFFERENT FERTILIZERS APPLIED AND ADEQUACY INDICES BT TYPE OF CROP AND MIX OF FERTILIZER USED

Fertilizer mix	Kg applied per treated hectare				Adequacy index Ai			
	Urea	TSP	MP	Total	Urea	TSP	MP	Total
T. Aman								
Urea	54.1	-	-	54.1	53	-	-	53
Urea, TSP	61.0	51.5	-	112.5	60	50	-	55
Urea, MP	29.2	-	40.8	70.0	29	-	107	50
Urea, TSP, MP	46.7	39.4	15.7	101.8	46	39	41	42
All mixes	51.5	42.8	16.2	89.4[a]	50	42	43	37
Aus								
Urea	49.5	-	-	49.5	49	-	-	49
Urea, TSP	66.8	54.4	-	121.2	65	53	-	59
Urea, MP	91.4	-	60.9	152.3	90	-	160	109
Urea, TSP, MP	32.8	44.9	18.7	96.4	32	44	49	40
All mixes	51.5	51.0	19.2	72.2[a]	50	50	51	30
Jute								
Urea	49.9	-	-	49.9	88	-	-	88
Urea, TSP	45.8	68.6	-	114.4	80	264	-	138
Urea, MP	94.0	-	50.1	144.1	165	-	135	153
TSP	-	114.2	-	114.2	-	439	-	439
Urea, TSP, MP	53.3	62.5	48.8	164.6	94	240	132	137
All mixes	56.5	65.3	49.3	91.5[a]	99	251	133	76
Fertilizer mix	Kg applied per treated hectare				Adequacy index Ai			
	Urea	TSP	MP	Total	Urea	TSP	MP	Total
Boro HYV								
Urea	95.0	-	-	95.0	40	-	-	40
Urea, TSP	118.4	118.4	-	236.8	49	65	-	56
Urea, MP	57.1	-	22.8	79.9	24	-	20	23
Urea, TSP, MP	84.1	88.8	31.0	203.9	35	49	27	38
All mixes	94.0	98.3	30.6	199.3[a]	39	54	27	37
Boro LYV								
Urea	93.1	-	-	93.1	91	-	-	91
Urea, TSP	109.2	79.4	-	188.6	107	78	-	92
Urea, TSP, MP	81.9	74.3	36.2	192.4	80	73	95	88
All mixes	87.1	74.8	36.2	161.0[a]	85	73	95	66

a. Components do not add up to total because the rates are based on treated area.

Source: Field survey 976/77

Results show that indices for both 'proper' and 'improper' mixes are generally very low in the case of T. Aman, Aus and HYV Boro. As a result, adequacy of overall mix in these crops is relatively low. Adequacy indices in the case of Jute, Boro LYV and Tobacco are on a higher plane, but there are some interesting features in these cases. In case of Jute, adequacy indices of 4 out of 5 mixes are substantially higher than 100 per cent; even users of only Urea applied nearly the recommended amount. Similar indices were computed in the case of tobacco. In the case of Boro LYV each of the different mixes is independently nearly adequate but the overall mix is not. Adequacy index of the proper mix is the lowest compared to improper mixes in all crops except Jute in which case index of the proper mix is the second lowest. Without yield records the rationale of so high indices of independent mixes in Jute, Tobacco and Boro LYV cannot be established. Complete yield data were not available to permit examination of this pattern.

Analysis of degree of fertilizer adoption (Tables 2-4) and adequacy indices (Table 5) indicate good potential for expanding the use of proper mixes of fertilizers in Boro HYV and greater quantities in proper mixes in the case of other crops. Expanded fertilizer application is expected to increase output substantially. To achieve this, application of TSP and MP need to be increased substantially. This conclusion is valid provided the current recommended dozes are correct. Questions about the appropriateness of currently recommended dozes have been raised elsewhere (Jabbar 1980).

FACTORS INFLUENCING RATE AND MIX OF FERTILIZER APPLICATION

It was hypothesized that, among others, the following factors individually and collectively influenced the rate and mix of fertilizer application : (1) fertilizing experience measured by the number of years since the farmer first applied fertilizer to any crop(s), (2) the size of total holding in acres owned by a farmer, (3) the size of total cultivated area in acres, (4) the size of the specific crop in acres, (5) tenurial status with respect to specific crops and (6) source of credit. For purpose of the analysis producers of a particular crop were cross-classified according to rate/mix of fertilizer application on the one hand and category/dimension of a specific factor on the other. The mixes of fertilizers identified are, no fertilizer; only urea; urea, TSP/MP; urea, TSP, MP. Rates of application varied between crops, hence different class intervals were used for different crops. Different class intervals were also used in case of size of holding, cultivated area and crop area. Three sources of credit were considered: none, private and institutional. If a farm borrowed from both private and institutional sources, it has been identified with the institutional category. To relate each factor to the rate and mix of fertilizer application Chi^2 test was applied. The test was not applied to tobacco.

Fertilizing experience appears to be the most important factor influencing both rate and mix of fertilizer application. With experience, farmers applied greater quantities of fertilizers and also gradually moved from an improper to a proper mix of fertilizer (from no fertilizer to only Urea, to Urea and TSP/MP to Urea, TSP and MP). Among the sample farms, producers of HYV Boro were the most experienced in fertilizer application (Table 7) and they were shown earlier to be the highest fertilizer adoptors (Tables 2-3).

Another aspect of fertilizing behaviour with respect to experience is that a farmer may not start fertilizing all his crops at the same time but extend fertilizer application to different crops with experience. For example, 53 per cent of T. Aman producers did not apply fertilizer to the crop in the survey year (Table 3) yet only 28 per cent of the same farmers reported having no experience with fertilizer application (Table 7). That means, 25 per cent of Aman producers had experience of fertilizer application in crop(s) other than T. Aman.

Table 6. Relationship between selected factors and rate and mix of fertilizer application in selected crops.

Crop	Rate of application		Mix applied	
	Degrees of freedom	Estimated Chi^2	Degrees of freedom	Estimated Chi^2
Fertilizing Experience				
T. Aman	30	111.50**	25	146.12**
Aus	30	99.34**	25	111.95
Jute	30	58.82**	25	62.31**
Boro HYV	30	48.77**	25	141.22**
Boro LYV	30	36.15	25	39.85**
Area of land owned				
T. Aman	42	90.82**	35	48.76
Aus	42	61.58*	35	50.27
Jute	36	36.08	30	23.88
Boro HYV	36	48.18	24	20.95
Boro LYV	42	47.21	28	37.24
Area of land cultivated				
T. Aman	36	43.39	30	47.62*
Aus	36	8.23	30	94.89**
Jute	30	18.68	25	22.82
Boro HYV	30	32.74	20	26.16
Boro LYV	30	28.26	20	42.72**
Area devoted to the specific crop				
T. Aman	30	59.42**	25	137.51**
Aus	30	45.66**	25	18.10
Jute	30	19.55	25	14.97
Boro HYV	30	31.93	20.21	37.21*
Boro LYV	12	21.95*	8	16.17*
Tenurial status with respect to specific crop				
T. Aman	12	21.49*	10	17.55
Aus	12	3.89	10	16.91
Jute	12	9.21	10	17.84
Boro HYV	12	13.10	8	5.13
Boro LYV	12	18.95	8	13.003
Source of Credit				
T. Aman	12	3.92	10	15.17**
Aus	12	11.55	10	15.04
Jute	12	41.33*	10	13.42
Boro HYV	12	18.19	8	2.98
Boro LYV	12	12.74	8	4.37

*, ** respectively indicate significan at 5% and 1% level of error.
Source: Field survey 1976/77

Influence of the size of ownership of holding on both rate and mix of fertilizer application seems to be less prominent than the size of cultivated holding and the size of specific crop. In general, the larger the size of cultivated holding, the better was the mix of fertilizer application. Such relationships were traced partly in the source of supply of fertilizer. Officially, registered retail dealers are the only source of fertilizer for farmer users. But 30, 39, 34, 33 and

61 per cent of T. Aman, Aus, Jute, Boro HYV and Boro LYV producers respectively reported buying fertilizer from unregistered dealers or from the local market. Taking all the crops, 34 per cent of fertilizer users bought at least some fertilizer from unregistered sellers. These percentages roughly correspond to the percentage of producers using improper combination of fertilizers (Table 4). Most of the larger farmers bought fertilizers from retail dealers who insist on selling proper mix. Unregistered sellers mostly buy Urea and some TSP from the registered dealers. Therefore, users buying from unregistered sellers are likely to apply improper mixes.

Table 7. Fertilizing experience of sample producers of selected crops

Experience, years	% producer by crop					
	T. Aman	Aus	Jute	Boro HYV	Boro LYV	All crops[a]
None	28.2	37.5	29.3	10.3	15.8	21.1
1	3.4	1.5	1.0	4.0	-	7.6
2 – 3	16.0	17.2	16.8	17.5	13.2	9.3
4 – 5	18.7	10.4	11.5	19.0	35.5	13.8
6 – 7	8.7	7.7	9.9	13.5	7.9	12.8
8 & above	25.0	25.7	31.5	35.7	27.6	35.4
Total	100.0	100.00	100.0	100.0	100.0	100.0

a. This column if calculated on the basis of the total sample which include other crops thanthose mentioned in this table.
Source: Field survey 1976/77

Institutional sources of credit had positive influence on mix of fertilizer in case of T. Aman and on rate of fertilizer application in case of Jute (Table 6), but nearly the same proportion of producers of all the selected crops borrowed from institutional sources (Table 8). There may be two explanations for this pattern. First, there were special credit programmes for both T. Aman and Jute, and fertilizer users in these two crops might be those who had access to institutional credit. The credit offered in this case was in-kind. Second, institutional credit borrowed for other crops might not have been used for purchasing fertilizer and fertilizer purchase might not have been intended while borrowing. Quantitative evidence on this cannot be provided because information on the purposes of seeking and using loans was not collected in the study.

Tenurial status does not appear to influence the rate and/or mix of fertilizer application (Table 6). Defining tenure status was a problem since a farmer might be a tenant in case of Boro LYV production but owner operator with respect to other crops. Since cropwise analysis has been done, the definitional problem has been taken well care of but the effect of specific tenure status on rate and mix of fertilizer has not become automatically explicit. Moreover, size of land ownership has some relationship with tenurial status. For example, large land owners are generally part-operators, medium owners are generally owner-operators while small owners are part-tenants. In case of part-tenants, one has to compare own land with rented land irrespective of size. In such situation isolation of the influence of size and tenure may be difficult. However,

more detailed data on the influence of tenure on rate and mix of fertilizer application are presented in Table 9.

Table 8. Proportion of producers of selected crops according to source of credit

Source of credit	% producer by crop					
	T. Aman	Aus	Jute	Boro HYV	Boro LYV	All crops
None	22	26	26	20	15	23
Private	20	18	22	25	28	22
Institution[a]	58	56	52	55	58	55
All sources	100	100	100	100	100	100

[a.] A farmer borrowing from institutional source(s) might also have borrowed from private source(s).
Source: Field survey 1976/77

The table indicates the following: (1) Incidence of share tenancy differ among crops, the proportion of pure tenants being highest in the case of Boro HYV and Boro LYV. (2) The degree of adoption of fertilizers do not differ substantially between tenure classes in case of Boro HYV but the degree of adoption differ substantially between tenure classes in the case of other crops; higher proportion of owner-operators used fertilizers compared to tenants and part-tenants. (3) Rate of application does not show any consistent pattern. In case of T. Aman, Boro LYV and Tobacco, rate of application was lower for tenants and rented land of part-tenants compared to own land of part-tenants and owner-operators; in case of Aus and Jute, part-tenants applied much less than owner-operators and tenants; in the case of Boro HYV, the rate of application does not seem to differ between tenure classes.

The degree of adoption and rate of application for all crops including Boro HYV can be explained to a great extent by established economic theory. Half crop sharing without input sharing cover 99 per cent of tenancy in Bangladesh (BBS 1978). Although detailed data on rental terms were not collected for the present study, it can reasonably be assumed that the national pattern would be applicable to the present sample. Under such arrangement, there is little incentive for the tenant to use adequate fertilizer because half of the additional output due to fertilizer is shared by the land owner without sharing any cost. Therefore, tenant will apply fertilizer at such rate where half the value of the marginal product of fertilizer equals the cost of the marginal unit of fertilizer. Application rates between owner farm and tenant farm or between own and rented land of part-tenant farm should not differ if the fertilizer cost is equally shared by the two parties (Bishop and Toussaint 1966). Costs were not shared in the case of Boro HYV yet application rates were generally much higher than other crops and rates did not differ between tenure classes. The most plausible explanation is that fertilizer to output ratio price is very high in case of Boro HYV so that half the value of marginal product of fertilizer covers at least the cost of the marginal unit of fertilizer. From the point of view of economic rationality, such a decision rule is totally justified but from the welfare point of view it is not. This decision rule results in highly unequal distribution of the benefits of fertilizer (and similar inputs) in favour of the land owner. To put it more simply, the degree of exploitation is much higher with high productivity inputs than with traditional inputs. In a land scarce situation as in Bangladesh, tenants are highly exposed to such exploitation as the above finding reveals.

Table 9 Fertilizing behaviour according to tenurial status in selected crops

Crop	Tenure Class			
	Owner-Operator	Part-tenant	Tenant	All classes
% of total producers by crop				
T. Aman	56.1	36.5	7.4	100
Aus	58.5	30.7	10.8	100
Jute	68.5	17.0	14.5	100
Boro HYV	59.1	16.5	24.4	100
Boro LYV	64.5	11.1	24.4	100
Tobacco	70.0	20.0	10.0	100
% producers using fertilizer				
T. Aman	52.0	40.9	35.7	46.8
Aus	56.6	38.8	53.6	50.8
Jute	43.1	38.2	31.0	40.5
Boro HYV	96.0	95.2	90.6	95.3
Boro LYV	65.5	100.0	54.5	66.7
Tobacco	50.0	25.0	50.0	45.0
% of crop area fertilized				
T. Aman	61.6	42.6/33.6a	45.9	52.1
Aus	54.0	29.6/17.8	38.1	42.3
Jute	32.8	35.7/44.33	19.5	33.2
Boro HYV	98.9	98.9/96.4	98.8	98.6
Boro LYV	43.6	76.2/60.6	45.0	48.4
Tobacco	69.0	53.3/0.00	62.3	60.3
Kgs applied per treated Hectare				
T. Aman	87.8	101.5/77.7[a]	68.6	87.8
Aus	74.1	56.7/63.1	100.6	72.2
Jute	100.6	64.9/66.7	104.2	92.4
Boro HYV	198.4	206.5/180.1	213.1	199.3
Boro LYV	181.0	186.5/153.6	115.1	161.8
Tobacco	107.9	285.3/0.00	102.4	128.0

[a.] The first figure refers to own land and the second figure to land rented from others.
Source; Field survey 1976/77

SUMMARY AND CONCLUSIONS

A survey of 384 farms in 1976/77 revealed that 79 per cent of the farms used some amount of fertilizer in that year. Taken separately, 95 per cent of Boro HYV, 67 per cent of Boro LYV, 31 per cent of Aus, 47 per cent of T. Aman, 45 per cent of Tobacco and 41 per cent of Jute producers used some fertilizer. Rate of application was inadequate assuming that the recommended dozes are correct. Only 37 per cent of the recommended doze was applied to the fertilized area under Boro HYV, compared to 66 per cent for Boro LYV, 76 per cent for Jute, 37 per cent for T. Aman and 30 per cent for Aus. Proper mix of fertilizers was applied to 60 per cent of the fertilized area under Boro HYV compared to 63 per cent, 49 per cent, 13 per cent, 19 per cent and 20 per cent respectively under Boro LYV, T. Aman, Aus, Jute and Tobacco. A large part of the fertilized area was treated with only Urea.

Fertilizing experience was the most important on-farm factor influencing rate and mix of fertilizer application. With experience users moved from an improper to a proper mix. Availability of institutional credit and purchase of fertilizers from government licensed dealers positively influenced rate and mix of application. Size of ownership of holding, the size of cultivated holding and the size of land under specific crop were found to be positively related to the rate and mix of application. Tenurial status also had significant influence in case of traditional crops but not so in case of Boro HYV. Application rate was generally lower for tenant farms and for rented land of part-tenant farms compared to owner-operators and own land of part-tenants in case of traditional crops. Although there was no evidence of cost sharing in case of Boro HYV, application rates did not differ between tenure classes. This was probably because high marginal product of fertilizer provided adequate returns to tenants. However, land owners derive most benefit of fertilizer and this is undesirable from welfare point of view.

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