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IMPACT EVALUATION OF SHALLOW TUBEWELL IRRIGATION

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Introduction

The availability of water in the dry season has a great impact on agricultural practices and production. Shallow tubewells (STW) for irrigation are a relatively new but rapidly spreading form of irrigation technology in Bangladesh. With the advent of shallow tubewells, more land, more labor, and increased amounts of other inputs are used to produce greater quantities of agricultural output.

In order to study the impact of shallow tubewell irrigation, a short reconnaissance survey was carried out in July, 1982, by USAID in cooperation with the Ford Foundation and the Rural Development Academy in Bogra.

Objectives of the Study

The study was designed to achieve the following specific objectives:

- (a) to evaluate the impact of STW irrigation on farmers' cropping patterns, crop utilization, and labor employment;
- (b) to assess the effects of STW irrigation on post-harvest operations involving women; and
- (c) to evaluate the response of the rice hulling industry to increased paddy output resulting from adoption of irrigation technology.

Survey Procedures

In all, three classes of respondents were personally interviewed:

- (a) farmers who used STW irrigation for crop production, both owners of STWs and those who purchased STW water for cultivation;
- (b) female members of the corresponding farm households who participated in post-harvest operations; and

- (c) owners/managers of rice hulling mills located in the region.

The survey was conducted during mid-July, 1982. Information was collected for the 1981 and 1982 boro seasons. Information was gathered: (1) from farmers on crop production, cropping patterns, crop utilization and labor use; (2) from women of corresponding farm households on post-harvest operations such as threshing, parboiling, drying, storage and processing; (3) from rice mill owners/managers on their paddy hulling operations.

The survey was conducted in Dhunat, Bogra Sadar, Gabtali and Sherpur Thanas of Bogra District and Singra Thana of Rajshahi District. These thanas were selected due to the high concentration of STWs.

The respondents selected for the survey included 36 farmers, female members of the corresponding 36 farm households, and the owners/managers of 11 rice hulling mills located within the area. Selection of respondents was not systematic or statistically determined. Therefore, no attempts should be made to generalize from survey results. These findings, however, provide an overview of the impact of STW irrigation in the region of the study.

Survey Findings

A. Farmers' Interview

All thirty six farmers interviewed cultivated HYV boro paddy using STW irrigation. Twenty five out of 36 farmers had been using STW irrigation for crop cultivation for more than one year. The average size of STW irrigated farms reported in 1982 was 2.48 acres, ranging from 0.33 to 8.67 acres. In 1981, the average size reported was 2.39 acres, ranging from 0.13 to 8.67 acres.

Eighty six percent of the respondents cultivated a high yielding variety introduced from China, known as "Purbachi" or "Chinese" paddy. Only 5 farmers (14%) cultivated IR-8. Farmers preferred the Purbachi variety because it matures about 20-25 days earlier than IR-8 and the grain quality is also slightly better. ^{1/} However, the yields of Purbachi were reportedly slightly less than IR-8.

^{1/} between that of coarse and medium quality characteristics.

Cropping Patterns: Cropping patterns and land use intensity were found to change automatically when irrigation was applied (Table 1). The introduction of STW irrigation brought about a major shift in the cropping patterns and resulted in increased cropping intensity and rice production. Prior to participation in STW irrigation, 78 percent of the respondents' land remained fallow during the rabi (winter) season. On those plots that were planted to rabi crops, mustard, pulses and wheat were the most common. All seven respondents in Singra Thana left their land fallow during the rabi season and cultivated only b. aman ^{1/} during the Kharif (monsoon) season. In Bogra, a majority of the farmers used to grow aus/jute followed by t. aman ^{2/} during the Kharif season.

After the introduction of STW irrigation all respondents in Bogra cultivated HYV boro. Most followed the boro production with t. aman, mainly HYV t. aman. A few farmers, however, cultivated mustard, pulses or wheat followed by aus/jute on the non-irrigated portion of their land. Four out of seven farmers interviewed in Singra Thana cultivated b. aman after harvesting the HYV boro; the rest grew only HYV boro and kept their land fallow during the Kharif season. None of the farmers cultivated oilseeds or wheat on the acreage that came under irrigation. Most limited their production to two cycles, although three cycles are technically possible. Even so, estimated cropping intensity rose from 153 percent to 192 percent.

Crop Output and Utilization: In 1982, respondents cultivating HYV boro realized average paddy yields of 41.2 maunds per acre, ranging from 15 maunds to 67.5 maunds per acre. The average yield in 1981 was 44.8 maunds of paddy per acre, ranging from 24 maunds to 75 maunds per acre. Crop damage due to hail was responsible for the lower yields in 1982.

1/ B. Aman: Broadcast Aman (deep water rice), April to November.

2/ T. Aman: Transplanted Aman, September to December.

TABLE 1: CHANGES IN CROPPING PATTERNS

<u>Cropping Patterns</u>	<u>Patterns Followed by Farmers</u>			
	<u>Before STW Irrigation</u>		<u>After STW Irrigation*</u>	
	<u>No. of Farmers</u>	<u>%</u>	<u>No. of Farmers</u>	<u>%</u>
Mustard/pulses/wheat followed by aus/jute*	8	(22.2)	-	-
Aus/jute followed by HYV t. aman	2	(5.6)	-	-
Aus/jute followed by local t. aman	9	(25.0)	-	-
Local t. aman only	6	(16.6)	-	-
HYV t. aman only	2	(5.6)	-	-
B. aman only	9	(25.0)	-	-
HYV boro only	-	-	3	(8.3)
HYV boro followed by b. aman	-	-	4	(11.1)
HYV boro followed by local t. aman	-	-	3	(8.3)
HYV boro followed by HYV t. aman	-	-	26	(72.3)
TOTAL:	36	(100.0)	36	(100.0)
Completely fallow during rabi season	28	(77.8)	-	-
Cropping Intensity*	153 %		192%	

* For straight forward estimation of cropping intensity, it was assumed that the farmers cultivated their total land under each crop mentioned in the cropping patterns. In actual practice, however, mustard/pulses/wheat were cultivated partially, both before and after introduction of STW irrigation. The actual cropping intensity, therefore, would be a little lower before irrigation and a little higher after STW irrigation was introduced.

Each respondent household received an average of 115.1 maunds of total paddy in 1982 compared to 133.1 maunds in 1981 (Table 2). These quantities include the rental receipts paid in paddy for shallow tubewell water and crop payments from land rental to share croppers. Such rental payment in kind amounted to about 7 percent of the total paddy in-take.

The market participation rate was very high among the farmers in the study area. Most of the boro paddy producers sold paddy. Among those who marketed paddy, each sold 58.6 maunds of paddy on the average in 1982 ranging from 3 maunds to 300 maunds. In 1981, each farmer marketed 81.1 maunds of boro paddy on the average, ranging from 2 maunds to 480 maunds. None of the respondents sold husked rice, however. The average selling prices of boro paddy were Tk. 115.2 per maund in 1982 and Tk. 95.7 per maund in 1981.

Seven categories were identified for the use of money earned from boro paddy sales: (1) purchase of consumption items, (2) purchase of agricultural inputs, (3) STW loans repayments, (4) purchase of irrigation water, (5) labor payments, (6) land purchase, and (7) house construction. Of the total respondents, 88 percent sold paddy to traders/consumers in the local village markets, while 12 percent of the respondents sold to traders who came to their premises. No respondent sold paddy at the Government Procurement Centers during 1981 or 1982. All respondents saved some seed from their production. However, 19 percent and 24 percent of the respondents purchased seed from the market to supplement their 1982 and 1981 requirements.

Use of Labor Input: The cultivation of labor intensive HYV boro paddy using STW irrigation resulted in increased labor employment at both the transplanting and harvest/post-harvest period. HYV boro paddy cultivation requires about 110 man-days, which is about 39%, 5%, and 120% more than local b. aus, jute and b. aman paddy respectively. 1/

1/ Cost and returns survey for Bangladesh -- 1978-79 Crops. Vol. I Aus Paddy. Vol. II B. Aman paddy, Vol. V Boro paddy and Vol. VII Jute. Agro-Economic Research Ministry of Agriculture and Forests, Dhaka, Bangladesh.

TABLE 2: PATTERNS OF PADDY DISPOSITION

<u>Paddy Use Category</u>	<u>Respondents</u>		<u>1982 Boro Season</u>	
	<u>No.</u>	<u>%</u>	<u>Average in Maunds Used for Each Category</u>	
			<u>Actual Allocation^{1/}</u>	<u>Computed Allocation^{2/}</u>
Paid in rent ^{3/}	14	(39)	19.6	7.6
Saved for seed	36	(100)	4.1	4.1
Sold as paddy	32	(89)	58.6	52.1
Kept for food	36	(100)	51.3	51.3
Total quantity received				115.1
			<u>1981 Boro Season</u>	
Paid in rent ^{3/}	10	(40)	20.5	8.2
Saved for seed	25	(100)	4.5	4.5
Sold as paddy	21	(84)	81.1	68.1
Kept for food	25	(100)	52.3	52.3
Total quantity received				133.1

1/ Average of respondents in each category.

2/ Average of all 36 respondents in 1982 and 25 respondents in 1981.

3/ For land as well as irrigation water.

All respondents hired laborers for HYV boro crop cultivation (Table 3). The farmers on the average expended Tk. 1,032 and Tk. 1,164 in 1982 and 1981 respectively, for the payment of the total hired labor engaged in harvesting and threshing operations. These amounts were imputed cash value of total wages that included cash wages, the value of meals, and other in-kind payments. Eighty nine percent of the respondents provided 3 meals in addition to the cash wages. All respondents in Bogra made labor payments on daily basis. Four out of seven respondents in Singra reported that they hired labor on a contract basis. Daily wage rates were about 3 percent less in 1982 than 1981 probably because there was more competition from migrant laborers in 1982 due to a preceding poor aman crop in 1981-1982. The migrant laborers mainly came from Pabna and Rangpur Districts.

Input Availability: Most respondents reported that they were able to get all the required inputs on time for the HYV boro paddy cultivation. Only 8 percent of the respondents could not get fertilizer on time and 11 percent reported unavailability of pesticides.

Intentions About Next Boro Crop: When asked about their Boro 1983 intentions, about 28 percent of the respondents indicated they would grow more boro in 1983 than they grew in 1982; while 11 percent intended to grow less boro in 1983 compared to 1982 due to the high price of water. None of the farmers cultivating HYVs intended to change the rice variety, however.

Crop Processing and Storage: All the respondents reported that they had enough space to thresh and dry their boro paddy production. Only 3 respondents, all of them from Singra, purchased paddle threshers at a cost of Tk. 1,200 each.

Seventy five percent of the respondents parboiled their boro paddy at home and then husked the entire parboiled paddy at nearby hulling mills. Nineteen percent of the respondents husked a small portion of parboiled paddy at home using the traditional "Dheki"^{1/} and the remaining quantity at hulling mills. Only six percent of the respondents parboiled and husked their entire paddy at home.

^{1/} wooden lever for pounding about 2 Kg. paddy at a time to separate husk from grain.

TABLE 3: LABOR USE FOR STW IRRIGATED BORO PADDY CULTIVATION

	<u>1982 Boro Season</u>	<u>1981 Boro Season</u>
Number of average adult male family labor units per household	2	2
Number of respondents hiring labor for harvesting and threshing boro	36	25
Cash wage rate (taka/day)	10.87	11.22
Origin of hired labor (number and percent of respondents hiring labor)		
All local	8 (22%)	5 (20%)
Mainly local	9 (25%)	8 (32%)
Mainly immigrant	18 (50%)	11 (44%)
All immigrant	1 (3%)	1 (4%)
TOTAL	<u>36 (100%)</u>	<u>25 (100%)</u>

The average mill hulling charge for paddy was Tk. 3.25 per maund in 1982 compared to Tk. 2.93 per maund in 1981. The average distance of rice hulling mills from respondents' households was 1.4 miles. Cost of transporting (excluding labor cost) one maund of paddy to the mill averaged Tk. 1.79 (Taka 1.28 per maund per mile). Labor was hired by 67 percent of the respondents to take their paddy to the rice mill for husking.

All respondents maintained storage for their own limited use. The storage space in the respondents' households was considered adequate. However, respondents did not store their total needs. All made some purchases in the market place, both for seed and for consumption.

B. Household Survey

The female members of the 36 farm households were interviewed to gather information on the household characteristics and assess the impact of increased boro paddy production on various post-harvest operations associated with female household members.

Household Characteristics: The size of the work space in the households averaged 2,225 square feet, ranging from 270 square feet to 9,000 square feet. Forty seven percent of the families were joint families. 1/ The average house consisted of 5 rooms--3 tin roofed rooms and 2 thatched roofed rooms. Ninety two percent of the households had shelters for animals. Each household averaged 6 permanent trees. The most common trees were jackfruit, mango, coconut and betelnut. Eighty three percent of the households had vegetable gardens. Most commonly grown vegetables included pumpkin, water gourd, egg plant, data (amarantus), puishak (Basilarubra) and bitter gourd. All surveyed households had latrins; 72 percent owned hand tubewells; 31 percent had dug-wells; and 14 percent had tanks (ponds). Thirty one households (86%) had either hand tubewells, dug wells, or both. The family members of these 31 households used water from hand tubewells or wells for drinking, cooking, washing pots and clothes. Those who did not have a hand tubewell would bring drinking water from neighbors.

Threshing: The 36 families surveyed threshed on the average 102.2 maunds of boro paddy in 1982 and 107.1 maunds in 1981. Thirty six percent of the families faced problems in threshing the boro paddy. The most common problem was the shortage of bullocks and laborers. Families solved the problems by borrowing bullocks 2/ and hiring laborers.

Parboiling: Parboiling is a post-harvest process usually performed by women. The average quantity of boro paddy parboiled per household was 38.6 maunds in 1982 compared to 44.4 maunds in 1981 which amounted to 34 percent of the total paddy received in 1982 and 33 percent for 1981. The balance was sold, saved for seed, dried and stored, or used to pay for seasonal labor. The most common problems encountered in parboiling paddy included shortage of firewood, containers and labor. Families solved the problems by buying and/or collecting firewood, borrowing containers or parboiling smaller quantities over a longer period of time and hiring female labor. However, a majority of the respondents (61 percent) did not face any problem in parboiling paddy.

1/ Extended family system.

2/ To be repaid by similar arrangement

Drying: Drying is another post-harvest process performed mainly by women. For consumption purposes, paddy is usually dried after parboiling and then husked. However, for storage and sale purposes, farmers usually dry unparboiled paddy. Eighty one percent of the respondents identified no problems in drying boro paddy. However, 6 families faced problems in drying paddy due to shortage of space and only 2 families reported shortage of family labor. The families solved the problems by drying in installments and hiring labor.

Processing: Seventy five percent of the households surveyed owned a "Dheki". However, with the increase in rice hulling mills, dheki was now seldom used. Only 25 percent of the respondents husked a portion of their paddy by the "dheki". However, about 28 percent of the families used the "Dheki" for crushing rice to make rice atta which is used to make various types of rice cakes.

Storage: All families stored some paddy/rice for consumption, or for sale in future. None of the families faced any problem in storing their paddy/rice.

C. Rice Hulling Mills

Eleven rice hulling mills in Bogra were surveyed in order to assess the impact of increased rice output on the private rice husking mills.

Five of the surveyed mills had parboiling and drying facilities. These rice mills usually parboil, dry and husk the paddy brought by the rice traders. The average size of the drying floor was 4,600 square feet. The other 6 rice mills surveyed had no parboiling or drying facilities. These rice mills only husked parboiled and dried paddy brought by the farmers. All rice hulling mills used electric power to drive the hullers.

On the average each rice mill employed one supervisor and two machine operators. Each of the five mills with parboiling facilities employed 5 male workers for carrying and parboiling paddy and 6 women for winnowing and sweeping.

All rice mill owners/managers reported that the number of rice mills was increasing rapidly in the region to meet the increasing demand for husking boro paddy. Seven rice mill owners reported that they husked about 50 percent

more boro paddy in 1982 compared to 1981. However, 2 mill owners husked about 15 percent less paddy for the period. Each mill on the average husked about 4,500 maunds of boro paddy in 1982. Purbachi was the major variety husked. None of the rice mills faced problems with the husking capacity of the mills. However, all the rice mills faced severe problems of frequent power failure. Boro paddy milling started in May and continued up to August with a June peak period. Forty five percent of the mill owners indicated they would increase the size of their existing mill and/or purchase new equipment to supplement their existing capacity if demand necessitates.

Conclusion:

Results of data analysis permit us to draw the following conclusions:

1. Prior to the inception of the STW irrigation, the study area was single or double cropped. In the monsoon season aus/jute and aman were the major crops grown. Most of the land remained fallow during the winter season. Mustard, pulses and rainfed wheat were cultivated to a minor extent during the dry season.
2. The provision of STW irrigation water supply brought about a significant change in the production plan of the farmers which in turn altered the traditional production practices. Irrigation led to increased cropping intensity and a shift from the Aus or b. Aman low yielding high risk crops to Boro high yielding, low risk crop. Moreover, the availability of supplementary irrigation during the early and late monsoon season enabled the farmers to use more high yielding varieties, invest more heavily in recommended inputs and improved cultural practices for the t. aman crop in the Bogra area. Since their growing seasons overlap, the increase in HYV boro area was accompanied by a decrease in the aus/jute and b. aman crop acreage.
3. Substantial increases in employment opportunities resulted from cultivation of labor intensive HYV boro. The more intensive land use pattern in the survey area created additional labor requirements. The additional farm labor requirements were met by employing hired labor, mostly landless laborers.

The additional employment opportunities also benefited under-employed farm family members during the dry season when agricultural employment is normally low. The flow of migratory laborers maintained an equilibrium between the demand for and supply of agricultural laborers during the peak seasons. Moreover, it was apparent that secondary employment opportunities generated by activities such as marketing of produce, transportation, processing and other services resulting from increased agricultural production were substantial, and it is certain that STW irrigation impact on total employment would go far beyond the incremental farm labor requirements.

4. An increase in the number of migrant laborers visiting and working in the survey area tend to have a moderately depressive effect on local wage rates. Migrant laborers came mainly from Pabna and Rangpur Districts.
5. The survey findings reveal that more than one half of the boro paddy output entered the market channels. The traditional marketing system in the study area was well developed and adequate to handle marketing of the increased paddy production. No serious marketing problems were encountered and increased grain production was easily absorbed locally or found ready markets in the nearby town. The government foodgrain procurement program had no direct impact on farmers' marketing decisions.
6. STW irrigation has undoubtedly contributed to rising household income of participating farm families, in particular for those in low cash availability categories prior to STW irrigation. Although the survey result do not directly demonstrate the change in household income, the increased production substantially contributed to marketable surplus which generated increased cash income for the farmers. During the course of the study, the surveyers who returned to the area for two years observed new houses, transistor radios, bicycles, and metal roofs that indicated improvement in the cash flow situation of the farm families.
7. Women have been directly impacted by the increased labor demands that were associated with increased production. They were required to expend more energy on the productive tasks of processing the harvest. These tasks are not new, but an intensification of processes traditionally performed by women.

8. Expansion of the private rice hulling industry was remarkable in the study area. The hulling industry effectively responded to increased demand when HYV rice and STW irrigation induced increased output. It was apparent that the private sector is quite capable of handling the increased volume of paddy.