International Journal of Multidisciplinary Research and Publications
ISSN (Online): 2581-6187

Benefit Cost Analysis of Solar Dug Well Irrigation Project in Barind Area

Sumanta K. Basak[1], Niloy Basak[2]
[1]Project Director, Barind Multipurpose Development Authority (BMDA), Rajshahi 6000, Bangladesh
[2]Ex-student, Rajshahi Govt. City College, Rajshahi, Bangladesh
Email address: [1]sumantabmda@gmail.com, [2]niloybasak666@gmail.com

***Abstract*—** *Solar dug well irrigation is now a very popular adoption to change the traditional agriculture practice in north-west region of Bangladesh. The present study was undertaken to determine the financial and economic profitability of solar dug well irrigation implemented by Barind Multipurpose Development Authority and to examine whether the profitability is appropriate for such type of irrigation system or not. In this study, costs and benefits of solar dug well irrigation have been investigated. Net present value (NPV), benefit cost ratio (BCR) and internal rate of return (IRR) are the relative measures of this study which are the main components used to help the farmers in decision making activities. After three consecutive years implementation of the project, the financial and economic NPV at 12% discount rate were 625.04 and 910.20 and at 25% discount rate were 100.39 and 235.53 respectively. The corresponding BCR were 2.21 and 2.77. The project's financial and economic IRR were 27.49% and 29.54% respectively. Considering all respects, the solar dug well irrigation was more feasible and acceptable in the study area*.

***Keywords*—** *Benefit-Cost Ratio; Internal Rate of Return; Net Present Value; Solar dug well Irrigation*.

I. INTRODUCTION

Bangladesh is mainly an agricultural country. Agriculture is the single largest producing sector of the economy and contributes about 13.02 % to the total Gross Domestic Product (GDP) of the country. *Bangladesh's GDP* growth is expected at 6.9% in *2022[1]*. This sector also accommodates around 40.6% (in 2016-17) of labor force. Due to natural calamities like flood, cyclone, storm, drought, loss of production in both food and cash crops are almost a regular phenomenon. Yet in recent years, there has been a substantial increase in food grain production. Agricultural holdings in Bangladesh are generally small, but use of modern machinery and equipment is gradually increasing. Rice, jute, sugarcane, potato, vegetables, wheat, pulses and maize are the principal crops of Bangladesh. Crop diversification program, credit supply, extension work, research and input distribution policies pursued by the government are yielding positive results. The country is now on the threshold of attaining self-sufficiency in food grain production [2].

The soil and environment are well suited for different kinds of crops all over the year. About 57% of its total land is arable. Despite of this achievement, a huge population has a limited access to enough land under their jurisdiction making agriculture a challenging option. On the other hand, the yearly transformation of a certain area (0.47%) of arable land from agriculture to non-agriculture use is a grave concern to agricultural community due to population pressure, urbanization and some non-agricultural purposes. Thus, getting more food from less land would be one of the most challenging concerns for the country even having some improvement of the existing agricultural system [3].

Dug well irrigation is now a very popular adoption to change the traditional agriculture practice in north-west region of Bangladesh. Mainly low water consuming crops, pulses, spices, oil seeds, vegetables etc. are producing through solar powered dug well and it has changed the cropping pattern in the study area. Rain water is also harvested and conserved in dug well which is a funnel type structure with solar panels installed in the upper face. An underground uPVC pipe line system is designed and set up to reduce the water conveyance loss which makes the whole irrigation system efficient. Some faucets or outlets are constructed for the supply of irrigation water in the crop land.

Irrigation water harvested through solar powered dug well can save in many cases of ripen T-Aman (Transplanted Aman) rice by providing supplementary irrigation, produce low water consuming crops, potato, vegetables, other non-rice crops etc. and may change the cropping pattern in the study area. Single and double cropped areas will be converted to triple and quadruple cropped areas. To achieve the targets, profitability of crops is a controlling factor in our agriculture.

In general, benefit cost analysis (BCA) of a crop, both financial and economic, is the basis of farmers' decision making. Nearly every public and private decision involves some comparison of benefits and costs. Farmers allocate their land and other resources in production of different crops on the basis of relative profitability. In most cases, financial profitability differs from economic profitability, because of some factors and product markets such as government taxes and subsidies, trade restrictions, monopoly elements in marketing, which are the common features in any developing economy. It is, therefore, necessary to determine the financial and economic profitability of a project whether it is feasible or not. Hence, Net present Value(NPV), BCR(Benefit Cost Ratio) and Internal Rate of Return(IRR) are the key elements of profitability analysis.

II. OBJECTIVES

The present study was undertaken to determine the financial and economic profitability of solar powered dug well irrigation implemented through Barind Multipurpose Development Authority (BMDA) and to assess and justify

Sumanta K. Basak and Niloy Basak, "Benefit Cost Analysis of Solar Dug Well Irrigation Project in Barind Area," *International Journal of Multidisciplinary Research and Publications (IJMRAP)*, Volume 5, Issue 6, pp. 47-50, 2022.

whether the profitability of solar dug well irrigation is appropriate or effective for the irrigation system or not.

III. Study Area

The study was conducted in Natore district. It is a northern district under Rajshahi division of Bangladesh, having an area of 1,896.05 km^2. Natore sub-division was established in 1845. It became a district in 1984. The study area consists of 7 upazillas. They are • Natore Sadar, • Bagatipara, • Lalpur, • Baraigram, • Singra, • Gurudaspur and • Noldanga.

Natore district is bounded on the north by Bogra and Noagaon districts, the east by Sirajganj and Pabna districts, the south by Pabna and Kushtia districts, and the west by Rajshahi district. It lies between 24°25' and 24°58' north latitudes and between 88°01' and 88°30' east longitudes.The average temperature of the district varies from a maximum of 37.8°C to a minimum of 11.2°C. The annual average rainfall of the district is 1862 mm [4].

Out of a total cropped area of 301856 ha, single cropped is 34675 ha, double-cropped 81515 ha, and triple cropped is 34441 ha. The number of families involved is 298499 and cropping intensity is 200.12 percent [5].

IV. Methodology

The most efficient approach for the feasibility study of an irrigation project is to find out the cost-benefit analysis. The indicators used in the study are PV (Present Value), NPV (Net Present Value), BCR (Benefit-Cost Ratio) and IRR (Internal Rate of Return). The project was operated in ground water irrigation mode. The solar powered dug well was used as irrigation equipment in the project.

Formulas for benefit-cost analysis

A. Present Value (PV)

Whenever the benefits and costs used in a benefit-cost analysis occur in the future, it is important to discount these future values to account for their present value. If the discount rate is r, then the following formula can be used to find the present value (PV) of an amount (Pt) received at some time t in the future:

$PV = P_t/(1+r)^t$

Where, PV is the present value of the amount invested, or benefit; P_t is the price value of the future amount in time t; r is the discount rate; and t is the year in which P_t is realized.

B. Net Present Value (NPV)

The net present value (NPV) is the current value of a project net benefits. The net benefits are simply the sum of benefits minus costs. The sum is discounted at the discount rate. Using this method, if the project has a NPV greater than zero then it appears to be a good approach for implementation. The formula used to calculate the NPV is:

$$NPV = \Sigma (B_t - C_t)/(1+r)^t$$

where t = 1 to T (project duration), B_t is the benefit in time t, C_t is the cost in time t and r is the discount rate.

If NPV is greater than zero, then the adaptation approach can be implemented. A high NPV indicates the most efficient and economic adaptation approach.

C. The Benefit - Cost Ratio (BCR)

It is the ratio of the net present value of benefits and the net present value of costs in time t, where t = 1 to T (project duration). The benefits and cost are each discounted at a chosen discount rate (r).

$$BCR = NPV(B)/NPV(C)$$

The benefit-cost ratio shows the overall value for money of the project. If the ratio greater than 1, the approach is acceptable.

D. Internal Rate of Return (IRR)

The internal rate of return (IRR) is the maximum interest that could be paid for the project resources, leaving enough money to cover investment and operating costs, which would still allow the investor to break even. In other words, the IRR is the discount rate for which the present value of total benefits equals the present value of total costs.

i.e., NPV(Benefits) -NPV(Costs) = 0

or, NPV (Benefit/NPV (cost) = 1.

In general, the IRR should be greater than the discount rate for a project to be accepted. In this study, the project feasibility period was considered as 20 years. The values of NPV, BCR and IRR were calculated at 12% and 25% discount rate. The project implementation period was three years (from 2019-20 to 2021-22).

Data Collection and Analysis

To fulfill the objectives of the study, both primary and secondary data were needed. Primary data were collected through observation, physical surveys, individual interviews, and focused group discussion. Several field surveys were done and open discussions were conducted with the authorities of different concerned organizations, experts, and people living in the study area. Secondary data were obtained from relevant studies, reports, journals, books, newspapers, and other government and non-government sources. Internet was another vital source of secondary data used in this report.

For the purpose of the present study, several types of data like irrigation, irrigation costs, equipment, production related costs, market prices and other related data were collected from Natore district offices, upazila offices, related departments and organizations, publications, journals etc. Some secondary data were collected from various sources, such as District Statistics 2011: Natore, Bangladesh Bureau of Statistic. After collecting the data and analyzing these, a conclusion has been made.

V. Results and Discussion

Costs and Benefits Analysis

The financial and economic assessment of a project is generally done by means of cost benefits analysis, where the main criterion for approving a project is an estimated internal rate of return (IRR) that exceeds a higher rate.

The basis of calculation for the profitability of the project was benefit-cost analysis. In this study, calculations of both financial and economic profitability have been done. The main indicators of the analysis are NPV (Net Present Value), BCR (Benefit-Cost Ratio) and IRR (Internal Rate of Return).

Costing of the Project during Implementation

The project was implemented during 3 consecutive years from 2019-20. Total 36 numbers of solar dug wells were installed in the study area during the study period. Out of these dug wells, 17 numbers were used in 2020-21 and 36 number in 2021-22. Here are some pictures of dug well installation and irrigation system during the implementation period of the project.

Investment costs for the project consist of costs for purchase of irrigation equipment and installation, re-excavation of dug well, construction of infrastructures and laying of irrigation equipment/materials, and maintenance costs of the project.

Operation and other costs used as revenue expenditure were related to office management. The year wise costing of the project is outlined in table 1.

Fig. 1: Lowering of dug well ring.

Fig. 2: Vegetable cultivation in dug well scheme.

Fig. 3: Supply of irrigation water through dug well's faucet connected with underground uPVC pipe line.

TABLE 1: Year wise costing of the irrigation project

Year wise costing of the irrigation project										
Sl. No.	**Heads of expenditure**	**Unit**	**Quantity**			**Unit cost (Lac BDT)**	**Total cost (lac BDT)**			**Item wise total cost (Lac BDT)**
			2019-20	2020-21	2021-22		2019-20	2020-21	2021-22	
1	Cost of solar panel and installation	nos.	0	17	19	7.50	0.00	127.50	142.50	270.00
2	Construction of dug well	nos.	0	17	19	5.50	0.00	93.50	104.50	198.00
3	Laying of underground uPVC pipe line	nos.	0	17	19	1.21	0.00	20.57	22.99	43.56
4	Construction of faucets @10 numbers per dug well over bridge	nos.	0	170	190	0.10	0.00	17.00	19.00	36.00
Total capital Cost of construction/installation							0.00	258.57	288.99	547.56
Maintenance cost							25.25	15.00	14.25	54.50
Total cost for the project implementation							25.25	273.57	303.24	602.06

[Here Sl. No.=Serial Number; BDT=Bangladesh Taka; nos.=numbers; uPVC=unplasticized Polyvinyl Chloride]

TABLE 2: Yearly irrigated area, production of crops, gross and net value of crops, irrigation charge realized, operating cost and benefits of the project.

Sl. No.	**Components**	**Implementation years**			
		2019-20	**2020-21**	**2021-22**	**2022-23(Expected)**
1	Irrigated area in ha	0	88	336	648
2	Production of crops in metric ton (considering 4.25 metric ton per ha)	0	374	1428	2754
3	Value of crops in lac BDT @ BDT 25000 per metric ton	0	93.50	357.00	688.50
4	Production cost in lac BDT@ BDT 78500 per ha	0	69.08	263.76	508.68
5	Net benefit of produced crops in lac BDT	0	24.42	93.24	179.82
6	Irrigation charge realized from solar dug well in lac BDT @ BDT 6000 per dug well per crop	0	1.02	2.16	4.17
7	Maintenance cost of solar dug well in lac BDT @ BDT 1000 per dug well and BDT 2000 per dug well from 5th year.	0	0.17	0.36	0.36
8	Net benefit (financial) in lac BDT	0	25.27	95.04	183.63
9	Net benefit (economic) in lac BDT [considering 125% of total benefit (includes benefit from crops, irrigation charge, trades and others)]	0	31.59	118.80	229.54

Benefits of the Project

The project benefits of the irrigation system were calculated from cost benefit analysis. Total 17 numbers of dug well were used in 2020-21 and 36 numbers in 2021-22. The total 88 hectares(ha) of land was cultivated in 2020-21 and 336 ha cultivated in 2021-22 and expected 648 ha in 2022-23. Mainly less water consuming crops like wheat pulses, spices, oil seeds etc. and vegetables were cultivated in the crop land.

A picture of yearly irrigated area, production of crops, gross and net value of crops, irrigation charge realized, operating costs and benefits of the project during the project implementation period is shown in table 2.

Results of cost benefit analysis

For profitability analysis of the project, a detail benefit cost analysis has been done. For this a detail study of the irrigation project was performed. The calculation was done in excel format. The results are given bellow in table 3.

TABLE 3: NPV, BCR and IRR of the benefit cost analysis of the project.

	NPV at 12%	NPV at 25%	BCR	IRR in %	Remarks
Financial	625.04	100.39	2.21	27.49	NPV>0
Economic	910.20	235.53	2.77	29.54	IRR>discount rate

For a project, if NPV is greater than zero, i.e., NPV>0, it appears a good approach for implementation. The high value of NPV at 12 percent and 25 percent indicates the most efficient and economic adaption approach. Since BCR was greater than 1 (one) i.e., 2.21 (financial) and 2.77 (economic), the project was more acceptable. The greater BCR shows the overall value for money of the project. Since the IRR both for financial and economic were greater (27.49% and 29.54% respectively) than the maximum discount rate (25%), the project was more acceptable and feasible. Here, we can say that the project was more appropriate for implementation.

VI. Socio-Economic Importance of the Project

The role of the people and farmers in operation and maintenance of the project activities is significant. The involvement of the local people during the implementation of various activities of the project in the project area can be observed. They actively participated during the project implementation. They are using their own agricultural machineries in the crop field. They are cultivating banana, papaya, beans, chilies and other vegetables in dug well schemes. The farmers are cultivating various less water consuming crops including wheat, pulses, gram, lentil etc. through solar dug well. Moreover, the rain water harvested from solar dug well reduces the ground water level. The local farmers are also playing significant role in the maintenance of the various facilities set up by the project. These active participations of the people in the study area proves the acceptability of the project. The benefit cost analysis of the present study shows that the technology is totally environment friendly and of low cost. Dug well has now given a new hope to the farmers and the people in this water stressed area.

References

[1] *Bangladesh: Economy. Asian Development Bank.* https://www.adb.org/countries/bangladesh/economy.
[2] BBS; 2021. Statistical Yearbook Bangladesh 2021. 41th edition EDITION. Bangladesh Bureau of Statistics, June 2022. Statistics and Informatics Division (SID). Ministry of Planning, Government of the People's Republic of Bangladesh. www.bbs.gov.bd
[3] M Nasim, S M Shahidullah, A Saha, M A Muttaleb, T L Aditya, M A Ali and M S Kabir; 2017. Distribution of Crops and Cropping Patterns in Bangladesh. Bangladesh Rice J. 21 (2): 1-55, 2017.
[4] BBS, 2013. District Statistics 2011, Natore. Bangladesh Bureau of Statistics, 2011. Statistics and Informatics Division (SID). Ministry of Planning, Government of the People's Republic of Bangladesh.
[5] Bangladesh Jatyo Tothyo Batayon . www.natore.gov.bd