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Performance evaluation of the rubber dam for improving socio-economic status of Rural Bangladesh

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Abstract

Chowmohani Rubber Dam was accountable for socio-economic enhancement as well as improvement of agriculture farming that was constructed over the Sonai River in Habiganj district of Bangladesh. A survey research was conducted to investigate the performance of the rubber dam on the basis of agricultural and environmental aspects in order to improve the socio-economic status of rural life. Both primary and secondary data were collected by conducting focus group discussions (FGD) with the 100 stakeholders by using a questionnaire and people of relevant local organizations of the dam area. The parameter such as Annual income, Employment opportunity, Agricultural production, Fish production, Command area Efficiency (CAE), Management Performance Ratio (MPR), and Benefit-Cost Ratio (BCR) were calculated. The result was demonstrated that about 88% increased annual income, 60% Employment opportunity, 45% agricultural production, 92% fish production increased that of earlier situation. However, it is observed from the study that the CAE of scheme-1 and scheme-2 of the project is 28.88% and 26.74% respectively, MPR is 0.018 and 0.021 and BCR is 1.36 and 1.53 in that order indicating substandard. Thereupon, the rubber dam project was economically preferable in respect of socio-economic condition and farmer profitability of that area.

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Introduction

Bangladesh is an agricultural country where 77 percent of the workforce lives in rural area and engages with agricultural practices (WS, 2016). The increasing demand of water due to the growth of population made it necessary to increase food production. Irrigation plays a vital role in the countries of agricultural productivity as well as overall economic growth. Groundwater is the main source of agriculture water which accounted for 80% of total water uses and rest 20% of surface water sources that is very limited (BADC, 2007). However, excessive groundwater abstraction for irrigation has posed a great challenge to the water table, which has declined alarmingly in many areas of Bangladesh. Therefore, uses of surface water irrigation are being feasible options to mitigate water demand which minimizing pressure on groundwater especially during dry season. Under these circumstances, rubber dam has evolved as a cost-effective new type of hydraulic structure for conserving surface water in the medium and small rivers which shows extra advantages over the conventional gated structures like sluice gate, regulator, and barrage (Abedur and Hasan, 2016).

Rubber dam, a kind of fabric dam is now being practiced in many countries of the world to divert water for irrigation, aquifer recharge, enabling fish passage, preventing saltwater intrusion and protecting low-lying coastal areas from tidal flooding (IWHR, 1994; Sarker *et al.*, 2011). The membrane of rubber dam is made by the multi-layer fabric of synthetic fiber and rubberized on one or both sides. The dams are cylindrical rubber fabrics placed across channels, streams and weir or dam crests to raise the upstream water level. The construction cost and time of rubber dam are faster which require less operation and maintenance compared with traditional RCC or brick made hydraulic structures. Additionally, it seems to be environmentally sound and friendly with a great design life of approximately 20 years (IWHR, 1994; SEIL, 1985). So, multiple uses of rubber dam can be contributed to saving water resources of Bangladesh especially the area where irrigation water needs to be conserved during the dry season.

The Sonai river is a trans-boundary river between Bangladesh and India which originated from the Boro-Hura mountainous region of Tripura state of India and enters Bangladesh under Madhabpur Upazila and Habiganj District. The characteristics of the river is 24km in length, 50m in width and 5 m depth with a basin area of 120 sq. Km. The river has been facing the large reduction of water flow in the summer season and a frequent tidal flood occurs in the rainy season that causes serious water tragedy of farmers for cultivating boro rice and other crops. As a temporary solution of the irrigation water, they use to build earthen dams by their own initiative and with the assistance of local administration that supply very limited amount of water. So, rainfall is limited during winter in the Habigonj district and irrigation demand is satisfied from surface water sources where rubber dam can contribute as a prime source of water. The existing rubber dam on Sonai river can be contributed (a) to supply surface water as irrigation water during the whole year by increasing cultivable command area (b) to control the flood at the rainy season (c) to enhance the socio-economic condition of the local farmers by improving the total agricultural conditions (f) improving fish cultivation by providing enough water upstream of the dam. Therefore, a performance analysis of the dam site is really needed to know the effects of rubber dam how changing the rural environments of the beneficiaries of Sonai river basin. Considering the above-mentioned importance, a study was carried out to investigate the performance of the rubber dam in terms of agricultural and environmental aspects that can help for socio-economic development of rural Bangladesh.

Materials and methods

Study area

The study was conducted in the Sonai Rubber dam located between the latitude 24.04'N and longitude 91.35'E of Chowmohini Bazar in the Madhabpur Upazila of Habiganj district of Bangladesh. The location of the river and study sites are described in Fig. 1. Local farmers are being able to divert the small water flow of Sonai River either by gravity flow or by using low lift pumps to the cultivation of Boro rice, wheat, and other crops.

The study site is characterized by the hot temperature at summer and heavy rainfall in the rainy season which sometimes occurs tidal flood. The economy of Habiganj district is predominantly agricultural. Out of total 342,178 holdings of the district, 57.61% holdings are farms that produce varieties of crops namely local and HYV rice, wheat, vegetables, jute, spices, cash crops, pulses, oilseeds and others. Various fruits like pineapple, banana, mango, guava, jackfruit, black berries, coconut, papaya, palm, lichi, dates etc. are grown (BBS, 2013).

Fig. 1. Location of Rubber Dam.

Description of the rubber dam

The construction of rubber dam in Sonai river is started in 2000 and finished in 2002 that expenditure of this project at 8 cores Tk. The components of rubber dam are shown in Table 1 and project details are described in Table 2.

Table 1. The components of rubber dam constructed on Sonai River.

Parameters	Measurement
Length and height	45 m and 4 m
Width of the bag	6.67 m
Thickness of rubber bag	8 mm
Bridge length	45 m
Duration of water filling in the bag	22-24 hours
Pump capacity	16 Hp
Establishment Committee	LGED
Operation and maintenance	Beneficiary community
Anchoring procedure of rubber bag	Concrete casting with steel pad
Bag construction	Korean

Field data collection

Data gathering process involved the collection of both primary and secondary data. The technical data of relevant to rubber dam were collected from the Local Government Engineering Department (LGED), Madhavpur Upazilla of Hobiganj district.

The operation and management of rubber dam project area are under the Directorate of Agriculture Extension (DAE), Hobiganj that provided data of Sonai river and agricultural crops. Based on the indicators a questionnaire was developed for primary data collection. Then, information's were justified through non-formal field inspections and interviews with block organizers, Chairman, farmers, and beneficiaries through the Focus Group Discussion (FGD). The sample size, who responded to the questionnaire, of this study was 100. The respondents were selected from among the beneficiaries and stakeholders of the project living in the project area. Besides, groups of stakeholders, LGED officials and staff (design, operation and maintenance officers and staffs), NGO people, agriculture extension people and people related with fisheries were consulted to get qualitative data for conducting the study.

The secondary data were also collected based on the identified indicators by both quantitative and qualitative types of inquiry for assessment of the impact of the Chowmohani Rubber Dam on the socio-economic status of the beneficiary as well as local agriculture and environment.

Finally, the indicators such as annual income, cultivable land, an opportunity of agricultural productions and social communication were selected as future performance analysis of the project.

Table 2. Salient features of the Chowmohani Rubber dam project on Sonai river of Hobigonj district of Bangladesh.

Name of the project	Construction of the rubber dam in small and medium rivers for increasing of food production project constructed in 2000 and finished in 2002.
Name of the Dam	Chowmohani Rubber dam project
Location	Muhabbotpur, Madhabpur Upazila, Habiganj district
Financed by	Ministry of Agriculture, Bangladesh
Number of villages	23
Number of beneficiaries	2500
Command area	3000 ha
Pump Capacity	100 m3/hr.
Irrigation method	Gravity flow
Pump house	2 no. [for filling & emptying dam bag]
Bag filling time	12-14 hrs
Scheme life	(15-20) yrs.

Indicators Analysis

The performance of the rubber dam project was evaluated based on the equations reported by Molden and Gates (1990) and Molden *et al.*, (1998).

Command Area Efficiency (CAE)

It is the ratio of actual command area to the potential command area under rubber irrigation project which expresses as follows.

$$\text{CAE} = \frac{Actual\ Command\ Area}{Potential\ Command\ Area} \times 100 \quad (1)$$

Management Performance Ratio (MPR)

It is the ratio of total volume of water supply to total volume of water demand.

$$\text{MPR} = \frac{Total\ Volume\ of\ water\ Supply}{Total\ Volume\ of\ water\ Demand} \times 100 \quad (2)$$

Where, total volume of water supply = Actual discharge capacity× total operating time and total volume of water demand = irrigation water requirement × actual command area.

Benefit Cost Ratio (BCR)

Benefit cost ration is the gross return to total cost of the project that can be expressed as follows.

$$\text{Benfit cost ratio} = \frac{Gross\ return}{Total\ Cost} \quad (3)$$

Net return = Gross return – total cost

Where total cost included seed/seedling, fertilizer, plows, labor charges, irrigation, insecticides, tax and operation and maintenance cost in Tk. ha^{-1} and gross return include the value of crops and straws Tk. ha^{-1}.

Results and discussions

Annual income increase

In order to determine the performance of the selected rubber dam, necessary data were collected and analyzed based on the net annual income from the project. Impact of dam on socio-economic status was assessed based on annual income increase of the beneficiary and employment level.

The impact of Sonai Rubber dam in terms of annual income increase of the beneficiary community is presented in Fig. 2. Quite a majority of the respondents (88%) expressed that their yearly income increased after implementation of the Sonai Rubber Dam Project and less than of one fifth reported no increase in their income level. Respondents (22%), answered positively, were again asked if their income increased then to what extent it had increased (Table 3).

Table 3. Amount of annual income increase due to construction rubber dam project.

Level of income increase (TK.)	No. of beneficiary	Percentage (%)
1000-10000	2	9.09
10001-20000	2	9.09
20001-30000	4	18.18
30001-40000	8	36.36
40001-50000	4	18.18
50001-60000	2	9.09
Total	22	100

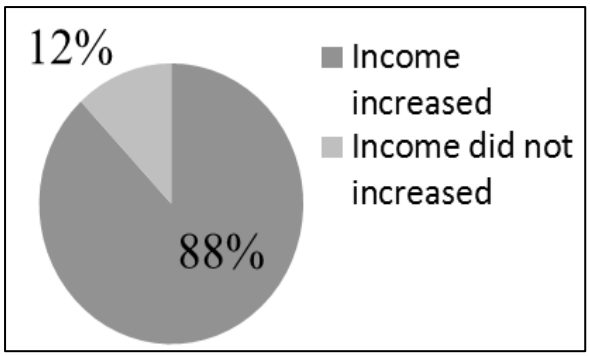

Fig. 2. Annual income increased of the respondent in the dam area.

It shows varied levels of income increase of the beneficiaries. Majority of the respondents (36.36%) mentioned that their annual income increases between Tk. 30,001-40,000. In total 81.82% of farmers reported that there was a significant increase in their income due to rubber dam construction. Only 18.18% of the respondents reported that their increase annually below Tk. 20,000 due to dam installation. Thus, it clear, due to the construction of the dam irrigation facilities improved and command area developed that impacted on agricultural crop yield as well as income of beneficiaries of dam project.

Employment opportunity

Yet the benefits of irrigation go beyond impacts on yields, with large potential benefits for nutrition security, health, and women's empowerment. To assess the of socio-economic condition due to the construction of rubber dam project the respondents were asked whether their employment opportunity increase or not as a result of the construction of the rubber dam installation, findings of that are presented in Fig. 3. According to this out of 100 respondents, 60% answered positively and 40% answered negatively. Due to the construction of rubber dam, they have huge the amount of irrigation water in dry season, so they have the chance to engage in the field for year long. So with increasing working facilities higher income and other family member's employment opportunity were a tremendous increase in the socio-economic lifestyle.

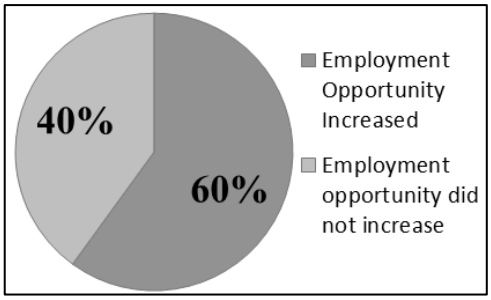

Fig. 3. The impact of employment opportunity in dam area.

Agricultural Production

To assess the impact of the rubber dam on local agricultural production, the respondents were asked whether their agricultural production were increased, whether or not increase in some specific agricultural product like paddy, fruit, vegetables and if there was an increase in their fish production as a result of the construction of the rubber dam, if increased then to what extent it increased and how was the amount of increase of different agricultural products. The respondents who answered positively farther asked the actual amount of increase in the production in mound per acre. The findings are presented in below Table 4. The data reveal that for 45% of the respondents the amount of increase was 5 to 10 mound per acre. For a significant portion (18.18%) the production raised for 11 to 15 pounds per acre, while it was 16 to 20 mounds for 36% of the respondents (Table 4).

Table 4. Amount of annual increase in agricultural production.

Amount of annual agricultural production increase (In mound per acre)	No. of beneficiary	Percentage (%)
5-10	10	45.45
11-15	4	18.18
16-20	8	36.36
Total	22	100

The findings mentioned above clearly indicate a very positive impact of the rubber dam on the agricultural production of the catchments areas of the rubber dam. In Table 5 shows that before implementation of the rubber dam project, the amount of production of paddy, vegetable, and fruits were lesser and after implementation of the rubber dam the crop production increased rapidly.

Table 5. Amount of annual crop production before and after implementation of the rubber dam project.

Types of crop	Amount production after rubber dam project (mound per acre)	Amount to production before rubber dam project (mound per acre)
Rice	65	40
Vegetable	20	17
Fruit	15	8

Fish Production

Rubber dam on Sonai River is created water head at the upstream of dam site that provides fish cultivation area. Fig. 4 reveals that 92% of the respondents opined in favor of increased fish production and 8% opposed it. The respondents, whom answered negatively, further reported that they do not have large space for fish production. .

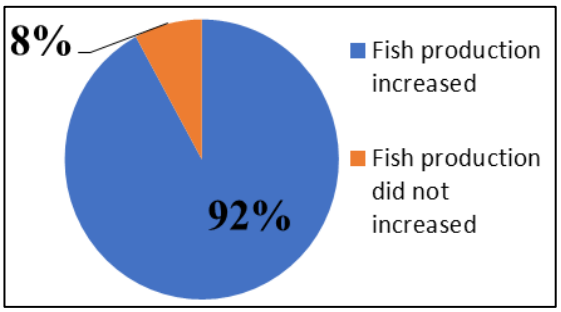

Fig. 4. Graphical presentation of impact on fish production.

Command Area Development (CAE)

Command area efficiency of scheme-1 and scheme-2 of the SRIP are tabulated in Table 6. Command area efficiency depends largely upon the irrigated area and potential command area. Actual command area depends on a wide variety of factors like farmer's involvement in irrigation, favorable soil conditions, interest for cultivation, regular maintenance of water conveyance system, and efficient water management practices.

Table 6. Command area efficiency of the SRIP.

SN	Name of irrigation schemes	Irrigated area, (ha)	Potential Command area, (ha)	Command Area Efficiency, (%)
1	Scheme-1	78	270	28.88
2	Scheme-2	115	430	26.74

Management Performance Ratio (MPR)

The management performance ratio (MPR) indicated (Table 7) that both schemes of SRIP were poorly performed due to higher farm canal density; lower operating times and delayed starting of irrigation activity. The discrepancy of MPR represented that there was a great scope to get better water management practices in these existing schemes of the project.

Benefit-Cost Ratio (BCR)

Benefit-Cost ratios of both schemes of the SRIP Project (Table 8) were reduced in the significance of mounting total cost and decreased gross return. Effective marketing system should be developed with the intention that; farmers can sell their product at a more competitive price.

Table 7. Irrigation water management performance ratio of schemes of the SRIP.

SN	Name of irrigation schemes	Name of the village under the scheme	Distribution attern	Total volume of water supplied (including conveyance loss) (m3)	Total volume of water demand (m3)	MPR
1	Scheme-1	Muhabbotpur, Madhabpur Upazila	Main canal	385677	21097000	0.018
2	Scheme-2	Komolpur, Chowmohani	Secondary canal	5407000	247000000	0.021

Table 8. Performance of benefit-cost ratio of schemes of the SRIP.

SN	Name of irrigation schemes	Gross return (Tk. /ha)	Total cost (Tk. /ha)	Net return (Tk. /ha)	Benefit-cost ratio
1	Scheme-1	80106	58709	22397	1.36
2	Scheme-2	74308	48503	25805	1.53

Conclusions and recommendations

This study assessed the performance of Chowmohani Rubber Dam in Habiganj district that information might be effective to the farmers, policy makers and extension workers for proper operation and management of the dam. The questionnaire survey indicates the performance of the dam in terms of socio-economic status can be considered satisfactory by implementing dam is helped to increase the annual income of the beneficiary and created more employment opportunity. The dam had positively impacted on local agriculture through increasing cultivable land and various agricultural productions. To consider all sides of the rubber dam project we can say that rubber dam project on Sonai River will have to a great step to change the socio-economic condition of that region. Therefore, the following recommendations are drawn to improve the performance of the irrigation schemes under this project. Necessary steps should be taken to restrict sand withdrawal from the downstream area. Irrigation water distribution system should be upgraded and The dam can be a great attraction for tourists if the beautification works are done.

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Conflicts of Interest

The authors declare no conflict of interest.

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