Economic Effects of Land Infrastructure on Agricultural Production in Bangladesh

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Economic Effects of Land Infrastructure on Agricultural Production in Bangladesh[†]

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We analyse how and to what extent land infrastructure affects productivity and profitability of High Yielding Variety (HYV) Boro rice production in Bangladesh. In our study, "land infrastructure" refers to some basic physical characteristics and facilities of farmland such as farm size, land fragmentation, and irrigation & drainage systems. Our empirical study reveals that in small, fragmented farmlands, production cost is higher, productivity is lower and profitability is marginal. While weak land infrastructure practically discourages the operation of modern agricultural facilities such as irrigation ones, usually large farmers benefit by them, if available. Our study also makes some policy prescriptions to approach these farm problems.

1. Introduction

Bangladesh agriculture is characterized by very low level of agricultural productivity. The goal of accelerating economic growth cannot be realized unless agricultural productivity is increased substantially. Being an extremely land scarce economy coupled with continuous high growth of population, virtually there is no scope for expansion of cultivable area as a source of growth of her agricultural production. Although the country receives huge average annual rainfall ranging from 1194 to 3454 millimetres, the problem lies in its highly uneven seasonal distribution. During the monsoon season (mid-June to mid-September) the high level of rainfall increases the water flow of the big rivers and the riverbeds become unable to carry it causing extensive floods on the flat terrain. In the remaining nine months of the year, rainfall in most of the parts of the country is so scanty that effective rice cultivation is impossible without irrigation. So, insufficient development and ineffective management of land infrastructure hinders the growth of agricultural production in Bangladesh. Land infrastructure has a wider connotation embracing various components of infrastructure pertaining to farmland. In our study, "land infrastructure" refers to some basic physical characteristics and facilities of farmland such as farm size, land fragmentation, and irrigation & drainage systems. The heavy monsoon rain down the Gangetic Plain into eastern India and Bangladesh reduces the benefit from irrigation in the wet season. More crucially, the small farm size and

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fragmented holdings make it uneconomical for most farmers to install pumps individually. The inability of private profit incentives to allocate resources efficiently to the development of land infrastructure is more pronounced in the case of gravity irrigation systems in communities of small peasants (Hayami and Ruttan 1985). Several studies (e.g., Mandal 1987; Biswas 1985; Jaim 1993) have been carried out so far focusing on the importance and management of irrigation in Bangladesh agriculture. Ando *et al.* (1991) observed in their case study in a northwest Bangladesh village (Tetulia) that *Chaunia* (a peculiar land tenancy system in which a land owner seasonally rents out a piece of land to a Shallow Tubewell (STW) owner who operates the land for a fixed amount of rent) afforded the STW owners much greater gains than simply selling water to the adjoining land holders. Fujita (1995) reported in his case study of the same village that various contractual arrangements for marketing of STW-water provided a means of giving credit to tubewell non-owners (specially to the small and marginal farmers) and opened a way for their involvement in irrigated rice cultivation. Our study attempts to assess the extent of land infrastructure development in rice field and to examine its impact on productivity and profitability of rice production. It also attempts to determine the nature and extent of changes in land productivity in Bangladesh and identify the factors causing such changes.

2. Methodology

Both primary and secondary data have been used for this study. The secondary information includes, among others, time series data on area and production of rice, use of growth-augmenting inputs such as fertilizer and irrigation in Bangladesh. Primary data were collected in 1999 by Farm Survey in an area comprised of three villages (namely Larua, Valta and Naihati) with similar ecological characteristics from Kahaloo Thana of Bogra district. The study area lies in a diluvial plateau called Barind Tract in northwest Bangladesh and is normally free from regular floods. A total of 63 farmers from the selected area was taken by using stratified random sampling on the basis of their land holdings. Out of the total sample farmers, 46 were small (0.02 – 1.00 ha), 13 were medium (1.01 – 3.00 ha) and 4 were large (3.01 ha and above) farmers (drawing 30% from each category of the population). Tabular technique was mainly followed for this study. Relative profitability of growing high-yielding variety (HYV) Boro rice under the existing land infrastructure with the available resource endowments has been examined on the basis of gross margin (GM) and net return analysis to see farm performances. For measuring growth rate the following model (Gujarati 1995) has been considered:

$Y_t = Y_0(1+r)^t$ where r = the compound (i.e., over time) rate of growth of Y

Y = yield of rice (MT/ha) and t = time (1, 2, 3, etc.).

3. Results and Discussion

Per hectare yield of rice has been considered as a proxy of land productivity for this study. The compound growth rate of rice yield over the period (1976/77 – 1998/99) is estimated to be 2.28 per cent (Table 1). It should be emphasized here, however, that the increase in yield is due to reallocation of land in favor of HYV rather than yield improvement of individual variety. The growth rates among different sub-periods indicate that there has been a serious deceleration or almost stagnation in growth in the recent years (1990/91 – 1998/99). The growth rate for Aman rice has become negative during this period. The negative trend is mainly because of the absolute fall in production in 1994/95 due to severe drought.

Table 1 Yield Growths (per cent) of Rice in Bangladesh (1976/77 - 1998/99)

Type of Rice	1976/77-1998/99	1976/77-1979/80	1980/81-1989/90	1990/91-1998/99
Aman	1.40**	0.79	1.92*	(-) 0.82
Aus	0.93**	0.01	0.74	0.34
Boro	1.48**	1.42	0.35	1.85**
All	2.28**	1.42	2.39**	1.17*

Data Source: Bangladesh Bureau of Statistics;

Note: * and ** denote 5 and 1 per cent level of significance, respectively.

The deceleration or almost stagnation of yield growths in recent years is of major concern in Bangladesh. One of the major causes may be the complete withdrawal of input subsidies and minimum persuasion of price support from 1983/84. The declining trend of growth performances may also be due to the intensification of rice monoculture that deteriorates soil fertility and the rapid expansion of the area under HYV Boro rice may have increasingly led to its cultivation in relatively less suitable lands.

Fertilizer and irrigation are the two modern inputs, which are considered very important in dissemination of modern rice technology. It was observed that fertilizer use increased at an annual rate of 8.00 per cent over the 1976/77 – 1998/99 period (Table 2).

However, the growth in fertilizer use declined from 13.94 per cent during 1976/77 – 1979/80, to 10.49 per cent during the eighties, and further to 4.11 per cent during the nineties. This decline is most pronounced in case of TSP (Triple Super Phosphate) and MP (Muriate of Potash). In fact, TSP has shown a negative growth thereby implying absolute decrease in its use in recent years. The decline in consumption of TSP is due to increase in its price following the removal of explicit subsidy and privatization of the import trade in recent years. Therefore, fertilizer use has become unbalanced resulting from inadequate complementation of non-nitrogenous fertilizer to total application which is adversely affecting soil fertility and land productivity. This becomes more evident when we look at Table 3, which also shows considerable deceleration in growth in fertilizer use in terms of its nutrient contents in recent years.

Table 2 Compound Growth Rates of Fertilizer Use in Bangladesh

(per cent)

Type	1976/77-1998/99	1976/77-1979/80	1980/81-1989/90	1990/91-1998/99
Urea	8.23**	12.87	10.64**	4.73**
TSP	(-) 1.68	14.73	10.10**	(-) 21.88**
MP	9.13**	24.77	10.59**	6.63*
SSP	41.87**	-	-	52.73**
Total	8.00**	13.94	10.49**	4.11*

Data Source: Bangladesh Chemical Industries Corporation (BCIC) and
International fertilizer Development Corporation (IFDC)

Note: * and ** denote 5 and I per cent level of significance, respectively.

Table 3 Compound Growth Rates of Fertlizer Use by Nuitrient Value in Bangladesh

(per cent)

Type	1976/77-1998/99	1976/77-1979/80	1980/81-1989/90	1990/91-1998/99
N	8.29**	12.08	10.65**	4.83**
P205	3.21**	14.51	10.05**	(-) 8.16**
K20	9.13**	24.07	10.62**	6.66*
S	24.27**	-	11.80	58.42**
Total	7.71**	14.16	10.50**	3.56**

Data Source: Bangladesh Chemical Industries Corporation (BCIC) and
International fertilizer Development Corporation (IFDC)

Note: * and ** denote 5 and I per cent level of significance, respectively.

Modern irrigation was introduced in Bangladesh in the early sixties. Trend growth rate of total irrigated area for the period of 1976/77 to 1997/98 is estimated to be 4.99 per cent (Table 4). But the increases in the growth rates from the eighties (4.14) to the nineties (5.45) are not so encouraging. The growth rate of groundwater irrigation over the period is found to be 15.24 per cent but it has sharply declined over different sub-periods

– from 54.06 per cent during 1976/77 – 1979/80 to 15.80 per cent in the eighties, and further to only 8.01 per cent in the nineties. It may be mentioned here that the high growth of groundwater irrigation (both STW and DTW) during the seventies is due to its low base of irrigation development during the period. The decline in growth rate of irrigated area is most pronounced in case of surface water, which showed a negative trend over the period and also in the eighties as well as in the nineties. This can be attributed to a decline in the growth of irrigated areas both through shallow and deep tubewells in the recent years.

Table 4 Compound Growth Rates (per cent) of Irrigated Areas by Ground and Surface Water in Bangladesh (1976/77 - 1998/99)

Mode of Irrigation	1976/77-1997/98	1976/77-1979/80	1980/81-1989/90	1990/91-1997/98
Ground Water				
Deep Tubewell (DTW)	7.95**	50.18	8.35**	8.3*
Shallow Tubewell (STW)	24.91**	105.97	26.54**	8.14**
Hand Tubewell (HTW)	32.18**	-	94.88**	(-)0.12
Sub-Total	15.24**	54.06	15.80**	8.01**
Surface Water				
Low-lift Pump (LLP)	0.52	7.33*	(-)1.49	4.66*
Major canal	1.59**	1.98	0.37	(-)1.16
Traditional	(-) 2.87**	6.73	(-)5.76*	(-)2.63
Sub-Total	(-) 1.91*	6.55	(-)2.81	(-)2.09
Total Irrigation	4.99**	11.22	4.14**	5.45**

Data Source: Bangladesh Bureau of Statistics;

Note: * and ** denote 5 and 1 per cent level of significance, respectively.

The average farm size (cultivated area) of small, medium and large farms in the study area were 0.53, 1.43 and 4.36 hectares (ha), respectively, out of which 98.40, 100 and 94.34 per cent were under rice cultivation. These small farms are also fragmented into a number of very tiny plots. Land fragmentation inhibits not only the adoption of improved production technology but also causes wastage of valuable land. The extreme fragmentation of land in Bangladesh causes high transaction costs for using irrigation water in scattered plots (Fujita 1991). Land fragmentation inhibits not only the adoption of improved production technology but also causes wastage of valuable land. Agricultural holdings without any fragmentation were not absolutely found in the study area. It was found that an average holding of 0.96 hectares is fragmented into 10.06 plots (Table 5). Average number of fragments per farm was observed to increase sharply with the size of farm. Again, when measured in terms of number of fragments per hectare, the degree of fragmentation for the smallest farm size group became almost twice as high as that for the largest farm size group. Thus it implies that small farmers were doubly handicapped with absolute smallness of farm size on the one hand and with higher degree of fragmentation on the other. The problem of fragmentation is becoming more acute perhaps due to higher population growth, higher polarization tendency (through distress sale of land part by part by small farm) and the inheritance law of Bangladesh. Moreover, the increasing transformation of joint family to unit family is also escalating the problem.

Table 5 Extent of Land Fragmentation by Farm Size Groups

Number of fragments per farm	Percentage of total number of farms			
	Small	Medium	Large	All
Non-fragmented	0.00	0.00	0.00	0.00
2-5 fragments	39.14	0.00	0.00	28.57
6-10 fragments	52.17	23.08	50.00	46.03
11-15 fragments	6.52	46.15	0.00	14.29
16 fragments and above	2.17	30.77	50.00	11.11
No. of fragments per farm	6.80	15.56	30.00	10.06
Average farm size (ha)	0.53	1.43	4.36	0.96
No. of fragments per hectare	12.83	10.81	6.88	10.48
Average plot size (ha)	0.08	0.09	0.15	0.10

Source: Field Survey, 1999.

Irrigation has been considered as the leading input in agriculture although it was originally developed in Bangladesh to promote Boro rice production. The introduction of modern irrigation has changed the cropping pattern in the study area, which in turn has increased farmers' income through their accesses to diversified crops. Before introduction of modern irrigation, the most popular cropping pattern was Aus-Aman-Fallow followed by Fallow-Aman-Mustard and Fallow-Aman (Table 6). Farmers were dependent on monsoon rain and therefore, rainfed Aman was the main crop at that time. Some farmers used to grow Broadcast Aus also because it requires less water and shorter growing period. In addition, Aus rice can make efficient use of rain in the later growing stage from May to July (JICA 1990). It was not possible to produce mustard or potato vastly due to lack of irrigation. After introduction of modern irrigation through DTWs and STWs in the study area, it has been possible to replace lower yielding non-irrigated Aus by irrigated HYV Boro. So, Boro-Aman-Mustard has become now the most popular cropping pattern followed by Boro-Aman-Fallow and Boro-Aman-Potato (Table 6). It was also observed that DTW was utilized only for irrigating Boro and other crops such as mustard, potato, cucumber, chilli, etc. were grown under STWs. Because all the farmers in the command area of DTW do not produce potato or mustard in all of their plots. So for irrigating less area, STW as a smaller unit compared to DTW becomes more suitable for its higher capacity use and easier management. Some farmers used to produce those crops by utilizing surface water also through traditional technologies like Swing Basket and Dhoon. However, modern irrigation in the study area has largely given the farmers' access to diversified crops.

Table 6 Changes in Cropping Pattern due to Introduction of Modern Irrigation

Months	No. of observations (plots)			
D J F M A M J J A S O N D	Small	Medium	Large	All
Before Irrigation:				
Fallow – Aus – Aman	201 (65.68)	90 (65.22)	18 (45.00)	309 (63.84)
Fallow – Aman	46 (15.03)	5 (3.62)	11 (27.50)	62 (12.81)
Mustard – Fallow – Aman	46 (15.03)	39 (28.26)	8 (20.00)	93 (19.21)
Potato – Fallow – Aman	9 (2.94)	4 (2.90)	3 (7.50)	16 (3.31)
Fallow	3 (0.98)	-	-	3 (0.62)
Fallow – Potato	1 (0.33)	-	-	1 (0.21)
Total	306(100)	138(100)	40(100)	484(100)
After Irrigation:				
Mustard – Boro – Aman	135 (44.12)	59 (42.75)	13 (32.50)	207 (42.77)
Potato – Boro – Aman	66 (21.57)	21 (15.22)	8 (20.00)	95 (19.63)
Fallow – Boro – Aman	93 (30.39)	54 (39.13)	16 (40.00)	163 (33.67)
Wheat – Boro – Aman	3 (0.98)	2 (1.45)	-	5 (1.03)
Wheat – Fallow – Aman	1 (0.33)	-	-	1 (0.21)
Mustard – Fallow – Aman	4 (1.31)	1 (0.72)	-	5 (1.03)
Chilli – Fallow – Aman	1 (0.33)	-	-	1 (0.21)
Cucumber – Boro – Aman	1 (0.33)	-	-	1 (0.21)
Potato – Fallow – Aman	-	1 (0.72)	-	1 (0.21)
Boro Seedbed – Boro – Aman	2 (0.65)	-	3 (7.50)	5 (1.03)
Total	306(100)	138(100)	40(100)	484(100)

(Figures in the parentheses indicate share in percentage)
Source: Field Survey, 1999.

Drainage is also considered to be important for crop production to remove the excess water from the field. In the study area, no permanent drainage structure was found to drain out the excess water of irrigation. It was observed that the plots by the side of the main irrigation channel as well as the plots surrounding the pumping machine (i.e. DTW) remained submerged under water due to seepage and percolation through the earthen channel. Since there is no proper drainage facility, water logging for long time may hamper plant growth resulting lower yield of Boro rice. The farmers of the study area report that water logging due to heavy monsoon rainfall sometimes hamper production of Aman rice in the wet season. Therefore, drainage perhaps is of great importance in case of Aman rice production.

The pattern of technology adoption by different farm size groups has been measured here in terms of the percentage of adopters to the total farm households. In the study area it was found that 99 per cent of Boro crop was under HYV and only 1 per cent was under Local Improved Variety that was locally known as ‘Kalimbom’. The farming

Table 7 Adoption of Modern Technology by Farm Size Groups in Boro Rice Production

(percentage)

Technology	Small	Medium	Large	All
High Yielding Variety	100.00	100.00	100.00	100.00
(HYV)	95.65	100.00	100.00	96.83
Fertilizer	56.52	92.31	100.00	66.67
Pesticide	100.00	100.00	100.00	100.00
Modern Irrigation	-	-	-	-
Tractor	60.87	92.31	100.00	69.84
Power Tiller	-	7.69	25.00	3.17
Seed Treatment	100.00	100.00	100.00	100.00
Transplanting in Line	-	-	-	-
Mechanized Weeder	6.52	23.08	25.00	11.11
Sprayer	-	-	-	-
Harvester	-	7.69	25.00	3.17
Paddle Thresher				

Source: Field Survey, 1999.

practice in the study area has become modern to some extent and the farmers have become advanced in adopting HYV, fertilizer, insecticide and irrigation. Again, in case of some modern inputs, modern implements and modern farming practices, large farmers were found to adopt more in comparison with medium and small farmers (Table 7). This may be due to their better capital possession and higher education compared to other farm categories.

Per hectare total cost of producing HYV Boro was estimated at Tk.25933.12, whereas it was Tk.26135.30, Tk.24858.65 and Tk.24705.07 for small, medium and large farms, respectively (Table 8). Therefore, total cost was found to be lower in case of large farms compared to small and medium farms. This is due to their less use of human labor, which is the major cost item in HYV Boro production. Human labor cost (prevailing wage rate of agricultural labor was considered as opportunity cost for family labor as demand of labor was high in the area) was the highest for small farms because they employed the highest number of human labor dominated by family labors (128.44 man-days of which 70.42 were family labors) compared to medium (113.72 man-days of which 25.42 were family labors) and large farms (90.09 man-days of which 7.11 were family labors). Less involvement of small farms in off-farm activities has perhaps led them to be employed more in farming activities. Again, for land preparation, large farms utilized Power Tiller and therefore, labor cost became lower for them. Fragmentation in the study area caused loss of productive time as the farmers had to travel unproductively to drive work animals and carry tools, seeds, fertilizers, etc., between scattered plots. Therefore, higher degree of fragmentation also caused increased labor input for small farms compared to medium and large farms.

Table 8 Per Hectare Costs of Growing HYV Boro Production According to Farm Groups

Items of cost	Quantity				Unit Price (Tk.)	Cost (Tk.)			
	Small	Medium	Large	All		Small	Medium	Large	All
Human Labor (man-day)	128.44	113.72	90.09	22.98	60.00	7706.40	6823.20	5405.40	7378.80
Draft Power:									
Animal labor (pair-day)	16.75	8.86	.66	14.48	55.00	921.25	487.30	366.30	796.40
Power Tiller (Tk.)	-	-	-	-	n.a	665.40	990.96	1065.06	907.14
A. Total Non-material Cost						9293.05	8301.46	6836.76	9082.34
Seed (Kg)	49.87	47.67	51.25	49.50	14.50	723.12	691.22	743.13	717.75
Manure:									
Cow-dung (Kg)	7998.68	5945.03	8185.78	7586.78	0.16	1279.79	951.20	1309.72	1213.88
Oilcake (Kg)	38.96	37.53	150.68	45.76	6.00	233.76	225.18	904.08	274.56
Fertilizer:									
Urea (Kg)	166.47	151.17	207.37	165.91	5.89	980.51	890.39	1221.41	977.21
TSP (Kg)	89.46	91.82	72.89	88.90	12.46	1114.67	1144.08	908.21	1107.69
MP (Kg)	60.64	74.71	60.54	63.53	8.39	508.77	626.82	507.93	533.02
Gypsum (Tk.)	26.63	31.00	45.35	28.72	3.46	92.14	107.26	156.91	99.37
Pesticide (Tk.)	-	-	-	-	n.a.	238.11	335.94	424.65	270.14
Irrigation (Tk.)	-	-	-	-	n.a.	3910.92	3843.49	3952.93	3899.67
B. Total Material Cost						9081.78	8815.58	10128.97	9093.30
Total Variable Cost (A+B)						18374.83	17117.04	16965.73	18175.64
C. Land Use Cost*						7484.85	7484.85	7484.85	7484.85
D. Interest on operating capital						275.62	256.76	254.49	272.63
Total Fixed Cost (C+D)						7760.47	7741.61	7739.34	7757.48
Gross Cost (TVC+TFC)						26135.30	24858.65	24705.07	25933.12

n.a. = not applicable, TVC= Total Variable Cost, TFC= Total Fixed Cost

*Land use cost has been estimated on the basis of cash rent of land for only Boro production in the study area.

Note: Depreciation has been ignored because it appeared negligible as most of the farmers used traditional tools and equipment. Farmers paid cash to owner of Power Tiller for ploughing their land on the basis of frequency of ploughing per unit of land.

Per hectare yield of HYV Boro was found to be 4425.76 kg, whereas it was 4372.95, 4498.13 and 4797.85 kg for small, medium and large farms, respectively (Table 9). The application of different types of fertilizer is yet far below the recommended level of HYV rice (100:80:60 kg/ha active ingredients of NPK). Especially the use of TSP and

Table 9 Per Hectare Return from HYV Boro Production by Farm Groups

Particulars	Unit	Small	Medium	Large	All
1. Yield (Product)	Kg	4372.95	4498.13	4797.85	4425.76
2. Price	Tk./Kg	6.25	6.25	6.25	6.25
3. Return from Product (1	Tk.	27330.94	28113.31	29986.56	27661.00
4. Return from By-produc	Tk.	1905.07	1882.44	2692.98	1950.43
5. Gross Return (3+4)	Tk.	29236.01	29995.75	32679.54	29611.43
6. Gross Margin (5-TVC)	Tk.	10861.18	12878.71	15713.81	11435.79
7. Net Return (5-Gross C	Tk.	3100.71	5137.10	7974.47	3678.31

Source: Field Survey, 1999.

MP is markedly lower than the recommended level. So, fertilizer use is insufficient on one hand and it is unbalanced on the other. Such type of fertilizer use dominated by Urea is causing damage to soil structure and thereby gradually lowering yield per unit of land. Again, most of the farmers were found to use mostly home supplied seed. But HYV seeds may be degenerated for its uses over the years. So, using home supplied seed, higher yield target may not be achieved for lack of its proper quality. Gross margin was calculated as Tk.11435.79, whereas it was Tk.10861.18, Tk.12878.71 and Tk.15713.81 for small, medium and large farms, respectively. The net return (i.e. profit) per hectare was found to be Tk.3678.31, whereas it was Tk.3100.71, Tk.5137.10 and Tk.7974.47 for small, medium and large farms, respectively (Table 9). The return per unit of labor was calculated as Tk.152.99 per man-day, whereas it was Tk.144.56, Tk.173.25 and Tk.234.42 for small, medium and large farms, respectively, which were also higher than the prevailing wage rate (Tk.60 per man-day). Return per unit of capital invested (Gross Return divided by Total Variable Cost) was 1.63 whereas it was 1.59, 1.75 and 1.93 for small, medium and large farms, respectively. Return to irrigation per Taka invested was found to be 3.93 implying that if one Taka is spent for irrigation in case of HYV Boro production, it can give a return of Tk.3.93. For small, medium and large farms the figures were 3.78, 4.35 and 4.98, respectively. Therefore, producing HYV Boro under the existing land infrastructure appears to be profitable although it is marginal. It is observed that the large farms are making the highest net return of Tk.7974.47 per hectare and the small farms are earning the lowest net return of Tk.3100.71. Therefore, the performance of large farms in the study area was found to be better than that of medium and small farms.

4. Conclusions and Policy Recommendations

In order to sustain the profitability of HYV Boro rice cultivation using tubewell irrigation, it is necessary among others, to ensure sustained increase in its yield. The issue prices of urea and TSP fertilizer produced domestically are below the costs of production and export parity for urea and import parity for TSP indicating implicit subsidy on domestically produced fertilizer. As a result, the prices of phosphate and potash fertilizer (which are mostly imported) have considerably increased following the removal of explicit subsidy and privatization of fertilizer trade. This has aggravated the imbalance use of fertilizer (excessive use of urea) with adverse effect on soil fertility and crop productivity. It is, therefore, necessary to take appropriate measures to maintain a balance in the relative price ratio of both imported and domestically produced fertilizer.

From entrepreneurial point of view, tubewell owners/managers would need to improve their efficiency pertaining to on-farm water management in a competitive but regulated environment, so that command area per machine is increased and cost of supplying water per unit of land reduced. Vast cultivation of diversified crops may make irrigation more profitable to the farmers as well as to the owners. Development in drainage infrastructure needs both public involvement and private participation. The government should help make planning for drainage infrastructure and provide financial support to the farmers.

To lessen the degree of fragmentation of land holdings, government may initiate land consolidation project involving farmers' compulsory participation. Since there is no alternative to intensive production strategy for accelerating crop production through expansion of minor irrigation, HYV seeds with complementary use of pesticides and higher doses of chemical fertilizer, its implications for environment should also be considered. Government should also ensure good quality seed, price support for output, institutional credit especially to the small farmers and strengthened extension services to promote agricultural production in the study area as well as in Bangladesh.

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