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DECLINING RETURNS FROM GROUND WATER IRRIGATION IN BANGLA DESH

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ABSTRACT

This paper presents an analysis of returns from major groundwater irrigation technologies-deep tubewells and shallow tubewells-on the basis of a number of recent studies conducted in different areas of Bangladesh. The inter-year comparisons revealed that the returns of tubewell owners/managers as well as water users from irrigated HYV paddy production have significantly declined over the years, and the current level of returns are too low to provide incentives for improving performance of Irrigation or production. The major factors associated with the decline in returns from irrigation appeared to be a decline in yields, an increase in production costs and operation and maintenance costs, and very low harvest prices of paddy. Some areas of government interventions are suggested.

I. INTRODUCTION

The literatures on the irrigation development of Bangladesh have stressed primarily the supply-side problems of irrigation and related inputs, and suggested technical, organizational and structural solutions (Biswas *at a/.* 1978; Murshid, 1985; Sattar and Bhuiyan, 1985; and Boyce, 1987). But surprisingly, have these studies given little importance to the economics- of irrigated crop production, which might have caused demand-side problems from the irrigated farmers' point of view. Until very recently, profitability of irrigated crop production was not questioned nor evaluated to any great extent, mainly because the production of HYV boro paddy production was highly profitable until early seventies, when irrigation, fertilizers and other inputs were heavily subsidized and prices of inputs and output were more favourable. It was not therefore surprising that the costs and returns of Irrigated crops and the economic efficiencies with which the irrig3tion equipment operated were being

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in different locations of the country were not mentioned in the important reviews of irrigation performance (eq. GOB, 1982; 8ottrall, 1983).

In recent years, returns from irrigation is believed to have declined, although the regional divesities in terms of physical and environmental conditions precludes any valid generalization. However, the government seems to have expressed concerns in important reviews (GOB, 1987). The major reason for such concerns is that the declining profitability of irrigated paddy production is likely to slow down the expansion of Irrigation and thus may affect the performance of emerging irrigation water market. The reversal of this situation warrants empirical understanding about the extent and causes of decline in returns from irrigation in different areas of the country.

This paper attempts to examine the issues related to the costs and returns of tubewell irrigation from both tubewell owners' and water users' point of views with a modest intention to derive general conclusions. For limitation of data, the study limited itself to only deep tubewell and shallow tubewell irrigation, although it is admitted that other farms of irrigation technologies such as hand tubewells, low-lift pumps and manually operated pumps are also important.

Section II of the paper deals with the methodology and sources of data used in the study. Returns to water users and returns to tubewell managers/owners are discussed respectively in sections III and IV. Section V discusses the returns from irrigation in a more general context and concluding remarks are made in the final section.

II. METHODOLOGY AND DATA

This paper is based on an analysis of data as available from three independent sources as follows :(i) primary data with respect to irrigated HYV boro paddy cultivation, collected during 1988 irrigation season from a sample of DTW and STW owners/managers and water users in Ghatail Upazila of Tangail district; where one-fourth share of crops was paid as water charges; (II) farm level data collected during several extensive field surveys to North Bengal districts, Comilla and Chittagong in 1938 irrigation season; and (iii) published and unpublished research reports in relation to tubewell irrigation.

The Ghatail survey was conducted on a cluster of 6 DTWs and 29 STWs located in the vicinity of eight contiguous villages of Jamoria union of Ghatail upazila in Tangail district. In each of the command areas of the sample tubewells, data were collected from the managers/owners and five other randomly selected farmers during the 1988 irrigation season. There were altogether 35 managers/owners and 175 farmers who were interviewed with structured questionnaires. A detailed socioeconomic background of the study area and sample farmers and a description of the survey procedures are given in Mandal (1989).

III. RETURNS TO WATER USERS

Returns from DTWs and STWs

Costs and returns of HYV boro paddy production have been calculated on the basis of the farm survey. In DTW schemes, net return over total cost for owned land under one-fourth crop share paid as water charge with some added payment for the linemen in terms of paddy per unit of land was on the average as low as Take 1865 per hectare (Table 1)[2]. This allowed, after deductions for the bank interest on the operating capital @ 16% and recently increased land tax, very little for the management services. This situation was far worse in the case of share-cropped land. When all costs of inputs including family labour were considered, net returns from share-cropped land became negative; the share-croppers did have some returns over the cash expenses which meant that they had been paid for their family labour at rates much below the going wage rates. Under the system where charge was paid as fixed cash per unit of land, the rate being Take 1666 per ha., net return appeared to be Take 6586 per ha[3]. With regards to the type of tubewells, net returns per hectare irrigated under STW was about twice as much under DTW, the major reason for this difference being about 17 percent higher yield under STWs than DTWs. This result is consistent with our earlier results, but why was this difference in yield levels ? One plausible explanation based on our field experience was that the timing and quantity of water delivery under STW was better than under DTW. Another explanation was the STW own are had better control over siting of their tubewalls and also over the selection or ‘screening of plots' so that more of better quality plots in terms of good soil and location were irrigated by STWs.

Table 1. Cost and Returns of HYV Boro Paddy Cultivation (Tk/ha) by Water Payment System and Land Tenure in Ghatail, Tangail, 1988

Variables	Share payment				Fixed payment
	DTW		STW		DTW
	Own land	Share-land	Own land	Share-land	Own land
Family labour	3861	4180	2718	3895	1953
Hired labour	3308	2363	4282	3098	4599
Family tillage	2600	2759	2544	1774	1806
Hired tillage	24	—	174	554	272
Seedlings	1799	1658	1968	2123	1988
Fertilizers	1904	1807	1804	1756	2059
Water	4408	1978	5209	2779	1666
Insecticides	—	—	5	—	—
Total cost	17905	14747	18706	15979	14343
Total cash cost	9644	6149	11516	8258	8598
Net income over total cost	1865	-6154	3445	-4042	6586
Net income over cash cost	10125	2444	10635	3672	12332

Source : Farm survey, 1988.

Changes in Returns Overtime

In this snction, we will discuss the change over time with respect to the major indicators of profitability of HYV boro paddy production in Ghatail area. It was estimated that net returns over total costs had declined both in nominal and real value terms between 1985 and 1988, variations in net returns depending on the system of payment for water, type of technology and the tenurial status of land (Table 2). The major factors responsible for such decline in profitability of boro cultivation were reported to be the decline in HYV boro yields, increase in production costs as a result of increase in nominal wage rates and prices of purchased inputs, and at the same time very small increase in paddy prices. For example, in the case of owned land in DTW schemes which operated under one-fourth crop-sharing with water, yield per

Table 2. Changes in Costs and Returns Per Hectare of HYV Boro Paddy in Ghatail, Tangail, Between 1985 and 1988.

Water payment System and Technology	Yield (kg/ha)		Cost of Production (Tk/ha)		Net returns (Tk/ha)		
	1985	1988	1985	1988	1985 (Nominal value)	1988 (Nominal value)	1988 (Real value)
Crop-share paymant							
DTW							
Own land	5476	4126	16064	17905	7482	1864	1462
Sharecropped land[2]	4591	3572	11566	14747	-1694	-6154	-7848
STW							
Own land	5690	4678	16687	18706	7780	3445	2701
Sharecropped land[2]	5173	4951	12535	15979	-1413	-4042	-5155
Fixed cash payment							
DTW							
Own land	5885	4324	12502	14343	12801	6485	5084
Sharecropped land	5780	—	11791	—	—11	—	—

1. Net returns in real value terms are calculated by deflating the nominal returns in 1988 with 0.784, which is obtained as the ratio between general consumer price index numbers of 1984-85 and 1987-88, considering 1973-74 as the base (for reference see BBS, 1990, Table 10.13, P. 473).
2. In case of sharecropped land, the sharecroppers received only a half of the gross output but paid for all costs, except that landowners paid a half of water changes which were paid from the field as one-fourth share of crop

Source : Calculated from BAU, 1985, Tables 6a and 14 ; Farm survey 1988.

hectare declined by 21 per cent, paddy harvest price increased by 7 per cent, total cost of production excluding water charges which were paid as one-fourth share of harvested crop, increased by 64 per cent, and net return over total cost declined by about 75 per cent in nominal terms and by about 80 percent in real value terms between 1985 and 1988 (Table 2 and Appendix

Table 1). It may also be noted that the undiscounted benefit-cost ratios in the case of owned land under deep tubewells were 1.5 and 1.1 for 1985 and 1988 respectively; while those under shallow tubewelli were 1.5 and 1.2 for 1985 and 1988 respectively.

Ofcourse yields and hence returns to water users varied between villages, regions and years depending on soils, topography, date of planting, rainfall, and also cropping intensity. But why have yields of HYV boro declined over the years ? A part of the explanation may be that the average fertilizer use per unit of boro land declined overtime. For example, a comparison of the amounts of Urea, TSP, and M P applied per hectare declined respectively from 241 kg, 128 kg, and 69kg in 1985 to 216kg, 105kg and 28kg in 1988 (Table 3). There is another possible explanation, almost all tubewell managers alleged that frequent power cut and disconnection of power lines at the critical stage of plant growth caused serious interruption in water delivery to command area plots, which resulted in reduced yields. This situation was more serious in 1988 than in 1985 be~ause 26 out of 29 STWs, and 5 out of 6 DTWs in the 1988 sample were electrically operated, whereas only 3 out of 37 STWs and 7 out 18 of DTWs were electrically operated in 1985.

IV. RETURNS TO TUBEWELL MANAGERS / OWNERS

Returns from water Selling and Own Cultivation

Managers' / owners' returns came from two sources - water selling and net return from their own cultivation in their own schemes. But before we discuss managers'/owners' returns from irrigation, we should take note of the different sources of operation, and maintenance costs of tubewells. As calculated from the Ghatail survey data, operation and maintenance costs per hectare were reported as Taka 2874 for diesel-run DTW and O&M costs ot electrified STWs were higher than for diesel-run STWs (Table 4)[4]. It may be surprising that for both deep and shallow tubewells electricity bills were higher than diesel-mobil bills. One possible explanation for this is that there was an intensive electrification of tubewells in Ghatail villages, and that unofficial payments of about Take 25-30,000 per DTW, and about Take 10-15,000 per STW had to be made to the concerned departments (there were also many news paper reports on such act of bribes). Added to this was the fact that

Table 3. Amount of Fertilizers Used and Yields Obtained per Hectare in Different Regions in Different Years.

Sources	Year of study	Coverage	Urea kg	TSP kg	MP kg	Yield kg
Hamid et al 1982	1982	Barind Tract	150	115	60	3657
		Gan. fld plain	127	97	32	4596
		Teesta f. plain	159	113	46	4151
		Him. P. plain	143	69	46	4449
AER 1984	1983-84	Bangladesh av.	176	123	49	3573
AER 1986	1986-87	Bangladesh av.	200	118	37	3966
BAU 1985	1985	Ghatail-Kalihati,	214	128	69	5120
		Tangail				5569
		Gazipur	146	67	48	4612
BAU 1986	1986	Ghatail	246	118	44	5320
ASR 1988	1988	Ghatail	216	105	28	4534
Quasem 1987	1985-86	Chandina, Bogra,	—	—	—	5099
		Nagarpur, Bhanga.				4592

Notes. a. 5120 kg = yield under DTW, and 5569 kg = yield under STW
b. 5099 kg = average yield for all areas in 1981-82, and,
4592 kg = average yield for all area in 1985-86.

many tubewells, especially STWs, got un-metered electricity connections and that electricity bills were charged on an average use basis, meaning that many tubewells operating on lower command area and pumping for lesser hours were charged more than actual consumption.

In Ghatail villages, managers / owners of DTW, and STWs run under one-fourth crop-sharing as water cearges received about Taka 17,000 and Taka 9,000 respectively primarily from water selling and a little from own cultivation. Returns to managers / owners of DTW from water selling alone under fixed payment system appeared to be about one-third of what could be obtained under one-fourth crop-sharing with water (Table 5). The reason for very little return from manager's / owner's own cultivation was that the amount of irrigated land falling under their own tubewells was very small (see Mandal 1989, Table 4).

Table 4. Operation and Maintenance Costs of Tubewells (Tk/ha) by water Payment System and Power Source in Ghatail, Tangail, 1988.

Items	Share payment				Fixed payment
	DTW		STW		DTW
	Diesel	Elec.	Diesel	Elec.	Elec.
Diesel	1179	—	1287	—	—
Mobil	108	—	220	—	—
Electricity	—	1829	—	1774	766
Spare parts	617	18	130	94	98
Mechanics	285	18	74	41	138
Drain repair	158	261	114	117	115
Managr salary	—	—	—	—	77
Driver salary	190	139	435	493	77
Linman salary	337	121	—	78	93
Misc.	—	6	—	10	10
Tot O&M cost	2875	2393	2261	2608	1373

Source : Farm survey, 1988.

Changes in Returns Overtime

A comparative analysis of managers '/owners' return over O&M costs revealed that for DTWs operated under one-fourth crop-sharing with water generated Taka 1157 per hectare over O&M costs in 1988, which were about 64% lower than returns obtained in 1985. For STWs returns to management per hectare of tubewell command area in 1988 was 36% lower than in 1985 (Table 6). It may be noted that these nominal returns earned in 1988, when converted to real value terms by deflating with the ratio between general consumer price Index numbers of 1984-85 and 1987-88, appeared to be still lower than returns earned in 1985. The important point to be noted here is that in 1985 returns to managers / owners operating tubewells under one-fourth crop-sharing with water were so high that the subsidized costs of DTW could be paid back in 2-3 years time. As a matter of fact, Grameen Bank landless groups in these villages paid their entire installment on STW loans well shead of scheduled time (Mandal 1985). In 1988, the situation was com-

Table 5. Returns from Water Selling and Own Cultivation from Own Tubewells, Ghatail, Tangail, 1988.

Variables	Share payment		Fixed payment
	DTW	STW	DTW
Gross income to manager (Tk/ha)[a]	4189	5122	1564
Water costs to managmt (Tk/ha)	2489	2571	1372
Cost of collecting water charge (Tk/ha)	543	566	0
Returns to management per ha (Tk/ha)	1157	1985	191
per scheme (Tk)	16787	8231	5002
Return from own cult. (Tk/manager)[b]	368	799	3215
Total income to management	17155	9030	8217

Source : Farm survey, 1988.

a. Assuming 5% water charges unrecovered.

b. Net return over all input costs accrued to the amount of land irrigated under the tubewell owners' own schemes. There is only one DTW under the fixed payment system, and the manager cultivated 0.6 ha. in his own scheme.

pletely different. Managers / owners' incomes came down to Taka 16787 per DTW and Taka 8231 per STW, which were not enough to cover the annualized capital charges for DTW and STW at full costs.

Returns to management of DTWs which charged fixed cash per unit of land for water was still lower than under one-fourth crop-sharing for water (see Table 5). This is corroborated by a supplementary quick survey in the adjacent union of Deulabari. All of the four DTWs studied in this area in 1985 were still operated under the fixed payment for water in 1988, but in 3 out of four DTWs the management increased the water charge by an average of Taka 631 per ha., which was an increase of 36% over 1985 rates. One DTW actually reduced water charge from Taka 2700 per ha. to Taka 2400 per ha., because of pressure from the water users, but the O&M cost of the DTW also dropped after having electricity connection. For these DTWs returns to management was estimated to be Taka 10438 on an average, which was in any case too inadequate to cover capital costs.

Table 6. Comparative Indicators of Tubewell Performance in Ghatail, Tangail, Between 1985 and 1988.

Variables	DTW			STW		
	1985	1988	% change	1985	1988	% change
Boro command area (ha)	19.44	14.33	—26.3	4.83	4.11	—11.2
Aman command area (ha)	—	4.98	—	—	1.36	—
Boro yield (kg/ha)	5120	4044	—21.0	5569	4721	—15.2
Total O&M costs (Tk/ha) (pertubewell)	38445	35718	— 7.1	11831	10340	—12.6
O&M costs (Tk/ha)	1979	2489	+25.8	2556	2634	+ 3.1
Return to management						
Tk. per ha	3244	1157	—64.3	3108	1985	— 36.1
Tk. per scheme	59284	16787	—71.7	15885	8231	—48.2

Source : Farm Survey, 1988.

Note. In these calculations only those tubewells which were operated under 1/4 crop sharing system are considered. 1988 calculations are based on the basis of field experinece and assumed that 5% of water charges could not be collected. Costs of harvesting and threshing 1/4 share of the paddy were deducted from the gross value of collected paddy.

The major reasons for such decline in returns to management appeared to be as follows : (i) command areas of deep tubewells had declined from 19.44 hectares in 1985 to 14.33 hectares in 1988, a decline of about 26%, and shallow tubewell command areas dropped from 4.63 hectares to 4.11 hectares, a reduction of 11% over a period of three years. This reduction in irrigation command areas was due to new installations of tubewells. Similar situation was also observed in Deulabari, an area of higher land topography. Here also command areas of the studied DTWs had declined by about 3.8 hectares per tubewell between 1985 and 1988; (ii) there was significant reduction in yield of irrigated paddy. For example, HYV boro yields per hectare declined from 5120kg to 4044kg under DTWs and from 5569kg to 4721kg under STWs over the period (Table 6). Such reduction

in yield per hectare, with a little increase of paddy in the price coupled with simultaneous reduction in tubewell command areas, meant a very large reductions in the total volume of paddy collected as water charges (because one-fourth share of crop was charged for water), and hence reduction in gross and net returns; and (iii) 0&M costs per hectare of command area had increased by about 26% for DTWs and about 3% for STWs. The main reason for moderate increase in 0&M costs in the case of STWs was that 26 out of 29 sample STWs were electrically operated, for which repair and mechanics costs were considerably reduced.

V. RETURNS FROM IRRIGATION IN A MORE GENERAL CONTEXT

In this section, the empirical evidence of changes overtime in returns from irrigated boro paddy production in other parts of the country is discussed. The analysis is based on three studies such as, my own update of costs and returns estimates of North Bengal STW irrigation by Hamid *et a/.* (1982); Agro-economic Research Reports of Ministry of Agriculture, and a STW study in tour regions of the country by Quasem (1987). It should be mentioned here that there are inter-study divergences In respect of the calcuiation of costs and returns of irrigations. 1 have therefore adopted intra-study comparison and used the same criteria adopted in the respective studies in order to highlight the extent of changes occured in the returns from Irrigated paddy production overtime.

First of all, let us look at the changes occuring with STW Irrigation in the North-West Bangladesh. The basis is an update by this author of Hamid *et al. (* 1982) study by multiplying the physical inputs given in the report by the 1988 average prices of respective inputs and output as compiled from the information collected through a two week extensive field surveys and farmer interviews in the North Bengal districts during 1988 irrigation season.

In all the regions of NW Bangladesh, net returns to cultivators over total costs in 1988 were positive but had declined in nominal terms as well as in relation to costs (Table 7). These returns could cover the cost of cash capital at the bank interest rate of 16% for 3 months, but for many water users who borrowed for boro cultivation from non-institutional sources at very high interest rates these returns could not cover the real costs of

capital. It was not of course understood whether Hamid *et al.* included or excluded all family supplied inputs such as seeds and animal power in the calculation of total costs. If these were included in the calculation of total costs, as was done in the case of family labour, then the returns to water users would have been reduced further. In our calculation of 1988 cost and returns we did assume yield to be constant at 1982 level, but as we saw in Ghatail through our survey, and in Chandina, Bogra, Nagarpur and Bhanga through Quasem (1987), and also given the alleged micro-nutrient deficiencies problems in some North Bengal districts, there were strong reasons to believe

Table 7. Changes in Costs and Returns of HYV Boro Paddy (Taka/acre) Under STW Irrigation in North-west Bangladesh, 1982-1988

Variables	BT		GFP		TFP		HP	
	1982	1988	1982	1988	1982	1988	1982	1988
Tot cost (exc. F L)	3009	5005	3322	5199	3067	5443	2518	4512
Gross ret.	4839	6742	6032	8475	5222	7653	5597	8203
Net ret.	1830	1737	2710	3276	2155	2210	3079	3691
Net ret. (inc. F.L.)	1126	504	2098	2324	1515	1090	2617	2767
B/C ratio (exc. F.L)	1.6	1.3	1 8	1.6	1.7	1.4	2.2	1 8
B/C ratio (inc. F.L.)	1 3	1.1	1.5	1.4	1.4	1.2	1.9	1 5

Source : Calculated from Hamid et al (1982), Table 5.3, p. 131. Input output prices used for 1988 calculations are the average of figures obtained during the ASR related field trips to the north Bengal districts in April, 1988. The average prices used are :

Seed=Taka 6/sr ; Urea=Taka 5/sr ; Tsp=Taka 5.2/sr ; MP=Taka 4.3/sr ; Manure=Taka 5/mnd ; Labour wage=Taka 28/md ; Pesticide=Tk 260/pack; Animal power=Taka 50/pd ; Harvest price of paddy=Taka 170/mnd ; F L =Family labour ; BT=Barind Tract ; GFP=Gangetic Flood Plain ; TFP=Teesta Flood Plain ; HP=Himalayan Piedmont Plain.

that yields had declined from 1982 levels. This implied that net returns to boro cultivators were likely to be still lower than the estimates presented in Table 7.

Our next piece of evidence on declining profitability is derived from Quasem's recent study on the financial costs and returns of boro paddy production from both water users and STW owners point of view covering four regions (Quasem 1887)[7]. These regions represent intensively STW developed area of Bogra, less intensive area of Bhagna, Faridpur, special new technology area of Chandina, Comilla, and Nagarpur, Tangail with one-fourth crop-sharing with water. Quasem repoted that net returns to water users had declined over the period 1981 / 82- 1985 / 86 by 1, 3, 13 and 16 percent respectively in Chandina, Bogra, Nagarpur and all regions. He also estimated that sharecroppers' net return per acre dropped from Taka 199 In 1981/82 to Taka -647 in 1985/86 in all regions (Quasem 1987, Tables 3.19 and 3.20). The increase in costs of purchased inputs, relative to output price was identified as responsible for this.

Finally, the evidence of declining returns are compiled from government documents A comparison of nominal costs and returns of irrigated boro paddy of all varieties between 1981/82 and 1986/87 shows that net return per acre was Take 1117 on full cost basis and Take 5647 per acre over cash costs, which were respectively 9 and 49 percent higher than obtained in 1981/82. This had reduced the undiscounted benefit-cost ratios of boro paddy production very significantly (Table 8). The major reason for such decline in rate of profitability was that gross returns had increased by 59 percent over the period, while cash costs as well as total costs increased by over 70 percent.

The evidence presented above shows contrasting situations regarding the STW owners return from tubewells. In intensively irrigated areas like Ghatail. Nagarpur and Bogra, ner returns of STW owners had declined because of relatively higher costs of operating tubewells, and decline in command areas per STW (in Ghatail an added factor was the decline in yields). In Chandina, financial returns to STW owners appeared to be negative although neither command area per STW nor yields had changed to any significant extent and prices of water charged by the STW owners increased by 38% over the period. My own recalculations of costs and return estimates of Humid *et a/*. (1982) by using 1988 data shows that STW owners in north-west districts were able

Table 8. Comparison of Costs and Returns of Irrigated Boro Rice Cultivation (Taka/acre) in 1981/82 and 1986/87

Variables	1981/82	1986/87	%change
1. Cash costs	1858	3321	+78
2. Total costs	4612	7851	+70
3. Gross return (yields x prices)	5636	8968	+59
4. Net return (cash cost basis)	3778	5647	+49
5. Net return (full cost basis)	1024	1117	+ 9
B/C at cash cost basis	3.0	2.7	—
B/C at full cost basis	1.2	1.1	—

Source : AER—MoA, 1981/82 ; 1986/87

to largely compensate for the increased cost of O&M by raising water charges (see Mandal 1989, Table 13). No doubt, this act of enhancing water charges can happen in places where competition for access to tubewells has not yet been very intense. Besides, in calculation of returns to irrigation, the cost of capital need not be assumed at a full rate, because a large number of private STWs being run in North Bengal districts were bought from the second hand market at cheaper prices. We have mentioned elsewhere that many of the STWs were not only bought second hand, but also fitted with locally made drum-tin pipes and bamboo-coir strainers, which involved low investment (Mandal cost 1989).

In my view, when there are unexploited potentials for tubewell development, especially STWs, in large areas of many North Bengal districts, the entrepreneurial tubewell managers can still make some profits from water selling. But given the high levels of natural and technical risk involved in STW operation, the pursuit of making 'normal profit' can be maintained as long as water charges can be adjusted upward for risks and increasing costs, and kept within tolerable limits. For example, in Khanpur and Shalpa in Sherpur upazila of Bogra district. a typical flood prone area of the Teesta flood plain, and also in parts of Sirajgonj near the Jamuna river, one-third crop-share was charged for water in 1988 because of high costs of pumping by deep-set STWs and also high risk of early floods. In contrast, in intensively irrigated areas of Tangail, this tolerance level of water charges had been reached, and further

increase of water charges from one-fourth share of crop meant inviting threats of losing irrigable plots to competing command areas. Moreover, in recent years STW owners in Tangail have started giving a sort of bonus by arranging; to provide supplementary irrigation for T. aman as an incentive for the cultivators to continue to use irrigation water for boro production from these tubewells in future too. As a matter of fact, being fixed up for long time with crop-sharing arrangement for water, the declining yields meant reduction of total water fee collections by the Tangail tubewell owners. In this situation the most feasible options for the tubewell owners were to improve management efficiency so that OEM costs per unit of irrigated land were reduced by increasing command area, and total collections were increased by improving yields.

IV. CONCLUSIONS

The analysis of the previous sections shows that the returns from HYV boro paddy cultivation using groundwater irrigation have declined from both tubewell owners /managers' and water users' point of view, and the estimated levels of net returns are too low to pay for the management services. The returns to sharecroppers were still lower and negative, meaning that they received for their family supplied labour and animal power less than the market wage rates. The major variables associated with the decline in returns from irrigated paddy production were the decline in HYV boro yields, increase in production costs and 0£tM costs resulting from an increase in nominal wage rates and prices of inputs and at the same time very low harvest prices of boro paddy.

The reasons for the reduction of boro yields are admittedly many, such as deplation of organic matter content of the irrigated soils, but the most apparent of the irrigated soils, but the most apparent one seams to be associated with the reduction in the use of fertilizers per unit of land. The increased fertilizer prices resulting from the withdrawal of subsidies partly explained this, but the more important reason was the very low prices of boro paddy during harvest. The procurement prices of baro paddy were not available to growers. In many districts such as Bogra and Tangail, the actual procurement:

of boro paddy In 1988 was lower than expected. In recent yeats, post-harvest paddy prices have been increased to some extent, but these are not enough to provide incentive to producers. Nevertheless, it is very important to ensure these prices during harvest season, when most paddy are sold by small and medium farmers.

In general, in the intensely competitive areas, the returns to tubewell owners/managers have declined mainly because average command areas per tubewell have declined and operation maintenance costs of diesel-run pumps have Increased. In areas, where water charges are collected as crop-share, the declining yields and low paddy prices during harvest have further reduced returns to tubewell owners/ managers.

One of the challenging jobs to improve profitability of irrigated boro paddy is that yields must be increased and sustained. This requires continuous improvement in fertilizer uses, soil management, agronomic practices, and plant protection measures. From the entrepreneurial point of view, tubewell owners/ managers will require to improve their efficiency of on-farm water management in a competitive but regulated environment, so that command area per tubewell is increased and cost of suppling water per unit of land reduced. Another area of government intervention to promote tubewell electrification with regular electricity supplies so that operation and maintenance costs of tubewells are reduced. In areas where tubewell electrification is already underway, appropriate measures should be taken to minimise bureaucratic 'rentseeking' to provide metered connections to tubewells and ensure uninterrupted power supplies.

Notes :

1. The villages were Sadhurpara Golgonda, Momrej Golgonda, Radhanagar Phulhara, Sreepur Phulhara, Gunogram, Koidala, South Korna, and Madhya Korna. The area was purposively selected for this study mainly because the author was involved in similar irrigation studies on 18 DTWs and 37 STWs in Ghatail-Kalihati Upazilas in 1985 and 1986, which gave an opportunity to compare the performance of tubewells between these rwo periods, and provided more insights into the dynamics of changas in the key parameters (for reference see BAU 1985, 1986). The cluster of

tubewells was chosen in such a way that it included most of the tubewells covered in BAU 1985 and 1986 surveys. One added advantage of clustering was that this allowed us to understand he process of competition between tubewell command areas and also to see the variability in command areas, yield and returns even within a relatively small geographic area.

2. In these calculalations the actual amounts of material inputs used on individual plots of the sample farmers were multiplied by their respective unit pcrices actually paid for, Gross returns were calculated considering the value of both paddy and straw, quantity of paddy being multiplied by the average harvest prices of Taka 170 per maund received by the cultivators,
3. However, since this evidence is based on only one DTW under the fixed cash payment system, extreme caution needs to be taken in interpreting the results.
4. Managers / owners' costs to irrigation water supply should ideally include both capital costs and operation and maintenance costs. The calculation of annual ammortized value of capital is difficult because individual aquipment has different quality, types, age or different mix of old and new pumps, engines and pipes, therefore has different working life which again varies with the intensity of use. We could not get reliable information on these other variables, nor was it possible in ime-bound survey; and hence we concentrated on calculating operation and maintenance costs as far as possible in details. However, we bear in mind tha question of capital costs while interpreting our findings on managers / owners returns.
5. This is no doubt a somewhat unique case with very large command area but charging as low as Taka 1372 per ha. for water.
6. It should be noted that inter-study comparisons had many prolems. One of the biggest problems was that the methods of estimation applied in different studies were different, and in many cases the key parameters such as wage rates, paddy prices (harvest or post-harvest), physical amounts of inputs used, and the actual year of data collection, were not presented, to the effect that valid comparison could not be made.
7. The study is commendable, but the basis of sampling and the time of data collection mosty through recall (five-year reference period on many tricky economic variables like input levels used and output harvested i s too long to recall without error) is subject to criticism.

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Appendix Table 1. Changes in HYV Boro Paddy Yields and Prices of inputs and Output in Ghatail, Tangail, Between 1985 and 1988

Variables	1985	1988	% changes
HYV boro yield (kg/ha)	5120	4044	– 21.0
Price of HYV boro paddy (Tk/MT)	4300	4600	+ 7.0
Wage rate (Tk/man-day)	20	30	+50.0
Urea (Tk/kg)	4.4	5.0	+14.0
TSP (Tk/kg)	4.4	5.0	+14.0
MP (Tk/kg)	3.5	4.4	+25.7
Total cost of production (Tk/ha)[1]	8215	13497	+64.3
Net return over total cost (Tk/ha)[2]	7482	1864	—75.0

1. Excludes water cost which is paid in terms of one-fourth share of crop.
2. Considers only own land irrigated by DTWs which charged one fourth share of crop as the payment for water.

Source : Farm surveys, 1985 and 1988.