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SHIFTING OF ENERGY SOURCE FOR SHALLOW TUBEWELL IRRIGATION SYSTEM: A FIELD STUDY

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Abstract

Shallow tube well (STW) is the main device for groundwater abstraction for irrigation purpose in Bangladesh. This paper focuses shifting of STW energy source used in the study area. Field survey was carried out in Digholkandi Union comprises five mauzas under Ghatail Thana of Tangail district in 2017 with a view to examine the quantity and type of energy used of STW, to identify the trends line of energy type from a base line and to address the causes of shifting from one to another. Primary and secondary data were used in this study. Primary data were collected through questionnaire survey and financial as well as sensitivity analysis were done to predict the profitability of STW irrigation business. The study revealed that two types of irrigation equipment were mainly used in the study area for groundwater abstraction. In 2007, diesel operated STW (DOS) was 44% and electricity operated STW (EOS) was 56% in the study area. In 2017, field survey data showed that DOS was only 4% and EOS was 96% in the study area. Last ten years using of DOS and EOS has been decreased and increased 40% respectively. DOS is in abolition stage and EOS has been reached tends to 100%. Study findings showed that EOS was highly profitable than DOS due to lower electric charges compared to fuel and lubricant cost and coverage of higher command area by EOS promoted the irrigation business. Some recommendations have been included in this paper for the sustainability of STW irrigation business.

Keywords: *GIS application, location and mapping of STW, cropping pattern, command area.*

Introduction

Bangladesh is an agricultural country and 80% people live in rural area and their livelihood based in agriculture (BER, 2015). The economical development of the country is depends on the agricultural development of the country and agricultural development is depends on groundwater based irrigation to a large extent. Groundwater widely used as irrigation for the production of rice. Rice is the main and staple food of Bangladeshi people that constituted about 90% of the total food grain production in Bangladesh (Huda, 2001).

Of the three types of rice Aus, Aman and Boro, the *Boro* rice alone contributed the highest share (55%) of total rice production since 1998-99 to till now (BBS, 2015). About 80 percent of groundwater was used for crop production in which Boro paddy consumed 73 percent of total irrigation (Rahman and Ahmed, 2008).

Groundwater is the main source of irrigation in Bangladesh, although surface water is also used on limited scale in some rural areas. (Shirazi *et al.*, 2010). The total area under irrigation in Bangladesh is 5,049,785 ha and 78.9% of this area is covered by groundwater sources including 3,197,184 ha with 1,304,973 shallow tube wells and 785,680 ha with 31,302 deep tube wells (DTW) (DPHE and JICA, 2010). It is estimated that, out of 9.03 million ha of total cultivable area, 7.56 million ha (84 %) are suitable land for irrigation (Shahabuddin and Rahman 1998). To meet up the different requirements of growing population, the using of agricultural land for the non-agricultural purpose has been increased a large extent. As a result, total cultivable land of the country has been reached to 8.50 million ha and approximately 7.41 million ha (87%) land is under irrigation (BBS, 2015). Two types of irrigation equipment such as STW and DTW were mainly used to abstract groundwater in Bangladesh where 60% areas are covered by STW [Halcrow and Partners, 1998; BADC, 2015].

That is STW irrigation system or technology has utmost importance for food production and food security and lifting millions of poor farmers out of poverty in Bangladesh. As STW irrigation is the only system/technology for further intensification of agriculture, its rational use should be ensured with sustainability in relation to the profitability.

Hossain and Moududi (2009) conducted a field study regarding STW irrigation system in Bangladesh and it was reported that the farmers sell pumped water commercially for producing

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Boro rice to other farmers to earn money like other business and following the process, STW irrigation system or technology has been established as a form of business in rural Bangladesh. Study revealed that electricity operated STW (EOS) irrigation business was more profitable than diesel operated STW (DOS) with respect to the then price of inputs and paddy. But the business will be unprofitable for DOS in uncertain situation considering 10% increase of O & M cost or 10% decrease of benefit or 10% increase of diesel price. They stated that it would be fairly unable to sustain the STW irrigation business in severe uncertain situations with rising of diesel of fuel prices without commensurate rising of paddy prices.

In 2007, diesel price was Taka 35.00 per liter, while in 2017 (and from the earlier) diesel price has risen to Taka 65.00 per liter. In changing situation over time, it is essential further study in order to examine the present situation about DOS and EOS irrigation system in that area. So, the overall objectives of the study were to examine existing number of STW and their energy type, to identify the trends line of energy type from a base line (year) and to draw recommendations for the improvement of STW irrigation system.

Methodology

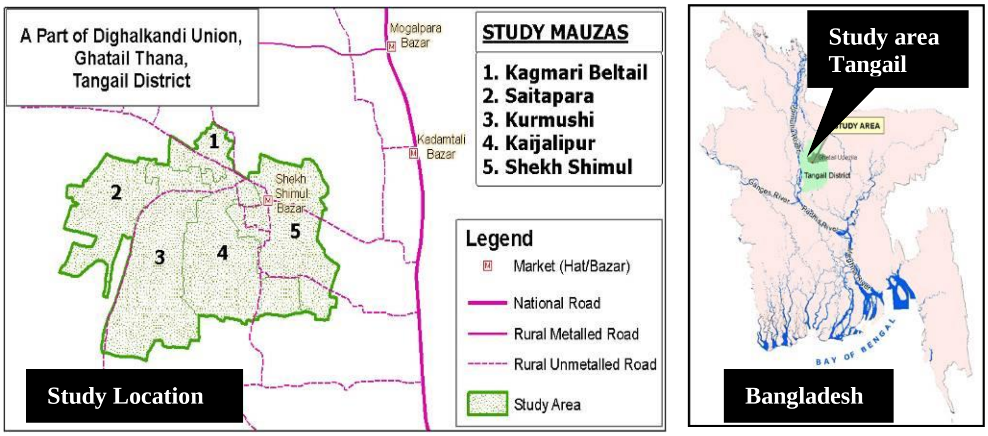

Fig. 1. The location of the study area

Location of the Study Area

The study area was within Dighalkandi union, which under Ghatail Upazila of Tangail district in Bangladesh. The area is situated between latitude 24^0 24’ 08.55”, longitude 89^0 57’ 26.84” and latitude 24^0 25’ 17.5”, longitude 89^0 59’ 10.10”. The study area comprises five Mauzas of Dighalkandi union (Fig. 1). The Mauzas were Saitapara, Kurmushi, Kagmari Beltail, Kaijalipur and Shekh Shimul. The Mauza is the revenue boundary and it is the smallest land boundary unit available in Bangladesh. The study area was chosen from an intensively irrigated area in the north central region of Bangladesh, which falls under the Indo-Gangetic basin region. Boro paddy was the main crop of this area, which cultivated in rabi season by groundwater irrigation. The entire irrigation system of the area mainly depended on STW irrigation technology.

Data collection and approaches

Primary and secondary data were used in this study. The primary data were collected through questionnaire survey in 2017 during irrigation periods and interviewed with farmer (STW owner). Complete survey technique was used for the STW owners to examine the existing number of STW and their energy type. Required secondary data (regarding STW used in the past) was collected from a baseline (1997 and 2007) in study area and data analyzed to understand the trend line of energy type, i.e. changing pattern of energy type of STW irrigation system in the study area. The locations of STWs were collected in the field by using Global Positioning System (GPS) and plotted them on the mauza maps according to energy type by identifying each plot. To examine the causes of shifting by energy source, the relevant data was collected and financial analysis was done to understand the profitability of STW irrigation business both for DOS and EOS. Sensitivity analysis was done to predict the STW irrigation business for future in changing input and output price.

Results and discussion

Number of STW with energy type

There were 68 tube wells in 1997 irrigation periods in the study area (Mandal, 1997). In 2007 irrigation periods, the total number of tube wells rose to 71 in the study area (Hossain and Moududi, 2009). In 2017 irrigation periods, the field survey data revealed that the total number of shallow tube wells down to 50 in the study area. The spatial distribution of the shallow tube wells of 2007 and 2017 is shown in Fig. 2. Among the 68 tube wells in 1997, 52 STWs (76%) were run by diesel and the remaining 16 STWs (24%) by electricity (Table 1). On the other hand, in 2007 irrigation periods, only 31 STWs (44%) were run by diesel and 40 STWs (56%) by electricity [Table 1 and Fig. 2 (left one)] and in 2017 irrigation periods, there were found almost EOS in the study area, only 2 STWs (4%) were run by diesel and 48 STWs (96%) by electricity [Table 1 and Fig. 2 (right one)], which proved the sensitivity analysis conducted by Hossain and Moududi (2009). The minimum tube well density of a mauza in the study area was 10 per km^2 at Kurmurshi mauza and the maximum was 20 at Kagmari Beltail mauza in 2017. The average tube well density of the study area was 15 STW per km^2 (Table 2).

Shifting and trend line of STW energy type

From the above discussion it is evident that last 20 years (from 1997 to 2007) DOS has been decreased from 76% to 44% and EOS has been increased from 24% to 56% (Fig. 3). On the other hand, last ten years (from 2007 to 2017) using of diesel engine has been decreased and using of electricity driven STWs has been increased 40% respectively (Fig. 3). It can be said that DOS is in abolition stage and EOS has been reached tends to 100%. Farmers informed the investigator that the causes for shifting the farmers from DOS to EOS were high price of diesel cost, high operation and maintenance (O & M) cost of diesel engine, less operation cost of EOS, larger command area of EOS system and the electric bill has to be paid after harvesting the crop. During survey investigator observed that there was no metering system at all except few STW in the study area. Concern authority made electricity bill on an average based on motor horse power. The STW owner informed the investigator that this average bill was much higher than the metering system bill. EOS owners opined that they got electricity connection with the help of middle man, who had good linkage with some of the concern officials. Middle man charged fixed cash to arrange electricity connection. The owners claimed that the major portion of electricity connection charges goes to middle man and concern officials. Miah and Mandal (1993) reported that the STW owners had to pay bribes to the concern officials for getting electricity connections.

Table 1. Mauza-wise number of STW and their type of energy source

Mauza	Number of STW			Type of Energy source					
				1997		2007		2017	
	1997	2007	2017	D	E	D	E	D	E
Kagmari Beltail	3	4	4	2	1	2	2	0	4
Kaijalipur	11	11	12	4	7	0	11	0	12
Kurmushi	27	21	11	25	2	10	11	0	11
Saitapara	12	17	8	12	0	14	3	2	6
Shekh Shimul	15	18	15	9	6	5	13	0	15
TOTAL	68	71	50	52	16	31	40	2	48

Note: D: Diesel; E: Electricity

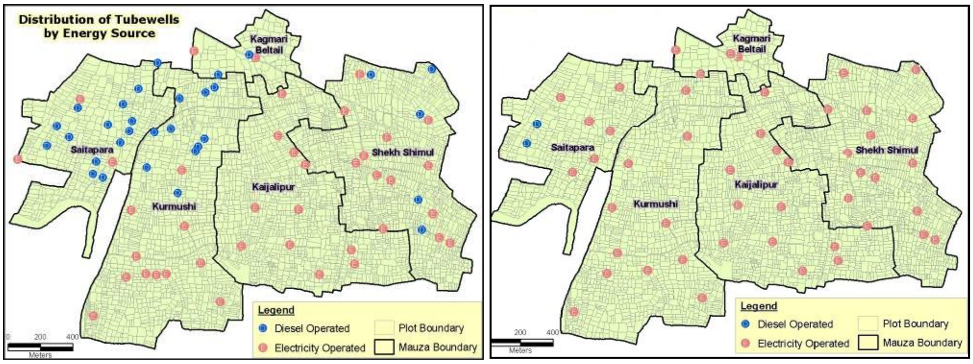

Fig. 2. Distribution of STWs by Energy Source in mauza map of the study area in 2007 (left) and 2017 (right) respectively.

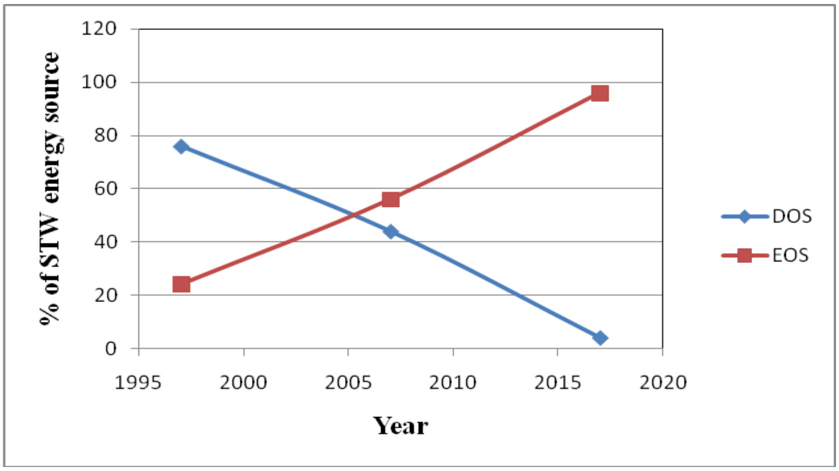

Fig. 3: Shifting and trend line of STW energy type

Table 2. Density of the STW in 2016 in the study area

Mauza	Number of STW	Area (Hectares)	Area in km²	Density/km²	Average Density/km²
Kagmari Beltail	4	20	0.20	20	15
Kaijalipur	12	95	0.95	13	
Kurmushi	11	109	1.09	10	
Saitapara	8	62	0.62	13	
Shekh Shimul	15	90	0.90	17	

(Source: Field survey, 2016)

Investment Cost, O & M cost of STW and return from STW irrigation system

Investment cost of STW included purchase of diesel engine/electric motor, pump, pipe and strainer, STW installation, construction of STW shed, irrigation channel making, registration fee for electric connection, switch board, connection cable, iron / wood made base, electric light etc. Investment cost of STW both for DOS and EOS is shown in Table 3. O & M cost of STW included fuel (diesel or electricity), mobil, spare parts and mechanics fee, operator's salary, irrigation channel repairing, STW shed repairing, labor for collection of rice from field etc. O & M cost of STWs both for DOS and EOS is shown in Table 4. Return or benefit included Boro rice and Boro straw of STW Irrigation system which is shown in below Table 5. From the field survey data revealed that the average command area was 2.82 ha and 3.57 ha for the DOS and EOS system respectively and the yield was 5.48 t/ha in both cases. As payment of water charge, DOS owner got on average 15.45 ton rice @ Tk. 21620 per ton (considering average 2.82 ha command area and 5.48 t/ha yield), while EOS owner got 19.56 ton rice @ Tk. 21620 per ton (considering average 3.57 ha command area and 5.48 t/ha yield); though return depends on command area to a large extent. Total return from DOS was lower than EOS in the study area due to smaller command area.

Table 3. Investment cost of STW irrigation technology, 2017

Cost Item	DOS Tk.	EOS Tk.
a. Purchase of diesel engine/electric motor	12800	12000
b. Purchase of pump, pipe and strainer	6000	7780
c. Installation	1400	1700
d. Construction of STW shed	2050	2590
e. Irrigation channel making	2145	2750
f. Others (Registration fee for electric connection, switch board, cable, iron / wood made base, electric light)	3000	20000
g. Total investment cost [a+b+c+d+e+f]	27395	46820

(Source: Field Survey, 2017)

Table 4. O & M cost per season of STW irrigation technology, 2017

Cost Item	DOS Tk.	EOS Tk.
a. Diesel cost [450 liter/season@65 Tk./liter]	29250	-
b. Mobil cost [10 liter/season@250 Tk./liter]	2500	-
c. Electricity cost	-	30000
d. Spare parts and mechanics fee	1800	800
e. Operator's salary	32000	31000
f. Irrigation channel repairing	1000	1100
g. STW shed repairing	900	1150
h. Others (Labor for collection of rice from field)	17116	16673
I. Total O & M cost (Tk.) [a+b+c+d+e+f+g+h]	84566	80723

(Source: Field Survey, 2017)

Table 5. Return or Benefit per season of STW irrigation technology, 2017

Return or Benefit Item	DOS Tk.	EOS Tk.
a. Value of rice (5.48 t/ha@21620Tk./t*CA/4)	83527	105741
b. Straw from rice	10000	11115
c. Charge for watering the vegetables plots and others	1000	500
d. Total return (Tk./season) [a+b+c]	94527	117356
e. Salvage value of STW	6600	8250

(Source: Field Survey, 2017)

Financial and sensitivity analysis of STW irrigation business

Benefit-Cost ratio was calculated (Table 6) from investment cost, O & M cost and return or benefit mentioned in Table 3, Table 4 and Table 5 respectively. Average life span is assumed for both engine and motor 10 years. Details analysis was shown in Annexure 1-9**.** From financial analysis, Table 6 showed that the irrigation business by EOS was highly profitable in the current situation (2017), because Internal Rate of Return (IRR) was quite higher than bank rate (10 percent) and DOS system. Though the IRR of DOS was 56 % (higher than bank rate), but it was much lower than the IRR estimated in other study (Mandal and Parker, 1995). This lower IRR rate in present situation clearly proved that the IRR rate decreased over time mainly due to increase of diesel price and maintenance cost. Again, lower electric charges compared to fuel and lubricant cost and coverage of higher command area by EOS promoted the irrigation business, which proved to be more profitable than DOS.

Last ten years, both diesel and electricity price and output price has gone up and down in Bangladesh. In 2007 diesel price was Taka 35.00 per liter, while in 2017 (and from the earlier) diesel price has risen to Taka 65.00 per liter. In case of electricity and output (paddy), the price has gone up and down. In this regard sensitivity analysis was done considering the both certain and uncertain situations. Sensitivity analysis showed that for a 10 % increasing of O & M cost or 10% decreasing of benefit when other cost remain the same, DOS business runs as unprofitable, while the EOS business still remains profitable (Table 6). The main reason is lower profit from DOS was the significant increased of diesel price. Again, other things remaining the same, only diesel price increased by 10% will still give a marginal profit for the DOS owners (IRR 32%) (Table 6). Moreover, if both diesel and rice price increased by 10% keeping other thing remaining the same; the irrigation business will be profitable. If diesel price increased by 20% and output price increased by 20%, the STW business will be even more profitable (Table 6).

Table 6. IRR, NPV and BCR in current and different uncertainty of STW irrigation business

Different certain and uncertain situations	Diesel operated STW			Electricity operated STW		
	IRR (%)	NPV (Tk)	BCR	IRR (%)	NPV (Tk)	BCR
In 2017 (current situation)	56	38499	1.07	360	184288	1.34
If O&M cost increased by 10%	-6	-14521	0.98	156	134692	1.23
If benefit decreased by 10%	-12	-20896	0.96	113	111866	1.21
If diesel price increased by 10%	32	19465	1.03	-	-	-

Different certain and uncertain situations	Diesel operated STW			Electricity operated STW		
	IRR (%)	NPV (Tk)	BCR	IRR (%)	NPV (Tk)	BCR
If diesel and output price increased by 10%	151	77797	1.14	-	-	-
If diesel price increased by 20% and output price increased by 20%	526	118158	1.20	-	-	-

(Source: Field Survey, 2017); NPV indicates Net Profit Value, BCR indicates Benefit-Cost Ratio.
Note: Calculations were done on the basis of data provided in Annexure 1-9.

Conclusions

The study revealed that two types of irrigation equipment (DOS and EOS) were mainly used in the study area for groundwater abstraction in the study area. In 2007, DOS was 44% and EOS was 56% in the study area. Last 10 year's scenario was totally changed. In 2017, field survey data showed that DOS was only 4% and EOS was 96% in the study area. Last ten years (from 2007 to 2017) using of diesel engine has been decreased and using of electricity driven STWs has been increased 40% respectively. Study findings showed that EOS was highly profitable than DOS. EOS has been increased due to upward trend of diesel price. Sensitivity analysis showed that for a 10 % increasing of O & M cost or 10% decreasing of benefit when other cost remain the same, DOS business runs as unprofitable, while the EOS business still remains profitable. Again, other things remaining the same, only diesel price increased by 10% will still give a marginal profit for the DOS owners (IRR 32%). Moreover, if both diesel and rice price increased by 10% keeping other thing remaining the same; the irrigation business will be profitable. If diesel price increased by 20% and output price increased by 20%, the STW business will be even more profitable.

Recommendations

In case of EOS, government should take steps to minimize cost of electricity connections fees and to review existing electricity connection procedure which might be improved the present situations. Concern authority should give priority to facilitate the provision of required electricity, metering systems and should ensure uninterrupted power supply. On the other hand, for DOS the government should monitor the diesel price and to ensure diesel supplying at the fixed price in time. Diesel price should continue to be subsidized to sustain irrigation water selling business as well as Boro rice production. To sustain the Boro rice cultivation, paddy price should be increased at least 20%.

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Annexure 1: Benefit-Cost analysis of EOS

Year	Investment cost (Tk.)	O&M cost (Tk.)	Total cost (Tk.)	Benefit (Tk.)	Incremental benefit (Tk.)	DF at 10%	Cost at 10% df	Benefit at 10% df
1	46820	80723	127543	117356	-10187	0.909	115937	106677
2	0	80723	80723	117356	36633	0.826	66677	96936
3	0	80723	80723	117356	36633	0.751	60623	88134
4	0	80723	80723	117356	36633	0.683	55134	80154
5	0	80723	80723	117356	36633	0.621	50129	72878
6	2500	80723	83223	117356	34133	0.564	46938	66189
7	0	80723	80723	117356	36633	0.513	41411	60204
8	0	80723	80723	117356	36633	0.467	37698	54805
9	0	80723	80723	117356	36633	0.424	34227	49759
10	0	80723	80723	125606	44883	0.386	31159	48484
			Total				539931	724220

Note: DF indicates discount factor

Annexure 2: Benefit-Cost analysis of DOS

Year	Investment cost (Tk.)	O&M cost (Tk.)	Total cost (Tk.)	Benefit (Tk.)	Incremental benefit (Tk.)	DF at 10%	Cost at 10% df	Benefit at 10% df
1	27395	84566	111961	94527	-17434	0.909	101773	85925
2	0	84566	84566	94527	9961	0.826	69852	78079
3	0	84566	84566	94527	9961	0.751	63509	70990
4	0	84566	84566	94527	9961	0.683	57759	64562
5	0	84566	84566	94527	9961	0.621	52515	58701
6	2500	84566	87066	94527	7461	0.564	49105	53313
7	0	84566	84566	94527	9961	0.513	43382	48492
8	0	84566	84566	94527	9961	0.467	39492	44144
9	0	84566	84566	94527	9961	0.424	35856	40079
10	0	84566	84566	101127	16561	0.386	32642	39035
			Total				545886	583321

Annexure 3: Sensitivity Analysis of EOS at 10 percent increases of O & M costs

Year	Investment cost (Tk.)	O&M cost (Tk.)	Total cost (Tk.)	Benefit (Tk.)	Incremental benefit (Tk.)	DF at 10%	Cost at 10% df	Benefit at 10% df
1	46820	88795	135615	117356	-18259	0.909	123274	106677
2	0	88795	88795	117356	28561	0.826	73345	96936
3	0	88795	88795	117356	28561	0.751	66685	88134
4	0	88795	88795	117356	28561	0.683	60647	80154
5	0	88795	88795	117356	28561	0.621	55142	72878
6	2500	88795	91295	117356	26061	0.564	51491	66189
7	0	88795	88795	117356	28561	0.513	45552	60204
8	0	88795	88795	117356	28561	0.467	41467	54805
9	0	88795	88795	117356	28561	0.424	37649	49759
10	0	88795	88795	125606	36811	0.386	34275	48484
			Total				589528	724220

Annexure 4: Sensitivity Analysis of EOS at 10 percent decreases of benefits

Year	Investment cost (Tk.)	O&M cost (Tk.)	Total cost (Tk.)	Benefit (Tk.)	Incremental benefit (Tk.)	DF at 10%	Cost at 10% df	Benefit at 10% df
1	46820	80723	127543	105620	-21923	0.909	115937	96009
2	0	80723	80723	105620	24897	0.826	66677	87242
3	0	80723	80723	105620	24897	0.751	60623	79321
4	0	80723	80723	105620	24897	0.683	55134	72139
5	0	80723	80723	105620	24897	0.621	50129	65590
6	2500	80723	83223	105620	22397	0.564	46938	59570
7	0	80723	80723	105620	24897	0.513	41411	54183
8	0	80723	80723	105620	24897	0.467	37698	49325
9	0	80723	80723	105620	24897	0.424	34227	44783
10	0	80723	80723	113045	32322	0.386	31159	43636
			Total				539931	651798

Annexure 5: Sensitivity Analysis of DOS at 10 percent increases of O&M costs

Year	Investment cost (Tk.)	O&M cost (Tk.)	Total cost (Tk.)	Benefit (Tk.)	Incremental benefit (Tk.)	DF at 10%	Cost at 10% df	Benefit at 10% df
1	27395	93023	120418	94527	-25891	0.909	109460	85925
2	0	93023	93023	94527	1504	0.826	76837	78079
3	0	93023	93023	94527	1504	0.751	69860	70990
4	0	93023	93023	94527	1504	0.683	63534	64562
5	0	93023	93023	94527	1504	0.621	57767	58701
6	2500	93023	95523	94527	-996	0.564	53875	53313
7	0	93023	93023	94527	1504	0.513	47721	48492
8	0	93023	93023	94527	1504	0.467	43442	44144
9	0	93023	93023	94527	1504	0.424	39442	40079
10	0	93023	93023	101127	8104	0.386	35907	39035
			Total				597843	583321

Annexure 6: Sensitivity Analysis of DOS at 10 percent decreases of benefits

Year	Investment cost (Tk.)	O&M cost (Tk.)	Total cost (Tk.)	Benefit (Tk.)	Incremental benefit (Tk.)	DF at 10%	Cost at 10% df	Benefit at 10% df
1	27395	84566	111961	85074	-26887	0.909	101773	77333
2	0	84566	84566	85074	508	0.826	69852	70271
3	0	84566	84566	85074	508	0.751	63509	63891
4	0	84566	84566	85074	508	0.683	57759	58106
5	0	84566	84566	85074	508	0.621	52515	52831
6	2500	84566	87066	85074	-1992	0.564	49105	47982
7	0	84566	84566	85074	508	0.513	43382	43643
8	0	84566	84566	85074	508	0.467	39492	39730
9	0	84566	84566	85074	508	0.424	35856	36072
10	0	84566	84566	91014	6448	0.386	32642	35132
			Total				545886	524989

Annexure 7: Sensitivity analysis of DOS at 10 percent increases of diesel price

Year	Investment cost (Tk.)	O&M cost (Tk.)	Total cost (Tk.)	Benefit (Tk.)	Incremental benefit (Tk.)	DF at 10%	Cost at 10% df	Benefit at 10% df
1	27395	87491	114886	94527	-20359	0.909	104431	85925
2	0	87491	87491	94527	7036	0.826	72268	78079
3	0	87491	87491	94527	7036	0.751	65706	70990
4	0	87491	87491	94527	7036	0.683	59756	64562
5	0	87491	87491	94527	7036	0.621	54332	58701
6	2500	87491	89991	94527	4536	0.564	50755	53313
7	0	87491	87491	94527	7036	0.513	44883	48492
8	0	87491	87491	94527	7036	0.467	40858	44144
9	0	87491	87491	94527	7036	0.424	37096	40079
10	0	87491	87491	101127	13636	0.386	33772	39035
			Total				563857	583321

Annexure 8: Sensitivity analysis of DOS at 10% increases of both diesel and benefit price.

Year	Investment cost (Tk.)	O&M cost (Tk.)	Total cost (Tk.)	Benefit (Tk.)	Incremental benefit (Tk.)	DF at 10%	Cost at 10% df	Benefit at 10% df
1	27395	87491	114886	103980	-10906	0.909	104431	94518
2	0	87491	87491	103980	16489	0.826	72268	85887
3	0	87491	87491	103980	16489	0.751	65706	78089
4	0	87491	87491	103980	16489	0.683	59756	71018
5	0	87491	87491	103980	16489	0.621	54332	64571
6	2500	87491	89991	103980	13989	0.564	50755	58645
7	0	87491	87491	103980	16489	0.513	44883	53342
8	0	87491	87491	103980	16489	0.467	40858	48559
9	0	87491	87491	103980	16489	0.424	37096	44087
10	0	87491	87491	111240	23749	0.386	33772	42939
			Total				563857	641654

Annexure 9: Sensitivity analysis of DOS at 20% increases both of diesel and benefit

Year	Investment cost (Tk.)	O&M cost (Tk.)	Total cost (Tk.)	Benefit (Tk.)	Incremental benefit (Tk.)	DF at 10%	Cost at 10% df	Benefit at 10% df
1	27395	90416	117811	113432	-4379	0.909	107090	103110
2	0	90416	90416	113432	23016	0.826	74684	93695
3	0	90416	90416	113432	23016	0.751	67902	85188
4	0	90416	90416	113432	23016	0.683	61754	77474
5	0	90416	90416	113432	23016	0.621	56148	70442
6	2500	90416	92916	113432	20516	0.564	52405	63976
7	0	90416	90416	113432	23016	0.513	46383	58191
8	0	90416	90416	113432	23016	0.467	42224	52973
9	0	90416	90416	113432	23016	0.424	38336	48095
10	0	90416	90416	121352	30936	0.386	34901	46842
			Total				581828	699986