

A COMPARATIVE STUDY ON MENONGCHARA AND BURAGHAT RUBBER DAM PROJECTS IN MYMENSINGH

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ABSTRACT

Rubber dams are water retention structures. A large number of rubber dam projects have been implemented by LGED, BWDB and BADC are in operation in Bangladesh. The main purposes of these projects are to retain water for irrigation. The present study has been undertaken as to compare the operation and management aspects and performance of two rubber dam projects implemented by different organizations. Performance of Menongchara and Buraghat projects has been evaluated considering technical, hydraulics, agricultural, environmental and socio economic indicators. Primary and secondary data were collected by field measurements and questionnaire survey conducted during 2018-19 crop season. In terms of actual irrigated area compared to design area, the performance of Buraghat project was better than Menongchara project. Irrigation efficiency and actual water productivity of two projects were almost same. Economic viability of both the project was found to be satisfactory. Profitability of farmer of Menongchara project was better than that of Buraghat project. Positive impact on fisheries, vegetation, livelihood, and wild life took place in both project areas. Few technical problems were identified in case of both projects. Project management committee of Buraghat project was found more active than that of Menongchara project. It was reported that LGED provides some financial and technical support in Buraghat project whereas no support is provided by BADC in Menongchara project. Based on this study it can be said that both Menongchara and Buraghat rubber dam projects are performing well. Certain problems were observed that are hindering optimal use of water. The uneven distribution of water in Buraghat project, lack of project management activity in Menongchara project, improper maintenance of canal are the problems faced by local people. If these problems were removed, more benefits could be obtained from the rubber dam projects.

Keywords: *Irrigation, Technical, Agricultural, Environmental, Socioeconomic.*

1. INTRODUCTION

Rubber dams are inflatable and deflatable hydraulic structures. Thousands of rubber dams have been installed worldwide for various purposes such as irrigation, water supply, tidal barrier, power generation, flood control, environmental improvement and recreations.

In 1957, the world first inflatable rubber dam appeared in Los Angeles, the United States, since then widely used all over the world. The rubber dam was installed in Australia and Japan in 1965, in Taiwan in 1977 and in Hong Kong in 1978. China built the first inflatable rubber dam in 1966 and that is the right door inflatable rubber dam in Beijing. More than 2000 rubber dams were built around the world, including Taiwan, Hong Kong, Japan, Australia (Saleh & Mondal, 2000).

In 1994 the Local Government Engineering Department with a joint technical team comprising experts from China Institute of Water resources and Hydropower Research (IWHR) in Beijing made a feasibility test for the first time on rubber dam construction. The joint technical team visited a number of areas at the field level and submitted a survey report titled “**Feasibility of rubber dam in Bangladesh.**” The report recommended construction of two rubber dams one on Idgaonkhal near Idgaon Bazar in Cox’s Bazar and another on Bakkhali river about 5 km from Cox’s Bazar on a pilot basis to assess some design parameters, performances, cost effectiveness and social acceptability. In the year 1995-96 these two pilot rubber dams were built and are being successfully used for agricultural purpose (LGED, 1994). Based on the success of two pilot rubber dams, the countries third rubber dam was constructed on the Bhogai river of Nalitabari thana of Sherpur district under the Ministry of Agriculture in the year 1996-97. The government of the People’s Republic of Bangladesh has built 11 rubber dams in which 10 rubber dam construction projects are under the Ministry Finance for its own funding. LGED has built 52 rubber dams. Bangladesh Water Development Board also constructed two rubber dams in Pekua Cox’s Bazar. Bangladesh Agricultural Development Corporation (BADC) involved with rubber dam project in 2009. They implemented eight rubber dams and few rubber dam are currently under construction.

A number of studies have been conducted to investigate into design aspects and to assess performance of individual rubber dam project. No study focuses on comparison of performance of projects under different management. The Menongchora and Buraghat rubber dam project, therefore, needs to be studied comparatively in order to investigate their performance in terms of the above mentioned aspects. So this comparative study on this rubber dam projects was undertaken.

1.1 Components of a Rubber Dam

Rubber dam comprises mainly of four parts: dam body or dam bag, anchorage of dam bag with concrete floor, control system (including water or air filling and emptying system, monitoring system and safety control system) and foundation (including foundation, top and side walls etc.). Some other parts: massive concrete base (dam base), vertical wall and slope wall, river bed inverted filter or block chamber, filter material and bench protection work. Schematic diagram of a rubber dam is shown in figure 1.

1.2 Expected Life of Rubber Bag

Dam bags usually have longevity of about 20 years (IWHR, 1994) and need full replacement after that period. In this regard, by loosening the anchorage, the used rubber bags are removed. New rubber bags are being placed in place and anchorage is being achieved again.

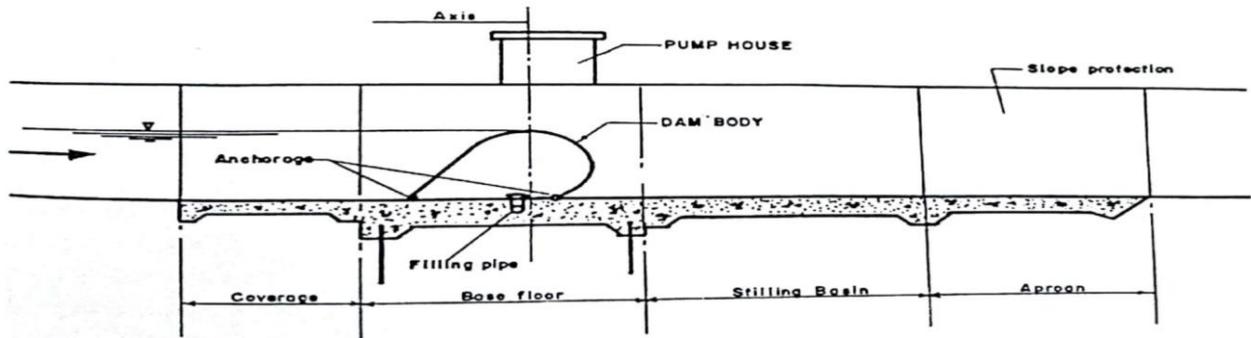


Figure 1: Cross-section of a Rubber Dam (Raquib, 1999)

2. METHODOLOGY

In this study Menongchara and Buraghat rubber dam projects were selected. Menongchara project was implemented by BADC and Buraghat project was implemented by LGED. In this study, evaluation of the performance of the two rubber dam projects was carried out using a standard set of performance indicators. The performance indicators such as water delivery performance, irrigation efficiency, yield efficiency, water productivity efficiency, fee collection efficiency, economic viability and profitability of farmer were used by Saleh and Mondal (2000). The command area efficiency was used by Ahmed (2014).

2.1 Water Delivery Performance

The indicator determines the degree to which water is delivered as arranged during the irrigation season. It is the ratio of the actual volume delivered to the target volume and is defined as

$$\text{Water delivery performance} = \frac{\text{Actual volume delivered}}{\text{Target volume}} \quad (1)$$

Actual volume of water delivered to the field was calculated by multiplying actual discharge with operating time. In the field discharge was determined by area-velocity method and the velocity was measured by floating method. Target volume data were obtained from feasibility report.

2.2 Irrigation Efficiency

Irrigation efficiency is also important indicator. It is the ratio of the amount of water consumed by the crop to the amount of water supplied through irrigation and is defined as

$$\text{Irrigation efficiency} = \frac{\text{Total demand of water}}{\text{Total supply of water}} \quad (2)$$

Net irrigation requirement of crop was calculated with the help of CROPWAT 8.0. Data were collected from BMD website. Total supply of water was calculated with the help of actual volume and actual irrigated area data.

2.3 Command Area Efficiency

Command area efficiency is the ratio of the actual irrigated area to the target area. In most cases the target area is taken as higher to show the project more attractive.

$$\text{Command area efficiency} = \frac{\text{Actual irrigated area}}{\text{Target irrigated area}} \quad (3)$$

2.4 Yield Efficiency

Yield efficiency is the ratio of the actual yield to the target yield

$$\text{Yield efficiency} = \frac{\text{Actual yield}}{\text{Target yield}} \quad (4)$$

2.5 Water Productivity Efficiency

Water productivity (kg of output per unit m³ of water used) indicates the efficiency in use of water for producing the ultimate result, the crop yield.

$$\text{Water productivity efficiency} = \frac{\text{Actual productivity}}{\text{Target productivity}} \quad (5)$$

2.6 Fee Collection Efficiency

The operation and maintenance cost of the project come from the fees collected from the farmers and beneficiaries. Fee collection efficiency is the ratio of irrigation fee collected to the irrigation fees assessed.

$$\text{Fee collection efficiency} = \frac{\text{Irrigation fee collected}}{\text{Irrigation fee assessed}} \quad (6)$$

2.7 Economic Viability

The economic viability of a project indicates whether the amount of the investments made is going to be recovered over the life of the project. The expense should include both capital and O&M costs. In public irrigation projects of Bangladesh the capital costs are not taken from the beneficiaries, just the O&M costs per ha per year of actual cultivated area have been considered. The indicator is defined as follows

$$\text{Economic viability} = \frac{\text{O\&M fee per ha}}{\text{O\&M Cost per ha}} \quad (7)$$

2.8 Profitability of Farmer

This indicator shows the benefit of farmers at the individual farm level. It is the ratio of benefit of irrigation per hectare to the irrigation fee per hectare. The benefit of rubber dam irrigation per hectare includes the difference between net benefit under irrigation with rubber dam and net benefit without the project. Net benefit of irrigation with rubber dam and without rubber dam was calculated by subtracting the total expense of irrigation from the gross benefit. The indicator is defined as follows

$$\text{Profitability of farmer} = \frac{\text{Benefit of irrigation per ha}}{\text{Irrigation fee per ha}} \quad (8)$$

Other indicators are: technical problems, impact on fisheries, impact on ground water table, impact on wild life and animals, impact on vegetation and impact on livelihood. All of these indicators are evaluated through visual observations and discussions with local people.

3. DESCRIPTION OF STUDY PROJECTS

Menongchara project area is located at Lokkhikura union of Haluaghat Upazila. There are four villages within the subproject area. This project was constructed by BADC in 2012. The net irrigable land under the studied project is about 900 ha. But actual area covered by the project is about 100 ha.

Buraghat Rubber Dam project is under Gazir Bhita union of Haluaghat Upazila in Mymensingh district. There are eight villages within the sub project area. The project was constructed by LGED in

2007. The net irrigable land under the studied project is about 725 ha. But actual area covered by the project is about 150 ha.



Figure 2: Menongchara and Buraghat rubber dam

Salient features of Menongchara and Buraghat rubber dam projects are shown in table 1.

Table 1: Salient features of Menongchara and Buraghat rubber dam projects

	Menongchara dam	Buraghat dam
Length of Rubber Dam (m)	30	30
Dam height (m)	4.5	3.5
Maximum retention	4.3	3.5
Length of concrete floor	27	27
Material	Reinforced Rubber	Reinforced Rubber
Shell thickness (mm)	10	8.0
Thickness of Cover sheet (mm)	3.0	3.0
Bridge (m)	30	30
Guide bunds (km)	10 (Earthwork)	8.0 (Earthwork)
Approach road (km)	2.0	2.0
Pump house	1 no.	1 no.
Bag filling time	12-15 hrs.	12-15 hrs.
Pump Capacity	100 m ³ /hr.	100 m ³ /hr.
Scheme life	(15-20) yrs.	(15-20) yrs.

3.1 O&M Problems

O&M problems of Menongchara and Buraghat rubber dam projects are summarised in table 2.

Table 2: O&M problems of Menongchara and Buraghat rubber dam projects

Menongchara dam	Buraghat dam
Erosion of river embankment	Erosion of river embankment
Damage of outlet pipe	The LLP need to be repaired several times in a season
The threaded gate of pipe outlet becomes loose	The soil of downstream settled

4. RESULTS AND DISCUSSION

4.1 Water Delivery Performance

Actual volume of water delivered to the field during the season was calculated by multiplying the actual discharge with the operating time. For Menongchara rubber dam actual discharge was determined by area-velocity method and the velocity was measured by floating method. Also 6 low lift pump of 3.5 HP and 1 low lift pump of 7.4 HP were operated during the season. The discharge was taken as 0.2265 cumec. The actual volume of water delivered during the crop season of 2018-19 is 1856156.54 cubic meter. For Buraghat rubber dam irrigation was done by operating 5 low lift pumps of 12 hp. Each pump was operated 24 hour in a day. The total discharge is 0.2832 cumec. Therefore the actual volume of water delivered during the crop season of 2018-19 was 2960686.08 cubic meter. Due to lack of target volume the water delivery performance could not be calculated in both the projects.

4.2 Irrigation Efficiency

The total demand of water of crop season 2018-19 was calculated with the help of CROPWAT software. NIR of crop season 2018-19 are shown in table 3.

Table 3: Calculation of Net Irrigation Requirement of crop

Month	ETc (mm)	Effective Rainfall, Re (mm)	NIR= ETc-Re (mm)
December	77.19	6.96	70.23
January	83.7	8.0	75.7
February	103.04	16.4	86.64
March	148.18	28.64	119.54
Total			352.11

For Menongchara rubber dam project total supply of water (in depth) = $\frac{1856156.54 \text{ m}^3}{101.25 \times 10^4 \text{ m}^2} = 1.833 \text{ m}$. Using equation (2) irrigation efficiency = $\frac{0.35211 \text{ m}}{1.833 \text{ m}} = 0.1921 = 19.21\%$. For Buraghat rubber dam project total supply of water (in depth) = $\frac{2960686.08 \text{ m}^3}{153.9 \times 10^4 \text{ m}^2} = 1.924 \text{ m}$. By using equation (2) irrigation efficiency is 18.30%. Based on result it can be said that irrigation efficiency of Menongchara and Buraghat rubber dam project seems to be low.

4.3 Command Area Efficiency

The actual and target irrigated areas of Menongchara rubber dam project are 101.25 ha and 900 ha respectively. In case of Buraghat rubber dam project the actual and target irrigated area is 153.9 ha and 725 ha respectively. By using equation (3) command area efficiencies of Menongchara and Buraghat rubber dam project are 11.25% and 21.23% respectively. The command area efficiency is very low. The reason is overestimation of target command area. The irrigated area is increasing in every season.

4.4 Yield Efficiency

According to farmers of Menongchara and Buraghat rubber dam projects the actual yield in the boro season was 5925.93 kg per hectare. From the feasibility report the target yields of Menongchara and Buraghat rubber dam project are 8450.62 kg per hectare and 7170 kg per hectare respectively. Using equation (4) yield efficiencies of Menongchara and Buraghat rubber dam project are 70.12% and 82.65% respectively. Yield efficiency of Menongchara and Buraghat rubber dam project seems to be good.

4.5 Water Productivity Efficiency

Actual productivity is the ratio between actual yield per square meter and actual depth of water supplied in the area. According to the farmers estimation the actual yield was 0.593 kg per square meter. Actual water productivities of Menongchara and Buraghat rubber dam project are 0.324 kg/m³ and 0.31 kg/m³ respectively. The actual productivity of water appears to be low. Due to lack of target productivity data, water productivity efficiency could not be calculated.

4.6 Fee Collection Efficiency

By using equation (6) fee collection efficiencies of Menongchara and Buraghat rubber dam project are 75% and 70% respectively. Fee collection efficiency of last few years is shown in figure 2.

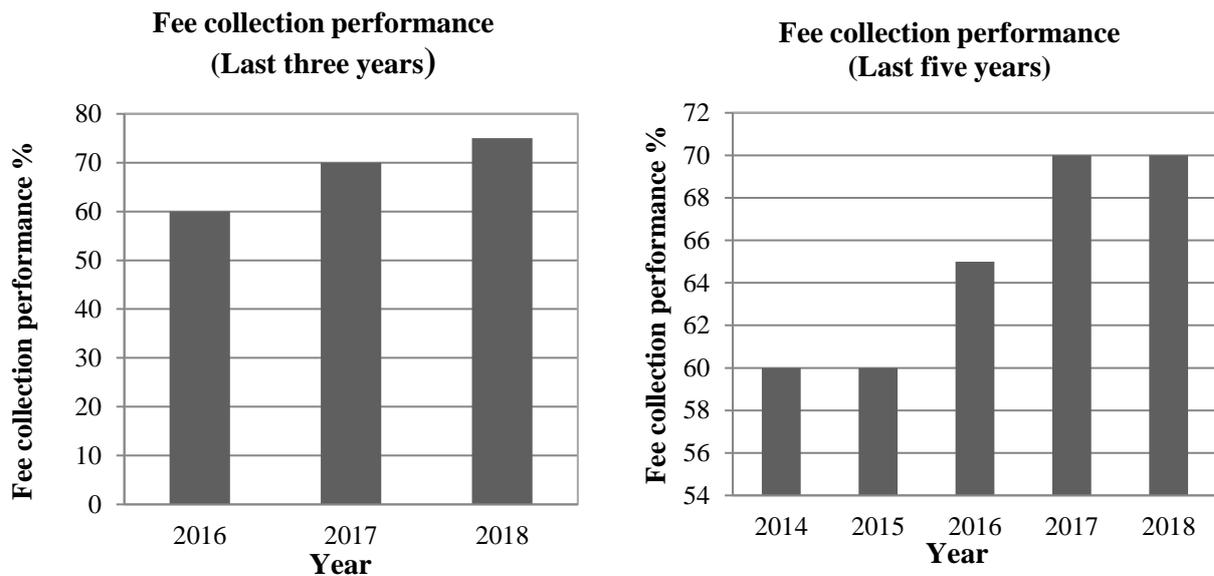


Figure 2: Fee collection efficiency of Menongchara and Buraghat rubber dam projects of last few years

4.7 Economic Viability

Economic viability determines how much of the investment made is going to be recovered over the life of the project. The irrigation fee including operation and maintenance fee are collected by the project management committee. The O&M service are provided by the project management committee. O&M fee of Menongchara and Buraghat rubber dam projects were taka 2470/ha and taka 3951/ha respectively. O&M costs of Menongchara and Buraghat rubber dam projects were 1838 taka/ha and 1854 taka/ha respectively. By using equation (7) economic viabilities of Menongchara and Buraghat rubber dam projects are 1.34 and 2.13 respectively.

4.8 Profitability of Farmer

For Menongchara and Buraghat rubber dam projects the gross return of boro crop season 2018-19 under irrigation was 88889 taka/ha. For Menongchara and Buraghat rubber dam projects total expenses of farmers including input cost, labor cost and irrigation fee were 66914 taka/ha and 70571 taka/ha respectively. The net benefit with rubber dam irrigation is 21975 taka/ha for Menongchara project and 18318 taka/ha for Buraghat project. As reported by the farmers of Menongchara and Buraghat rubber dam projects the gross benefits without rubber dam irrigation were 59260 taka/ha and 56297 taka/ha respectively. Total expense of farmers including input cost and labor cost was 44445 taka/ha for Menongchara project and 45680 taka/ha for Buraghat project. So the net benefits without rubber dam irrigation of Menongchara and Buraghat projects were 14815 taka/ha and 10617 taka/ha respectively. The benefit of rubber dam irrigation per hectare is 7160 taka for Menongchara

project and 7701 taka for Buraghat project. According to farmers of Menongchara and Buraghat projects the total irrigation fee in the season were 3347 taka/ha and 3951 taka/ha respectively. Using equation (8) profitabilities of farmer of Menongchara and Buraghat projects are 2.14 and 1.95 respectively.

4.9 Technical Problems

According to Menongchara rubber dam operator the operating nut of rubber bag is loose so they cannot operate it properly. In Buraghat rubber dam project the outlet water sometime overflows which causes the operating valve tube submerged. As reported by local people other problems were frequent sliding of river bank, damage of outlet pipes and leakage of water through opening of gravity pipes. No leakage in rubber bag, no mechanical problem in filling pump and no anchorage problem were found in Menongchara and Buraghat rubber dam projects.

4.10 Comparison of Performance of Menongchara and Buraghat Rubber Dam Project

Table 4: Values of performance indicators for Menongchara and Buraghat rubber dam projects

Performance Indicator	Menongchara Project	Buraghat Project
Irrigation efficiency	19.21%	18.30%
Command area efficiency	11.25%	20.52%
Yield efficiency	70.12%	82.65%
Actual water productivity	0.324 kg/m ³	0.31 kg/m ³
Fee collection efficiency	75%	70%
Economic viability	134.4%	213%
Profitability of farmer	214%	195%

Table 5: Comparison of the performance of Menongchara and Buraghat rubber dam projects

Topic	Menongchara Project	Buraghat Project
Irrigation fee	2470 Taka/ha	3951 Taka/ha
O&M cost	1838 Taka/ha	1854 Taka/ha
Meeting	Very few in a crop season	Monthly in a crop season
Water distribution	Gravity and LLP	LLP
Irrigated area	101.25 ha	153.9 ha
Water management	Participated by all farmers	Farmers are not involved
Project committee	Less active	Active
Solving O&M problems	By local people and technician hired by committee	By local people and technician from LGED
Authorities involvement in O&M work	No	Yes
Social acceptance	Not good	Good
Impact on fisheries	Good	Good
Impact on vegetation	Good	Good
Impact on livelihood	Significantly positive	Significantly positive

Impact on ground water	Positive	Positive
Wild Life and Animals	Positive impact	Positive impact

5. CONCLUSIONS

The overall performance of Menongchara and Buraghat rubber dam project were assessed through field visits and observations of rubber dam bag, river, canal, condition of LLPs, rubber dam pump etc. The conclusions are summarized below.

Amount of water delivered to Menongchara and Buraghat rubber dam projects is satisfactory. Irrigation efficiencies of Menongchara and Buraghat rubber dam project is 19.21% and 18.3% respectively, which are less than national average value. Current irrigated areas of Menongchara and Buraghat rubber dam project are 101.25 hectare and 153.9 hectare respectively. The values are much less than target values. In every season irrigated area are increasing for both the projects. Yield efficiency of Menongchara project is 70.12% and Buraghat project is 82.65%. From the result it is seen that yield efficiency of both the project is satisfactory. Actual water productivity of Menongchara and Buraghat rubber dam projects are 0.324 kg/m³ and 0.31 kg/m³. Actual water productivities of Menongchara and Buraghat project appear to be satisfactory. Fee collection efficiencies of Menongchara and Buraghat rubber dam project are 75% and 70% respectively. From the study it can be said that fee collection efficiency of Menongchara and Buraghat project are increasing every year. The project management committee of Menongchara and Buraghat project performing well. Economic viabilities of Menongchara and Buraghat rubber dam project are 134.4% and 213% respectively. Both the projects show good performance in terms of economic viability of the management committee. Operation and maintenance cost per hectare of Menongchara and Buraghat rubber dam project are 1838 taka and 1854 taka respectively. It is seen that both the project committee collected O&M fee more than O&M cost. But according to the committee members of Menongchara and Buraghat rubber dam project, they are not able to save money due to maintenance work. It is to be noted that the management committees are paying only operation and maintenance cost. They are not contributing to cost recovery of the projects. From the study it is seen that profitability of farmer of Menongchara project is 2.14 and Buraghat project is 1.95. Based on result it can be said that the farmers are benefitted from the projects. From the field visit and discussion with the beneficiaries it can be said that BADC did not involve in O&M of the project, they only handover the project to the beneficiaries group. Whereas in Buraghat project LGED provides technical support in O&M of the project. Few technical problems are observed for both Menongchara and Buraghat project. Based on study it can be said that Menongchara and Buraghat project show positive impact on fisheries. Fish cultivations are increasing in both the project area. After Menongchara and Buraghat project was implemented vegetation are increased in both projects area. Based on result it can be said that no adverse impact was found on ground water level, wild life and animals, and livelihood due to Menongchara and Buraghat rubber dam project. According to farmer rubber dam is more preferable compared to earthen dam. Operation and maintenance is not very difficult and moreover it is not required to build in every year.

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