IMPACT OF RURAL DEVELOPMENT ACADEMY (RDA) DEVELOPED LOW-COST DEEP TUBEWELL IN KALAI UPAZILA UNDER JOYPURHAT DISTRICT

A THESIS

BY

UMMA HABIBA

REGISTRATION NO. 1505295

SEMESTER: JULY-DECEMBER, 2017

SESSION: 2015-2016

MASTER OF SCIENCE (M.S)

IN

IRRIGATION AND WATER MANAGEMENT

DEPARTMENT OF AGRICULTURAL AND INDUSTRIAL ENGINEERING

HAJEE MOHAMMAD DANESH SCIENCE AND TECHNOLOGY UNIVERSITY, DINAJAPUR

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DEDICATED TO

MY

BELOVED PARENTS

AND

HONOURABLE

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All praise to Almighty "Allah" who enabled me to pursue study and to complete the thesis for the degree of M.S in Irrigation and Water management, Department of Agricultural and Industrial Engineering.

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December, 2017 ***The Author***

ABSTRACT

The study was carried out at Harunja, Kalai under Joypurhat district to know the impact of Rural Development Academy (RDA) developed low-cost Deep Tube Well (DTW) technology during 2016-2017. Data were collected from DTW owners, farmers and RDA research documents for the purpose. Field data were collected by individual interview, Focus Group Discussion (FGD) and direct observation method from 100 respondents. Statistical analysis was done by using logistic regression model and R programming language. RDA has been improved some structural facilities in the study area. Installation costs of DTW, overhead tank, buried pipe irrigation system and domestic water supply network were 45%, 21%, 22% and 12%, respectively. Annual expenditure of electricity bill, salary of water charge collector, operation & maintenance cost, salary for operator were 66%, 18%, 9% and 7%, respectively. Annual income obtained from drinking and irrigation water charges were 51% and 49%, respectively. Gross expenditure and gross income were Tk. 1.37 and 2.35 lakhs, respectively. Net benefit from the project was obtained Tk. 0.98 lakh. This technology improved the sanitation facilities in the rural areas. In this area, 23% respondent had no toilet facility; however percentage has been decreased to 6%. Situation of water borne diseases have been improved. Maximum 56% respondents suffered diarrhea but this percentage has been decreased to 4%. Entertainment assessment also has been increased by the effect of technology. The 39% respondents were not able to buy television but this number has been decreased to 13%. There were 20%, 4% and 2% respondents who had 3, 4 and 5 mobile phones. Yearly frequency of medicare for water borne diseases has been improved in the area. The 5% respondents had not visit doctor but this percentage has been decreased as 65%. The value of ‘p’ for rice and potato yield were 6.12×10^{-6} and 3.71×10^{-6}, respectively indicated significant increase in grain yield against the cropping pattern. The effect of cropping pattern on rice yield is greater than the potato yield because of the cultivation of modern rice variety and improvement of boro rice cultivation. Medical cost has not been changed significantly with the changing cropping pattern. Facilities of irrigation and drinking or domestic water by Rural Development Academy (RDA) developed low-cost Deep Tube Well (DTW) technology improve their livelihood status as well as ensure their food, health and education of this project area.

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LIST OF ABBREVIATIONS

BADC	: Bangladesh Agricultural Development Corporation
BMDA	: Barind Multipurpose Development Authority
BPDB	: Bangladesh Power Development Board
BWDB	: Bangladesh Water Development Board
CIWM	: Center for Irrigation and Water Management
DTW	: Deep Tubewell
EPWAPDA	: East Pakistan Water Power Development Authority
HSTU	: Hajee Mohammad Danesh Science and Technology University
HTW	: Hand Tubewell
HYV	: High Yielding Variety
JFCL	: Jumuna Fertilizer Company Ltd.
JMBA	: Jamuna Multipurpose Bridge Authority
KTCCA	: Kotali Thana Central Cooperative Association
LGED	: Local Government Engineering Department
PVC	: Poly Vinyl Chloride
RDA	: Rural Development Academy
STW	: Shallow Tubewell
L	: Liter
Mm	: Millimeter
M	: Meter
Mg	: Miligram
m^3	: Cubic meter
MS	: Mild Steel
Rft	: Running feet
Hp	: Hourse power
et al.	: et alia (1) and other
etc	: Ecentera (L) and other

CHAPTER I

INTRODUCTION

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INTRODUCTION

Bangladesh is an agricultural country. In this country water supply is a very significant factor for drinking and irrigation water purposes. Irrigation is very much a social process. Water springs from the ground, flow through canals and field channels and enters the plant root zone only with some form of human interventions. To ensure an adequate and predictable supply of water to the fields, an organizational structure is required, be it small farmers organizations or large irrigation bureaucracies. Irrigation water is of sociological importance because people must organize collectively to secure it, transport it, divide it into usable shares, rules for its application, pay for it, and dispose of unused portions. The kinds of social organizations the patterns of power, decision-making, conflict and co-operation while people create and maintain for the social control of water intimately affect the productivity of its use.

As surface water is not sufficient, ground water is the most important sources to mitigate the demands for water in agriculture and household uses. Government strategies on conjunctive surface and groundwater management are very limited although new regulations at state level to limit groundwater use are now being developed. The development of piped distribution and micro irrigation supplied by surface water outlets and groundwater has been identified as a possible entry point for conjunctive irrigation. At present, about 70% of irrigation and 90% of potable water needs of the country are being provided by ground water.

Deep tubewells were first introduced in Bangladesh to supply potable water in large quantities to major towns in order to meet their domestic and industrial demands. The use of DTW technology for irrigation purpose was basically started in early 1960s. The first major tubewell project was undertaken in Thakurgoan and Dinajpur areas during 1962-65 by EPWAPDA (now BWDB) with the assistance of German Government. Under this project 380 number of four cusec (112 liter per second) electrically operated DTWs were sunk. In a second pilot project implemented during 1963-70 by Kotali Thana Central Cooperative Association (KTCCA) in Comilla 211 number of two cusec (56 lps) diesel powered DTWs were sunk by manual drilling techniques (Hanratty; 1988, Sahni, 1985). Later, BADC played the pioneering role in promoting minor irrigation for cultivation of HYV rice and in the expansion of groundwater irrigation system, particularly during the post liberation year i.e.1970s. Among groundwater irrigation technologies DTW was the most popular during 1971-1980. In fact, till the introduction of private sector irrigation through suction mode pumping by STW during 1980, minor irrigation in the country was mainly based on DTW technology. At that time, cost of DTW installation for irrigation was highly subsidized by the government. But, when the government subsidy was withdrawn, cost of DTW had a sudden increase and became burden to the farmers. Alternately, STW irrigation became more popular among the farmers due to socio-economic factors and simple management practices (Morton, 1989). But, groundwater abstraction by STW technology has been found to be a great concern due to several technical and environmental reasons.

Rural Development Academy (RDA), Bogra is a national level training and research organization in Bangladesh. It has established in 1974 under the ministry of local government, rural development and co-operatives. The major objectives of the academy are to offer training to the personnel of different nation building department and agencies involved in rural development works, to conduct research on rural development issues, to action research or pilot experiments in different aspects of rural development and to offer consultancy services to different national and international agencies as well as NGOs on various rural development programmes. To achieve the objectives, the academy has been working on a wide range of rural development activities since 1974 giving more emphasis on exploring and managing water resources as a means of rural development. Achievement of self-sufficiency in food is dependent on increased agricultural product largely reliant on expansion of agriculture. Therefore, the demand for ground water has significantly increased over the last few years. These high cost DTW technology hampers the agricultural production such as crops, vegetables etc. because it is not easily affordable to the farmers.

The Rural Development Academy, Bogra has developed the low-cost DTW model in 1998. Total cost of abstracting water by traditional DTWs becomes high because of selection of bigger size of pump and prime mover (engine/motor) without consideration of the actual demand of water abstraction and high power consumption. Usually the DTWs are operated only in the irrigation season and remain idle during rest of the period. If the power line is not disconnected there will be again a minimum bill for line rent. Ultimately, the operational cost of such a traditional DTW becomes a burden to the users unless the command area is large. Due to high capital investment and operation and maintenance (O & M) costs as well as complex management system, use of traditional DTW only for seasonal irrigation purpose has not been found economically viable. Keeping the above facts in view, RDA has carried out experiment for developing the low-cost and demand based DTW technology for which discharge capacity ranges from 0.5 cusec to 2 cusecs. Water supply is ensured from the main aquifer by such a low-cost demand specific DTW, which is based on economical, design and is suitable for Bangladesh context. The RDA DTW model is demand based where due consideration is given to calculate the actual demand of water abstraction and to select the size of the pump and prime mover (motor) accordingly. Until now the sizes of RDA developed DTWs vary from 0.75 to 30 hp; at the same time discharge capacity of pumps vary from 3 to 200 m^3/hr. RDA low cost DTW technologies that have brought revolutionary change in production of crops as well as supply of safe drinking water in rural peoples. RDA is able to supply arsenic and iron free safe water to the rural and urban community and practically make the community free from water borne diseases like diarrhoea, cholera, typhoid and paratyphoid fever, infectious hepatitis, amoebic bacillary dysentery, arsenicosis, and skin disease etc.

In recent years, irrigation cum domestic water abstraction system developed by RDA has been adopted by many agencies. Barind Multipurpose Development Authority (BMDA), Rajshahi has installed RDA developed DTW model for dual purpose i.e. irrigation and domestic at 26 sites on pilot basis. Moreover, Jamuna Multipurpose Bridge Authority (JMBA), Local Government Engineering Department (LGED), Proshika, Bangladesh Power Development Board (BPDB) and Jamuna Fertilizer Company Ltd. (JFCL) have already installed such low-cost DTWs at Bhuapur, Sirajganj, Sherpur, Manikganj, Baghabari, Bheramara, Jamalpur, respectively. This DTW technology has also become popular among some farmers and private enterprises for their dual cum multipurpose uses. Recently there have been contracts of sinking of more low-cost DTWs for multipurpose uses in other places within the country. But, only a preliminary study in relation to workability and durability of this low-cost DTW technology has been made recently (Matin *et al.,* 2000) on the basis of stakeholders' views.

For the above circumstances, Kalai Pourashava under Joypurhat District is suffering to serious crisis of safe water both for drinking and irrigation water, Pourashava has been established in 1983. Inception of this Pourashava, they have no own access of water supply in the Pourashava and peoples had been used water from pond, river, dug well, Hand Tubewell (HTW) etc. Recently, surface water was not getting available in the pond, river as well as dug well especially in dry period. In dry season, ground water table is going to down day by day. Peoples are now suffering a serious crisis of safe water from long time in this Pourashava. Besides, Pourashava could not provide adequate fund to arrange the water supply system. In the interim, Center for Irrigation and Water Management (CIWM), RDA, Bogra has been installed safe water supply package like DTW, overhead tank, drinking and irrigation pipeline in 2013 by the request of Pourashava authority according to their demand to mitigate safe water supply under a GoB funded project entitle creation of additional employment, increase in marginal productivity of labour economic activities and poverty alleviation through irrigation and water management. No study has been made yet on the performance of RDA DTWs based on socio-economic in this area. Therefore, the impact of RDA developed low cost DTW on rural community is required for further expansion of the technology.

Objectives of the research work

The main objective of the research work is to know the impact of RDA developed low cost Deep Tubewell technology in different sites.

The specific objectives of the research works:

1. To identify the irrigation structural facilities developed in the study area.
2. To determine the cost-benefit analysis of the deep tubewell.
3. To identify the livelihood improvement.

CHAPTER II

REVIEW OF LITERATURE

CHAPTER II

REVIEW OF LITERATURE

Ground water exploration and utilization have become important through the country as the water use in agriculture is increasing. The future strategies for the utilization of ground water resource should be established by predicting the present and previous information of the concerned ground water basin.

Biswas and Khan (1976) studied the groundwater condition in Dinajpur district. They analyzed the existing well logs at different Places in Dinajpur district to characterize the water bearing formation and to predict the groundwater reserve. It has been observed that there exists continuous layer of permeable formation in Dinajpur district between the depths of 10 to 100 m. Groundwater reserve available in this layer would be adequate to irrigate the area under study by deep tubewells at least once in a year after which storage of ground water would against be mode up through recharging.

De Los Reyes (1978) stated that behavior related to water distribution and allocation indicate the basic understanding that once a farmer has access to water, he has a continuous right to irrigation. Coward mentioned that the organization of the system requires the functioning of linkage role roles, for the co- operation of action between the authorities and users. These rules will identify channels of communication among farmers themselves on matter pertaining to irrigation. Wickham in her study found that farmers generally have good relation and communications with ditch tender. Farmers were asked whom they preferred to see should they have an irrigation problem; many preferred the ditch tenderis very prospective. Very limited research works have been conducted on design of Low-cost DTW Technologies so far. Most of the works done are seemed to be suitable for Ground water resource development.

Hamid (2003) conducted an experiment on 15 Nos. of RDA-developed Low-cost DTWs. The evaluation study laid emphasis on appraising the technology used for drilling; its development in easier form and labour intensiveness and cost effectiveness in materials used for well and pumping plants meticulously. The study reveals that the drilling cost of RDA DTW is very reasonable in comparison to the traditional force mode DTW. He also found that the total cost of RDA-developed tubewell varies from sixty thousand to five lakh (excluding buried pipe lining and home supply network), which seems to be within the purchasing capacity of rich or middle class farmers of relevantly advanced rural areas.

Khan (1991) stated that Deep aquifers generally include those aquifers whose waters have no access vertically upward and downward but flow very slowly along the dips and slopes of the aquifers. The depths of the deep aquifers in Bangladesh containing usable water range from 190 to 960 m on the Dinajpur platform and 250 to 1500 m in the basin and mainly include the sediments of the Gondwana, Jaintia, Surma and Tipam groups and parts of the Dupi Tila Sandstone Formation.

Matin (2008) stated that the impact of the irrigation technological diffusion in crop production, based on comparison of data between pre and post period of the deep tubewell technology transfer project located at Mahastangar. It was found from the results of the analysis that after irrigation technology diffusion, double and triple cropped area increased by 41.55% and hence cropping intensity from 113.48 to 165.98. Enormous changes in cropping pattern and crop rotation were identified. Due to availability of irrigation water throughout the year farmers are using HYV seeds and find variation on species selection. It was found that yield rate increased resulting significant increment of crop production. As a whole, farmers earned 20% more profit than pre-project period in the study area. It is revealed that agriculture sector has the ability to contribute more in the national economic development if the irrigation technology diffusion properly spreads over the whole country considering also other important agricultural inputs such as seeds and fertilizer. With some limitation, irrigation technological diffusion would significantly promote crop production and hence attain national food security.

Matin *et al.,* (2000) pointed out that RDA developed transferable appropriate technologies like Multipurpose use of DTW and Water Filtration Plants for supplying safe drinking water are the most popular and demandable ones. However, suggested to assess the workability, durability and acceptability of these technologies in order to make them easily available to the rural poor. They agreed that such technologies should be appropriate, cost effective, users friendly and less hazardous towards environmental pollution.

Matin *et al.,* (2001) examined the safe drinking water supply system introduce at rural level through RDA-developed low-cost DTW technology and was found that DTWs are using for multipurpose such as domestic water supply, irrigation (through buried pipe), livestock & poultry rearing, horticulture & nursery development, aquaculture etc.

Matin *et al.,* (2000) studied that RDA DTWs housing pipes are made of three types of materials namely PVC, MS and RCC. For cost minimization housing pipe of most DTWs are made of PVC. But RCC housing pipe which is very cheap (Tk 300/m) is the new addition of RDA developed DTW model and the study also reveals that in case of traditional DTWs drilling can be done by sophisticated mechanical methods using rigs. The most commonly used such methods adopted in Bangladesh are the Hydraulic Rotary Methods-both direct circulation and reverse circulation. Both the methods are fast, efficient in drilling with some inherent limitations, but they are very expensive (MPO 1986). The cost of drilling per meter of depth of aquifer by these methods is around Tk. 2000.00 such drilling methods need heavy equipment, mobilization, separate power generation and so many accessories as well as skilled persons. As a result, now a day cost of drilling becomes very high. Considering this factors RDA-developed a semi-mechanical labour intensive and low-cost drilling techniques based on reverse circulation method. Drilling part is conducted by manual labour and water circulation and mud pumping is carried out by a 16 hp centrifugal pump. The drilling cost ranges from Tk. 10000.00 for a depth of 27m to Tk. 70878.00 for a depth of 83m. So the drilling cost per meter varies from Tk. 370.00 to Tk. 852.00 which is much cheaper than traditional rig-method.

Asaduzzaman (1985) indicated that Irrigation based on groundwater use in Bangladesh is becoming very popular. Utilization of groundwater by means of tubewells is associated with many special advantages. Recharge is satisfactory in most of the areas. High land far away from the water courses can be irrigated. Tubewell equipment stands security for use round the year, minimizing risk of crop failure due to drought. Deep tubewells, Shallow Tubewells and Hand tubewells are in use for irrigation in Bangladesh. Though Shallow tubewell is more cost effective as compared to deep tubewell, but due to too deep water table and high draw-down, some areas cannot be developed by shallow and Hand tubewell.

Morton (1989) stated that among ground water irrigation technologies DTW was the most popular during 1971-1980. In fact, till the introduction of private sector irrigation through suction mode pumping by STW during 1980, minor irrigation in the country was mainly based on DTW technology. At that time cost of DTW installation for irrigation was highly subsidized by the Government. But, when the Government subsidy was withdrawn, cost of DTW had a sudden increase and become burden to the farmers. Alternately, STW irrigation becomes more popular among the farmers due to socio-economic factors and simple management practices.

Miah and Mandal (1993) made a financial analysis of STW projects in Ghatail, Tangail. They calculated that the benefit cost ratio ranged from 1.30 to 1.51 for 20% and 25% crops share respectively. Miah and Hossain (1984) reported in irrigated deep tubewell cropping system in Salna, Gazipur that the benefit cost ratio was 0.77.

Nelson (2012) reported that groundwater pumping has caused excessive groundwater depletion around the world, yet regulating pumping remains a profound challenge. The methodology used is the social science-derived technique of content analysis, which involves using a coding scheme to record these three elements in local rules and plans, and State legislation, then analyzing patterns and trends. The study finds that Californian local groundwater managers rarely use, or plan to use, mandatory and fee-based measures to control groundwater depletion. Most use only voluntary approaches or infrastructure to attempt to reduce depletion, regardless of whether they have more severe groundwater problems, or problems which are more likely to have irreversible adverse effects. The study suggests legal reforms to the local groundwater planning system, drawing upon its empirical findings. Considering the content of these recommendations may also benefit other jurisdictions that use a local groundwater management planning paradigm.

Rahman *et al.,* (1996) reported that groundwater was adequate and dependable source for irrigation in Mymensingh district. It was observed that in this area whatever depletion of ground water level in the aquifer occurred in dry season was completely replenishment in wet season.

Saleth (2011) reported that against the discussion on the rationale and scope for water demand and supply management in India, this paper provides a brief overview of the status and effectiveness, as well as the technical, institutional and financial requirements of six demand management options (i.e. water pricing, water markets, water rights, energy regulations, water saving technologies, and user and community organizations) and one supply management option. The paper then develops a framework that captures the analytics of water demand management in terms of both the impact pathways of and operational linkages among the options and their underlying institutions.

Zahid *et al.,* (2009) Stated that the character of the deposits varies remarkably vertically. Coarse and medium sand with gravel are found mainly in the northern border areas of greater Rangpur and Dinajpur districts. The sediments of coastal areas and northwestern part of Rajshahi district are predominantly silt, clay and fine sand with occasional coarse sand. The deeper aquifer consisting of fine to medium sand vertically extends 180 to more than 250 m depths from the surface and is separated by 10 to 50 m thick clay layer from the overlying aquifer and is promising for groundwater exploration in Chittagong coastal plain aquifer.

Zahid *et al.,* (2004) conducted that Bangladesh occupies the major part of the delta of the Ganges-Brahmaputra-Meghna (GBM) river system and lies mostly within the Bengal Basin. The unconsolidated near surface Pleistocene to Recent fluvial and estuarine sediments underlie most of Bangladesh, generally form prolific aquifers, and groundwater is drawn predominantly from these quaternary strata. Since the 1960's, groundwater has been used extensively as the main source of drinking and irrigation water supply. Continuous decline of groundwater tables due to over-withdrawal has also been reported from some areas. Thus the overall situation calls for urgent groundwater management for sustainable development. Groundwater management must adopt an integrated approach taking into account a wide range of ecological, socio-economic and scientific factors and needs

CHAPTER III

MATERIAL AND METHODS

CHAPTER III

MATERIALS AND METHODS

3.1 Description of the experimental site

3.1.1 Location

In order to assess the parameters in relation to fullfill the objectives and workability of RDA low cost DTW technology at Harunja, Kalai under Joypurhat, appropriate scientific methods were applied.

Fig. 3.1: Location of the research work

3.1.2 Study Period

The study was carried out at Harunja, Kalai to know the impact of Rural Development Academy (RDA) developed low-cost Deep Tube Well (DTW) technology during 2016-2017.

3.1.3 Soil characteristics

Generally, the soil type of the region is Calcareous Brown Floodplain soils. They have cambic B-horizon that is predominantly oxidized containing lime in the profiles. They comprise pale brown to olive brow, friable, loamy and clay soils.

3.1.4 Climate

Kalai is an Upazila under Joypurhat district of tropical climate. In summer there is much more rainfall than winter. The average annual temperature in here is 25.4°C and the average annual rainfall is 1738mm. The driest month is December with 3mm. Most precipitation fallss in July, with an average of 364 mm. The warmest month of the year is August with an average temperature of 28.9°C. In January, the average temperature is 18°C. It is the lowest temperature of the whole year. The difference in precipitation between the driest month and the wettest month is 361 mm. The average temperatures vary during the year by 10.9°C.

3.1.5 Land use pattern

Transplanted aman is the main crop entire the region. Rabi crops mainly potato and maize is grown in this area. Vegetables are grown on the higher elevated lands. The present land use pattern is mainly single cropped area.

3.1.6 Cropping pattern

The cropping patterns within the command area were identified by asking the crop sequences of the individual plot of the farmers. The cropping patterns of the surveyed sites have given below:

i. Fallow – Fallow – T. Aman rice
ii. T. Aman rice – Fallow – Fallow
iii. Vegetable – Fallow – Fallow

3.2 Water quality

Water quality is important because it directly affects the health of the people, animals and plants that drink or otherwise utilize the water. Groundwater quantity issues may have substantial impacts on human health. When water is compromised, its usage puts users at risk of developing health complications. The environment also suffers when the quality of water is low. The availability of high quality water is a key determinant for human, animal, and plant survival. Without water, living things could not survive, making water quality one of the most important factors.

3.3 Water utilization

Aiming these targets, DTW uses in the different purpose already installed in the field. During sampling for this study installed DTW was categorized into two groups based on the purpose of uses. The DTW users' groups are categorized on the basis of its (DTW) use on

i) Irrigation purpose

ii) Domestic purpose

3.4 Specification of RDA developed low-cost Deep Tubewell

3.4.1 Pump specification for Burried pipe irrigation system

1. Pump Model: Submersible pump KSB Brand of India BPN 394/1+ HBC-253
2. Type of Pump: Submersible
3. Discharge capacity, Q= 100-150 m^3/hr
4. Head, H=51-34 m
5. Pump Horsepower, H_p = 25
6. Voltage: 440

3.4.2 Pump specification for domestic water supply

1. Submersible pump
2. Discharge capacity, Q=10-18 m^3/hr
3. Head, H=35-27 m
4. Pump Horsepower, H_p = 3

3.4.3 Others specification

1. Type of strainer: PVC
5. Diameter of housing pipe: 350 mm dia (5 mm thickness) MS housing
6. Diameter of Column pipe: 150 mm dia MS
7. Diameter of delivery pipe: 150 mm dia MS
8. Diameter of well screen: 100 mm dia pipe (PVC Class-C) well screen (6 no. Slot)
9. Operating hours per day: Irrigation – 12-14 hours, Drinking – 2 hours
10. Type of Prime Mover: Electric motor

3.5 Parts and functions of RDA developed low-cost Deep Tubewell

Motor: It imparts energy to the pump for operation.

Pump: Pump is a device installed to lift the water from underground.

Delivery pipe: The main function of delivery pipe is delivers pumping water which in turn carries water to the field.

Housing Pipe: It is the most important part of Deep tubewell. This Deep tubewell diameter is 350 mm. This pipe is necessary for housing the pump and the suction pipe.

Well casing: The casing pipe supports the hole during drilling or installed after used to complete the well assembly.

Well screen: A well screen is a strainer which separates the groundwater from the granular material in whose pores it is contained. Generally all formations except stable rock require well screen. The well slot openings are used as wide as possible by matching the opening with the grain size distribution of the material surrounding the screen.

Strainer Pipe: Perforated pipe with opening so designed to exclude coarse sand partical entering into the tubewell. It also prevents the clogging of the bore hole.

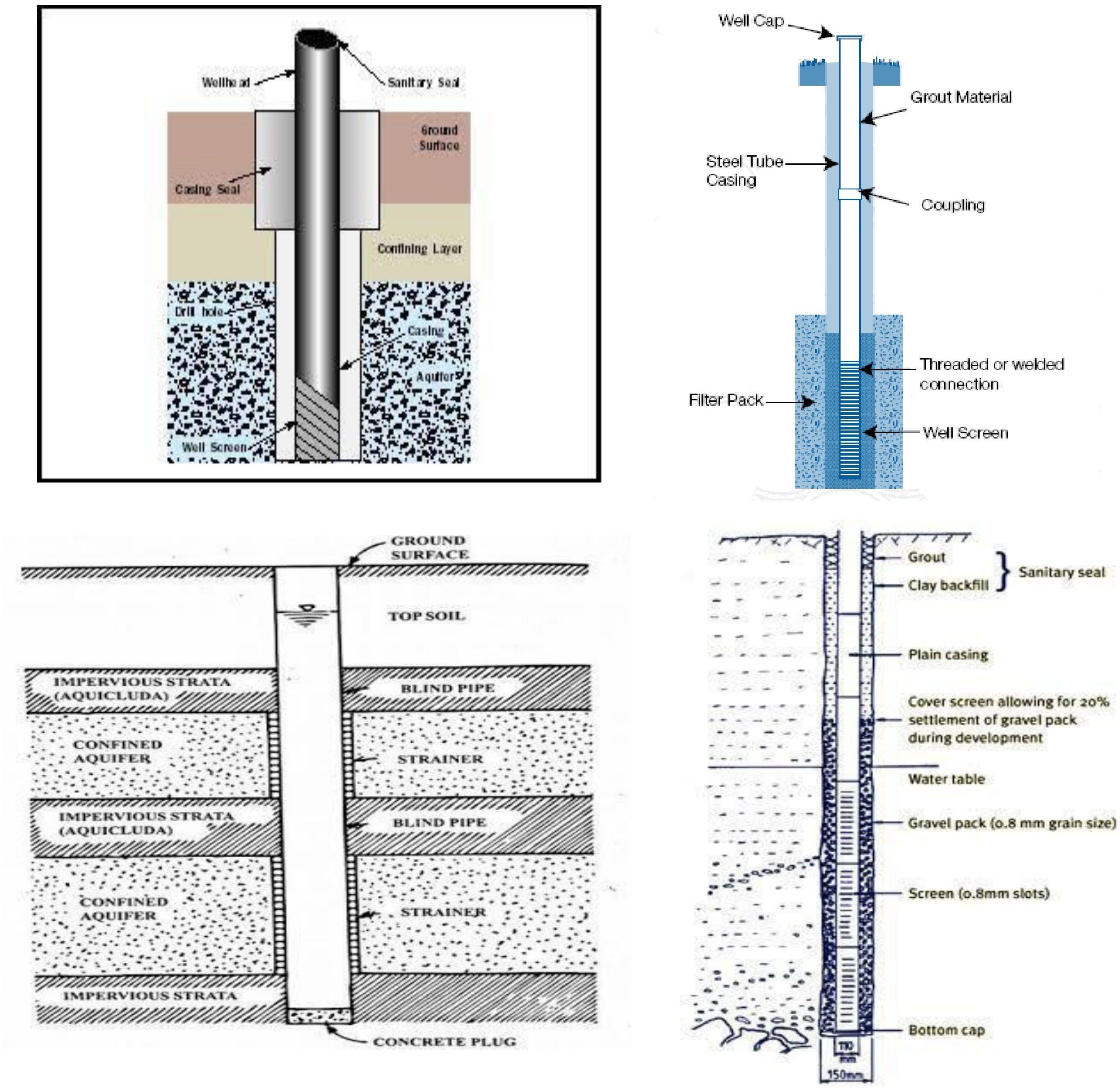

Fig. 3.2: Different components of Deep Tubewell

Blind pipe: It covers the impervious layers formation. It serves to prevent suction of water by the strainert from the impervious layers and the bottom of the bore hole.

Depth gauge: Instrument for indicating water level.

3.6 Installation of Deep Tubewell

RDA developed a deep tubewell which are submersible type. The submersible pump consists of a pump and motor assembly, a discharge column, a head assembly and a water proof cable to conduct the electric current to the submerged. In submersible pump the motor is fixed directly below the intake of the pump. The pump element and motor operate entirely submerged. The ease of installation is an outstanding feature of the submersible pump. The pump motor assembly is lowered first into the well, adding pipe lengths as required. When lowering the pump and piping, care is taken not to damage the outside sheathing of the water-proof cable with pipe tools or against the top edge of the well casing. The cable is taped to the column pipe at every 2 meter. A pipe camp is used at the top of the well to support the pipe and the delivery pipe. A sluice valve usually fitted at the discharge end of the pump. Since the complete pump and motor assembly is in the well, no pump house is required. The control board consisting of the switch, stater and meter should be enclosed in a water-proof box.

3.7 Operation of Deep Tubewell

The pump is started with the sluice valve closed or slightly open. During the initial run it is observed whether the water pumped is clear or muddy and whether any impurities are being pumped. If the water containes sandy or gritty particles or other impurities, care is taken not to stop pumping. Otherwise the particle will settle down inside the pump and on top of the non-return valve and may choke or seize the pump. The sluice valve is kept partly closed and the pumping continued until the water clears. When the water is reasonably clear, the valve is opened a little more, checking whether the increased flow of water brings up more impurities. The valve is adjusted so that impurities are kept to the minimum. The pumping is continued in this manner until it is possible to pump at full open valve without having a large proportion of sand and grit in the water at any time. When the water is running clear, the pump may be stopped and restarted as required.

3.8 Water conveyance system of Deep Tubewell

Water is conveyed by an underground pipeline water distribution system. An underground pipeline water distribution system consists of buried pipes for conveying water to different points on the farm and allied structures required for the efficient functioning of the system.

The system offers many advantages over open channels in water conveyance and distribution. Since the pipes are laid underground, cultivation can be done above the pipeline, no culverts or other structures are required.

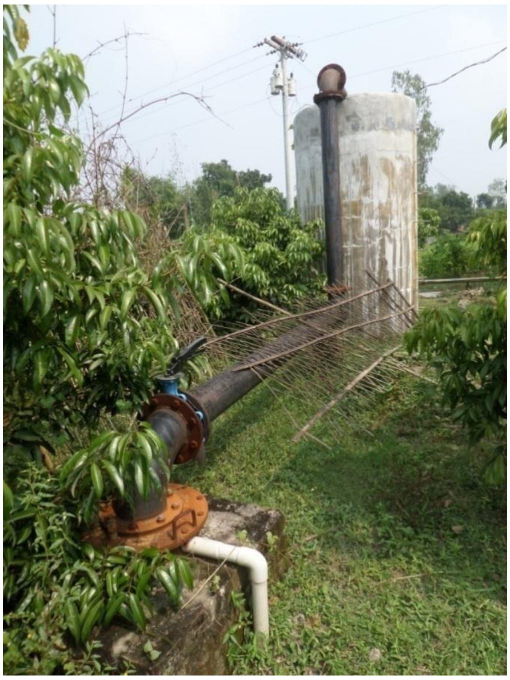

Fig. 3.3: Tank used for Burried pipe irrigation line

Fig. 3.4: Overhead tank used for domestic water supply

Open channels often take 2 to 4 percent of the land area out of cultivation which is saved by adopting the underground water distribution system. The pipelines do not interfere with farming operations. When properly installed, they have long life and low maintenance costs. They are essentially leak-proof. Their placement below ground level prevents damage to pipes and eliminates water loss by evaporation. Since underground pipeline operate under pressure, they can be laid uphill or downhill. Thus, permitting delivery of irrigation water to areas are not accessible by open channels. Pipelines are spaced to suit the field layout and soil type.

3.9 Data collection procedure

Basic information on aquifer lithology, tubewell design with installation fixtures and cost estimates were used from the open file reports of RDA**.** Data were collected in the following ways,

i) Individual interview

ii) FGD (Focus Group Discussion) method

iii) PRA (Participatory rural appraisal) method

iv) Direct Observation method

v) RDA Research Journal & other documents

3.9.1 Focus Group Discussion

A focus group discussion (FGD) is:

- a method of qualitative research
- a situational method
- a multi-dimensional communication process

A focus group is an organized discussion through structured in a flexible way of between 6 and 12 participants. It usually lasts one or two hours and provides the opportunity for all the respondents to participate and to give their opinions.

The purpose of FGD

The purpose of an FGD is to obtain in-depth information on concepts, perceptions, and ideas of the group. An FGD aims to be more than a question-answer interaction (Focus group interview is different). Here the idea is that group members discuss the topic among themselves.

Focus groups are used

- gain understanding of the subject being researched
- evaluate and analyse needs
- test new ideas or programmes
- improve existing programmes
- obtain a wide range of information on a given topic in order to develop more structured questionnaires

Advantages of focus groups

- The advantage of focus group over individual interviews is that the comments of one participant can generate comments from other participants
- Ideas and opinions can be developed and explored more so than in individual interviews
- These types of discussions can be very productive Researches and interviewers can benefit from the ideas generated in these discussion
- In a short amount of time, a large quantity of information can be collected

Some weaknesses are

- The researcher has less control over the flow of discussion in the group interview as compared to the individual interview
- Results are harder to analyze than interviews
- Facilitating and conducting a focus group interview requires considerable skill

3.9.2 Participatory rural appraisal

The basic idea of PRA is to rather quickly collect, analyze and evaluate information on rural conditions and local knowledge. This information is generated in close co-operation with the local population in rural areas. Tools like mapping, diagramming and ranking were developed or improved in order to gather information for decision-makers in development agencies. The approach aims to incorporate the knowledge and opinions of rural people in the planning and management of development projects and programmes.

The four major types of process are

a. participatory appraisal and planning
b. participatory implementation, monitoring and evaluation of programs

c. topic investigations

d. training and orientation for outsiders and villagers

The four major sectors are

(a) Natural resources management

(b) Agriculture

(c) Poverty and social programs

(d) Health and food security

Some features of PRA which make it well-suited as a learning and problem-solving tool for the rural poor are

- It encourages group participation and discussion
- The information to be processed is collected by group members themselves
- It is presented in highly visual form, usually out in the open and on the ground, using pictures, symbols and locally available materials

3.9.3 Direct Observation

Observation is a technique that involves systematically selecting, watching and recording behaviour and characteristics of living beings, objects or phenomena. Without training, our observations will heavily reflect our personal choices of what to focus on and what to remember.

Type of Observation:

1. **General observation:** General observation may be used as the starting point in to be familiar with the setting and the new context
2. **More focus observation:** More focus observation may be used to evaluate whether people really do what they say they do
3. **Access the unspoken knowledge of subject**, that is, the subconscious knowledge that they would not be able to verbalize in an interview setting
4. **Compare phenomena:** Compare a phenomena and its specific components in greater detail

Dimensions of Observation

1. Space
2. Actors
3. Activities

4. Object
5. Time
6. Goal
7. Feeling

Preparing for Observation

1. Determine the purpose of the observation activity as related to the overall research objectives
2. Select the site(s), time(s) of day, date(s) and anticipate how long collect participant
3. Determine the population to be observed

All of the method a questionnaire will be developed to assess the views of stakeholders on socio-economic status, operation and maintenance (O&M) and utilization of DTW for multipurpose uses may be obtained through open discussion and questionnaire survey. All the data obtained from questionnaire survey have been sorted and analyzed in order to find out ownership pattern, water utilization, water quality aspects, socio-economic improvement, awareness about the quality of life etc.

3.9.4 RDA Research Journal & other documents

Research Journal & other documents were collected from the RDA library. Different types of data such as pump specification, pump model, pump horsepower, pump capacity, overhead tank capacity, length of buried pipe irrigation line, length of domestic water supply network were collected from the RDA Research Journal and other documents. Diameter of housing pipe, well casing, well screen, column pipe, delivery pipe were also known from the documents. Detailed cost estimation of production Deep tubewell for Buried pipe irrigation and domestic water supply were collected from the documents. The construction cost of overhead tank (20,000 liter), buried pipe irrigation network (3000 rft) and domestic water supply network (4000 rft) were collected from the RDA research journals.

3.10 RDA developed DTW with Traditional DTW

The Rural Development Academy (RDA), Bogra has developed the low cost Irrigation and Water Management Technology in 1998. It has got the superiority over the traditional DTWs, especially in respect of cost and supply of water on regular basis. Because of selection of bigger size of pump and prime mover (engine/motor), total cost of extracting water by traditional DTWs becomes high. For a traditional DTW running with a 30 hp motor the annual electrical bill is around Tk. 35-40 thousand. Generally, the operation of traditional

DTWs remains stop during off irrigation season. Comparison of RDA developed DTW with Traditional DTW are given in the following table.

Table 3.1: Comparison of RDA developed DTW with Traditional DTW

Parameter	**RDA model**	**Traditional DTW**
Drilling method	Manual water jetting and reverse circulation which is easy and cost effective	Traditional rig method (hydraulic rotary and reverse rotary)
Housing pipe	PVC, RCC or 4 mm MS sheet	MS sheet, Fibre glass
Strainer	PVC, Bamboo net	Stainless steel, Fibre glass
Prime mover size	Demand based (min. 0.75-30 hp)	Not demand based usually 30 hp
Pumping plant	Submersible/mono-sub pump	Deep well turbine pump
Pump house /shed	No need	Compulsory
Pump efficiency	High	Low
Power transmission loss	Low	High
Damage due to natural hazards and flood	No damage and can be operated during flood	Possibility of damage and cannot be operated during flood
Construction cost	Low (Tk. 0.5 – 5 lakh)	High (Tk. 10-20 lakh)

3.11 Statistical analysis

Logistic regression model and R Programming Language were used for Statistical analysis. Logistic regression model was used for study the relationship between the probability p of dependent variable Y take a value and the independent variable X. According to the dependent variable values, Logistic regression model has two categories: one is Binary Logistic regression (dependent variables take only 0 or 1 two values) and Multinomial Logistic regression (dependent variable could take more than two values). R is software for statistical analysis and graphics. R is an object oriented language. These are described below:

Logistic Regression

Logistic regression is statistical method for analyzing a dataset in which there are one or more independent variables that determine an outcome. The outcome is measured with a dichotomous variable in which there are only two possible outcomes. In logistic regression, the dependent variable is binary or dichotomous i.e it only contains data coded as 1 (true, success) or 0 (False, Failure). The goal of logistic regression is to find the best fitting model to describe the relationship between the dependent variable and a set of independent variables. Logistic regression generates the coefficients and its standard errors and significant levels of a formula to predict a logit transformation of the probability of presence of the dependent variable. If $P<0.05$ then the variable contributes to the prediction of the outcome variable. The logistic regression equation is:

$$Y=\beta_0 + \beta_1X_1 + \beta_2X_2 + \beta_3X_3 + \beta_4X_4 + €i$$

Here

Y= Cropping pattern as dependent variable

X_1=Monthly income as independent variable

X_2=Rice yield as independent variable

X_3=Potatoes yield as independent variable

X_4= Yearly medical cost as independent variable

$\beta_0, \beta_1, \beta_2, \beta_3$ and β_4 are logistic regression coefficients.

R Programming Language

R is an open source programming language and software environment for statistical analysis, graphics representation and reporting. R programming language was designed by Ross Ihaka and Robert Gentleman. R is currently developed by the R Development Core Team. The R language was first appeared in August 1993. The R language is widely used among statisticians and data miners for developing statistical software and data analysis. The R language filename extensions are .r, .R, .R Data, rds, rda. The source code for the R software environment is written primarily in C, FORTRAN and R. R is freely available under the GNU General Public License and pre-compiled binary versions are provided for various operating systems like Linux, Windows and Mac. While R has a command line interface, there are several graphical front ends available. R programming language is very much important programming language for statistical analysis. It is used for the probability test of data. Data can be directly entered into R but we will usually use MS Excel to create a data set. Data sets were arranged with each column representing a variable and each row representing a subject. Data sets with 5 variables recorded on 100 subjects were represented in an Excel file with 5 columns and 100 rows. Data entered and edited using Excel. Excel saved files in .cvs files, these .cvs files can then be read into R for analysis.

CHAPTER IV

RESULTS AND DISCUSSION

CHAPTER IV

RESULTS AND DISCUSSION

4.1 Structural facilities developed in the study area

RDA has been improved some structural facilities in the study area. The main components of the project were production DTW, overhead tank, domestic water supply network, buried pipe irrigation system. Production of Deep Tubewell was one of the most important facilities. Overhead tank has two parts having capacity of 20,000 liter such as upper part is used for supplying drinking water and bottom part is used for irrigation purposes. Domestic water supply network has been laid 4000 rft. Buried pipe irrigation system network has been constructed 3000 rft. Low-cost DTW capacity for Irrigation and Domestic water supply are 68-14 m^3/hr and 10-18 m^3/hr, respectively. The investment costs of those components are given below.

Table 4.1: Component-wise cost of the projects

SI. No.	Component	Unit	Quantity	Amount (Tk.)
1	Production Deep Tubewell for Burried pipe Irrigation (Appendix-A)	m^3/hr	145	1,429,100
2	Production Deep Tubewell for Domestic water supply (Appendix-A1)	m^3/hr	18	300,050
3	Overhead Tank Capacity (Appendix –B)	Litre	20,000	798,000
4	Buried Pipe Irrigation Line (Appendix-C)	rft	3000	924,540
5	Domestic Water Supply Network (Appendix-D)	rft	4000	468,610
		Total		**3,920,300**

4.2 Investment cost for structural facilities

Installation costs of production DTW, overhead tank, buried pipe irrigation system and domestic water supply network were 45%, 21%, 22% and 12%, respectively (Fig. 4.1). The highest investment cost (45%) was involved for production Deep Tubewell and lowest investment cost (12%) was carried on domestic water supply network.

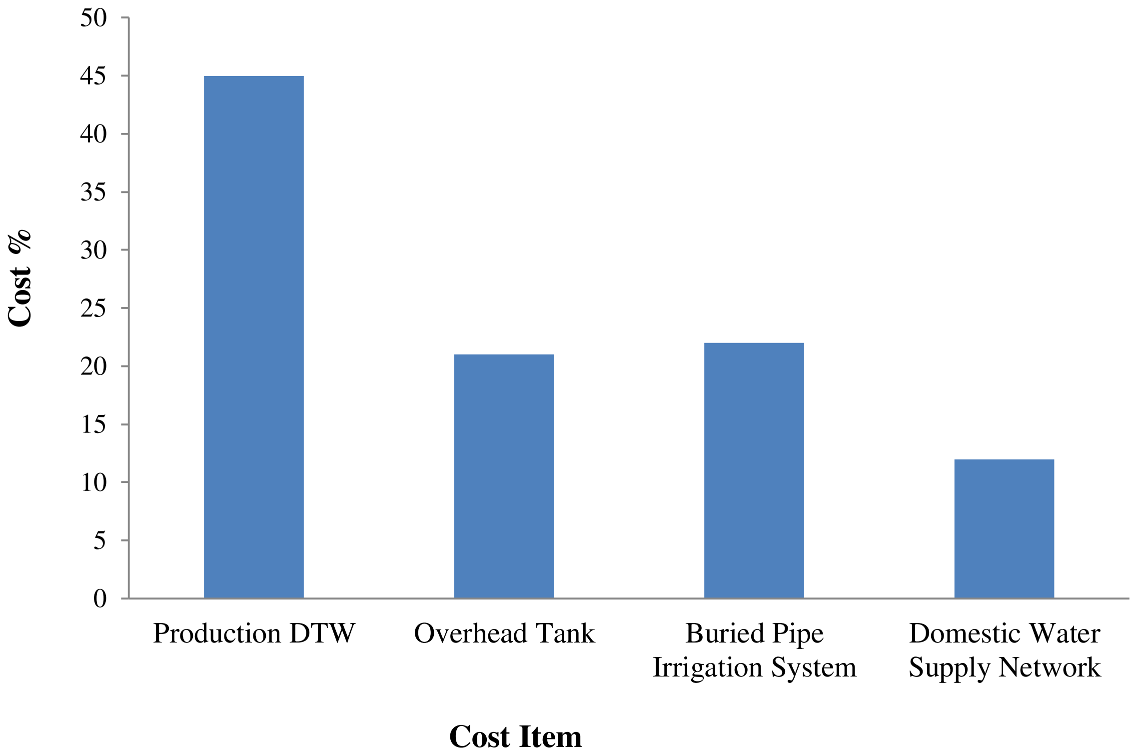

Fig. 4.1: Investment cost of various infrastructure of the project

4.3 Expenditure through domestic water supply and irrigation

Expenditure for imbursement of electricity bill, salary for operator, charge collector, operation and maintenance etc. throughout domestic water supply and irrigation purposes were Tk. 1.37 lakh per year that represented in Table 4.2.

Table 4.2: Expenditure through domestic water supply and irrigation

Items	Quantity	Rate per month (Tk.)	Yearly cost (Tk. in Lakh)
Drinking			
Electricity bill	-	3000	0.36
Salary for operator	1	2000	0.24
Charge collector, Operation & Maintenance including others	L/S	1000	0.12
Total			**0.72**
Irrigation			
Electricity bill (Irrigation period for 3 month)	-	18000	0.54
Operator salary(Irrigation period for 3 month)	1	3500	0.105
Grand Total Cost			**1.37**

4.3.1 Annual expenditure

Annual expenditure for electricity bill, salary for water charge collector, operation & maintenance cost, salary for operator were 66%, 18%, 9% and 7%, respectively (Fig. 4.2). The highest expenditure for electricity bill and the lowest expenditure involved in operator salary for three months of irrigation purposes.

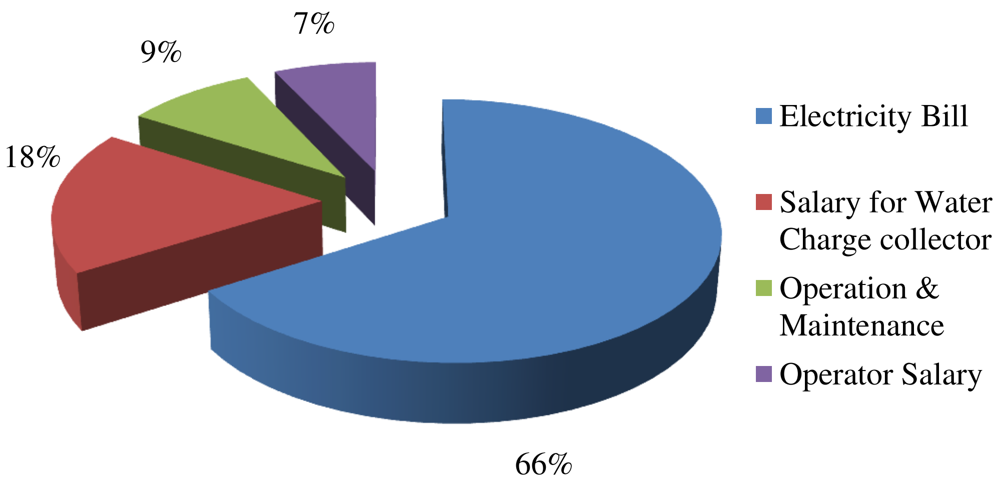

Fig. 4.2: Yearly Expenditure in the project

4.4 Return through domestic and irrigation

For supplying safe drinking water total household connections were 100 numbers. Deep tubewell owners has been undertaken Tk. 1000 for installing the main line for domestic water supply and Tk. 100 per household per month as input cost for supplying of safe drinking water. Total yearly income for domestic water supply was Tk. 1.2 lakh. For irrigation facilities under the Deep tubewell total command area were 32 acres. Total yearly income for supplying water in irrigation was Tk. 1.15 lakh. All of the values were represented in Table 4.3.

Table 4.3: Income from Water Supply Facilities

Item	**Quantity**	**Rate per Month(Tk.)**	**Yearly Income (Tk. in Lakh)**
Drinking Water Charge	100 nos	100	1.2
Irrigation Charge	32 acres	3600	1.15
Grand Total			**2.35**

4.4.1 Annual income

Annual income obtained through collection of water charge and irrigation were 51% and 49% respectively (Fig. 4.3). The greatest income has come from domestic water supply and the remaining income has come from water supply in irrigation field for crop production.

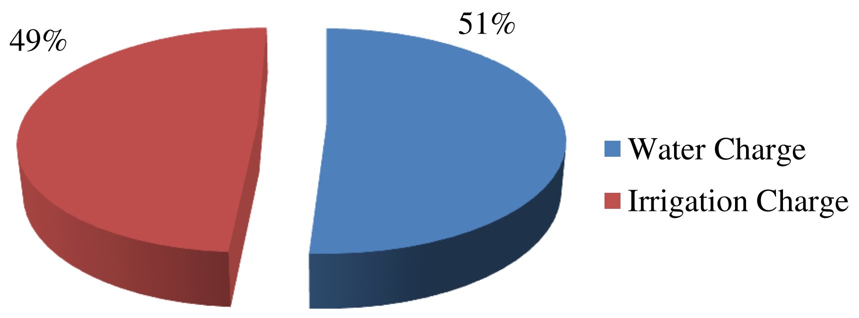

Fig. 4.3: Yearly Income from the project

4.5 Cost Benefit analysis

Cost benefit analysis was showed in Figure 4.4. The figure showed that gross expenditure and gross income were Tk. 1.37 and Tk. 2.35 lakh, respectively. Net benefit obtained from the project was Tk. 0.98 lakh.

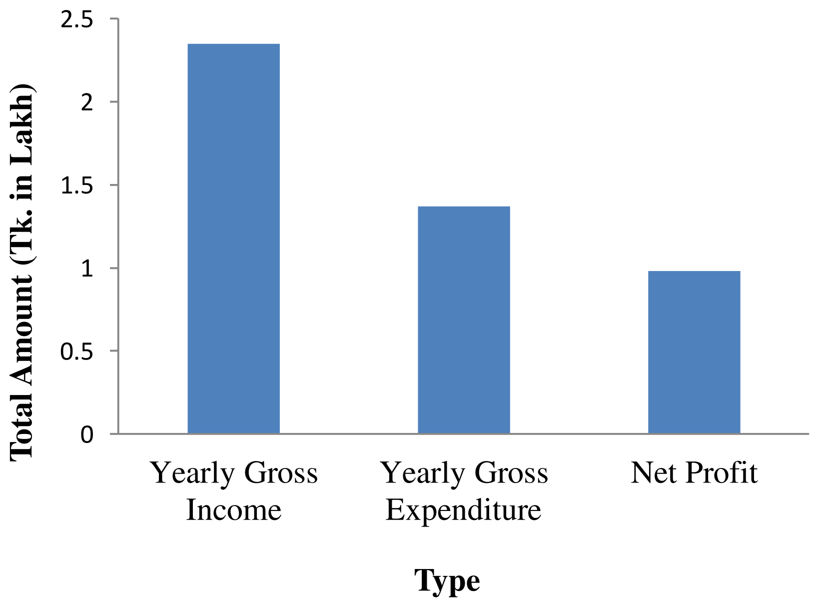

Fig. 4.4: Cost Benefit analysis

4.6 Water quality of extracted water

Quality of extracted water had been tested in CIWM laboratory of RDA, Bogra. Major quality parameters were arsenic (mg/L), iron (mg/L) and pH (Table 4.4). Those parameters represented in the table that comparing with WHO standard and Bangladesh standard values against each parameter**.** The obtained water quality parameter values were in standard range level**.**

Table 4.4: Water quality of extracted water

Indicator	**Water quality parameters**		
	Arsenic (As), mg/L	**Iron(Fe), mg/L**	**pH**
WHO guidelines values	0.01	0.3	6.5-8.5
Bangladesh standard for drinking water	0.05	0.3-1.0	6.5-8.5
Collected sample	nil	1.2	7.1

4.7 Livelihood improvement

Livelihood improvement were identified basis on the data which are the use of broadcasting as an educational tool, the promotion of traditional culture, communication and information sharing, entertainment and income promotion.

4.7.1 Cropping intensity

Cropping intensity is the number of times a crop is planted per year in a given agricultural area. It is the ratio of effective crop area harvested to the physical area. The cropping intensity has been calculated on irrigated crops only, and becomes practically the ratio of the harvested irrigated areas over the area equipped for full control irrigation actually irrigated. Natural precipitation increases cropping intensity in the command area but due to greenhouse effect in present situation precipitation is not regular where temperatures are not a limiting factor. Cropping intensity within the command area has been increased after replication of RDA- developed irrigation and water management technology.

4.7.2 Major cropping pattern

By asking the crop sequences of individual plot of each of the farmers in a cropping year, the cropping patterns within the command area of sub-project were identified (Table 4.5). The information was compiled regarding the crops and cropping patterns of this site in the table before and after construction of the irrigation infrastructure. The addition of two triple cropped patterns in the catchment area like Maize – Boro rice - T. aman rice and Potato-Maize - T. aman rice after replication of RDA-developed irrigation and water management technology.

Table 4.5: Major cropping patterns identified within the command area

Major cropping pattern	
Before	**After**
1. Fallow – Fallow – T. Aman rice 2. T. Aman rice – Fallow – Fallow 3. Vegetable – Fallow – Fallow	1. Maize - Boro rice- T. aman rice 2. Mustard - Boro rice -T. aman rice 3. Potato – Boro rice -T. aman rice

4.7.3 Changes in source of potable water

Sources of potable water reported by the respondents were pond and Hand Tubewell. Multiple responses were observed by the respondents regarding the sources of potable water in before and after situation. Figure 4.5 represents that 10% and 90% respondents were used pond and hand tubewell respectively before the installation of RDA deep tubewell. After the installation of RDA deep tubewell 100% respondents are used this deep tubewell.

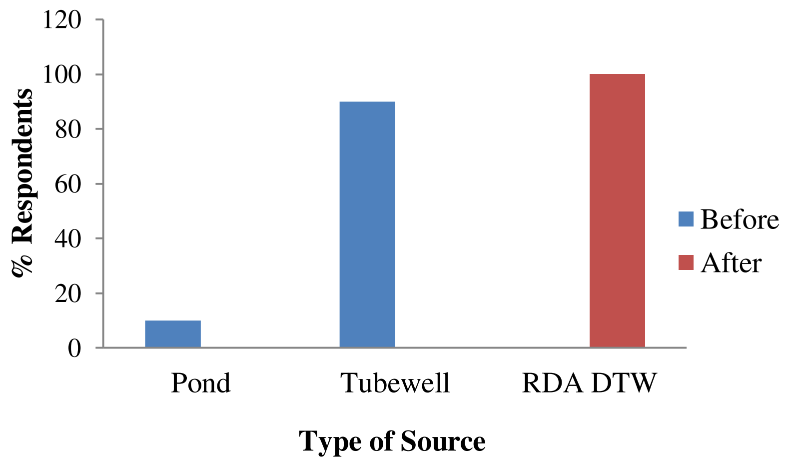

Fig. 4.5: Effect of technology on changes in source of potable water

4.7.4 Sanitation

Figure 4.6 shows before and after situation of the sanitation facilities. It represented that sanitation facilities developed in the study area. Before situation 40% respondents reported that their toilet situated in house, 37% outside house and 23% no toilet. After the installation of deep tubewell this situation has improved. In the study area 45% respondents have had toilet in house, 48% outside house and 6% no toilet.

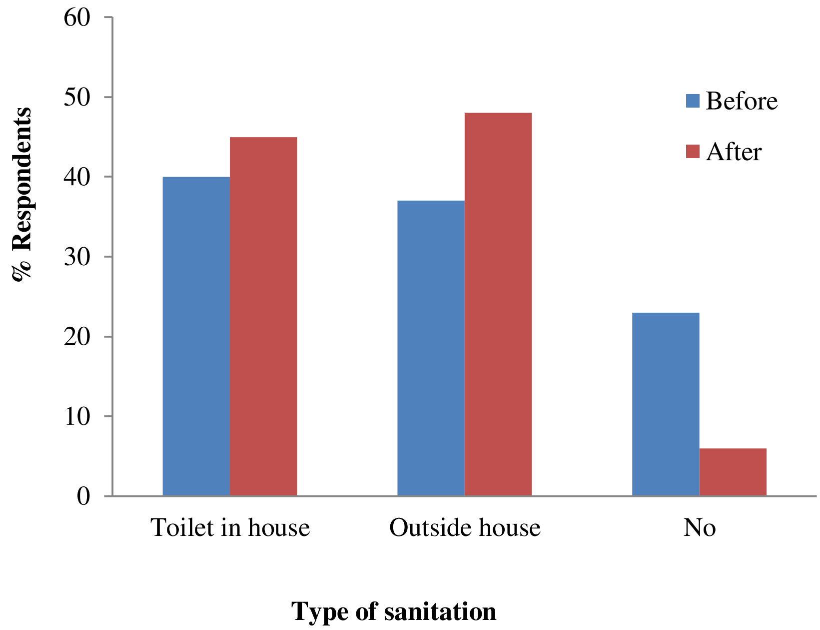

Fig. 4.6: Effect of technology on situation of sanitation facilities

4.7.5 Situation of water borne diseases

The respondents expressed that they had been suffering from various water borne diseases like diarrhoea, dysentery and others as the sources of water were not safe for potable water. Figure 4.7 represents before and after situation of water borne diseases. It was showed that 56%, 28% and 12% respondents had been suffered diarrhoea, dysentery and others diseases, respectively before the installation of deep tubewell. After the installation of deep tubewell 86% respondents were no water borne disease and 4%, 5%, 5% respondents had been suffered diarrhoea, dysentery and others diseases, respectively. RDA water management practice has been mitigated the water borne diseases.

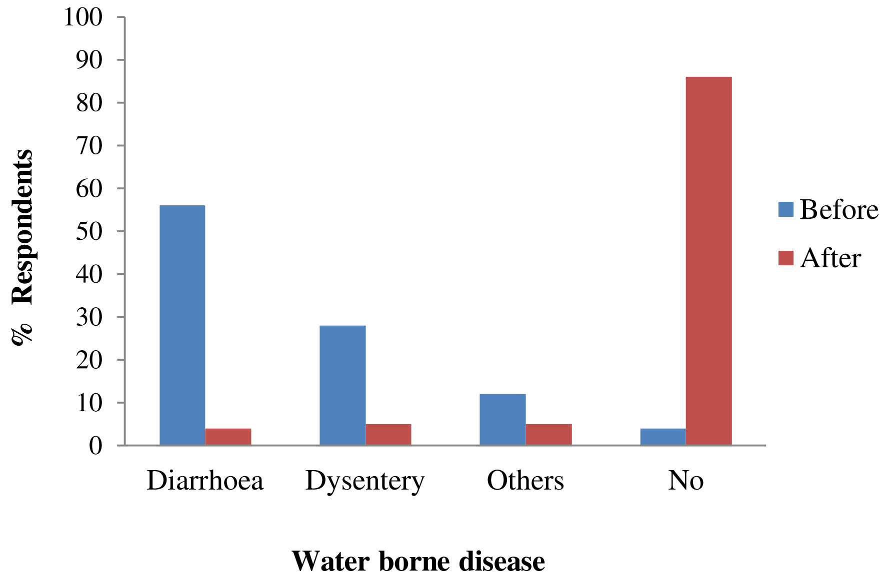

Fig. 4.7: Effect of technology on situation of water borne diseases

4.7.6 Entertainment assessment

Figure 4.8 shows that before and after situation of entertainment assessment. From the figure it obviously stated that their livelihoods were improved. Their entertainment assessment has been increased in present year. The respondents were reported that they are not used radio. In present year 87% respondents have television. Entertainment is very much important for monotonous life. Before 39% respondents were not able to buy television but in present situation this number has decreased as 13%.

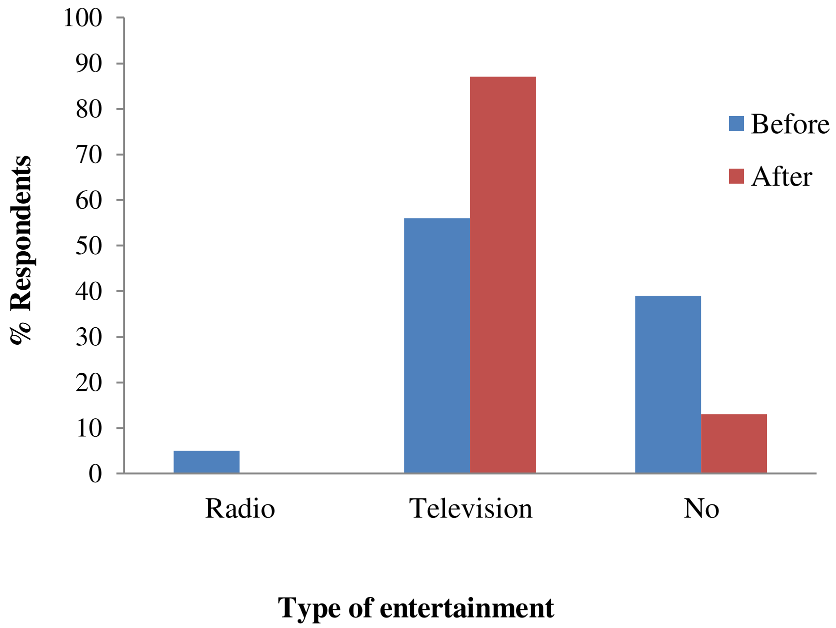

Fig. 4.8: Effect of technology on entertainment assessment

4.7.7 Number of Mobile phone

Figure 4.9 shows that the number of mobile was increased at after situation. Maximum 41 respondents opined that they had 2 mobile. This project area only 2% respondent opined that they had no mobile phone. Before situation there were no respondents who had 3, 4 and 5 mobile phones. But after situation there were 20%, 4% and 2% respondents who had 3, 4 and 5 mobile phones.

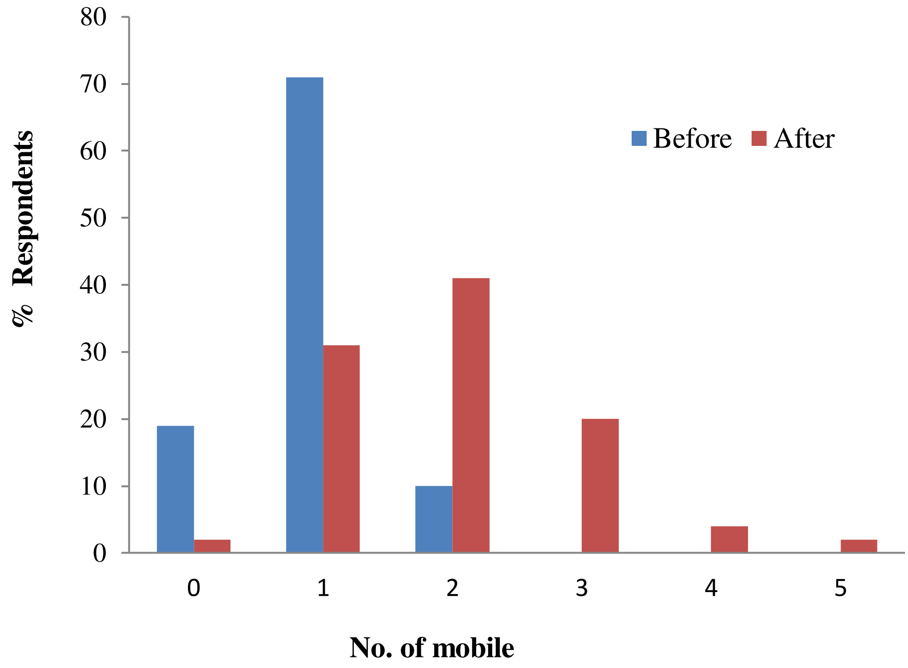

Fig. 4.9: Effect of technology on number of Mobile

4.7.8 Yearly frequency of Medicare

Figure 4.10 represents that frequency of health care activities of an individual family compared with before and after situation in the project area. The respondents reported that 22% respondent visit homeopathy doctor, 15% MBBS doctor 58% others and 5% no doctor. The respondents expressed that after the installation of RDA developed deep Tubewell technology, water borne diseases were decreased with before situation and frequency of visit per year to doctors as 7% homeopathy doctor, 9% MBBS doctor 19% others and 65% no doctor.

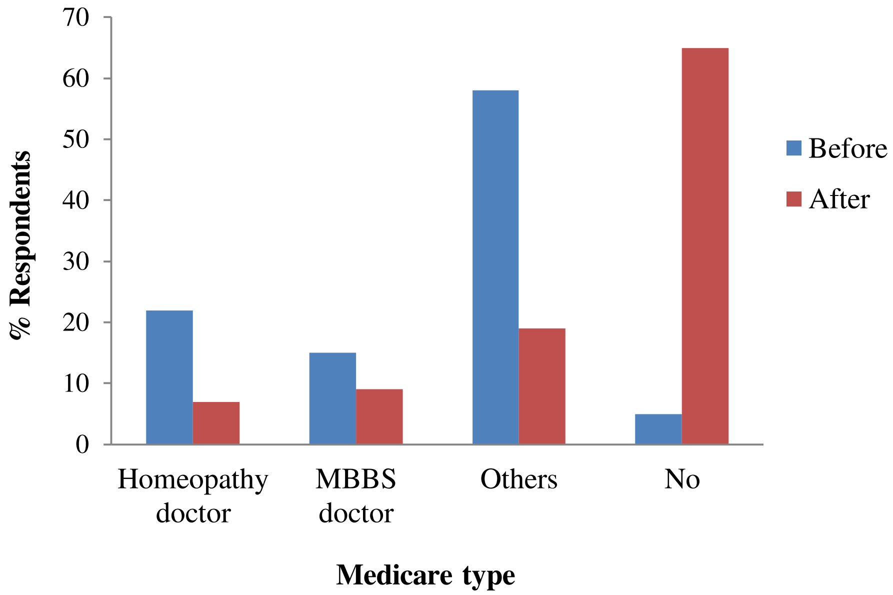

Fig. 4.10: Effect of technology on yearly frequency of Medicare

4.8 Effect of technology on food security

Water and food are the two most fundamental basic needs of humans. Water is key to human food security and nutrition. Population and economic growth in developing countries will pose serious challenges for humanity in simultaneously meeting food requirements and water demands. In reality the country with this small amount of surplus production is in a vulnerable situation as it is always threatened by frequent disasters like drought, flood, cyclone and sidr etc, which causes damage to the country's valued rice crops almost every year. As a result, the government has to seek for foreign aid and import every year to make food reserve as buffer stock. The amount of import and foreign aid varies according to extent of natural calamity and domestic production. The external sources of food were highest in 1998-99 as country was severely affected by flood. Boro rice usually, is less affected by natural disaster and consequently occupied largest share of total rice production. Boro rice yield was about two and three times higher than aman and aus rice respectively. More-over, 98 percent of boro rice is HYV and produced under irrigated condition. In such circumstances, people rely on boro rice production and they provide full efforts to overcome the crisis. Boro rice compensated the deficits because of its less reliant on nature and varietal improvement. Moreover, effective implementation of rehabilitation programs by the government and timely supply of inputs including irrigation equipments was also another reason of success.

4.9 Effect of technology on health security

The incidence of water borne diseases was lower in households that used drinking water from the deep tube well than in those that used water from different source of water. The key observation for this analysis is that the proportional decrease in the incidence of water borne diseases. The effect of the study is that obtaining drinking water from the deep tube well was associated with a significantly lower incidence of diarrhoeal disease in children aged less than 5 years. It appears that factors associated with using the deep tube well, such as less convenient access to the main source of drinking water and the possibility that drinking water was stored for longer in the home, did not have a major impact on the incidence of diarrhoeal disease. One possible explanation is that household wells, regardless of their arsenic content, continued to be used for personal hygiene. However, it appears that the microbial quality of low arsenic water pumped from the deep tube well might be higher than that from shallower household wells, though this should be determined more rigorously. It is possible that the greater physical separation between deep tube well and major surface sources of microbial contamination, such as latrines and ponds, may have provided a protective effect. The incidence of childhood diarrhoea declined dramatically irrespective of water source but discussion of the reasons for this decline lie beyond the scope of this analysis.

4.10 Effect of technology on education security

The technology has improved the education of the children at the village. School absenteeism is common in rural areas, partly due to demand for household farm labor, particularly on small and marginal farms. The evaluation study showed that access to DTW irrigation could have two plausible impacts: (i) access to DTW irrigation might free up farm labor normally required for different operations and, in turn, allow children to attend school who might not have done so otherwise; and (ii) DTW irrigation might encourage farmers to farm more intensively, requiring more hands, including those of household children, and thereby restricting children's attendance at school. From the survey it is stated that the technology contributes for improving the nation by developing the children education.

4.11 Statistical analysis

A logistic regression model can fit the relationships between the attribute variables and describe the interaction between the variables. Taking into account the stratified sampling of original data, choose the SURVEYLOGISTIC process in R programming language software parameter fitting to complement the information and get better results. The results of the analysis are reported in Table 4.6.

Table 4.6: Logistic regression model analysis

Variable	Estimate	Std. Error	z value	P
Monthly Income, X_1	7.871×10^{-5}	5.687×10^{-5}	1.384	0.1663
Rice Yield, X_2	0.37616	0.08318	4.522	6.12×10^{-6}
Potatoes Yield, X_3	0.08868	0.01917	4.627	3.71×10^{-6}
Yearly Medical Cost, X_4	1.765×10^{-5}	7.906×10^{-5}	0.223	0.823

4.11.1 Effect of cropping pattern on Rice yield

Figure 4.11 shows the effect of cropping pattern on rice yield. From statistical analysis, it has been shown that rice yield has changed with the change of cropping pattern. Rice production has increased significantly with the change of cropping pattern.

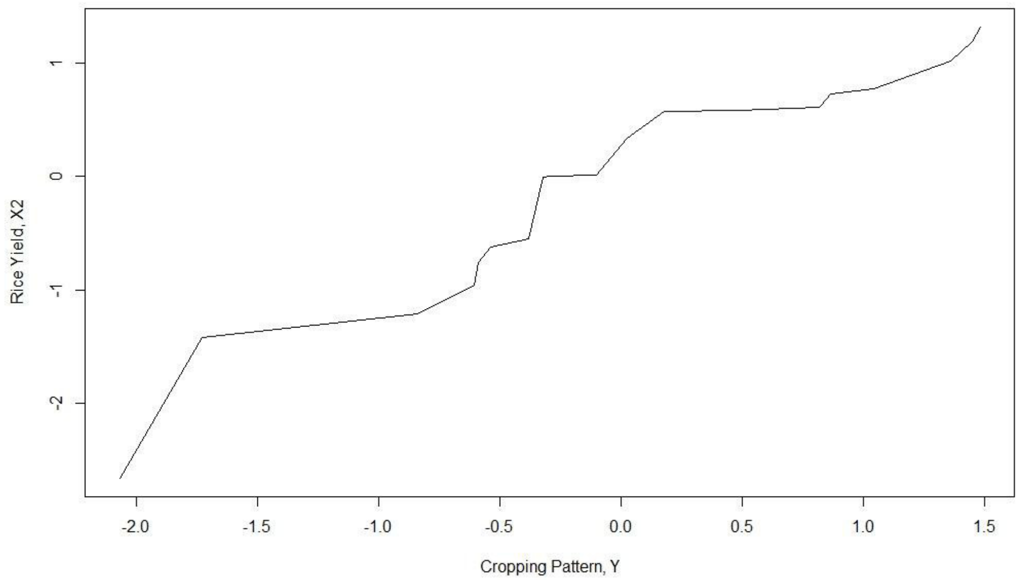

Fig. 4.11: Effect of cropping pattern on Rice yield

4.11.2 Effect of cropping pattern on Potatoes yield

Figure 4.12 shows the effect of cropping pattern on potatoes yield. From statistical analysis, it has been shown that potatoes yield have changed with the change of cropping pattern. Potatoes yield have increased significantly with changing cropping pattern.

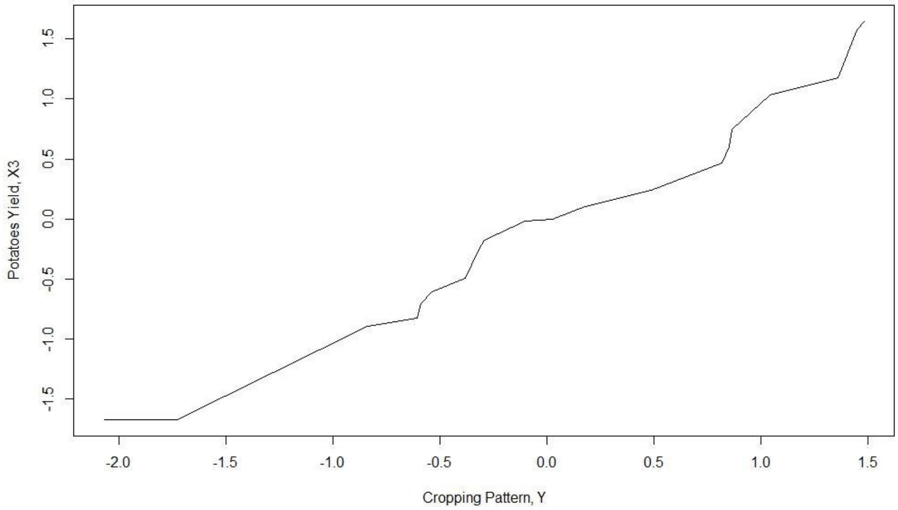

Fig. 4.12: Effect of cropping pattern on Potatoes yield

4.11.3 Effect of cropping pattern on yield

The effect of cropping pattern on rice and potatoes yield is compared as shown in Figure 4.13. It turns out that the effect of cropping pattern on rice yield is greater than the potatoes yield. Because of improvement of boro rice cultivation increased the average production of rice.

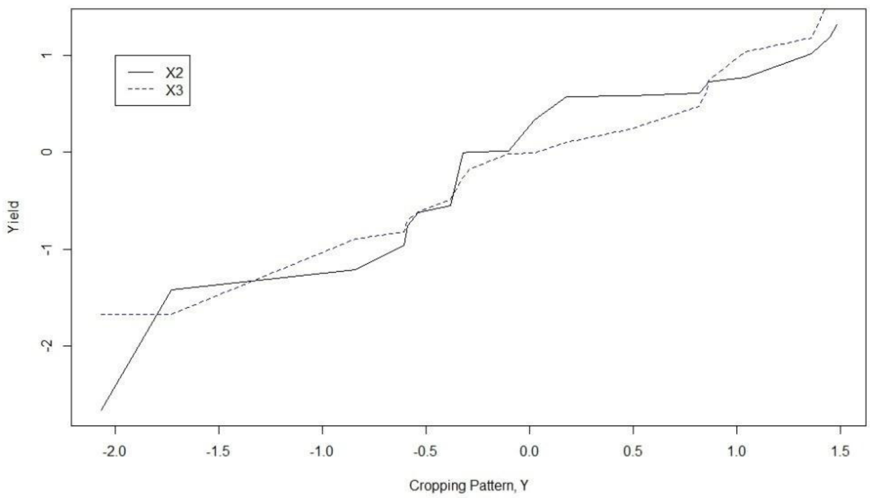

Fig. 4.13: Effect of cropping pattern on yield

4.11.4 Effect of cropping pattern on Income

Figure 4.14 shows the effect of cropping pattern on income. From statistical analysis it has been shown that income has changed less significantly with the change of cropping pattern.

Since there are many people who do not own cultivated land, many of them are labour or rickshaw pullers. But there are many people who did not cultivate land before installing deep tubewell. After the installation of deep tubewell, they started cultivating land from other farmers for low-cost irrigation facilities and their income increased. But the income of those who grow more in the field of cultivated land has increased.

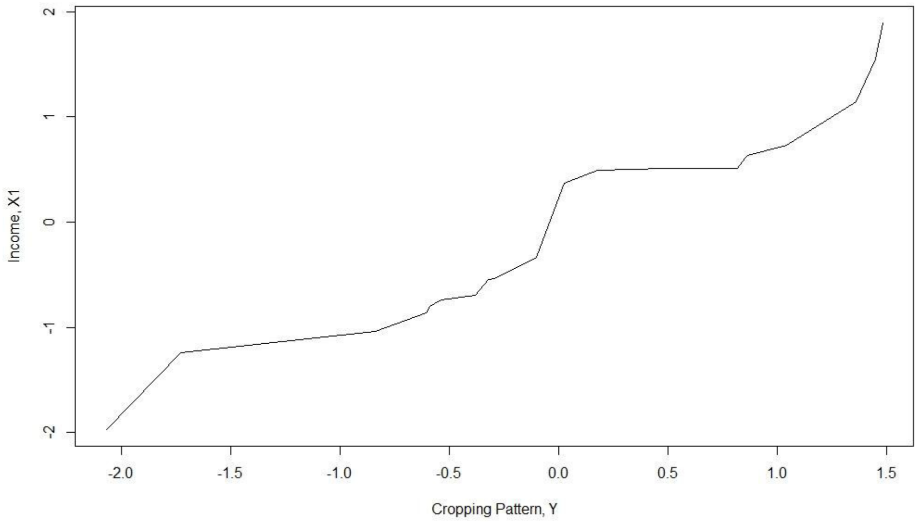

Fig. 4.14: Effect of cropping pattern on Monthly Income

4.11.5 Effect of cropping pattern on Yearly Medical cost

Figure 4.15 shows the effect of cropping pattern on yearly medical cost. From statistical analysis, it has been shown that medical cost has not changed significantly with the changing cropping pattern. Since it is not directly affected by the changing cropping pattern but it is affected by the income.

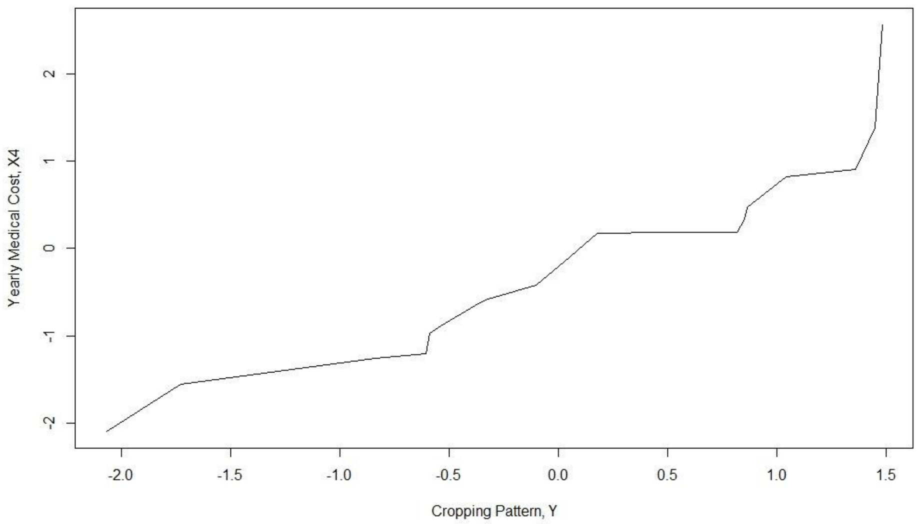

Fig. 4.15: Effect of cropping pattern on yearly Medical cost

4.11.6 Comparison between dependent variable and independent variables

The comparing effect between dependent variable and independent variables is shown in Figure 4.16. In this figure X1, X2, X3 and X4 are independent variables and Y is dependent variable. This figure rice yield is represented by red line, potatoes yield are represented by blue line, income is represented by black line and yearly medical cost is represented by green line.

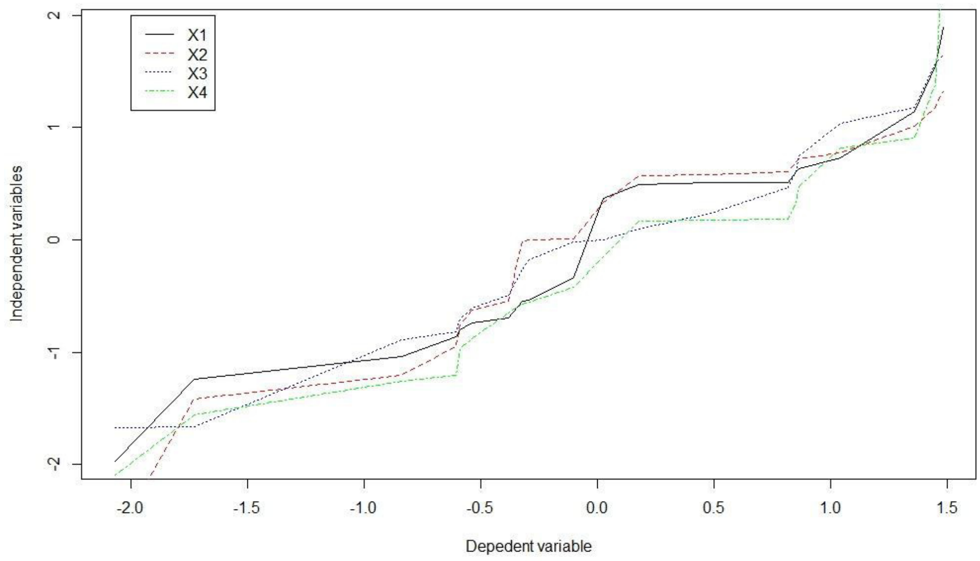

Fig. 4.16: Comparison between dependent variable and independent variables

CHAPTER V

CONCLUTIONS AND RECOMMENDATIONS

CHAPTER V

CONCLUTIONS AND RECOMMENDATIONS

5.1 Conclusions

Proper utilization and management of available water resources are the main factors in accelerating agricultural development of the country. RDA developed low-cost DTW technology which is based on demand specific and economic design can be used suitably for multipurpose uses. Annual expenditure for electricity bill, salary for water charge collector, operation & maintenance cost, salary for operator were 66%, 18%, 9% and 7%, respectively. Annual income obtained through collection of water charge and irrigation were 51% and 49%, respectively. Gross expenditure and gross income were obtained Tk. 1.37 and 2.35 lakh, respectively. Net benefit obtained from the project was Tk. 0.98 lakh. This DTW model has been proven as a cost effective and viable technology. This model has made direct impact on the socio-economic development and quality of life through providing safe drinking water supply. Before the installation of DTW, 90% respondents used hand tubewell, now they are using RDA DTW supply water. This technology has improved the sanitation facilities. In this area 23% respondents had no toilet before but this percentage has decreased to 6%. Situation of water borne diseases have improved where maximum 56% respondents suffered diarrhoea but this percentage has decreased to 4%. Entertainment is very much important for monotonous life. Entertainment assessment also has been increased by the effect of technology. Before 39% respondents were not able to buy television but in present situation this number has decreased as 13%. Communication facilities also developed this technology. There were no respondents who were able to buy 3, 4 and 5 mobile phones. In present situations there were 20%, 4% and 2% respondents who had 3, 4 and 5 mobile phones. Yearly frequency of medicare for water borne diseases has improved in the area where 5% respondents had not visit doctor but this percentage has decreased as 65%. The value of 'p' for rice yield and potatoes yield were 6.12×10^{-6} and 3.71×10^{-6}, respectively which values indicate yields are significant against cropping pattern. The DTW has made significant contribution towards improving agricultural production alleviated socio-economic and rural livelihood conditions in the village.

5.2 Recommendations

The following recommendations may be put forward for future research work-

1. Similar model should be undertaken in water scarce areas of Bangladesh addressing climate change to cover a large section of the farming community who often suffers for potable and irrigation water.
2. Cropping intensity should be increased by better utilization of land.
3. Necessary training program should be undertaken to motivate the related farmers about crop production practices and better management of irrigation water and domestic water.

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APPENDICES

APPENDICES

Appendix-A Detailed cost estimate of production of Deep Tubewell for Buried pipe Irrigation

SI. No.	Description	Unit	Quantity	Rate (Tk.)	Amount (Tk.)
Part-A					
1	Mobilization and Demobilization	-	L/S	8000	8,000
2	Test Boring 150 mm	lin. m	45	850	38,250
3	Drilling 1100 mm diameter hole for screen and casing	lin. m	42	4500	189,000
4	Furnishing and installing 350 mm dia (5 mm thickness) MS housing	lin. m	40	7500	300,000
5	Furnishing and installing 100 mm dia pipe (PVC Class-C) well screen (6 no. Slot) with fitting and centering guides	lin. m	98	550	53,900
6	4´´ MS Elbow and T	No.	24	1800	53,900
7	PVC (Class-C) end cap and boos socket	No.	24	1000	24,000
8	Gravel packing (including transport)	Cum	20	4200	84,000
9	Develop well	hr.	12	2500	30,000
10	Disinfection and capping well	-	L/S	-	30,000
11	Demobilization	-	L/S	-	8,000
12	Supply and installation of column pipe 150 mm dia MS	lin. m	L/S	3950	102,700
13	Supply and installation of delivery pipe 150 mm dia MS	-	L/S	-	37,550
14	Pump lowering and commissioning	-			30,000
Sub-total (A)					960,600
Part-B					
15	Submersible pump KSB Brand of India BPN 374/2 + HBC 303, H=51-34 m, Q=68-145 m^3/hr, H_P=30	No.	1	375000	375,000
16	Cable size (3×6 SQ, MM)	lin.m	80	550	44,000
17	Panel board with sensor cable	Set	1	49500	49,500
Sub-total (B)					468,500
Total (A+B)					1,429,100

Taka in Word: Forteen lakh twenty nine thousand and one hundred only

Appendix -A1

Detailed cost estimate of production Deep Tubewell for Buried pipe Irrigation

SI. No.	Description	Unit	Quantity	Rate (Tk.)	Amount (Tk.)
Part-A					
1	Mobilization	-	L/S	8000	8,000
2	Test Boring 100 mm	lin. m	35	850	29,750
3	Drilling 350 mm diameter hole for screen and well casing	lin. m	35	1400	49,000
4	Furnishing and installing 150 mm dia MS housing top	lin. m	16	3500	3,500
5	Furnishing and installing 150 mm dia pipe (PVC Class-B) blind pipe	lin. m	16	900	14,400
6	Furnishing and installing 150 mm dia pipe (PVC Class-B) well screen (6 no. Slot) with fitting and centering guides	No.	3	1050	12,600
7	Furnishing and installing 150 mm dia pipe (PVC Class-B) bail plug	No.	3	1050	4,500
8	Gravel packing (including transport)	Cum	5	4200	21,000
9	Develop well	hr.	12	2000	24,000
10	Disinfection and capping well	-	L/S	-	8,000
11	Demobilization	-	L/S	-	8,000
12	Supply and installation of column pipe 50 mm dia GI	lin. m	15	1020	15,000
13	Supply and installation of delivery pipe 50 mm dia MS	-	L/S	-	15,000
14	Pump lowering and commissioning				10,000
				Sub-total (A)	223,050
Part-B					
15	Submersible pump, H=35-27 m, Q=10-18 m^3/hr, H_P=3	No.	1	50000	50,000
16	Cable size (3×1.5 SQ, MM)	lin. m	25	280	7,000
17	Panel board with sensor cable	Set	1	20000	20,000
	Sub-total (B)				77,000
	Total (A+B)				300,050

Taka in Word: Three lakh and fifty only

Appendix-B

Detailed cost estimate of production Deep Tubewell for Overhead tank (Capacity 20,000 Lit)

SI. No.	Description of works	Unit	Quantity	Rate (Tk.)	Amount (Tk.)
i) Overhead Tank					
1	Layout and Marking	sqm	19.63	20.18	396.13
2	Earth work in excavation in foundation trence with all complete and accepted by the Engineer	cum	29.64	105.38	3,123.46
3	Earth filling work in foundation 1/3 part of total earth cutting and accepted by the Engineer	cum	12.79	268.54	3,434.63
4	Sand filling in foundation 1/5 part of total earth cutting trenches and plinth with sand having F.M. 0.80 with all complete and accepted by the Engineer	cum	5.93	833.75	4,944.14
5	Mass concrete (1:2:4) in foundation with cement, sand (F.M. 1.2) and picket jhama with all complete and accepted by the Engineer	cum	1.08	7,730.7	8,349.16
6	Reinforcement cement concrete works (rate is including the cost of wooden shutter) with minimum cement content ratio to mix 1:2:4 having minimum f'cr=26 Mpa, best quality course sand F.M. 2.2-2.5, 20 mm down well graded crushed brick chips & cement conformin	cum	17.37	12,313.1	213,878.55
7	Ext rate over per 4 meter 260 taka ext height (7.20m(-) 4m) for over head tank	cum	8.38	1,036	8,681.68
8	40-grade deform bar with minimum f=250 Mpa & tensile strength at least 460 Mpa: (Use for footing, column, grade beam, slab beam, slab) Use brand and accepted by the Engineer	Kg	2820.12	94.50	266,501.34
9	Minimum 12 mm thick cement sand (F.M>1.2) plaster with neat cement finishing to (1:4) with cement sand with aii complete in all respect as per drawing and accepted by the Engineer	sqm	35.33	228.07	8,057.71
10	Minimum 12 mm thick (F.M. 1.2) plaster (1:4) with cement sand all complete in all respect as per drawing and accepted by the Engineer	sqm	127.14	182.75	23,234.84
11	Minimum 12 mm thick (F.M. 1.2) plaster (1:4) with cement sand all complete in all respect as per drawing and accepted by the Engineer	Nos	62	120	7,440
12	Puddlow work all complete accepted by the Engineer	Kg	10	190	1,900
13	Railing 25 mm dia G.I. pipe for horizontal and 12.5 mm GI pipe for vertical post all complete in all respect as per drawing and accepted.	rm	16.66	295	4,914.70

SI. No.	Description of works	Unit	Quantity	Rate (Tk.)	Amount (Tk.)
14	Construction of masonry inspection pits up to a depth of 2´-6´´ with125 mm thick brick work plaster with NCF, RCC Slab with all complete approved and accepted by the Engineer	nos	1.00	6,000	6,000
15	Water Stopper work use Overhead tank Cylindrical wall joint accepted by the Engineer	rm	24.00	345	8,280
16	Painting Snow ceam (Cement Paint/ Dove Gray) work all complete approved and accepted by the Engineer	sqm	127.14	80	10,171.20
17	Sign board (IWM-RDA-BOGRA) Writing With Painting to Cylindrical wall all complete approved and accepted by the Engineer	L/S			4,000
18	100 mm dia PVC pipe connection for nearest canal/Pond accepted by the Engineer	rm	12	200	2,400
19	i)Overhead tank connection inlet, outlet, wash line work (Brand=Hatim, Boshundhara, Union) Gold				
	ii) 100 mm dia GI pipe	m	29	1800	52,200
	iii) 75 mm dia GI pipe	m	8.50	1400	11,900
	iv) 75 mm dia gate Valve	Nos	1.00	4200	4,200
	v) 75 mm dia bend	Nos	4.00	460	1,840
	vi) 100 dia elbow	Nos	6.00	815	4,890
	vii) 100 mm dia dresser	Nos	2.00	650	1,300
	viii) 100 mm dia socket	Nos	4.00	400	1,600
	ix) 100 mm dia gate valve	Nos	2.00	6000	12,000
20	Site preparation and clearing work	L/S			2,194.81
	Sub-total Overhead Tank (i)-				677,832.34
Pump House					
1	Sand filling in foundation 1/5 part of Total earth cutting trenches and plinth with sand having F.M. 0.80 with all complete and accepted by the Engineer	cum	3.36	833.75	2,801.40
2	Mass concrete (1:2:4) in foundation with cement, sand (F.M. 1.2) and picket jhama chips with all complete and accepted by the Engineer	cum	0.73	7,730.70	5,643.41
3	250 mm thick brick works (Below plinth level) with first class bricks in cement sand (F.M. 1.2) mortar (1:4) with all complete and accepted by the Engineer	cum	0.74	5,141.98	3,805.07
4	125 mm brick works with first class bricks in cement sand (F.M. 1.2) mortar (1.4) with all complete and accepted by the Engineer	sqm	23.73	785	18,628.05

SI. No.	Description of works	Unit	Quantity	Rate (Tk.)	Amount (Tk.)
5	Reinforcement cement concrete works (Rate is including the cost of wooden shutter) with minimum cement content ratio to mix 1:2:4 having minimum f'cr=26 Mpa, best quality course sand F.M. 2.2-2.5, 20 mm down well graded crushed brick chips	cum	2.18	12,313.1	26,842.56
6	60-grade deform bar with minimum f=250 Mpa & tensile strength at least 460 Mpa: (Use for footing, column,grade beam, slab beam, slab) Use brand and accepted by the Engineer	Kg	290.19	94.50	27,422.96
7	Minimum 12 mm thick cement sand (F.M. 1.2) plaster with neat cement finishing to (1:4) with cement finishing to (1:4) with cement sand with all complete in all respect as per drawing and accepted by the Engineer	sqm	18.56	228.07	4,232.98
8	Minimum 12 mm thick (F.M. 1.2) plaster (1:4) with cement sand all complete in all respect as per drawing and accepted by the Engineer	sqm	61.73	182.75	11,281.16
9	Brick flat Soling works all complete and accepted by the Engineer	Nos	7.30	120	876
10	Drip course all complete and accepted by the Engineer	rm	7.29	95.43	695.68
11	Door complete (4´- 6´´×7´-0´´), A/F 40 mm×4 mm/25 mm×4 mm, angle & Sheet 22SWG	Nos	1.00	7,000	7,000
12	Without with grill work (size 3´-0´´×4´-6´´) (F/bar 20 mm×4 mm) angle & Sheet SWG	Nos	1.00	6,000	6,000
13	Painting Snow ceam (Cement Paint/ Dove Gray) work all complete approved and accepted by the Engineer	sqm	61.73	80	4,938.40
Sub-total for Pump House works (ii)					120,167.66
Total works (i+ii)					798,000

Taka in word: Seven lakh ninety eight thousand only

Appendix -C

Buried pipe Irrigation network

Item No.	Description of works	Unit	Quantity	Rate (Tk.)	Amount (Tk.)
1	Header tank	nos	1	50,000	50,000
2	8´´DiaPVC(Class-O) Thick.2.27-3.10 mm	ft	3000	600,000	600,000
3	Earth cutting, pipe lying, joining and earth filling etc(Depth-3 ft)	ft	3000	84,000	84,000
4	Water control structure, Paccanaca with vent pipe, Painting & netting	nos	10	132,600	132,600
5	8´´ MS pipe thickness-4 mm	ft	20	25,000	25,000
6	Road boring (below-15´)	no.	1	3,000	3,000
7	Road boring (above-15´)	no.	1	4,500	4,500
8	Solvent cement (200 rft @ 500 gm) made by singapur	nos	15	13,440	13,440
9	Carrying and others		L/S	12,000	12,000
Total for Buried pipe irrigation network (B)					924,540

Taka in word: Nine lakh twenty four thousand five hundred forty only

Appendix-D

Domestic Water Supply network

Item No.	Description of works	Unit	Quantity	Rate (Tk.)	Amount (Tk.)
1	6´´ dia PVC pipe (Class-B) all complete and accepted by the Engineer	ft	300	225	67,500
2	5´´dia PVC pipe (Class-B) all complete and accepted by the Engineer	ft	400	153	61,200
3	4´´dia PVC pipe (Class-B) all complete and accepted by the Engineer	ft	700	106	74,200
4	3´´ dia PVC pipe (Class-B) all complete and accepted by the Engineer	ft	700	72	50,400
5	2´´dia PVC pipe (Class-C) all complete and accepted by the Engineer	ft	700	44	30,800
6	1.5´´dia PVC pipe (Class-D) all complete and accepted by the Engineer	ft	500	30	15,000
7	1´´dia PVC pipe (Class-E/Weter Grade) all complete and accepted by the Engineer	ft	550	24	13,200
8	3/4´´dia PVC pipe (Weter Grade) all complete and accepted by the Engineer	ft	500	22	11,000
9	Earth cutting and filling with all complete and accepted by the Engineer	ft	4350	14	60,900
10	Pipe laying and joining with all complete and accepted by the Engineer	ft	4350	6	26,100
11	Inspection pit. (Inside size 2´×2´) with all complete and accepted by the Engineer	no.	3	4300	12,900
12	Road boring with all complete and accepted by the Engineer	no.	5		
13	Road boring (below-12´)	no.	3	2000	6,000
14	Road boring (above-12´)	no.	2	3000	6,000
15	Solvent cement @ 400 ft per 500 gm made by singapur	nos	11	896	9,856
16	Fittings, Fixing, Bridge connection, Carrying and others (Say 8% for total cost of PVC pipe) with all complete and accepted by the Engineer	L/S			23,554
	Total for Domestic Water Supply network (C)				468,610

Taka in word: Four lakh sixty eight thousand six hundred ten only

Appendix-E

Water Quality Test of extracted water

SI. No.	Water Quality parameters	Unit	Collected sample	Bangladesh standard for drinking water	WHO guidelines values
1	Arsenic	mg/L	nil	0.05	0.01
2	Iron(Fe)	mg/L	1.2	0.3-1.0	0.3
3	pH	-	7.1	6.5-8.5	6.5-8.5

Questionnaire on Impact of RDA developed Low-cost DTW in Kalai Upazila under Joypurhat District

[Owners Level]

Name of respondent..
Father's name..
Village..
Upazila... District..

(Please provide information on the following aspects)

1. Who operates the Deep Tubewell? ☐ Yourself ☐ Paid Driver ☐ Other
2. Do you get regular electricity? ☐ Yes ☐ No
3. If no, how often and how long (hr) you get electricity in a day?
…………………………………….
4. Is lubricant easily available in local market?
☐ Yes ☐ No

5. Have you changed any spare parts of Motor? ☐ Yes ☐ No

6. If yes, when and what are these? ………………………………

7. Have you changed any spare parts of pump? ☐ Yes ☐ No

8. If yes, when and what are these? ……………………………….

9. Do you run the DTW throughout the year? ☐ Yes ☐ No

10. After installation of DWT, is there any trouble shooting of Motor and /or Pump?

☐ Yes ☐ No

11. What is the main purpose (s) of using the DTW?
………………………………………………………………………
12. What Irrigation distribution system is involved in this DTW scheme?
....
13. What method of irrigation is used in the DTW command area?
…………………………………………………………..
14. What is your comment on water quality in relation to drinking standard?
………………………………………………………….

15. Is there evidence of any disease occurred by drinking water from this DTW?

☐ Yes ☐ No

16. If yes, what are those?

i.

ii.

iii.

17. Expenditure through domestic water supply and irrigation

Items	**Quantity**	**Rate per month (Tk.)**	**Total cost (Tk.)**
Drinking			
What is the Electricity Bill per month?	-		
What is the Salary for operator per month?	1		
What is the cost of Charge Collector, Operation & Maintenance including others?	L/S		
Monthly Cost			
Yearly Cost			
Irrigation			
What is the Electricity Bill of Irrigation period for 3 month?	-		
What is the Salary for operator of Irrigation period for 3 month?			

18. Income from Water Supply Facilities

Item	**Quantity**	**Rate per Month (Tk.)**	**Total Income (Tk.)**
What is the Water Charge per month in Tk.?			
Total Monthly Income			
Yearly Income			
What is the Irrigation Charge per month in Tk.?			
Yearly Gross Income			

19. You purchase the equipment and accessories for installing the DTW?

☐ Yes ☐ No

20. If no, Purchased/Supplied by whom?

……………………………………………………………………………………………………

21. Are you benefited from this DTW?

☐ Yes ☐ No

22. If yes, How?

…………………………………………………………………………………………………….

Questionnaire on Impact of RDA developed Low-cost DTW in Kalai Upazila under Joypurhat District

[Farmers Level]

Serial No..................................

Name of respondent....................................

Village..

(Please provide information on the following aspects)

1. **a) Age:** .... Years **b) Height:** …..................... **c) Weight:** ………………...

2. Level of education

a) 0 b) 1 to 5 c) 6 to 10 d) 11 to 12 e) above 12

3. Family size

Total: ...., Male: ...., Female: ...., Children: ....

4. Farm size

Types of land	**Before**	**After**
Cultivated land		
Uncultivated land		

5. Occupation (1-Teaching, 2-Govt Service, 3-Private Service, 5-Business, 6-Farmers, 7-Labour, 8-Rickshaw puller, 9-Auto driver)

Type and investment	**Before**	**After**

6. Monthly Income

Before	**After**

7. Changes in source of potable water (1-Pond, 2-Tubewell, 3-RDA DTW)

Before	**After**

8. Sanitation (1- Toilet in house, 2- Outside house, 3-No)

Before	After

9. Entertainment assessment (1-Radio, 2-TV, 3-No)

Before	After

10. Number of Mobile

Before	After

11. Before and after situation of water borne diseases

(1-Diarrhoea, 2-Dysentery 3-Others, 4-No)

Before	After

12. Yearly frequency of Medicare

(1- Homeopathy doctor, 2- MBBS doctor, 3- Others, 4-No)

Before	After

13. Yearly Medical cost

Before	After

14. Cropping pattern

(1-Fellow, 2-T.aman, 3-Potato, 4-Mustard, 5-Vegetable)

Before	After

15. Yield of crops

Crops	Yield	
	Before	After
Rice		
Potato		
Mustard		
Vegetable		

Appendix-F

R Programming Language code for significant test

```
data<- read.csv ("Report.csv")

dim(data)

 Y <- data[,1]

 X1<- data[,2]

 X2<- data[,3]

 X3<- data[,4]

 X4<- data[,5]

model <- glm(Y ~ X1,family=binomial(link='logit'))

summary(model)

model <- glm(Y ~ X2,family=binomial(link='logit'))

summary(model)

model <- glm(Y ~ X3,family=binomial(link='logit'))

summary(model)

model <- glm(Y ~ X4,family=binomial(link='logit'))

summary(model)
```

Appendix-G

R Programming Language code for plotting data

```
data<-read.csv("Report.csv")

Y<-sort(rnorm(20));X1<-sort(rnorm(20));X2<-sort(rnorm(20));X3<-sort(rnorm(20));X4<-sort(rnorm(20))

plot(Y,X2,type="l",xlab="Cropping Pattern, Y", ylab="Rice Yield, X2")

plot(Y,X3,type="l",xlab="Cropping Pattern,Y",ylab="Potatoes Yield, X3")

plot(Y,X2,type="l",xlab="Cropping Pattern,Y",ylab="Yield")

lines(Y,X3,lty=2,col="blue")

legend(-2,1,c("X2","X3"),lty=c(1,2),col=c("black","blue"))

plot(Y,X1,type="l",xlab="Cropping Pattern, Y",ylab="Income, X1")

plot(Y,X4,type="l",xlab="Cropping Pattern, Y",ylab="Yearly Medical Cost, X4")

plot(Y,X1,type="l",xlab="Depedent variable",ylab="Independent variables")

lines(Y,X2,lty=2,col="red")

lines(Y,X3,lty=3,col="blue")

 lines(Y,X4,lty=4,col="green")

legend(-2,2,c("X1","X2","X3","X4"),lty=c(1,2,3,4),col=c("black","red","blue","green"))
```