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Participatory Irrigation Management: Barind Model a New Sustainable Initiative

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Abstract During the past 20 years, substantial efforts were made to improve irrigation Management-Operation & Maintenance (MOM) through introduction of participatory irrigation management (PIM). PIM proved generally successful on small and medium schemes but it has yielded limited results on large schemes. Stakeholder engagement in irrigation system shapes hydrosocial territories: (1) by reducing tension between stakeholders, (2) by redirecting regional planning and strategy, (3) by highlighting water crises, (4) by decentralizing water responsibilities and (5) by integrating values and beliefs from different stakeholders (Sandra Ricart, et.al, 2018). Privatization started to become politically fashionable in the late 1980. In this context privatization means off-loading government ownership or responsibility for operation into the private sector, either to the farmers themselves or to an intermediate private subcontractor. But is it just a means of off-loading responsibility from a government line management system that can't cope, or is it really to benefit the farmers? (Adrian Laycock, 2011). Barind Multipurpose Development Authority (BMDA) is an autonomous authority. The BMDA does not require external finance and sustainable finance to operate the irrigation project. There are around 16,000 deep tube wells and surface lift pumps covering around 0.6 million hectares (round the year) under BMDA management. BMDA is managed by a board chaired by an appointee of the government. There are three other members representatives from farmers including other relevant department's representatives. BMDA has introduced innovative concept for prepayment for water; this was started using a system of using electronic prepaid meters. There are no formal WUOs established instead keeps a very close liaison with the farmers and the communities through their field offices, this approach appears to be effective. The chief executive of a successful irrigation project should have a clear idea about people, land and water.

Keywords Irrigation, Sustainable Management, Self-Financed, Pre-Paid Meter and Smart-Card

1. Introduction

1.1. Participatory Irrigation Management

J. Raymond Peter (Executive Director, International Network on Participatory Irrigation Management, Washington, DC) states the term participatory irrigation management refers to the participation of users-the farmers-in the management of the irrigation system. Further he refers the Handbook on PIM defines Participatory Irrigation Management as the involvement of the irrigation users in all aspects of irrigation management, and at all levels. All aspects include planning, operation and maintenance, financing, decision, rules and the monitoring and evaluation of the irrigation system. All levels include the primary, secondary and tertiary levels. In the governance paradigm, PIM can be considered as a partnership between governments, agencies and users [1].

Mark Svendson and others stated Participation in irrigation management by water users can take a wide variety of forms. Farmers can be involved in various system management functions, planning, design, operations, maintenance, rehabilitation, resource mobilization, and conflict resolution. Moreover, they can be involved in these functions at various system levels; from the field channel to entire system. Almost all irrigation systems have some involvement by water users in system management. When people speak of introducing "Participatory Irrigation Management" (PIM), they are thus usually referring to a change in the level, mode, or intensity of such participation that would increase farmer responsibility in management process. PIM is designed to shift the financial burden for irrigation services from the agency to the users [2]. This idea is being supported by Mr. Adrian Laycock, as he stated, Privatization started to

become politically fashionable in the late 1980. In this context privatization means off-loading government ownership or responsibility for operation into the private sector, either to the farmers themselves or to an intermediate private subcontractor. But is it just a means of off-loading responsibility from a government line management system that can't cope, or is it really to benefit the farmers? [3].

Sandra Ricart and others show how stakeholder engagement in irrigation systems shapes hydrosocial territories: (1) by reducing tension between stakeholders, (2) by redirecting regional planning and strategy, (3) by highlighting water crises, (4) by decentralizing water responsibilities, and (5) by integrating values and beliefs from different stakeholders. Stakeholder engagement is one of the main characteristics of the shift from governmental to non-governmental ownership, management and administration of water resources and services [4]. Stakeholder engagement implies a combination of *collaboration* – which involves cooperation to achieve goals of efficiency, equity and sustainability in water resources and comprehension – which is made up of forces, systems and mechanisms consisting of the ability to put oneself in the place of the other, sharing social identity, and promoting work together to achieve particular outcomes at different scales.

Barind Multipurpose Development Authority (BMDA) is an autonomous authority. The BMDA does not require external finance to operate the irrigation project and sustainable finance. There are around 16,000 deep tube wells and surface lift pumps covering around 0.6 million hectares (round the year) under BMDA management. BMDA is managed by a board chaired by an appointee of the government. There are three other members representatives from farmers including other relevant department's representatives. BMDA has introduced innovative concept for prepayment for water; this was started using a system of using electronic prepaid meters. There are no formal WUOs established instead keeps a very close liaison with the farmers and the communities through their field offices, this approach appears to be effective. The chief executive of a successful irrigation project should have a clear idea about people, land and water.

1.2. Analysis of PIM

A major weakness that continues to plague the productivity of large irrigation schemes is the lack of efficient and sustainable Maintenance Operation and Management (MOM). As a consequence, the infrastructure of these schemes is degraded and needs rehabilitation and modernization. Other reasons include inadequate Government financing, lack of beneficiary empowerment and engagement in MOM; and limited capacity of public agency resulting in weak service delivery. Specific issues are the: (i) inadequacy of budget to support system MOM; (ii) lack of distinction between annual, periodic or emergency maintenance of a system; and (iii) poor cost recovery from the water management groups

Water management is very limited with minimal attention to how the scarce water resources are allocated and most schemes only meet a small portion of their target production. Many farmers turn to the use of groundwater to support limited and irregular water supplies. The mix of irrigation from surface and groundwater makes evaluation difficult and masks deficiencies of the surface water supplies.

During the past 20 years, substantial efforts were made to improve irrigation MOM through introduction of new model of participatory irrigation management (PIM). PIM proved generally successful on small and medium schemes but it has yielded limited results on large schemes. The variable performance of PIM in improving irrigation MOM is internationally documented and private sector participation through public private partnership (PPP) is seen as an interesting alternative approach. It has demonstrated promising results in few developing countries such as Brazil, Morocco and Ethiopia but is still to be developed in Asia. The irrigation systems in Asia are characterized by densely populated farmers doing subsistence agriculture. The farm size among Asian farmers, are small as opposed to large commercial farms in the west, farmers are generally poor and usually augment incomes through non agriculture related activities. Inequities among farmers in terms of farm size, access to credit and markets, caste structures make irrigation in Asia very complex[7]. However, in Bangladesh this issue of cast structure is not evident especially in irrigation sector.

1.3. Water User Association (WUA)

There are Water User Association (WUA) and cooperative groups in government documents but practically is not in effective form especially in most the irrigation schemes in South East Asia If there is any WUA in any irrigation scheme -that is only in paper. If one asks the farmers, the president or secretary of the WUA are for how many years- the reply would be from the beginning of formation of WUA. The problem is the stake holders as farmers are of very heterogeneous – there are rich and poor farmers, educated and illiterate farmers, own land owners and share croppers or lessee farmers. Practically, it is quite critical issue. Moreover, this Water Users Association is advocated by most of the studies but possibly one aspect is overlooked or bye-passed, the remunerations to office bearers of the WUA. How one can expect they will render their services properly? It is believed those office bearers of WUA or so called cooperatives manage certain benefits monetarily or other ways (own land irrigated by the cost of other water users). However, this unholy practice is being followed in most of the WUA and cooperatives of irrigation schemes [5].

2. Barind Multipurpose Development Authority (BMDA)

The Barind Multipurpose Development Authority (BMDA) is an autonomous authority reporting to the Ministry of Agriculture. BMDA has taken an innovative approach to management of rural infrastructure, particularly the distribution irrigation water and management of irrigation systems. The part of greater Rajshahi, Dinajpur, Ranqpur and Boqra District of Bangladesh and the Indian territorial Maldah District of West Bengal is geographically identified as the Barind Tract. The hard red soil of these areas distinguishes it from of the other parts of the country. A typical dry climate with comparatively high temperatures prevails in the Barind area from November to May. The total cultivable area is 600,000 ha of which 84% is single-cropped,13% is double cropped and the rest is triple cropped. The Barind Multipurpose Development Authority (BMDA) was established under the Ministry of Agriculture in 1992 through the Secretarial power of the concerned Ministry. However, Parliament passed the Act in October 2018 and now covers 16 districts; 124 upazilas, 1,094 unions, and 20,153 mouzas i.e. whole of Northwest part of Bangladesh shown in figure 1.

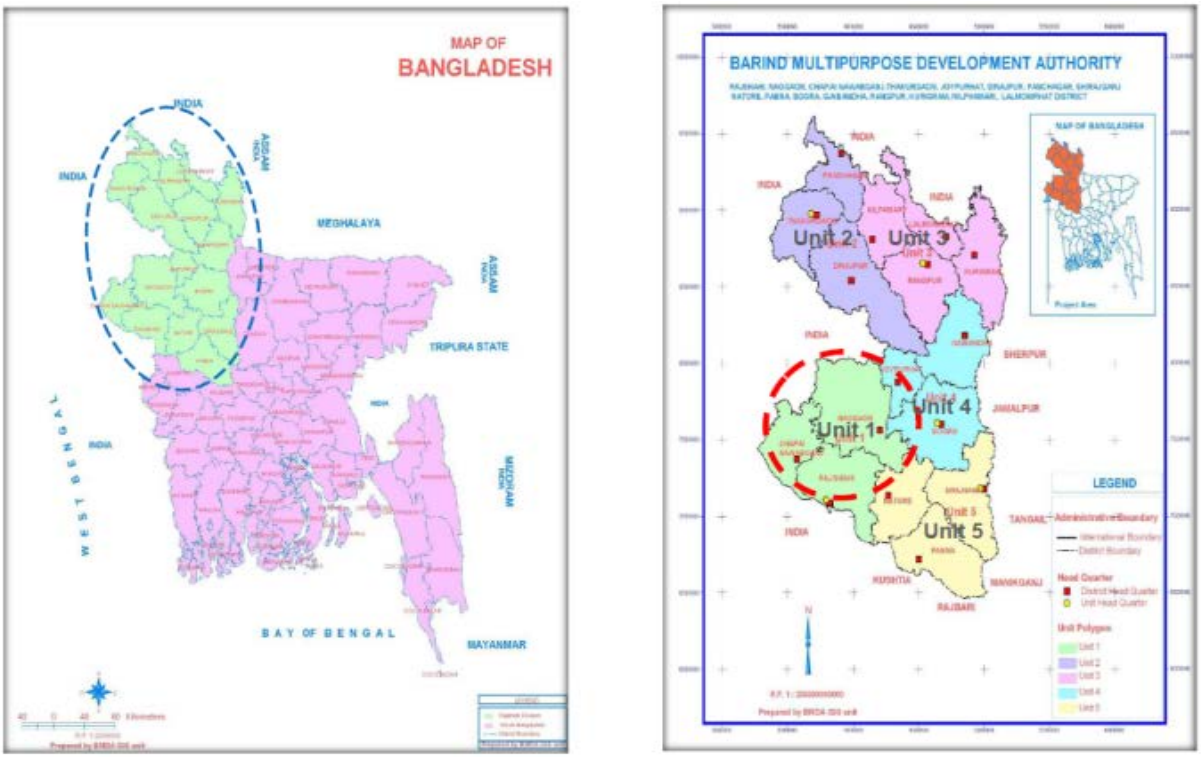

Figure 1. Map of Barind Authority

2.1. BMDA Management

BMDA is managed by a board chaired by an appointee of the Prime Minister. The Executive Director (Chief Executive Officer) of the Authority is a member and also secretary of the Board. The Board is constituted as follows [6]:

I. Chairman - Appointed by Prime Minister
II. Member - Deputy Inspector General of Police, Division
III. Member - Deputy Commissioners of the districts
IV. Members - Three members representatives from the farmers
V. Member Secretary - Executive Director, BMDA.
VI. Advisor - Members of the Parliament of BMDA jurisdiction

2.2. Irrigation Development

There are around 16,072 number of irrigation equipment (Tubewell-15,553 and Surface Water lift pump-519) under BMDA management and all are governed by BMDA Zone (field) Offices. Most important aspect not a single irrigation equipment is in idle condition for technical, financial or political reasons. BMDA pays employee salary, wages, all allowances, retirement benefits, and support costs for its around 1,036 regular staff members, 375 Muster roll staff and 1,6072 nos. of pump operators on hourly basis (no work no remuneration) i.e. total around 17, 483 engaged manpower, O&M costs of all irrigation equipment and transports, irrigation equipment's electricity bills. BMDA bears all the above costs without seeking unreliable funding sourced from the Government. The detail of irrigation equipment and its use is shown in table 1 [7].

However, the year wise use of number of irrigation equipment and corresponding irrigated area are shown below in the graph, figure 2.

Table 1. Status of present irrigation Equipment and its use.

Year	Used nos. of irrigation equipment		Total nos. of Irrigation equipment	Irrigated area (Ha.)	Realized Irrigation Charges (Million BDT)	Realized Irrigation Charges (Million USD)
	Tube well	Surface water lift				
2018-19	15,553	519	16072	540240	1561.80	19.52

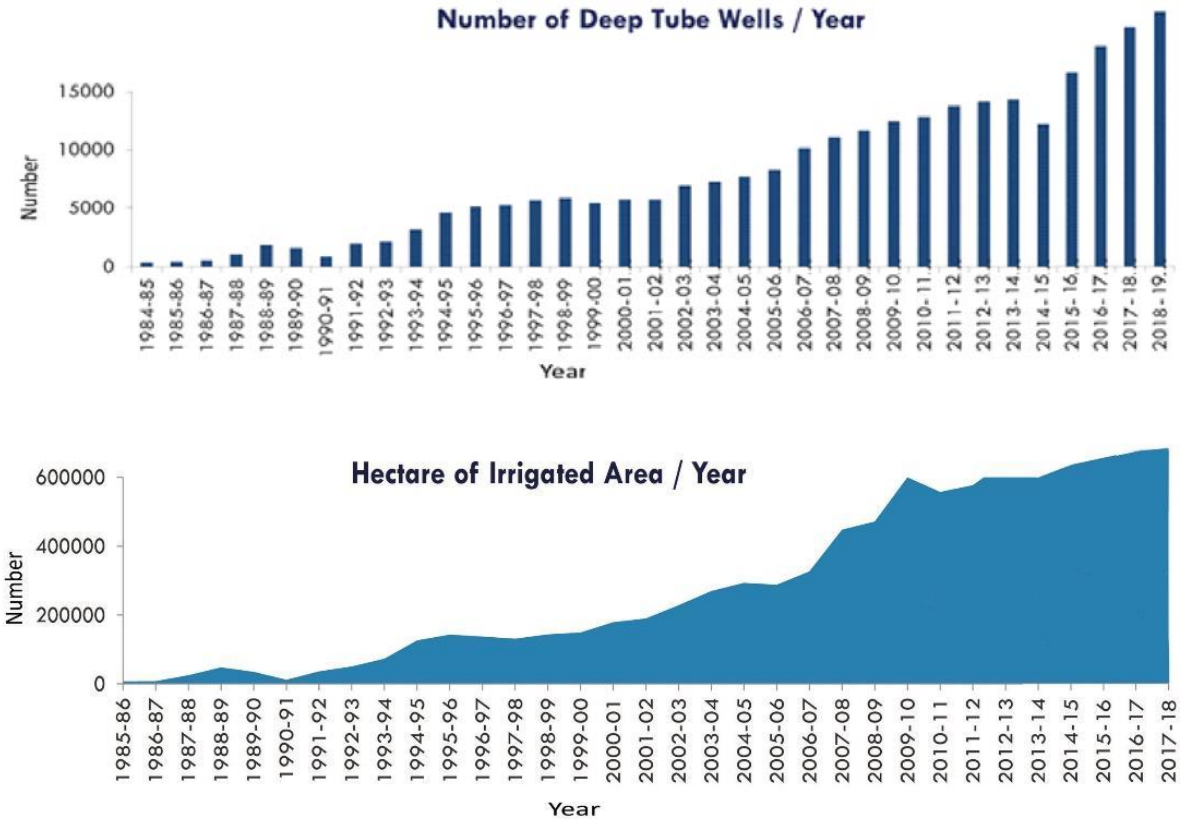

Figure 2. Year wise Deep Tube Well and Irrigated Area (Hector)

2.3. Prepaid Metering System & Smart Cards

Despite its success, BMDA does not follow the principles of the Guidelines for Participatory Water Management (GPWM) nor does it follow the participatory processes that global lessons claim are necessary for sustainability. A significant feature of the BMDA operation is the pre-payment, by farmers, for irrigation water.

In response to the universal concern for irrigation sustainability, that O&M will fail through a lack of user raised funding, BMDA has introduced two innovative concepts for collection of the irrigation charge (IC) - a prepaid metering system. The Prepaid Metering System provides every farmer with a user card. The user card, provided by BDMA has photo ID, name and a user number. The card is loaded with credit by paying cash at any BMDA office, or to an accredited dealer. The card is then inserted in a slot at the pump station and water is pumped automatically with the charge levied against the credit on the card. The meter, usage and pump delivery is checked everyone or two days by a BMDA official in a similar manner as for the coupon system. Card uploading stations (vending stations) are connected electronically to a central BMDA operator and all data can be monitored remotely. The process works using technology similar to that used for loading credit to cell phones. The initial concern for the introduction of a high technology electronic system was dismissed on viewing the system in operation. Farmers were using the card with confidence and the procedure was working. It fails when there is no electricity, but then so do the electrically powered pumps.

Figure 3. Components of prepaid meter

2.4. Mode of Operation of Prepaid Meter & Card

- Each farmer is issued with a pre-paid User card which when introduced into a pre-paid Meter enables the pump to start and water delivered until such time as the card is removed or its credit expires. The amount debited to the card is proportional to the pumping duration and therefore volume.
- Farmers recharge their cards using a hand held Mobile Vending Unit (MVU) kept by a Dealer who collects farmer payments. The Dealer recharges his MVU credit whenever required from a Vending Station (VS) at the local BMDA office after depositing the recharge amount into the BMDA bank account.
- The prepaid meter system which currently extends over 16 districts is managed by BMDA. Repairs to the system, for example for the 16,072 Meters, are done under contract with a private company (currently Sanakosh Associates Ltd). The system was supplied and installed by Wasion Group, China.
- All the pumps under BMDA are electric pumps. There are issues of reliable electricity but the farmers manage an informal backup system pumping from ponds and khals. Farmers understand the limitations of electricity and some schemes are not fully planted due to the limitations of the number of hours of electricity.

2.5. Benefits of Pre-Paid Meter and Smart Card

- all water provided is paid for in advance;
- there is no opportunity to by-pass the meter;
- the system is completely transparent with checks and balances in place to counter fraud;
- People cannot coerce the operator to deliver water free of charge;
- Farmers cannot be exploited by land owners who may control the well;
- Prepaid water charges go to BMDA coffers which support the sustainability of the BMDA

The findings of benefits after installation of Pre-Paid meter could be seen in the following table 2.

Table 2. Findings of benefits after installation of pre-paid metering system

Component	Without Pre-Paid Meter	With Pre-Paid Meter	Comparison
Irrigation Cost/ Ha. (BDT)	11,040	5,440	51% improvement
Irrigation Cost/Ha. (USD)	138	68	51% improvement
Average Water use/Ha. (Inch)	82	59	28% improvement
Water Required /Kg of Boro Rice production. (Liter)	3400	2250	34% improvement
Avg. Yield / Ha. (Kg)	6,084	6,602	34% improvement
Avg. Earning /Ha. of Boro Rice (BDT)	31,200	44,480	43% improvement
Avg. Earning /Ha. of Boro Rice (USD)	390	556	43% improvement

2.6. Impact of Prepaid Metering System and Smart Cards

Analysis of different parameters of irrigation system shows a miraculous picture after installation of prepaid metering system and smart cards. The following table 3 and show the impact before and after installation of prepaid meters.

Table 3. Impact Before and After installation of Pre-Paid Metering System

Parameter	Before Pre-Paid Meter	After Pre-Paid Meter	Comparison
Irrigated area / Well in Ha	30	39	30% increase
Nos. of water users/ Well	70	89	27% increase
Irrigation Charges/ Well in BDT	254,960	286,560	12% increase
Irrigation Charge/ Well in USD	3,187	3,582	12% increase
Annual operating hours /Well (Avg.)	2,884	3,132	9% decrease
Annual Electricity Bill /Well in BDT	129,040	117,360	9% decrease
Annual Electricity Bill in USD	1,613	1,467	9% decrease

3. Assessment of Irrigation Charges

The irrigation charges per irrigation equipment under BMDA management are calculated by a committee of engineers. The committee calculates and recommend for consideration of the BMDA board. Once BMDA board approves the rate of irrigation charges, become effective for implementation in the field. The rate of irrigation charges to be such that all with the intention to keep Barind Irrigation as a sustainable model and different stakeholders feel satisfied. However, the following parameters are being considered for the assessment of irrigation charges.

Irrigation Charge = EC+ POR+ RMC+ MCB+ DC+ SO+ MVC+ VAT

Where,
EC = electricity cost per hour KWh
POR= pump operator remuneration
RMC = repair and maintenance cost
MCB= maintenance cost of buried pressure pipe system
DC= depreciation cost of machine and equipment
SO= scheme operational staff cost
MVC= mobile vendor's commission
VAT= Value Added Tax

The present rate of irrigation charge as been assessed and approved for irrigation equipment are as follows. The per hour irrigation charges are as follows for ground water lifting and surface water lifting and those are variable on the basis of discharge from the pumps are shown in table-4A and table-4B. Per hour irrigation charge is dependable on main aspect i.e. rate of electricity tariff.

Table 4-A. Present rate of irrigation charges per hour for Tube wells pumping

Varied Discharge capacities for Tubewells				
Unit	**14 Lt./Sec.**	**15 to 21 Lt./Sec.**	**22 to 28 Lt./Sec.**	**29 to 56 Lt./Sec.**
Per Hour Rate in BDT	Tk. 85/	Tk. 100/	Tk. 110/	TK. 125/
Per Hour Rate in US$	$1.06	$1.25	$1.37	$1,56
Price per 1000m^3 in BDT	Tk. 1687	Tk. 1323	Tk.1091	Tk. 620
Price per 1000m^3 in US$	$21.08	$16.54	$13.64	$7.75

Table 4-B. Present rate of irrigation charges per hour for surface water lift pumping

Unit	Single Lift Pumping 28 to 56 Lt. / Sec.	Double Lift Pumping 28 to 56 Lt. / Sec
Per Hour Rate in BDT	Tk. 125	Tk. 160
Per Hour Rate in US$	$1.57	$ 2.00
Price per 1000m^3 in BDT	Tk. 1240.00	Tk. 776.70
Price per 1000m^3 in US$	$15.50	$9.71

Note: i) Effective from 1st February, 2018 ii) 1 USD equals 80 BDT

4. Financial Viability

Financial viability of irrigation project is the key factor for achieving the sustainable irrigation management system. The chart in the Figure 4 shows the year wise earnings vs expenditures of the authority. Regarding financial viability Dr. Tushaar Shah who wrote in one of his publication after visiting and interviewing the farmers in 2014, *"The revenue s earned are used for O&M and for expanding the system. Studies suggest that this system is financially self-sustaining. …The institutional arrangement is incentive -compatible. The Barind's socio-economic impacts are deep and wide. In a region where farmers found it hard to grow one crop, today they grow up to three crops annually. Some 1.5 million small farmers have benefited and many more will benefit when the remaining 450,000 ha are brought into the tubewell programme"* [8]. Similarly, Tonkin + Taylor did a field study of Barind in 2016 under Swiss Red Cross sponsorship and wrote "BMDA in Barind has a highly capable and well organized management system with 100% revenue return on water pricing." [9] These all study reports show that Barind Irrigation Management system is a self-sustained model.

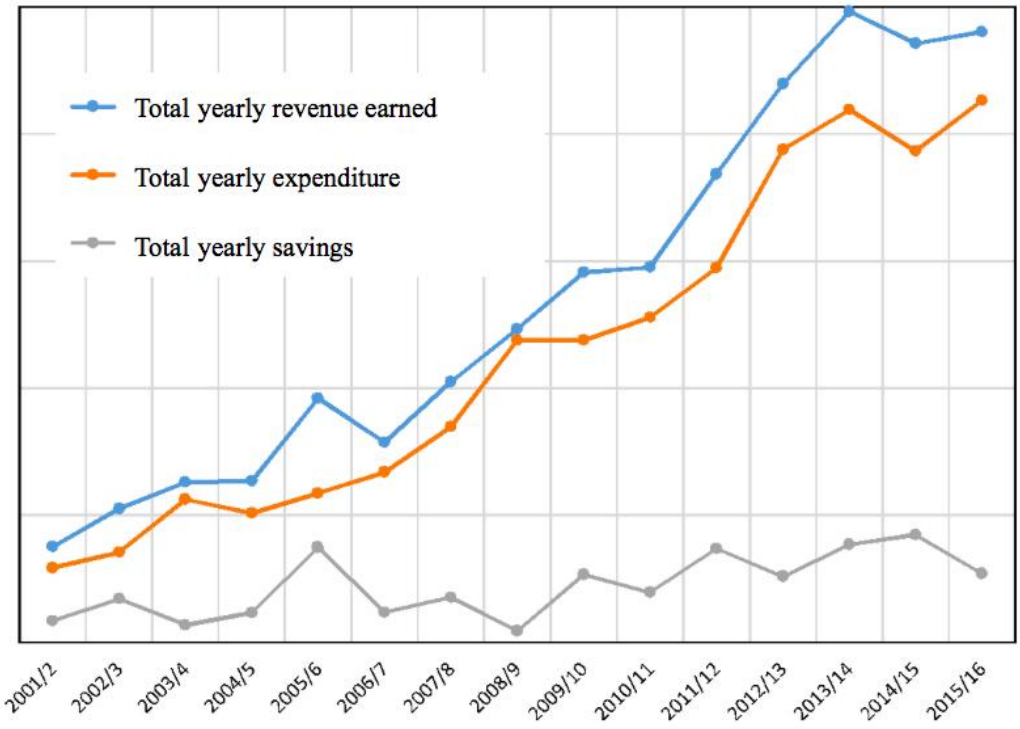

Figure 4. Year wise revenue earning vs expenditures [10]

5. Conclusions with Salient Features

5.1. Financial Cost Recovery

- The pre-paid smart card system ensures 100% collection from farmers and by being totally transparent eliminates rent seeking and corruption. It is also fair with farmers paying according to volume of water they use.
- The use of electric power for pumping greatly reduces pumping costs due to the Government's subsidy. In most areas covered by the BMDA load shedding is not a major problem.
- Farmers themselves provide an informal back up of water supplies by pumping from ponds and khals.
- The BMDA pre-paid smart card system requires electric powered pumps and power supply for the meters.
- With a buried pipe distribution system the pump runs for 10-20 seconds after a farmer's user card is withdrawn (the amount being charged to the card). Another card needs to be inserted within this time of the pump shuts down. Once a pump stops it cannot be restarted for 3-5 minutes to avoid damage to the motor.
- BMDA undertakes a number of cost recovery/income generation activities which help support the financing of the authority as well as provide direct and indirect benefit to farmers.

5.2. Water Use Efficiency

- While the pre-paid card system can work with open channels operational losses are significant as the canal prism empties / fills when water is rotated to different outlets. A buried pipe system remains full. Pipeline diameters used vary from 6-10 inch (160 – 250 mm).
- Farmer irrigation service is good with a direct link between volume supplied and cost. It is claimed that water use efficiency has greatly improved as farmers minimize their costs.

5.3. Scheme Size

- The full pumped flow (typ. 28-56 l/s) is used by one farmer who may split the flow so that field crop damage is avoided.

5.4. Cropping

- With the prepaid user card and buried pipe system farmers irrigate a variety of crops, including tomato, and boro – paddy lock in is avoided.

5.5. Backup Power

- Despite frequent power cuts the Barind does not provide any back up power supply. Farmers individually or collectively provide some back up supply from ponds and Khals (drains)

5.6. Concluding Remark

In conclusion, the author was asked by IWMI representative in an interview during India Water Week on 8-12 April, 2013 and published in the IWMI's under the title "Boom in Barind: a model for India's irrigators to follow is being enclosed as Appendix A [11]. Based on the field experience in Barind for more than 20 years author strongly believes that the Chief Executive of successful irrigation project should have a clear idea about water, soil and people.

Appendix-A [11]

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India Water Week

8-12 April, 2013 - Vigyan Bhawan, New Delhi

Boomtime in Barind: a model for India's irrigators to follow?

IWMI's Anna Deinhard talks to Dr Asaduz Zaman about the innovative approach his organization took to sustainable irrigation management in Bangladesh, which he recently presented at Asia Water Week in Manila, Philippines.

In the Barind region of Bangladesh rainfall is highly seasonal and poverty is endemic. Farmers with few resources were only able to grow one crop per year. In the late 1980s the Barind Multipurpose Development Authority was set up to explore ways of improving livelihoods through sustainable farm irrigation. New rice varieties that could grow in a relatively dry environment were introduced. To reduce water loss through evaporation an extensive network of tube wells and a pipe system were sunk into the ground as a replacement for surface irrigation channels.

Testing of a tube well to determine needed head and capacity of the pump.
Photo: Asaduz Zaman

Farmers still had to pay for access to water but cash transactions were replaced with a pre-paid swipe-card system for pump usage. This helped avert corruption and led to more optimal water usage, allowing more farmers access to groundwater and an expansion of irrigable land by over a fifth. Aside from poverty elimination, the project's major driver, other positive changes were observed. The electricity network, for instance, that was set up to run the pumps led to improved household electrification and the operation of a rice mill.

IWMI: The *Barind model* of irrigation management has proved such a success that the ADB is now planning to replicate it in other regions. What was Barind like before the project, and what changes did you achieve?
AZ: The farmers used to be very dependent on rainfall to grow a (variety of) monsoon rice crop. Consequently farm laborers (the poorest residents in the region, and therefore a key target for the project) could only work for around 4 months each year and then had to move elsewhere to sustain their lives. In addition rainfall in Barind used to be the lowest in the country and desertification started to become a problem.

Now after the implementation the farm labourers seem actually happier than land owners. They have work through the year and are even able to bargain. The demand for female labour has risen a lot too for certain agricultural practices.
Desertification is unheard of today. Irrigation wells are now performing a dual purpose for drinking water supply through pipe distribution system with overhead tank.

What were the challenges farmers had to deal with?
Well, first of all farmers did not have experience in how to grow seeds for Boro (the new dry season rice variety), which we introduced as an alternative to monsoon rice. It is a totally different procedure, so famers had to be trained. Knowledge of crop diversification and high value crops were also a totally new concept to the farmers.

In your presentation you highlighted the "Pre-paid-meter system. What is special about it and how does it work?
From the beginning of the project, we had the intention to avoid cash money and introduce a prepaid system for the irrigation system. Initially we started a coupon system, printing coupons from a government press. But even though, we ended up having problems with corruption and found the coupons being replicated on a local press. The police had to intervene. It was then that I started thinking about the swipe cards.

How was the system perceived by the farmers and other users?
At first some of the MPs and also some of the farmers seemed a bit reluctant. However soon after introduction of the new system those farmers came back and said, "This is good. We are saving money, water and time."

Do you think the model could be replicated in, for instance, India?
Back in 2004-05 when we introduced the pre-paid meter it still seemed very high tech, but I would say it is very easy to introduce nowadays. I am confident the model could be replicated in India for irrigation purposes.

In your opinion which are critical factors for the success of a replication?
I think the Irrigation project authority should introduce the provision of incentives and penalties for good and bad performances respectively. Then there are matters of infrastructure, all wells should be electrified. The area should be brought under a buried plastic pipe water distribution system. But these factors are not impossible to achieve.
Last but not the least I think the chief executive of a successful irrigation project should have a clear idea about people, land and water.

About the interviewee:
Dr. Asaduz Zaman from Bangladesh has 40 years of work experience in groundwater and surface water irrigation management. He worked with the Barind Multipurpose Development Authority (BMDA), where he was responsible for the implementation of an irrigation project known as "Barind model".
Presently he is working with the Asian Development Bank (ADB) on a replication of this model.

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