

GOVERNANCE OF INVESTMENT IN PUMPED DRAINAGE IN WATERLOGGED POLDERS

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ABSTRACT

Polder 2 in Satkhira district in SW Bangladesh suffers from waterlogging during and after monsoon. The waterlogged areas are not suitable for farming during most of the year. The main objective is to show local farmers that an investment in pumps will raise their income and increase their nutrition intake. Therefore three lines of research are necessary (i) Water management: test the technical feasibility of installing pumps for drainage; (ii) Governance research: how to organise the farmers for management of the pumping for successful operation and maintenance of the pumps ;(iii) Economic analysis, do the benefits of the extra crops outweigh the costs of pumped drainage. At one location pumps are installed and operated for at least one year to learn also from the practical issues that pop up in this year to be dealt with by the farmers and the researchers. A methodology is developed based upon the three lines of research to give structure to the project, the learning process and the diffusion of this concept after the pilot. The methodology and results from this pilot are applied in a guidebook to stimulate and facilitate adoption of the concept by adjacent farmers and elsewhere.

1. INTRODUCTION

Polder 2 in the Satkhira district in South-West Bangladesh (figure 1) suffers from waterlogging during and after the monsoon season. About four decades ago, this polder was constructed. Drainage of excess water was arranged through khals, relatively large canals, that discharged their water through sluices into the river during low tide by gravity. This allowed the local community to grow two or even three crops a year. Since then the land within the polder subsided and the river bed has raised due to increased sedimentation. Nowadays, the largest part of the polder cannot be drained by gravity anymore and in addition most sluices are completely silted up. Waterlogged areas are not suitable for farming during most of the year. During monsoon season most small farmers rented their land to larger fish farming companies and looked for jobs outside of the polder.

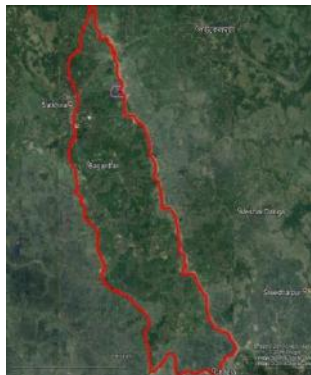


Figure 1. Overview of Polder 2 on a Google Earth map and some polder characteristics.

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Legend

Red line: boundary of Polder 2

Purple line: location pilot Beradanga

Polder 2 characteristics

Area size: 12296 ha

Boundaries:

- East: Betna River (tidal)
- South and South West: Marichap River (tidal)

Drainage systems:

Khals, mainly in eastern and western direction, discharging through sluices to tidal rivers.

Surface elevation:

- General slope downward in southern direction
- Numerous small earth levees

Rainfall (1985-2016):

- Annual average: 1828 mm
- Average June 1 to Sept. 30: 1308 mm (72%)
- Monthly maximum: 808 mm

A feasibility study (Vergroesen, 2014) indicated that the current single rice production period per year can be extended to two or even three rice crops per year by pumping the excess water out of the polder.

2. OBJECTIVES

The basic hypothesis of this paper is that if farmers in a waterlogged area invest themselves in a pump, that will drain the excess water more quickly during and right after the monsoon season, the extra crop yield due to the pumped drainage should exceed the pumping costs.

The objective of this project is three fold:

- Prove of concept** - to test whether pumped drainage is a viable solution to water logged areas in SW Bangladesh. If pumped drainage is economically feasible it can increase livelihood of farmers (SDG1), achieve food security and improved nutrition (SDG2), sustainable management of water (SDG6) and promote sustainable inclusive growth (SDG8).
- Pilot** - During the pilot local people will be trained to operate the pumping station themselves and take care of basic maintenance and simple repairs. That way they can take over the pump operation completely once the pilot is proven successful. Farmers will be learned how to grow more valuable crops.
- Diffusion** - When the pilot is proven to be successful, similar drainage can be applied at other locations. In this project the road towards diffusion is paved.

3. METHODOLOGY

The methodology developed is a combination of the methodology on investment decisions (e.g. Cost Benefit Analysis, (Romijn and Renes, 2013), on the project cycle (Biggs and Smith, 2003), on diffusion of technologies (Rogers, 2003) and on evaluation (Rossi et al., 2018). Our case deviates from the standard diffusion literature, due to the fact that the pump and the subsequent drainage system have to be bought, operated and maintained collectively. This methodology is tested in a pilot case in polder 2

(location Beradanga, figure 2). This location is selected based upon the methodology. The link between the methodology applied is presented in Table 1.



Figure 2. Location of Beradanga pilot area and proposed pump house location on a Google Earth map.

Table 1. The 6 steps of the methodology developed, the questions to be answered in each step and the link to the literature on which the methodology is based

Step	Question to be answered	CBA methodology (Romijn and Renes, 2013)	project cycle methodology (Biggs and Smith, 2003)	diffusion methodology (Rogers, 2003)	Evaluation (Rossi et al., 2018:62)
1. Potential	Can pumped drainage offer a solution?	Problem analysis	Programming	Knowledge stage.	Theory of Change
2. Suitability	Are the conditions right for pumped drainage?	Define policy alternative & Determine effects and benefits	Identification	Persuasion stage	Intervention proposal
3. Selection	Is the WMG ready to invest?	Overview of costs and benefits		Make the decision	Agreement on goals
4. Design & Installation	What is the most optimal set-up?		Design		Agreement on performance criteria
5. Implementation	How to improving operation & productivity?		Implementation	Implementation	
6. Evaluation	How to improve the pumped drainage		Evaluation	Confirmation	Evaluation and monitoring

Our methodology consists of six steps to be taken consecutively and three domains (within each step).

These three domains are presented in Table 2 and are based upon Ostrom (2009) and Burnhem et al., (2015).

Each domain is linked to one line of research as follows:

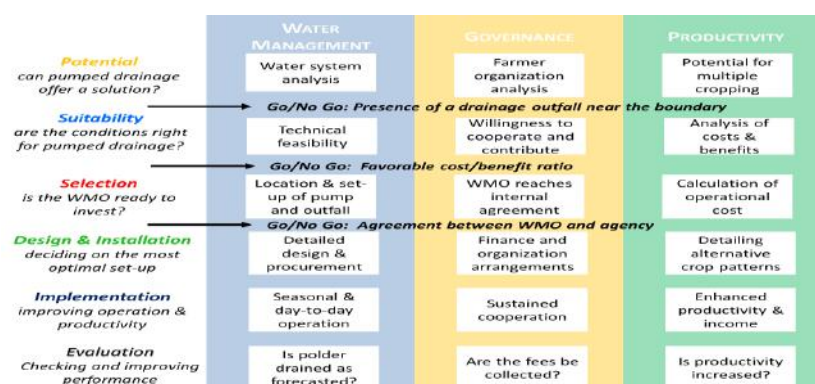
- Water management: Test the feasibility of installing pumps for drainage in polder 2;
- Governance: how to organise the management of pumping;
- Productivity: do the benefits of the extra crops outweigh the costs of pumped drainage to be shown during at least 1 year in the polder.

Table 2. The three domains of the methodology, linked to the underlying literature

	A. Water management	B. Governance	C. Productivity
Ostrom (2009)	Resource system and Resource units	Governance system	Users
Burnhem et al., (2015).	Technology	Social/political/economic system	Factors regarding the adaptor

The methodology applied is the combination of Table 1 and Table 2, presented in Table 3. This methodology is developed at the beginning of the project to have maximum advantage of the learning process in the pilot and to prepare for the important governance structure for the upscaling phase after finishing the pilot and speed up diffusion.

Table 3. The methodology



4. THE PILOT STUDY

The aforementioned methodology is elaborated, tested and adapted based upon a case study in polder 2 near Satkhira (SW Bangladesh). This is a Blue Gold polder (<http://www.bluegoldbd.org/>), in which water management groups (WMOs) were established recently. This paper focusses on the governance and productivity domain, because this often does not receive the attention needed in water management diffusion processes. The distinguished steps (see Table 3) are elaborated below:

4.1 Potential

A water system analysis, including a rainfall frequency analysis, was carried out. Because the monsoon differs from year to year a historical period of 32-year daily rainfall was examined for a three crop growing season. The three crops considered, Boro, T.Amon and Shorisha, were derived from a wish list of local farmers. Hydrologic conditions (table 4) during the year were applied in a simplified spreadsheet model (EXCEL). Water was discharged above a certain water level until a pump switch-off level was accomplished. Relevant aspect to realize is that once water is drained, it is gone and when the water level drops below the required minimum water level for that crop

irrigation is required. The result of this analysis was that a pumping capacity of 2.5 litre/sec/ha is sufficient to produce these three crops in one year. The model calculated that due to severe monsoon rains on average once every 4 or 5 years some yield reduction will occur.

Table 4. Required hydrologic conditions for Boro, T.Amon and Shorisha and how they are modelled

Crop	Required time	Current season	Modelled season
Boro	120 – 140 days:	Dec – Apr 15	
	<ul style="list-style-type: none"> 1 month planting (1.5" water) 		Feb 15 – Mar 15
	<ul style="list-style-type: none"> 2 months growing (2-3" water) 		Mar 16 – May 15
	<ul style="list-style-type: none"> 0.5 month harvest (0 water) 		May 16 – May 31
T.Amon BRR152)	140 – 160 days:	Jul 15/Aug 15 – Dec 15	
	<ul style="list-style-type: none"> 1 month planting (2-3" water) 		Jun 16 – Jul 15
	<ul style="list-style-type: none"> 3.5 months growing (6-12" water) 		Jul 16 – Oct 31
	<ul style="list-style-type: none"> 0.5 month harvest (0 water) 		Nov 1 – Nov 15
Shorisha mustard)	50 – 70 days:	Nov – Dec	
	<ul style="list-style-type: none"> Dry conditions during whole season 		Dec 1 – Jan 31

A few locations (sub-catchments) in Polder 2 were preselected where pumping could be viable from an agro-economic and socio-organisational point of view. Initially areas around 500-600 ha were preselected based upon their apparently urgent water logging problem. An important aspect of the success of the pumped drainage concept is the cooperation between farmers. Although farmers are collaborating within WMGs, they have no experience in collaborative investments. Interviews with the WMGs revealed that they tried to do some small-scale pumped drainage, but these projects failed due to the missing capacity for operation and maintenance before. It also became clear that the WMG members do not have any experience in investing collectively. Therefore, the size of the pilot areas has shrunk to 30-50 ha, to limit the number of farmers, raise the chance for successful cooperation and to reduce purchase and construction costs. The coordination of the domains and the process is important. Therefore, an NGO with local experience, called the the agency in the remainder of this paper, was hired to facilitate the process with the farmers.

Five smaller sites were selected for the suitability step. Based upon readily available data and information collected during a site visit a preliminary cost benefit analysis (CBA) is performed from society point of view, and a business case was elaborated. In the CBA also the effect of reduced waterlogging on the household was included. An important

4.2 Suitability

In this step the 5 preselected sites were visited and the WMGs were interviewed to get a first indication of their willingness to participate in pumped drainage. Because one (part

of a WMG) could represent the farmers in each site, it was decided upon that the WMG should be the agent to sign the contracts. For various reasons in three of these five sites the WMG's were not interested (fish contracts for the next three years, alternative drainage method was working sufficiently, preference of fish over crops).

Not only support but also willingness to contribute to the installment of pumped drainage is a prerequisite for the suitability of an area. The stakeholders (preferably the WMG) need sufficient information to decide whether they want to support and contribute to installation of pumped drainage. This step includes therefore a discussion about the costs, benefits, advantages and disadvantages of pumped drainage with local farmers. During this discussion the financial contribution to the operation and maintenance of the pumps should also be discussed. All the different farmer categories should be represented in this discussion, including large landowners, aquaculture farmers, small landowners and female headed households. Besides farmers, it is recommended to keep other key stakeholders well-informed. This can be done by an information event or individual meetings.

As 'Seeing is believing', a field visit to a successfully implemented pumped drainage project is recommended. This allows participants to witness successful practice at hand and to ask questions about it. This knowledge exchange can empower people and help to develop a more effective pumped drainage project.

After all the available information is provided, it might take some time for the WMG or other farmer organization to decide whether they would like to continue with the process to install pumped drainage. During this reflection period, the agency should be ready to answer questions of the farmers and negotiate on the (financial) conditions. Local presence is -again- recommended as it will be easier for farmers to approach the agency for questions. In this process support of the local authorities and water authorities could help in the decision of the farmers to implement pumped drainage. These authorities should therefore be well-informed about the process. The next step can be taken if the farmers agree to continue with the project.

For the CBA the farmers were interviewed to obtain information on their land use in the three distinguished seasons and their yields and benefits. Their cropping plans for the situation with pumped drainage were discussed. Farmers referred for the pumped drainage situation to the cropping plan when the polder was just developed (three rice crops), they had no plans to grow vegetables or other more valuable crops.

Table 5. Summary of cost benefit analysis for Beradanga site (45.5 ha) in BDT*1000 per year

Kharif-1 crop	ha	Kharif-2 crop	ha	Rabi crop	ha	Other benefits		Benefits (*1000 BDT)
Current								
HYV T.Aus	34.125	Fallow	45.5	HYV Boro	45.5	Off farm labour (persons)	20	
Fallow	11.375					# Homestead with vegetables	0	3654
Pumped								
HYV T.Aus	45.5	HYV T.Aman	45.5	HYV Boro	45.5	Off farm labour (persons)	0	
				Mustard	45.5	# Homestead with vegetables	45	5785
							Balance	2131

The yearly benefits of pumped drainage exceed the yearly costs

One of the preliminary results was that farmers refer to the old cropping pattern with three rice crops (from before the water logging problems). However, a more intensive cropping pattern is warranted (e.g. including vegetables) to obtain a more favourable cost benefit ratio.

4.2.1 Selection

Meetings with the WMG were held, facilitated by the NGO, to come to an agreement on the contract to install, operate and maintain the pumps. The conditions for the pumps in this pilot were made clear:

- Pumps and pump house construction to be arranged and financed by project organization;
- Training on pump operation and maintenance to be arranged by project organization;
- WMG to purchase pumps project organization after pilot ending (2 or 3 years);
- WMG to arrange internal drainage (draw a plan how to organise drainage towards the pump);
- WMG to arrange all labour necessary to maintain, operate and guard the pumps;
- WMG to raise funds to pay for the energy bill. This element caused the most discussion, the farmers tried to convince the project organization that they had not enough funds.

After agreement of the WMG to contribute to the operation and maintenance of the pumps and the energy bill, the roles of the agency and the WMG should be made clear. A discussion on the involvement of the agency, WMG and other stakeholders in the design, construction, operation and maintenance of the pumps is recommended. Roles of other authorities, for example final approval of the pump design by the Bangladesh Water Development Board (BWDB), should be made clear as soon as possible. An internal discussion within the WMG might be required to come to a final agreement. This is also the moment to discuss potential land acquisition for the pump and compensation for disadvantaged farmers

One farmer offered part of his land to dig the pump-pit, where the drainage water from the pilot area accumulates to pump into the river. They preferred electric pumps over diesel pumps because of the smaller labour input required to operate electric pumps. The downside of electric pumps was discussed, because especially during rain storms, when pumps are needed, the power often breaks down. The farmers felt that one day delay of pumping was not essential (as was ascertained by the hydrological analysis), they were willing to take this risk instead of applying diesel pumps. A template for the contract with the WMG was developed, including the abovementioned conditions. Finally, the contract was signed by the representatives of the WMG.

Key stakeholders from the communities and agencies will be involved with a view to establish commitment and preparing for future ownership, operation and maintenance of the equipment and hydraulic/regulation works.



Figure 3. Impressions of a meeting at WMG Beradanga.

To enable evaluation (step 6), a baseline survey has been done, to be able to assess the effects of pumped drainage and its costs and benefits, after the installation of the pumps.

4.2.2 Design and Installation

The required pumping capacity (2.5 l/s/ha) and the estimated pilot area, determined the total required pumping capacity to be approx. 100 l/s. It was decided to apply two pumps of 60 l/s and 1 spare pump of the same capacity. Based on this a pump house was designed. The pump house location was determined in close consultation with the local BWDB field officer. The pump house design, including a water collection pond, the river dike crossing of the discharge pipes and the outflow protection measures for the river bed were discussed with the local BWDB Executive Engineer.

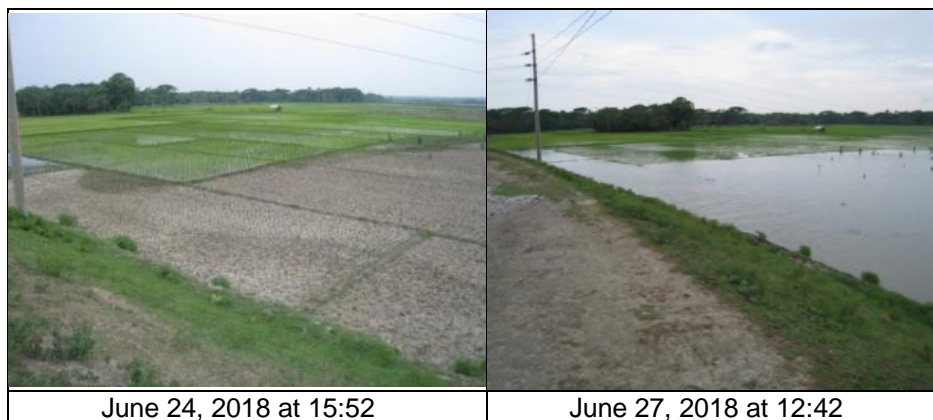


Figure 4. Flooding caused by several severe rainstorms in a few days at Beradanga pilot area at the foreseen pump location.

Not everyone can be involved in the design and construction process of the pump, therefore it is recommended to set-up a committee with 3 to 5 representatives. These representatives, all with their own task, was more heavily involved in the design, construction and operation and maintenance of the pump. Part of the representatives are the envisaged pump operator, financial caretaker and a member of the WMG board.

The committee is responsible to draw up the internal rules for operation and maintenance.

These rules have to be confirmed by all the farmers in the area that will be affected by pumped drainage. Not all farmers will be member of the local WMG, the farmers not represented should be as much as possible involved in discussions on rules and contribution. Although the financial contribution of the WMG has already been decided,

a decision has still to be made on how to divide this contribution among the farmers. The selected payment schemes is payment based on the total acreage of land in use.

Furthermore, a decision should be taken on how to collect the contribution and how to pay the bills. A bank account is required for an electrical pump (to pay the energy bill). Cash payment can be more sensitive for corruption. The WMG should take a final decision based on their internal discussion. The agency can support this discussion with relevant information

4.2.3 Implementation

During the pilot local people will be trained to operate the pumping station themselves and take care of basic maintenance and simple repairs. That way they can take over completely once the pilot is proven successful.

As the farmers were not used to the pumped drainage field conditions and to the new opportunities they have under pumped drainage, a training programme was developed together with the department of agricultural extension. Farmers will be learned how to grow other crops, especially in parts of the area where, due to pumping, water on land will hardly ever occur anymore.

A relevant issue that emerged is that the local community and especially the farmers just outside the pilot boundaries should realize that the pilot will be less successful or even can fail if the pilot boundaries are destroyed in order to drain an additional area (outside the pilot area). Only if the pilot is successful it will be extended to other areas. Hence, neighbouring farmers will also benefit from the pilot, however somewhat later in time.

4.2.3 Evaluation

A logic model was developed for the pumped drainage to find the relevant indicators for evaluation (see Table 6). After the committees and organisational rules are established the pump can be installed and operated. We suggest to set-up a monitoring and evaluation procedure, which allows frequent evaluation of the organisational structure and internal rules.

This leads to a more professional organisation. Seasonal meetings in which the committee reports the performance (hours operated, electricity used, waterlogged area, crop change and productivity) and problems can be followed up with discussions on the operation, financial organisation and maintenance.

There is suggested that every 2 years the farmers select a new committee responsible for operation and maintenance. Furthermore, external monitoring and evaluation can also be valuable, especially in the first years. Therefore, WMGs that installed pumped drainage could evaluate each others way of organisation. To facilitate evaluation; before installing the pumps the farmers within the pilot area were surveyed as well as a group of farmers in a reference polder, to enable the estimation of all the effects of the pumps.

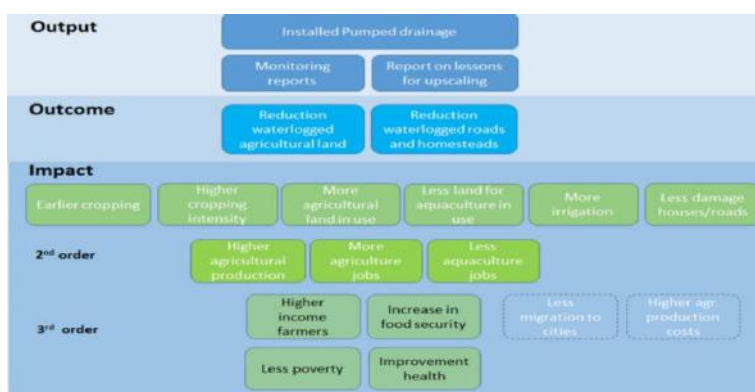
5. UPSCALING AND CONCLUSIONS

The goal of upscaling/diffusion is that farmers themselves decide to jointly invest in pumped drainage. To facilitate this diffusion process a guidebook for diffusion of pumped drainage was started from onset and is updated during the pilot with the information gathered and lessons learned. The attention towards governance and productivity paid off during the pilot frequently:

- The groups size should be small (around 50 farmers), to facilitate decision making on collective investments. Larger groups can be useful if these groups are well organised (with respect to decision making and financial contributions);
- Already in the potential (1st) step a preliminary cost benefit analysis was done, to analyse the conditions for successful implementation of pumped drainage. In the following steps this CBA was refined;
- The researchers only arranged the external conditions for pumped drainage, the WMG has to organise internal drainage, collection of the financial contribution etcetera;
- An NGO with local expertise was, as an independent agency, connected to the pilot, to solve issues (between farmers, between farmers and researchers, between pilot and government) and facilitate diffusion;
- Practical issues popped up in this pilot to be dealt with by the farmers and the researchers were documented in the guidebook;
- The department of agricultural extension was linked to the pilot in an early phase to reap the benefits of pumped drainage as soon as possible

The lessons learned during this pilot and laid down in the guidebook for diffusion can arrange a smoother installation and operation process of pumped drainage at other locations. These lessons can be taught by the agency supported by the WMG.

Table 6. Pumped drainage evaluation framework



One of challenges will be to arrange funds for the farmers' investment. As this is a new technique for Bangladesh the credit organisations are not acquainted with the return rates and the risks. Diffusion will be speeded up if an NGO will guide the aforementioned process (the methodology), preferably an NGO that also can arrange the funding. Another challenge is the free rider problem. Farmers who do not participate in the pumped drainage project might try to get some of the benefits (e.g. by making changes in the drainage system), these free riders can affect the benefits for the contributing farmers negatively. Mechanisms to reduce free riders behaviour should be elaborated, based upon the experience in the pilot.

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