

## PREPAID TELEMETERING SYSTEM FOR IRRIGATION MANAGEMENT IN WATER STRESSED BARIND TRACT

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### ABSTRACT

A prepaid telemetering system (PPTM) for irrigation program has recently been introduced by Barind Multipurpose Development Authority in the water stressed Barind Tract. The superiority of this newly introduced system over the simple prepaid metering (PPM) system has been carried out considering the technical and financial benefits. The study shows that irrigation cost saving is BDT 2441.00 (16.64%) per hectare per cusec discharge for PPTM program compared to PPM program. Average 2 hectares more land (15.38% more land) can be irrigated per cusec discharge for PPTM over the PPM operated irrigation equipment. The PPTM program requires 15.73% less operating hours (14 operating hours) for Boro Rice (Rabi Season) cultivation than PPM program. Furthermore, reduction of monitoring or supervision by the field or controlling offices is 71.43% (20 visits) in PPTM than PPM during the irrigation period. It is found in the study that burning/damaging reached to on an average 0.54 number in PPTM from 1.58 numbers in PPM program which reduces about 65.83% burning/damaging of equipment that saves the operation and maintenance costs of BMDA. Farmers physical visits to concern office reduced about 78.57% annually to inform the common problems of respective scheme. Again the study shows that with the investment of BDT 1293.60 million to install the PPTM in remaining 16000 irrigation equipment, BMDA may save about BDT 1064.23 million and BDT 267.65 million for irrigation and BDT 21.12 million for field visit annually. Moreover, 421 million cubic meter of ground water may save per year which help to restor the environment. The financial viability of the project is evaluated and it is found that the NPV, BCR and IRR of the project is 38106.60, 3.45 and 51% respectively. Therefore, the introduction of PPTM system for complete irrigation program will be viable and beneficial for the water stressed Barind Tract as well as other part of the country.

**Keywords:** *Telemetering, prepaid, irrigation, management, barind tract*

### 1. INTRODUCTION

Barind tract is one of the soil tracts of Bangladesh which is the largest Pleistocene era physiographic unit in the Bengal basin. The part of greater Rajshahi, Rangpur, Dinajpur and Bogra district of Bangladesh and Indian territorial Maldah district of west Bengal is geographically identified as Barind tract. Barind tract in Bangladesh situated in the north-west part of the country is a drought prone water stressed area, which is completely different from the other parts of the country. Peculiar dry climate prevails in the area. Rainfall is less compared to the country average. Annual rainfall varies from minimum of 1250 mm to a maximum of 2000 mm (IWM, 2012), whereas country average is 2500 mm. Temperature ranges 4 °C to 44 °C. Most of the land is undulated terrace type where the elevation varies of 47 m in its central part to 11 m in the southeast and 9 m in the northeast parts (IWM, 2006). Due to this high elevation of Barind, it is a flood free zone. Based on the topography, the area is divided into three categories – High Barind, Medium Barind and Low Barind (IWM, 2006). In high Barind there are about 80% lands terraced or undulated. The middle part of the area is relatively high and uneven. Most of the rivers of this area get dried up during dry season.

Scarcity of adequate water is the main problem of this area. The abstraction of groundwater for drinking or irrigation purposes with installation of any types of centrifugal or reciprocating pumps is not easy because of very high static level of water table. So, most of the people had to collect water from pond, common wells (dug well), tube well and rain water for domestic and drinking purposes (FAO, 1988). The Hossain et al. (2021) reported that the main aquifer does not occur in the upper layer due to presence of thick clay deposits in Barind tract. Therefore, ground water is relatively thin, fine grained sand zones that occur within clay sequence. The aquifer is capable of supporting only small domestic water needs.” Moreover, Ground water circle of the Bangladesh Water Development Board (BWDB, 1985) reported about the Barind tract that only deep set hand tube wells for domestic purpose can be installed while it is not suitable for irrigation purpose.

Barind Multipurpose Development Authority (BMDA) is an authority for providing the irrigation in the Barind tract. The BMDA started the irrigation program with prepaid coupon for irrigation in 1992. However, Souza et al. (2020) showed that the Brazilian Electricity Regulatory Agency (ANEEL) regularized the electricity prepayment system and opened a general discussion about the technologies, resources, and implementations for the prepayment metering system. Mateo et al. (2020) discovered that exploiting the implementation of a Prepaid Electricity Program in the region of Antioquia (Colombia), they estimated the impact that switching to a prepaid program had on users’ energy consumption behavior. Akand et al. (2019) proposed that prepaid meter was one of the new improvements in the billing system of the power system of Bangladesh. Prepaid electricity meters were favored by power distribution companies to improve revenue collection, debt prevention and ensure customer satisfaction (Rabbani et al., 2020). In that paper, they investigated changes in bill payments pattern of customers in Dhaka, Bangladesh who had switched from post to pre-payment meters. Rodrigo et al. (2016) showed that most of the developing countries were moving in to smart meters equipped with prepayment facility to measure electricity in order to reduce the financial losses faced by utilities due to consumer reluctance to make bill payments on time. Prepaid smart meters enable consumers to effectively manage their electricity usage. However, nobody thought to use this prepaid metering system in irrigation management. In progress of time BMDA introduced various prepaid program by starting the smart card based simple prepaid metering system in 2004. Operation of irrigation equipment using prepaid program opened a new chapter in the field of irrigation water management. But some of the drawbacks were found during operation of irrigation equipment in that program. Furthermore, they implemented smart card based prepaid telemetering system in 2016 in the field of irrigation management to overcome the difficulties and problems of the simple prepaid irrigation program as a pilot scheme. Therefore, the major focus of this study was to evaluate the system considering the technical, economic and social aspects in aiming to implement the technology for the total irrigation management of the BMDA.

## 2. METHODOLOGY

### 2.1 Study Area

The study area was selected under the jurisdiction of Barind Multipurpose Development Authority (BMDA), Rajshahi, Bangladesh. The area covers 25 upazillas of three districts of Bangladesh named- Rajshahi, Chapai Nawabganj and Naogaon.

### 2.2 Data Collection

In BMDA all of the farmers use prepaid card or user card to receive irrigation water from respective irrigation equipment. From the server of BMDA it had been found that average 16 numbers of farmers used prepaid card per irrigation equipment. Sample size of farmers of comparable irrigation equipment was selected using the Guilford and Fruchter formula:

$$n = \frac{z^2 pq}{d^2} \quad (1)$$

where,

$n$ = sample size

$z$ = value certain case

$d$ = expected rate of success (level of significance)

$p$ = value of parameter in a population

$q$ =  $1-p$  (because,  $p+q=1$ )

Applying the value of above parameters it was found that the sample size,  $n= 384$  number of farmers. Sample numbers of irrigation equipment following the 16 numbers of farmers per equipment was:  $384 \div 16 = 24$ . To get a very authentic and good findings of the study 24 numbers of zone offices from 23 upazillas had been taken as the main sample stations. From every station 03 to 04 numbers of simple prepaid operated irrigation equipments and from the same station 03 to 04 numbers of prepaid telemetering operated irrigation equipments had been chosen randomly following the minimum distance from one program to another of the equipments. Then the average of each program of each zone had been found out which had been used as the “representative data” of each programs for 24 zone offices. Therefore, the total numbers of sample irrigation equipment of 24 zones for both of the programs were 95. The Table-1 represents the numbers of sample stations and sample irrigation equipments of the two programs of study area:

Table-1: District wise number of sample irrigation equipment of two programs

Sl. No.	Name of districts	Number of zone offices or sample stations	Number of sample irrigation equipment of two programs	
			PPTM	PPM
1.	Rajshahi	8	31	31
2.	Chapai Nawabganj	5	20	20
3.	Naogaon	11	44	44
	Grand total	24	95	95

### 2.3 Data Analysis

After collecting the data of two programs the average or representative data for specific parameter was calculated. Then average or representative data for PPTM and PPM of all stations analyzed using bar diagram to get the findings of the study. On the other hand by a questionnaire the data also collected from the experienced respondents and analyzed.

The parameters which were selected to analyze for comparison were as follows: i) irrigation cost per hectare per cusec discharge, ii) average irrigated area per cusec discharge, iii) operating hour per hectare per cusec discharge of rice, iv) reduction of visit of field workers, v) reduction of burning/damage of equipments and vi) reduction of physical appearance of farmers to inform common problems at respective office.

### 3. RESULTS AND DISCUSSION

The income and expenditure of BMDA were considered for the financial year of 2010-2011 to 2019-20. The obtained results are presented in Table 2. All the parameters were analyzed and found the results in numerical form and in percentage. Now the results were used to find out the impact on BMDA and on farmers as followings:

Table 2: Yearly Average Operated Irrigation Equipment, Irrigated Area, Income and Expenditures of BMDA

Fiscal Year	Nos. of Operated Irrigation Equipment	Irrigated Area of Boro Rice (Lakh Ha)	Income from Irrigation	Expenditures (Tk. in lakh)				Total
				Salary and allowance	TA Bills	O & M of Irrigation Equipment	Electricity Bill of Irrigation Equipment	
2010-11	12841	2.47	10578.12	2710.11	144.31	2373.65	5142.21	10370.28
2011-12	13770	2.71	13345.52	2846.25	159.82	2488.26	6449.61	11943.94
2012-13	14090	2.61	15678.44	2899.78	240.73	3938.41	7885.16	14964.08
2013-14	14280	2.55	17605.83	3279.82	225.04	4125.6	8791.29	16421.75
2014-15	14684	2.57	14805.08	3378.81	222.43	4328.33	7407.51	15337.08
2015-16	15458	2.76	15584.43	4724.31	232.2	4249.04	7876.93	17082.48
2016-17	15745	2.69	14661.69	6084.55	288.43	3777.81	7619.29	17770.08
2017-18	15992	2.75	14973.85	5930.75	284.91	4452.08	7821.31	18489.05
2018-19	16072	2.76	20230.71	5909.51	311.62	4248.27	10012.54	20481.94
2019-20	16057	2.86	15218.58	5962.02	273.04	3825.48	7745.82	17806.36
<b>Average</b>	<b>14899</b>	<b>2.67</b>	<b>15268.23</b>	<b>4372.59</b>	<b>238.25</b>	<b>3780.69</b>	<b>7675.17</b>	<b>16066.7</b>

### 3.1 Irrigation Cost per Hectare per Cusec Discharge

Table 2 shows that on an average irrigation charge Tk. 15268.23 lakh was earned per year by BMDA. For the first parameter it was found by analysis that PPM required 16.64% more irrigation charge over PPTM. So, for using PPM the farmers of BMDA paid about Tk. 2540.63 lakh excess irrigation charge per year. If all irrigation equipment might be operated by PPTM farmers would get the scope to save Tk.2540.63 lakh irrigation costs per year. According to the field investigation by questionnaire all of the respondents agreed that the PPTM saved irrigation costs. So, by the study it was found that PPTM saved the irrigation costs. The irrigation costs existed difference at the individual Zones as because of many factors in the field of crop production. The factors are as follows: soil textures, location of land, topography, rainfall, variety of crops, discharge of irrigation equipment, irrigation water application period, etc. These were the main factors of crop cultivation which were always kept constant for both of the programs to complete the research. Depending on the above factors the irrigation costs of irrigation changed.

### 3.2 Average irrigated area per cusec discharge

From Table-2 it was found that average irrigated area of rice covered by BMDA per year was about 2.67 lakh hectares. For the second parameter it was found that PPTM irrigated 15.38% more of land over PPM program. So BMDA may extend irrigation area about 0.41 lakh hectares more of land if all the irrigation equipments might be operated by PPTM.

If that excess land cultivated and the average production of rice per hectare taken as 04(four) Metric Ton per hectare then about 1.64 lakh Metric Ton more rice would be produced per year. Accordingly if the market price per Ton of rice was Tk.25000.00. The farmers of that area might get the opportunity to earn a gross amount about Tk.41000.00 lakh more per year. The cost of production per hectare according to BMDA was Tk.95000.00. Thus total costs of production of 0.41 lakh hectare of land for rice cultivation were about Tk.38950.00 lakh per year.

So, BMDA may create the facility for the farmers to reduce irrigation costs and to increase the production of crops thus the farmers may maximize net benefit per year is about (Tk.41000.00-Tk.38950.00)=Tk.2050.00 lakh for crop production. According to the field investigation by questionnaire all of the respondents agreed that the PPTM increased the irrigation area.

### 3.3 Operating hour per hectare per cusec discharge of rice production

Table-2 showed that average irrigated area covered by the BMDA per year was about 2.95 lakh hectares. For the third parameter it was found that PPTM saved 14 operating hours per hectare per cusec capacity

of irrigation equipment for irrigation. If all irrigation equipment might be operated through PPTM about 41.30 lakh hours of operation would be reduced which ultimately would be saved about 421 million cubic meter irrigation water per year.

BMDA uses mostly ground water. So, this quantity of ground water may be saved which help to sustain ecological balance. On the other hand 14 operating hour reduction per hectare showed that about 15.73% operating hour was saved by the PPTM program. So, this 15.73% of electricity bill may be saved by the PPTM program. Thus BMDA may save about Tk.1207.30 lakh electricity bill per year for PPTM program from all of the irrigation equipment.

### **3.4 Reduction of visit of field workers or staffs**

This parameter saved the following items:

#### **3.4.1 Reduction of travelling allowances (T. A.) bill**

Every year BMDA spends a huge amount of travelling allowance for its manpower for monitoring irrigation equipment. Table-2 showed that average Travelling Allowances spend per year by BMDA was Tk.238.25 lakh. For the parameter no. four it was found that PPTM saved 20 numbers of field visit per year over PPM which ultimately reduced about 71.43% of field visit. If all irrigation equipment might be operated by PPTM about Tk.170.18 lakh needed not to pay for Travelling Allowances (T.A. Bill) for the field personnel or staffs of BMDA. So, Tk.170.18 lakh may be saved per year for using PPTM program which may be reduced costs and may be increased the net income of BMDA.

#### **3.4.2 Reduction of field workers**

The latest organogram of BMDA includes 2460 numbers of strength which are divided into two categories, one for working in the office and another for working in the field. Numbers of strength for office and field are 1505 and 955 respectively. From the study it was found out by comparison that about 71.43% of field visit was reduced for PPTM program. So, the field workers were not needed as the existing setup of BMDA. The number of field workers of BMDA generally requires 955 if it follows the old PPM program. For pay and allowances of field personnel BMDA requires about Tk.5146.36 lakh per year. So, if all the irrigation equipment may operate using PPTM program numbers of field personnel and their yearly salary and allowance costing both will be reduced. But for starting the new technology a huge number of field personnel reductions at 71.43% rate will not be wise. If it is taken 50% of 71.43% reduction it will be 35.72%. So, taking 35.72% reduction of field personnel BMDA gets the required number of field personnel is  $(955 - 341) = 614$ .

Similarly, the pay and allowances will be reduced and reduced amount of pay and allowances will be minimum Tk.1838.28 per year. That is Tk.1838.28 will be saved per year for using PPTM. On the basis of total manpower of the organogram it is found that about 13.86% of total manpower and 13.20% of salary and allowance of BMDA will be reduced.

### **3.5 Reduction of Burning/Damage of Equipments**

Another large head of costs of BMDA is operation and maintenance of irrigation equipment. Table-2 showed that BMDA spent about Tk.3780.69 lakh per year for Operation and Maintenance (O & M) purposes for irrigation equipment. For the parameter no. five it was found that PPTM had been saved about 65.83% burning of equipment. So, if all irrigation equipment may be operated by PPTM program about Tk.2488.83 lakh needs not to spend for Operation and Maintenance purposes. So, Tk.2488.83 lakh may be saved for using PPTM program which also may be increased the net income of BMDA.

### **3.6 Reduction of Physical Appearance of Farmers, to Inform Common Problems at Respective Office**

Farmers of 16000 numbers of irrigation schemes regularly receive irrigation water from BMDA's irrigation equipment. But they generally spend money for coming to BMDA offices to inform the

common problems of irrigation equipments or schemes. But it was found by testing the parameter number six that 78.57% common problem was solved for using PPTM program. So, PPTM had reduced the extra hazards of BMDA and had reduced “Time , Cost and Visit (TCV)” of farmers.

It was found out by the study that PPTM program saved long time(T), saved cost about (Tk.268.80-Tk.57.60)= Tk.211.20 Lakh per year and saved visit(V) about 11 times per year.

#### 4. CONCLUSIONS

Based on the objectives the study was conducted to investigate the superiority of prepaid telemetering system (PPTM) over the old simple prepaid metering system (PPM) in the field of irrigation for crop production in Barind area. The operating principle of PPTM is very simple and comparatively easier than the PPM. after completion of the study it was proved that PPTM saved about 16.64% irrigation costs which was known as revenue and saved amount of revenue would be about Tk.2540.63 lakh for farmers as well as for BMDA per year. About 15.73% of operating hour saved which ultimately saved the consumption of electricity at the same rate and the saving amount of electric bill of BMDA would be Tk.1207.30 lakh per year. Quantity of ground water saving of BMDA for PPTM was about 421 million cubic meters per year and by this water about 41000 hectares more land area may be irrigated per year. PPTM program saved 14 operating hours per hectare for boro rice cultivation and total saving of operating hour may be about 41.30 lakh per year for BMDA. The degree of damage reduction for PPTM was about 65.83% over the PPM and PPTM may be saved operation and maintenance costs of BMDA about Tk.2488.83 lakh per year. PPTM saved about 16.64% irrigation costs of farmers. Moreover, it saves Time, Cost and Visit (TCV) of farmers and saving amount of farmers for common problem solution may be about Tk.211.20 lakh per year. The field investigated data of the two irrigation programs were analyzed by bar diagram forms to find out the superiority of any one of the two irrigation programs. According to the result of analysis for each parameter it had been proved that the PPTM was better than the PPM. To improve the Tele Metering Prepaid System (PPTM), i) security of the server of BMDA and teleprepaid meter is needed and ii) Detail study considering all factors of telemetering prepaid system should be done.

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