Impact Evaluation
of
Enhancement of Agricultural Production and Rural Employment through Extension of Agricultural Engineering Technologies (2nd Revised)

Conducted by

Evaluation Sector
Implementation Monitoring and Evaluation Division (IMED)
Ministry of Planning
Government of the People's Republic of Bangladesh
Sher-e-Bangla Nagar, Dhaka-1207
Bangladesh

June 2014

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of
Enhancement of Agricultural Production and Rural Employment through Extension of Agricultural Engineering Technologies (2nd Revised)

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FOREWORD

The Evaluation Sector, Implementation Monitoring and Evaluation Division (IMED), Ministry of Planning conducted a study to evaluate the project" Enhancement of Agricultural Production and Rural Employment through Extension of Agricultural Engineering Technologies (2nd Revised)" implemented under the Department of Agricultural Extension (DAE) of the Ministry of Agriculture with an investment cost of BDT 5722.11 in lakh from July 2005 to June 2011. It was implemented with the aim to make agriculture economically profitable and commercially viable by extension of agricultural engineering technologies through reduction of cost in every stage of operation in agriculture and losses of produced crops.

The basic task of the study were to: (i) assess whether the use of better irrigation technologies had resulted in cost reduction for irrigation thereby contributing to improve productivity; and (ii) assess the impact of mechanized cultivation on agriculture farming system in general and on farm productivity in particular.

The findings of the impact evaluation indicated that the project considerably increased the productivity of farm labour, agricultural production and profitability on account of timeliness of operation, better quality of work and more efficient utilization of inputs. It has also increased on-farm and off-farm employment opportunities. The project is playing a significant role in national agriculture and water environment to ensure cost-competitiveness of agricultural commodities and food security of the country. The study also identified a number of strengths and weaknesses of the project design and implementation which will be very useful for the Government, the donor agencies and development partners for future direction.

I thank Ms Salma Mahmud, Director General, Evaluation Sector, IMED and her colleagues for completing the report in time.

Thanks are also due to the Consultant of the study, Dr M M Amir Hossain for producing an analytical work. I would also like to appreciate the members of Technical and Steering Committees for their technical support and useful feedbacks.

I am very hopeful that the recommendations that are made in the impact evaluation study would be helpful for the Ministry of Agriculture and concerned departments in the design and implementation of similar project in future.

(Suraiya Begum ndc)
Secretary
IMED, Ministry of Planning

PREFACE

The Evaluation Sector of Implementation Monitoring and Evaluation Division (IMED) under the Ministry of Planning conducted a study to evaluate the impact of project" Enhancement of Agricultural Production and Rural Employment through Extension of Agricultural Engineering Technologies (2nd Revised)" implemented under the Department of Agricultural Extension (DAE) with an investment cost of BDT 5722.11 in lakh from July 2005 to June 2011. It was implemented with the aim to make agriculture economically profitable and commercially viable through extension of agricultural engineering technologies by reduction of cost in every stage of operation in agriculture and losses of produced crops.

The main tasks of the study were to assess whether the technologies could: i. increase irrigated area, reduce cost of irrigation and enhance production through appropriate on-farm water management practices; ii. increase cropping intensity, reduce loss of grain/crop and upgrade the quality of agricultural product through encouraging use of (pre and post-harvest) agricultural machinery.

The findings of the impact evaluation indicated that the project considerably increased the productivity of farm labour, agricultural production and profitability on account of timeliness of operation, better quality of work and more efficient utilization of inputs. It has also increased on-farm and off-farm employment opportunities. The project is playing a significant role in national agriculture and water environment to ensure cost-competitiveness of agricultural commodities and food security of the country. The study also identified a number of strengths and weaknesses of the project design and implementation which will be very useful for the Government, the donor agencies and development partners for future direction.

I would like to thank Dr. M M Amir Hossain, the consultant of the impact evaluation study and his sincere and hard works as well as all the concerned officials of Evaluation Sector and field interviewers for completion of the report in time.

Thanks to all Technical and Steering Committees members especially to Secretary, IMED for her guidance and pertinent suggestions to improve the quality of report. Appreciations are also due to the learned participants of the workshop for their observations which have been duly incorporated in the report as per need of the evaluation objectives.

I believed that the findings and recommendations as put forward in the report will contribute to a greater extend for future planning, management and effective implementation of agricultural sector development projects.

Salma Mahmud
Director General
Evaluation Sector, IMED
Ministry of Planning

Abbreviations

AE	:	Agricultural Engineer
AEO	:	Agriculture Extension Officer
AEZ	:	Agro-ecological Zone
BARI	:	Bangladesh Agricultural Research Institute
BAU	:	Bangladesh Agricultural University
BBS	:	Bangladesh Bureau of Statistics
BRRI	:	Bangladesh Rice Research Institute
CV	:	Curriculum Vitae
DAE	:	Department of Agricultural Extension
DG	:	Director General
DPP	:	Development Project Proforma
ES	:	Evaluation Sector
FGD	:	Focus Group Discussion
GDP	:	Gross Domestic Product
GOB	:	Government of Bangladesh
IGA	:	Income Generating Activities
IMED	:	Implementation Monitoring and Evaluation Division
KII	:	Key Informant Interview
MDGs	:	Millennium Development Goals
MOA	:	Ministry of Agriculture
MT	:	Metric Ton
PCR	:	Project Completion Report
PRA	:	Participatory Rural Appraisal
RM	:	Round Meter
SAAO	:	Sub-Assistant Agriculture Officer
SC	:	Steering Committee
SRS	:	Simple Random Sampling
TA	:	Technical Assistance
TC	:	Technical Committee
TOR	:	Terms of Reference
UAO	:	Upazila Agriculture Officer

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EXECUTIVE SUMMARY

Introduction: For the extension of various kinds of farm equipment including irrigation equipment along with improved water management practices, Department of Agricultural Extension implemented a project "Enhancement of Agricultural Production and Rural Employments through Extension of Agricultural Engineering Technologies Project (AETEP)" from July 2005 to June 2011 with the cost of *BDT 57.22 crore*. The ultimate goal of the project is to reduce production cost, increase production, and create self-employment opportunities for the rural farm families.

Study Methodology: A list of beneficiary farmers was collected from each of the 14 study upazilas. In this way a total of 726 samples were drawn from the 14 upazilas of 7 districts. The highest (39%) of the farmers were selected from landless which is followed by small (30%) and marginal (19%) but the lowest was selected from large farmers followed by medium (8%). Both primary and secondary data were collected for this study. Primary data was collected through face-to-face interview using a structured questionnaire. In addition of the above quantitative survey, qualitative survey instruments such as FGD, KII and physical observation were also used to obtain first-hand information of the project.

Rationale of the project concept and design: Water management and mechanization are the most important but less attended sub-sectors which were addressed through this project to increase irrigation efficiency, reduce production cost, increase productivity and crop intensity. Timely completion of cultural practices is prerequisite for increasing cropping intensity and production. Mechanization has ensured higher cropping intensity as well as reduction of the harvesting loss. In addition, mechanization has also to create new employment opportunities in the rural area. Therefore, the concept and design of the project was relevant to the emerging needs of the agricultural sector.

Findings of the study

Procurement: Procurements carried out under the project follow the PPR rules and regulations as well as bid document specifications as reported by the IMED team.

Farm machinery

Present conditions of farm machinery: Around 57% of the supplied equipments are completely damaged while 29% are in partially damaged which can be used with repair and maintenance. Only 14% of the supplied equipments are in working condition which was supplied in 2010.

Extent of use of farm machinery: The highest (88%) of the supplied farm machineries are currently using while only 12% of the supplied equipments are not using regularly which is using sometimes basis due to lack of operators.

Repair and maintenance: Two third (72.88%) of the supplied equipments were regularly repaired and maintained by the owners while 27.12% equipments were not regularly or never repaired and maintained by the farmers due to non-availability of the spare parts and its associate cost.

Overall quality of the supplied equipment: Two third (85) numbers of the supplied equipments were in very good quality while 33 numbers of the supplied equipments were in average quality. This is mainly due to non popular dongfeng brand of power tiller.

Irrigation and water management

Response on the use of Irrigation water and its source: Around all (98.6%) of the respondents reported that they used irrigation water especially in rabi season where most (84.57%) of the respondents reported that they used underground water and rest (15.43%) used surface water.

Methods of irrigation facilities used: The highest percentage (50.83%) of respondents reported that they used improved earth canal irrigation method for crop cultivation while it was only 1.79% in baseline data. As a result the increase of irrigation facilities calculated over the baseline data recorded before project is 2738.46%. This increase was achieved only due to training and demonstration on improved earthen canal irrigation facilities in the project upazila. Conversely, 17.04% decreasing trend in use of irrigation facilities/method was observed for others categories

of irrigation method such as earthen canal as recorded compared to the baseline data.

Training and Demonstration Programs

Number of respondents received training: Around (77%) of the respondents reported that they received training from the project.

Types of training received: Majority (59.54%) of the participants reported that they have received training on farm machinery followed by improved irrigation technology (34.22%) while lowest 6.24% in case of others such as operators and repair and maintenance.

Impact of training in skills development: The highest (95.43%) participants reported to have positive change in skills development due to training and demonstration while only 4.57% participants responded negatively

Level of skill improved: Majority (61.68%) participants reported that the skills have been improved at satisfactory level followed by average (29.89%) and very satisfactory (7.89%). Only negligible (0.435%) participants reported the improvement of skills at non-satisfactory level.

Impact of training in skills development: Highest (95.429%) participants reported that their skills improved due to training and demonstration. Most (61.68%) participants opined that training and demonstration was of satisfactory level to improve skills followed by average (29.89%).

Socio-economic impact

Impact on the ownership of land: No significant change is observed in the ownership of land where only (1.527%) increase in the size of homestead garden and 2.608% increase in own land under own cultivation. Areas of pond and lease land are reduced by 4.667% and 2.771% respectively.

Impact on the reduction of irrigation cost: Most (88.6%) of the respondents reported to have positive changes in reduction of irrigation cost. The study has found that introduction of modern irrigation technologies reduced losses of water by 18.64% which would ultimately lead to saving of cultivation cost by at least BDT 1,100 per hectare of land.

Impact on the reduction of crop loss: Around (99.2%) of the respondents opined that crop loss has been reduced up to 63.33% due to adoption of farm machinery technology which would ultimately increase income by at least Taka 5,320 per hectare of land.

Impact on the land use pattern and cropping intensity: There is 0.96% reduction in single cropped area, 0.84% and 1.27% increase in double and triple cropped area due to more coverage of irrigation facilities in rabi season. This ultimately increased cropping intensity by 1.04%.

Impact on the crop production: Around (99.7%) of the respondents reported to have increased crop production by 16.66% which would ultimately increase farmers' income by at least Taka 11,200 per hectare of land.

Impact on income: Most (99.449%) of the respondents reported that income from agriculture and non-agriculture has been increased by 63.33% and 30.77% respectively which would ultimately increase farmers' income by at least Taka 65,360 and 11,000 from agriculture and non-agriculture respectively per annum.

Extent of changes in quality food production: Almost all (99.449%) reported that quality of food has increased due to use of farm machinery which is 69.42% followed by use of on-time adequate amount of irrigation (67.91%).

Impact on Employment Generation: Majority (66%) of the respondents reported that employment opportunities have been created.

Type of changes occurred: The highest (90.81%) response was recorded in case of employment opportunities increased followed by employment opportunities decreased (7.72%). However, the lowest (1.46%) response was reported in case of no changes in employment.

Categories of job created: Majority (65.97%) of the respondents reported in case of rental business followed by repair and maintenance (58.62%), operators (53.79%), and day labor (30.80%). However, the lowest (0.69%) was reported in case of others category followed by NGOs job (3.21%), dealer business (15.402%), crop carrying related job (16.09%), and crop processing (16.78%).

Strengths

- Training and demonstration on the farm machinery and water management facilitated to improve skills and awareness among the farmers. Similarly, Agriculture engineers posted at upazila level supported to farmers to learn more about farm mechanization technology.
- Use of farm machinery has increased crop productivity and crop quality. In face of shortage of labor in agricultural activities, farm mechanization has ensured continuous production to ensure food security with less input cost.
- Water management and irrigation facilities are contributing to efficient use of irrigation water, thereby reducing irrigation cost and wastage of underground water.

Weakness

- Project has also lost 170 skilled personnel due to discontinuation of the project. This has interrupted the dissemination of agricultural engineering technology at the field level.
- Absence of training on a continuous basis. This need to be continued to disseminate farm mechanization like specialized technology.
- Lack of skilled operators, spare parts and repair and maintenance facilities. Therefore farmers are unable to repair and maintain the equipments and incurred huge losses.

Recommendations

- More farm machinery need to be provided with 30% subsidized price for mechanized crop production. Adequate policy and strategy need to be formulated in this regards. Institutional credit to be arranged for the resource-poor farmers to purchase farm machinery. Continuation of project like farm mechanization is needed to meet the increasing demand for food staffs in the country.
- Regular training both for DAE field level officials and farmers on various aspects of farm mechanization along with improved water management practices need to be organized.
- Farm machinery fair to be organized at upazila level annually by DAE for disseminating and promoting locally made/improved/imported farm machinery and irrigation equipments.
- Continuous research to invent more economic and cost-effective farm machinery and water management technology is required.
- More awareness and demonstration program on judicious use of water, fertilizer, pesticides and other inputs in the farmer field is required to be organized by DAE in order to safeguard environmental need.
- Integrated and comprehensive agricultural sector development project is needed to attain all priorities issues of the sector together. Ministry of Agriculture needs to take such initiatives involving all relevant departments and agencies

Sustainability

Project has completed around 4 years before and farmers are using most of the technologies as they are getting desired benefit. Therefore, project activities will be sustainable even without any further support from the government. But further support and long-term vision in this field will expedite the use of mechanized technologies.

Conclusion

The project has been playing key role in increasing inputs on account of higher average cropping intensity and larger area. Therefore, increase productivity of farm labour, agricultural production and profitability on account of timeliness of operation, better quality of work and more efficient utilization of inputs. It has also increased on-farm and off- farm employment opportunities such as deployment of labour in manufacturing units, operators, repair, servicing and sales. Therefore, it can be concluded that the project is playing a significant role in national agriculture and water environment to ensure cost-competitiveness of agricultural commodities and food security of the country. This type of project needs to be implemented with more financial outlays for mechanization of agricultural sector including marketing support.

CHAPTER 1

INTRODUCTION

1.1. Background

Bangladesh is predominately an agricultural country. To feed her more than 150 million people from 8.2 million hectares of cultivable land is a tough task (Hossain, 2009). Every year almost 0.20 million people are being added to the total population whereas the estimated annual shrinkage of agricultural land is about 0.08 million hectares due to various non-agricultural activities like constructions of houses, offices, roads, mills, factories etc. (BRRI, 2009). The contribution to GDP by agriculture is about 16.51% of which crops, fisheries, livestock and forestry account for 9.53, 3.19, 2.29 and 1.50%, respectively (BBS, 2013).

The country's food production has increased from 11.0 million tons in 1971 to about 33.83 million tons in 2013 (DAE 2013). The country is, at present, about to achieve self sufficiency in cereal production. This is due to irrigation development and partial mechanization in other agricultural operations. But to meet up the food requirements of the ever growing population of the country in 2015, an additional 5 million tons of food grain need to be produced from the continuously decreasing agricultural lands. To achieve this target, there is no other better option than to increase production per unit of land as well as cropping intensity.

Thus, to increase production and cropping intensity, the most important gain will be the faster development of agricultural mechanization as well as variety development. Replacing the traditional inefficient agricultural tools, efficient mechanized cultivation must be introduced and extended. The good news is that the government has already attributed due importance to agricultural mechanization in the National Agricultural Policy (MoA, 2009). In the Policy it is included that "The Government will encourage production and manufacturing of agricultural machinery adaptive to our socio-economic context. Manufacturing workshops and industries engaged in agricultural mechanization activities will be provided with appropriate support."

In 2000, the land preparation was done almost 70% by machine (Farouk et al, 2007) which has now been raised to about 80%. But, bed makers, seeders, weeders, harvesters and winnowers-all have limited uses. However, threshing of maize is accomplished almost 100% by power and hand maize shellers and those of paddy and wheat, over 80%, by both power and manual threshers. Efforts are being continued by the researchers to improve the machine performance.

1.2. Rational of the Project

Per hectare yield of Bangladesh land is lowest among the countries of the world despite of satisfactory level of soil fertility. Technologies related to HYV seed, balanced fertilizer, irrigation and pesticides have reached a certain level but still agriculture remaining as an unprofitable sector. The main reason for that is poor efficiency in every stage of cultivation, excessive loses in using inputs and production. Under the situation of open competitive world economy this trend need to be changed urgently to mitigate the coming food demand of increasing population.

Technology transfer in the field of agricultural engineering like on-farm water management and farm mechanization has largely been neglected. Therefore, it has become crying need to transfer the technologies to enhance efficiency in this area. The technologies are: irrigation with optimum amount of water and timely application of water according to life cycle of crop, appropriate use of water, proper design of irrigation canal, operation liked land preparation, seedling, fertilizer application, harvesting, crop collection and storage in mechanized way at the door steps of farmers. In using these technologies farmers can be able to: reduce water loses, increase irrigated area, enhance crop intensity, and reduce post harvest losses. At the same time, after mitigation of food demand surplus domestic resources also can contribute in establishment of agro-based industries. To do so, the B.Sc. Agricultural Engineers graduated

from Bangladesh Agricultural University can play a key role in performance the above activities. Considering this, Agricultural Engineers position along with other agriculture related officers of existing DAE organogram has created at upazila level to transfer agricultural engineering technologies to grass root level with the direct help of field DAE staff,

1.3. Project Summary

<table>
<tr><td>i</td><td>Name of the Project</td><td colspan="3">Enhancement of Agricultural Production and Rural Employment through Extension of Agricultural Engineering Technologies (2nd Revised)</td></tr>
<tr><td>ii</td><td>Sponsoring Ministry</td><td colspan="3">Ministry of Agriculture (MOA)</td></tr>
<tr><td>iii</td><td>Executing Agency</td><td colspan="3">Department of Agricultural Extension (DAE)</td></tr>
<tr><td>iv</td><td>Funded by</td><td colspan="3">GOB</td></tr>
<tr><td>v</td><td>Location of the Project</td><td colspan="3">56 districts and 112 Upazilas from all the 7 divisions of Bangladesh</td></tr>
<tr><td rowspan="2">vi</td><td rowspan="2">Estimated Cost</td><td>Original Cost</td><td>Latest Revised Cost</td><td>Actual Cost</td></tr>
<tr><td>TK 5298.97lakh</td><td>Tk. 5777.44 lakh</td><td>Tk. 5722.11</td></tr>
<tr><td rowspan="4">vii</td><td rowspan="4">Implementation Period</td><td></td><td>Date of commencement</td><td>Date of Completion</td></tr>
<tr><td>Original</td><td>July 2005</td><td>June 2010</td></tr>
<tr><td>Latest Revised</td><td>July 2005</td><td>June 2011</td></tr>
<tr><td>Actual</td><td>July 2005</td><td>June 2011</td></tr>
</table>

1.4. Major Components of the Project

The project has the following major three components:

i. Project Management
ii. Agricultural Mechanization; and
iii. Irrigation and Water Management

The major activities of the components are as follows:

a. Establishment of 7028 nos. of water management & mechanization demonstration.
b. 274372 man days of farmers training.
c. 219771, CUM amount of re-excavation of canal & water bodies.
d. Construction of 59254 R.M. of drainage canal
e. 5 no. of multipurpose use of deep tube well
f. 1137 Nos. of set agricultural machinery supply.

1.5. Objectives of the Project

Main objectives of this project is to make agriculture economically profitable and commercially viable by extension of agricultural engineering technologies through reduction of cost in every stage of operation in agriculture and losses of produced crops and related domestic resources so that our agriculture can sustain in competitive world economic situation.

The specific objectives of the project are to:

- increase irrigated area, reduce cost of irrigation and enhance production through appropriate on-farm water management practices;
- increase cropping intensity, reduce loss of grain/crop and upgrade the quality of agricultural product through encouraging use of (pre and post-harvest) agricultural machinery;
- employ the Agricultural Engineers at Upazila level in order to motivate the farmers using modern and engineering based technologies;
- reconstruct and to re-excavate canal and other water bodies on a partnership basis to increase use of surface water for irrigation purpose;

- impart training to the owners, operators, mechanics and users of irrigation equipment with a view to increase the efficiency and life of the machine; and
- introduce internet based improved data base & census for minor irrigation & agricultural machinery with a view to modernize agricultural information system.

1.6. Objectives of the Current Assignment

- To review the target and achievement (physical and financial) of the project as well as present functional status of major inputs/ activities;
- To assess whether the use of better irrigation technologies such as improved earth canal, buried pipe; pre-cast canal and sprinkler irrigation had resulted in cost reduction for irrigation thereby contributing to improved productivity;
- To assess the impact of mechanized cultivation on agriculture farming system in general and on farm productivity in particular;
- To examine whether the procurement process (Invitation of tender, evaluation, approval procedures, contract award etc) of the packages (goods, works and services) under this project was followed as per PPR' 2008;
- To check whether the re-excavation of canal and water bodies was done as per project target and the extent of its contribution to increased use of surface water for irrigations purpose and to increase in cropping intensity in the sample areas;
- To assess the project's impact in terms of sustainable crop and non-crop production income and employment opportunities;
- To identify the strengths and weaknesses with respect to management of water kits and mechanization technology and other related aspects of project activities as well; and
- To suggest measures for more sustainable performance of project activities and scope for replicating best practices in similar agricultural development projects in the country.

1.7. Scope of Services

The study design and field works plan was prepared considering the following components of the project. Sampling of the impact evaluation was made on the basis of coverage of work and area as below:

Coverage of work	Area Coverage
Implementation and functional status of irrigation structure and Canals	At least 10 % of the districts and Upazilas under the project area
Assessing the productivity of crops, use of irrigated lands, rural employment and socio-economic status of the local community.	
interviewing direct beneficiaries and conducting in- depth discussions and FGD meetings with community leaders, teachers, key officials/ informants and concerned stakeholders etc.	

Responsibilities of the Consultants are to:

- analyze the procurement related functions based on predetermined indicators.
- review implementation status of major components of the project.
- assess improvement of the beneficiaries in line with objectives of the current assignment;
- review the impact of the project on over all socio-economic improvement
- review the strengths and weaknesses of project activities;
- data entry, processing and analysis;
- prepare impact evaluation report based on the primary and secondary data; and
- present draft report in the national level workshop for dissemination of the study findings and finalize the report incorporating workshop inputs.

1.8. Major Findings through Review of Journal/Reports in Similar Activities

Agriculture of Bangladesh is characterized by overwhelmingly small holdings due to higher population density and nearly 80 per cent of its population residing in the rural areas coupled with unabated land fragmentation due to the inheritance laws of the country. With the introduction of small-scale mechanization the nature of using cultivation power has changed significantly and it appeared that the use of power tiller (PT) for tillage has increased rapidly and draught power (DP) to some extent has been replaced by PT in some areas of Bangladesh. Mechanization may be defined as the process of injecting power and machinery between man and materials in a production system (Canalequzzaman and Karim, 2007). Some other agricultural activities have already been mechanized and the most important one is water pumping through STW and DTW. Moreover, most of the farmers have started using weeder, sprayer, thresher and other small tools and equipment in small farm practices. The technological improvements in Bangladesh agriculture have brought about revolutionary increase in agricultural production. The increased use of purchased inputs in agriculture necessitated to raise their use efficiencies through mechanization. Many studies have been done on Bangladesh agriculture and the following states some of the major findings and thoughts of agriculture engineering technologies in this sector.

The baseline study of the Enhancement of Agricultural Production and Rural Employment through Extension of Agricultural Engineering Technologies Project (AETEP) revealed that almost all kinds of agricultural machinery are being used in varying degree in the upazila under the study areas. The owners and operators of agriculture machinery clearly expressed their keen interest to gain knowledge and skill on various aspects of the agricultural engineering technologies (Baseline Survey, AETEP-DAE 2006)

Rahman *et al*. (2010) conducted a study in three northern districts of Bangladesh during the period of 2009-10 to find out the effect of mechanization on labour use and profitability in wheat cultivation. The findings revealed that less number of labour per hectare is required to complete the production process by mechanized farm compared to traditional farm. The yield of wheat under mechanization (2.65 t/ha) is higher than that of traditional farms (2.57 t/ha). Total variable cost is significantly higher for traditional farms. Gross margin is found to be higher for mechanized farm (Tk. 14,168) compared to traditional farm (Tk. 10,102). Similar trend of results has also found in the study of Islam et al. (2004), where the power tiller operated reaper has 0.14 ha/hr field capacity and can save about TK 900 per ha compared to sickle harvesting. For rice, the radial flow hold-on type open drum thresher has a threshing capacity of 350 to 400 kg/hr and save TK 70 per ton over traditional method. The axial flow throw-in type thresher (TH 7 & TH 8) have the cleaning mechanism and equally suitable for rice and wheat. The threshing capacities of TH 7 are 500-700 kg/ha and 300-500 kg/ha for rice and wheat respectively; and can save TK 100/ton over traditional method of threshing. However, the threshing capacities of TH 8 are 800-1000 kg/ha and 600-700 kg/ha for rice and wheat respectively; and can save TK 130/ton over traditional method of threshing. The capacity of power operated grain cleaner 350-450 kg/hr which can save TK 60/ton over traditional method of winnowing.

Keller (1990) found that modern technology can result in less water wastage because water is conveyed in pipes and irrigators can control the amount of water applied and its timing more easily which can increase productivity per unit of water. He suggests that traditional methods have limited productivity and are dependent on a farmer's willingness to invest in land preparation and coaxing water to spread evenly over the land. Similar results has also found in the study of Department of Civil Engineering, Rajshahi University of Engineering & Technology (RUET). All the farmers and water user beneficiaries' views were positive in improved distribution system especially of buried pipe system. According to them, development of this lining technology is very appropriate in Bangladesh context and also in developing countries. More than 70% of the farmers and water user beneficiary opined that channel of every DTW schemes could be constructed buried pipe system. The conveyance efficiency of PVC buried pipe for Bogra, Thakurgaon and Godagari zone were 95.37%, 90.46% and 94.46% and rate of water loss were 6.11%, 9.55% and 5.45% respectively. BMDA developed water distribution

systems are more effective, efficient and far better than the conventional system and developed water distribution systems at different locations in the country are running in good condition without any major constraint. This system could be widely adopted as a model in the field for increasing agricultural production in Bangladesh. Among all the water distribution systems, the PVC Buried pipe line system is the most suitable among all distribution systems (Rahman *et al.*, 2008). In India, similar results has also found regarding adoption of drip irrigation technology that has increased the net sown area, net irrigated area and thereby has helped in achieving higher cropping intensity and irrigation intensity (Kumar, 2004).

From the study of International Water Management Institute (IWMI), it has found that water is becoming an increasingly scarce resource and limiting agricultural development in many developing and developed economies across the world. A study shows that around 50 per cent of the increase in demand for water by the year 2025 can be met by increasing the effectiveness of irrigation (Seckler et al. 1998). In India, almost all the easily accessible and economically viable irrigation water potential has already been developed, but the demand for water for different sectors has been growing continuously (Saleth 1996, Vaidyanathan 1999). Moreover, the water use efficiency in the agricultural sector, which still consumes over 80 per cent of water, is only in the range of 30-40 per cent in India, indicating that there is considerable scope for improving the water use efficiency. However, the project completion report (PCR-AETEP, 2011) claimed that around 30% water loss has decreased compare to initial stage of the project. Farmers now know more about the functions of different kinds of irrigation method and are using various type of farm machinery thus increase their food security situation in great extent.

CHAPTER 2
METHODOLOGY

2.1. General

The study team was formed with the key personnel of evaluation section of IMED and individual external consultant. After critical analysis of the TOR, review of similar studies, discussion with project personnel and field visits an appropriate methodology has been designed for this study. Details are presented below:

2.2. Methodology

The methodology for impact evaluation study comprises the following:

2.2.1 Sampling of the Respondents

It is indicated in TOR that at least 10% of the project districts will be considered for study. The consultant has considered the farmers as sample unit. Since consultant has no information on necessary parameters viz. population size and standard deviation, the consultant had used the appropriate formula fit for without Finite Population Correction (FPC) recommended by Daniel (1999) for calculating sample size at the field level as given below:

$$n = \frac{Z^2 PQ}{d^2} \times Designeffect$$

Where,

n = Sample size without finite population correction,
P is the use of power tiller technology by farmers. We consider, P=70% in this study.
Q = 1-P,
Z is a standardized variation. It is 1.96% at 5% level with 95% confidence interval,
d = Precision or allowable margin of error (If the precision is 5%,
then d=0.05

With these values the calculation of the sample size gives

$$n = \frac{(1.96)^2 \times 0.70 \times 0.30}{(0.05)^2} \times Designeffe\,ct$$

For this study design effect is considered 2.

Using the information given above, **n=645.388**

For this study, we consider round figure of sample size 700.

The sample size was stratified by farmer's category based on country and district-wise respective group of farmer farm holding which have been presented in the following tables.

Table 1: Sample Size against Country Total Number and Percentage of Farm Holdings by Categories

Farm Holdings	Number	Percentage	Same Size
Landless (with no own cultivated area)	10881791	40.04	280
Marginal farmers (with 0.01-0.49 acre cultivable land)	5361245	19.73	138
Small Farmers (with 0.50-2.49 acre cultivable land)	8564699	31.51	221
Medium farmers (with 2.50-7.49 acre cultivable land)	2136415	7.86	55
Large farmers (with 7.50+ acre cultivable land)	234396	0.86	6
All	**27178546**	**100**	**700**

Note: For small sample test, sample size is needed at least 30

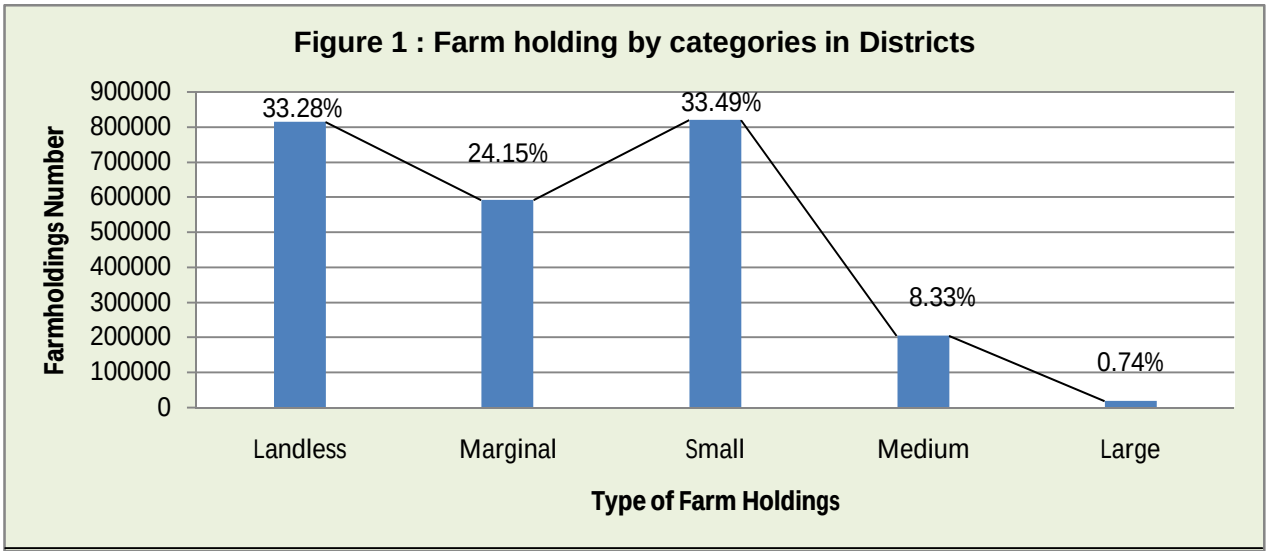
As the sample size of large farmers is only 6 thus it is needed to increase at least 32 to fulfill the requirement of small sample test. Thus, we consider final sample size for this study is **726.**

Table 2: Total Number and Percentage of Farm Holdings by Category in District[1]

Division	Sample District	Farm Holdings				
		Landless (with no own cultivated area)	Marginal (with 0.01-0.49 acres of cultivable land)	Small (with 0.50-2.49 acres of cultivable land)	Medium (with 2.50-7.49 acres of cultivable land)	Large (With 7.50+ acres of cultivable land)
Barisal	Barisal	114488 (14.05%)	161431 (27.30%))	171779 (20.95%)	29899 (16.98%)	1747 (10.47%)
Chittagong	Cox bazar	168736 (20.71%)	66344 (11.22%)	81464 (9.94%)	13846 (7.86%)	1402 (8.41%)
Dhaka	Rajbari	79621 (9.77%)	39489 (6.68%)	76409 (9.32%)	19390 (11.01%)	1250 (7.49%)
	Gopalganj	66394 (8.15%)	35480 (6.00%)	95810 (11.69%)	30035 (17.05%)	1833 (10.99%)
Khulna	Jessore	171368 (21.03%)	133825 (22.63%)	211190 (25.76%)	49788 (28.27%)	3441 (20.63%)
	Meherpur	38777 (4.76%)	24702 (4.18%)	70635 (8.62%)	16585 (9.42%)	1169 (7.01%)
Sylhet	Sylhet	175350 (21.52%)	129962 (21.98%)	112595 (13.73%)	44286 (21.73%)	5836 (34.99%)
	Total	**814734**	**591233**	**819882**	**203829**	**18139**

Note: Parenthesis indicates percentage of farm holdings by category

The highest 33.49% represent small farmers which are close to landless farmers (33.28%). While lowest 0.74% farmers represent under the category of large farmers followed by medium (8.33%) and marginal farmers (24.15%) in the study districts.



2.1.2 Allocation of Farmers by Upazila

In order to reach beneficiary farmers, we adopt two-stage random sampling procedure. Firstly, around 14 upazilas from 7 project districts was randomly selected where baseline survey conducted. Secondly, then totally 726 farmers selected by using stratified random sampling procedure and the following allocation was done for data collection.

[1] Agricultural Statistic Year Book 2011 (BBS)

Table 3: Allocation of Beneficiary Farmers by Upazila

Sample District (10%)	Sample[2] Upazila (2 from each district)	Farm Holdings					
		Landless (with no own cultivated area)	**Marginal** (with 0.01-0.49 acres of cultivable land)	**Small** (with 0.50-2.49 acres of cultivable land)	**Medium** (with 2.50-7.49 acres of cultivable land)	**Large** (With 7.50+ acres of cultivable land)	**Total**
Barisal	Sadar	21	16	23	4	2	66
	Banaripara	21	16	23	4	2	66
Cox bazar	Sadar	30	8	12	2	2	54
	Ukia	30	8	13	3	2	56
Rajbari	Sadar	14	7	11	2	2	36
	Baliakandi	14	7	11	2	2	36
Gopalganj	Sadar	12	6	12	4	2	36
	Maksudpur	12	6	12	4	2	36
Jessore	Sadar	31	13	28	6	2	80
	Manirampur	31	13	28	6	2	80
Meherpur	Sadar	9	6	9	3	3	30
	Gangi	9	6	9	3	3	30
Sylhet	Sadar	23	13	15	6	3	60
	Companiganj	23	13	15	6	3	60
Total	**14**	**280**	**138**	**221**	**55**	**32**	**726**

2.2.3 Instruments used for Data Collection and Respondents

(a) Questionnaire for Beneficiary: The project beneficiary farmers was filled in a set of pre-designed questionnaire encompassing issues to assess different aspects of mechanized technologies and impact in sustainable and improved crop production.

(b) Guidelines for Focus Group Discussion: The target audiences farmers, owners, operators, mechanics, and user of irrigation equipments, SAAO, UAO, CPS, AE, AEO of DAE, local elite, NGOs and project partners etc. Total 7 FGDs (each in districts/sadar upazila) was conducted to cover under this method of opinion collection and validation of the study findings.

(c) Checklist for Key Informant Interview (KII): Out of total 18 Key Informant Interviews, 14 KIIs in 14 sample upazilas, and 4 in HQ of DAE at Dhaka was consulted and verified about the project activities regarding project management including procurement process and financial aspects of the project, contract management, project planned and actual period, costing, strengths and weaknesses etc of the projects.

(d) Checklist for Physical Observation: The field staff and consultant observed and inspected functional status of 10% agricultural machinery, water management structure, canal and drainage structure.

[2] Project has maximum of 2 above-mentioned upazila in each district

Table 4: List of indicators/variables corresponding to the data collection instruments and the sampled respondents

Objectives	Variables/ Indicators	DCIs/Documents	Respondents type	No of respondents
Review target and achievement (physical & financial) and implementation status of the project	objectives, inputs, and outputs	Review of PCR, DPP, project record, document & in-depth discussions through KII	Senior Officials of DAE related to project management and planning	18
assess use of better irrigation technologies such as improved earth canal, buried pipe; pre-cast canal and sprinkler irrigation	Irrigated area under better irrigation technologies	Interview and discussions	Household & Upazila level	-
assess the impact of mechanized cultivation on agriculture farming system	Reduction of crop loss, increase quality of crop, reduce inputs cost etc	Interview and discussions	Farmers, UAO officials, NGOs, & local elite	Altogether 7 FGDs
re-excavation of canal and water bodies was done as per project target and the extent of its contribution to increased use of surface water for irrigations purpose and to increase in cropping intensity in the sample areas.	Extent of the use of surface water, area coverage etc	Interview and discussions	Household & Upazila level	-
impact in terms of sustainable crop and non-crop production income and employment opportunities	Socio-economic improvement	Household survey using structure questionnaire	landless, marginal, small, medium and large farmers	726
examine whether the procurement process was followed as per PPR' 2008.	Transport, manpower, equipments etc	Checking of project record/secondary data and In-depth discussion through KII	Project Authority includes PD and other available concerned persons of DAE at HQ, district & Upazila etc	As referred in objective # 1
strengths and weaknesses with respect to management of water kits and mechanization technology and other related aspects of project activities as well	Lessons learned from the project			
suggest measures for more sustainable performance of project activities & scope for replicating best practices in similar agricultural dev. projects in the country.	A way forward with the best practice	Focus Group Meetings (FGDs)	All categories of farmers, owners, operators, dealers, mechanics & DAE (SAAO, UAO, AE, AEO) officials etc	07 FGDs (Maximum 140 participants)
			Total	**885**
present functional status of the project input/activities	Farm machinery and irrigation and water management structure present status	Physical visit and observation	Functional status of agricultural machinery	114 (Nos)
			Functional status of deep tube well	3 (Nos)
			Drainage canal	5925 RM
			Re-excavation canal	21971 CUM
			Water management demo	702 (Nos)

2.3. Implementation and Data Management Plan

2.3.1 Finalization of Questionnaire

The questionnaire was finalized on the basis of pre-testing results and comments and suggestions of the client.

2.3.2 Recruitment of the Field Staff

A total of 14 field staff was recruited by the IMED to collect data from the field.

2.3.3 Training of the Field Staff

A two days training program was organized for the field staff to provide a common understanding of all aspects of the study so that they can administer the designed instruments properly for collecting required data. The consultant along with IMED explained specific sections of the instruments designed for data collection. Various codes and their appropriate use were also explained to them. The training program was two types: (a) basic training and (b) advanced training.

2.3.4 Method of Data Collection

(i) Beneficiary Interview: Direct personal interview approach was adopted for collection of primary data. A list of landless, marginal, small, medium and large farmers were collected from the respective upazila. The farmers was randomly selected from the list with the support of SAAO for collection of data using structured questionnaire to cover the required numbers of farmers so that the representative samples of data (726) can be obtained.

(ii) Focus Group Discussions (FGDs): Total seven (7) FGDs were conducted in each of the sample district/sadar for different target groups and stakeholders in the respective communities both from public and private sector.

(iii) Key Informants Interview (KII): A total of maximum 18 KIIs were carried out using checklists for project management personnel and DAE relevant officials at upazila, districts and HQ level.

(iv) Physical Observation and Inspection: the field staffs with consultant were observed the functional status of agricultural machinery, water management structure, canal and drainage structure.

2.3.5 Inspections and Supervision of Field Work

The supervisors, IMED and consultant intensively supervised data collection. The consultant visited some selected places to oversee the field staffs survey activities to ensure quality of data collection. Besides, the consultant participated in some Focus Group Discussion (FGD) and observed formally and non-formally the collection of information using mobile phone.

2.3.6 Data Processing and Analysis

Each questionnaire was edited and coded before entry into the computer. The edited and coded questionnaires were dispatched to computer operators for data entry/punching to the software installed for this purpose. All the collected information were processed and analyzed in the in light of the scope of work of the study. MS Access and SPSS program was used for data entry, validation and tabular analysis. The option for Multi-variable Analysis was explored as per requirements of the impact study.

CHAPTER 3

GENERAL FEATURE OF THE PROJECT

3.1 General

Project management and implementation is the process and activity of planning, organizing, motivating, and managing resources, procedures and protocols to achieve specific goal of the project. A project is a temporary endeavor designed to produce a unique result with a defined beginning and end undertaken to meet unique goals and objectives, typically to bring about beneficial change or added value. This chapter describes overall project management and implementation status and achievements of the project which was implemented under the Department of Agricultural Extension (DAE). The objective of the project was to reduce production cost, increase production and create self-employment in the rural farms families. As per the objectives, findings of the study have been presented herewith mainly based on the primary and secondary data.

3.2 Project Implementation status

The project was initially planned to be implemented in five years starting from July 2005 to June 2010 with a total cost of 5298.97 lakh taka. But the actual implementation period of the project was July 2005 to June 2011 with an additional 1 year extension through revision of DPP two times. Price escalation was the main cause of first revision. Cost of every item was estimated based on price of 2005 which in fact doubled or more than doubled in 2006. Price escalation had been jeopardizing the whole project implementation process. As such, it was decided and instructed by the second steering committee meeting to revise the DPP by changing the unit price of items in accordance with market price. Hence, it was vital to revise first time the project cost from 5298.97 to 5777.44 lakh taka to cope with the price escalation. The project was scheduled to start from July 2005 but actual field activities were started from July 2006 with 1 year delay due to 1st revision of the DPP. Therefore, the second revision of the project was due to complete remaining project activities with unspent project money of 638.58 lakh taka, which was 10% of total project cost.

3.2.1. Financial target and achievement

Based on secondary information[1], collected from the IMED and DAE, the status of financial aspects related to target and achievement of the project has been furnished in Table-5 & 6.

It is revealed from the Table 5 & 6 that almost 99.04% *(BDT 57.22 crore out of BDT 57.77 crore)* of the project was utilized efficiently and effectively for the project. Only 0.96% (BDT 0.553 crore) fund was remained unutilized under the line item of manpower (50.52 lakh taka) and multipurpose use of deep tube-well (4.8 lakh taka). It was mainly due to resignation of agricultural engineers caused by discontinuation of the project services, where around 30 posts were vacant until last 6 months of the project. The maximum fund was utilized under line item of demonstration which was 23.68% followed by manpower (22.80%), and re-excavation of canal and water bodies (16.30%). The lowest budget was utilized under website development and internet usage (0.22%) followed by census (0.54%) and furniture (0.80%).

Table 5: Cost of the project

Estimated Cost (In lakh taka)		Actual Expenditure (In lakh taka)	Cost over-run (% of original cost)
Original	Latest Revised		
5298.97	5777.44	5722.11	99.04%

[1] *Project Completion Report-July 2011, DAE*

Table 6: Component-wise financial target and achievement

Major Components	Unit	Target (as per 2nd revised of DPP)		Actual Achievement		% of total cost
		Physical (Quantity)	Financial (Lakh Taka)	Physical (Quantity)	Financial (Lakh Taka)	
Manpower	nos	175	1353.89	175	**1304.39**	**22.80**
Training & Workshop	nos	297258	794.20	297258	**794.20**	13.88
Demonstration	nos	7294	1356.21	7294	1355.19	**23.68**
Minor irrigation & agriculture machinery census	nos	112	30.72	112	**30.72**	**0.54**
Web & Internet connection			12.74		**12.74**	**0.22**
Contingency			181.74		181.74	3.18
Baseline Survey		112	28.00	112	**28.00**	**0.49**
Sub-total-A: Revenue Component			**3737.50**		**3706.98**	**64.78**
Acquisition of Assets						
(a) Agriculture Machinery	nos	1137	448.28	1137	448.28	7.83
(b) Equipment	nos	207	78.12	207	78.12	1.37
(c) Furniture	nos	1306	45.51	1306	45.51	0.80
Transport & Vehicles		1 Jeep + 112 motor cycle	68.27	112	68.27	1.66
Re-excavation of canals & water bodies		2197171	932.75	2197171	**932.75**	**16.30**
Construction of drainage canal		59254	340.68	59254	340.68	5.95
Multipurpose use of deep tubewell	nos	5	79.33		79.33	1.30
Sub-total-B: Capital Component			**2019.94**		**2015.14**	**35.22**
Grand-total (A+B)			**5777.44**		**5722.11**	

3.3 Rationale of the project concept and design

The cultivable land is decreasing every year due to rapid spread of inhabitation and industrialization. Bangladesh has no other way but to increase vertical expansion which can be achieved by increasing production rate and cropping intensity. In both cases modern technique and timely supply of balanced inputs are prerequisite. On-farm water management and mechanization are the most important but less attended sub sectors. Irrigation water is becoming very costly and scare. Irrigation efficiency in Bangladesh is about 30%, which is 45% in neighboring and 65% in developed countries (DPP-AETP, 2005). Moreover water productivity is the lowest in the world. Under this dire need, the project was undertaken to save 30% water at farm level. This savings of irrigation water result in decreasing irrigation cost and expansion of irrigation area. On the other hand, sprinkler irrigation; drip and shower irrigation have increased the water application efficiency which resulted in higher water productivity. Implementation of on-farm water management activities of the project has reduced the irrigation cost and increased the productivity. Re-excavation of canal/water bodies is another vital item of the project. It has increased the surface water retention capacity and helped in conjunctive use of surface water and sub-surface water. Consequently threatening incline of ground water level has mitigated and cost of pumping has also reduced. Therefore, the environment is protected from arsenic

contamination. Multipurpose low cost deep tube well is another item to attract the potential use of irrigation wells.

Conversely, mechanization is a vital item for reduction of production cost, increasing productivity and cropping intensity. Draft animals are decreasing and labor shortage in planting and harvesting season is acute. In time finish of cultural practices is prerequisite for increasing cropping intensity. Appropriate mechanization can ensure higher cropping intensity. Pre and post harvest machinery can reduce the harvesting loss from 13%-14% to 5%-7%. DAE is the most appropriate platform for dissemination of on-farm water management and mechanization techniques. But DAE is handicapped by shortage of proper manpower in the field. This project created scope to employ agricultural engineers to disseminate water management and mechanization techniques. Therefore, it can be concluded that the concept and design of the project was relevant to the needs of the sector specially to ensure the food security of the country.

3.4 Appointment of project director (PD)

It revealed from the PCR that there were three (3) Project Directors in 4 spells of the project period. The first PD was transferred on promotion within 6 months of his joining. The second PD was PRL after rendering 37 months inputs but again first PD was recruited for about 19 months before recruitment of third PD on 03 October 2010 and continued up to 30 June 2011.

3.5 Procurement of goods, works and services

Public Procurement Act, 2006' and 'Public Procurement Rules, 2008' have been formulated by the Government of Bangladesh to ensure transparency and accountability in public procurement and to ensure fairness and open competition among bidders intending to participate in the procurement process. Public procurement activities in Bangladesh have been regulated and carried out according to these rules and regulations. All procurements carried out under Enhancement of Agricultural Production and Rural Employment through Extension of Agricultural Engineering Technologies Project of DAE has also followed the aforesaid rules and regulations as well as bid specification. The following three types of procurement were completed in the project:

Procurement of transport vehicle: Only 01 jeep and 112 motor cycles were procured in 2008 in maintaining proper guidelines of the PPR and DPP. The transports were disposed to the DAE at the end of this project.

Table 7: Procurement of transport

SL	Description of Item	Quantity	Procurement Date	Transfer to transport pool with date
1	Jeep	1 No.	31/03/2008	DAE 17/07/2008
2	Motor cycle	112 nos.	26/05/2008	UAO on 26/05/2008

Procurement of office and field equipment: Data depicted in Table 8 revealed that out of 10 items of the equipment, most (9) item of the equipment such as computer, laptop, photocopier, AC machine, telephone, fax, intercom, spiral binding machine, and survey instruments procured within the year 2006, but only 1 item of the equipment such as avometer was procured in 2007 in following the guidelines of the PPR 2006.

Table 8: Procurement of office and field equipment

SL	Description of Item	Quantity (№)	Procurement Date	Remarks
1	Computer	5	23/05/2006	Procurement was completed in maintaining proper procedure of PPR 2006 of the Government of Bangladesh and equipment was disposed to DAE upon completion of the project
2	Laptop	1	20/08/2006	
3	Photocopier	2	23/05/2006	
4	A C machine	2	23/05/2006	
5	Telephone	4	02/03/2008	
6	Fax+phone	1	15/11/2006	
7	Intercom (12 points)	1	15/11/2006	
8	Spiral binding machine	1	23/05/2006	
9	Survey Instrument	56	10/05/2006	
10	Avometer	134	12/03/2007	

Procurement of agriculture machinery: Data showed that out of 09 items of agricultural machinery, most (5) items such as reaper (self-propelled), seeder, weeder, sprayer, and drier were procured in 2007 while parts of power thresher (rice & wheat) and sprinkler irrigation set were procured in same year of 2007 and rest of the agricultural machinery were procured in 2008 and 2009. Only one item namely power tiller was procured in 2006 and rest in 2009. Only two items, power winnower and power thresher (maize) were procured in 2009, while parts of sprinkler irrigation set were procured in 2008. The country's three renowned organizations, Bangladesh Machine Tools Factory, Alim Industries and Mallick Group, were selected through open tender method (OTM) to supply Agriculture Machinery. Around BDT 4.00 lakh was allocated for each upazila under the agriculture machinery.

Table 9: Procurement of agriculture machinery

SL	Description of Item	Quantity (№)	Financial		Procurement Date
			Target	Actual	
1	Power tiller	224	156.26	156.26	11/11/2006 & 27/12/2009
2	Seeder	95	1.90	1.90	15/08/2007
3	Weeder	95	0.95	0.95	15/08/2007
4	Sprayer	95	3.80	3.80	15/08/2007
5	Reaper (self propelled)	56	30.80	30.80	17/12/2007
6	Reaper (power tiller operated)	56	19.60	19.60	04/06/2008
7	Power thresher (rice & wheat)	224	92.72	92.72	04/06/2007, 25/03/2008 & 27/12/2009
8	Power thresher (maize)	60	29.22	29.22	27/12/2009
9	Power winnower	112	22.23	22.23	27/12/2009
10	Drier	80	8.00	8.00	03/10/2007
11	Sprinkler irrigation set	40	82.80	82.80	17/06/2007 & 22/05/2008
	Total	**1137**	**448.28**	**448.28**	

Procurement of office furniture: Data presented in Table 10 indicated that the highest number (432) of armed chair was procured under the project in 2006 followed by armed less chair (216). While the lowest number (5) of each category of computer table and computer chair was also procured under the project in 2006. The third highest number (108) of each category such as steel almari, file cabinet, rack, wall board, and full secretariat table was also procured in 2006.

Table 10: Procurement of Office Furniture

SL	Description of Item	Quantity (№)	Financial		Procurement Date
			Target	Actual	
1	Full secretariat Table	108	12.90	12.90	23/05/2006
2	Revolving Chair	108	5.38	5.38	
3	Computer table	5	0.15	0.15	
4	Computer Chair	5	0.10	0.10	
5	Armed Chair	432	4.25	4.25	
6	Armed less Chair	216	1.28	1.28	
7	Steel Almari	108	6.95	6.95	
8	File cabinet	108	5.90	5.90	
9	Rack	108	2.15	2.15	
10	Wall board	108	6.45	6.45	
	Total	**1306**	**45.51**	**45.51**	

Procurement of irrigation and water management works: From the data depicted in the Table- 11 that the re-excavation of canal and water bodies and construction of drainage canal works was completed within budget provision of DPP whilst multipurpose use of deep tubewell that includes construction of low-cost deep tubewell, overhead tanks, construction of buried pipe and domestic water supply cost was required less than the budget provision of the DPP which are around 5 lakh. The re-excavation and excavation works of canal, multipurpose use of deep tubewell and demonstration works etc were completed under the supervision of the DAE and the project authority in light with the PPR.

Table 11: Irrigation and water management works

Sl	Item	Quantity	Target (lakh taka)	Actual (lakh taka)
1	Re-excavation of canal & water bodies	2197171 cum	932.75	932.75
2	Construction of drainage canal	59254 cum	340.68	340.68
3	Multipurpose use of deep tubewell	5 nos	79.33	74.53

Procurement of services: It is understood from the key informants interview with the project personnel that only 5 officials was deputed from the DAE and rest 170 project officials and staff were recruited directly with open competition in following the guidelines of PPR for recruitment of outsourcing officials and staffs. Among them 24 and 11 personnel were female official and staff respectively. Out of 170 project personnel, the highest number (112) of agriculture engineers were posted at the 112 upazilas followed by senior agricultural engineers (16) at district and senior agriculture engineers (14) at regional and the lowest number (2) of engineers at head quarter level. All recruitments were project based and their service is no longer available at the DAE hence project farmers are depriving their service of farm mechanization.

Table 12: Project personnel

Item	Manpower		Manpower Employed	
	DPP provision	Employed during execution	Male	Female
Officer	135	135	65	24
Staff	40	40	27	11
Total	175	175	92	35

During discussion with the project director, it was ascertained that project has followed the PPR provision during recruitment of agricultural engineers, procurement of works and goods etc. The consultant has reviewed the relevant documents of the procurement to ascertain whether it has followed PPR 2008 in selection of bidders or not. It found that all the necessary steps of the procurement have followed to select bidders as per bid document specifications. Three types of committee were formed to select bidders for procurement of agriculture machinery such as

tender opening committee (TOC), technical sub-committee (TSC) and tender evaluation committee (TEC). All the selection was completed through these three committees. The brief of the evaluation procedures has been furnished in the Appendix-6 with supporting documents.

Quality testing: Technical sub-committee (TSC) with the representatives of the Bangladesh Agricultural Research Institute (BARI), Bangladesh Rice Research Institute (BRRI) and Bangladesh Agricultural University (BAU) was responsible to test the quality of the supplied equipment and machineries. All the equipments were tested to the BARI premises for analysis of the quality and standard of equipments as per bid documents specification before awarded the bidders.

3.6 Land utilization pattern of the study upazilas

Information on land utilization pattern of a particular area is essential for designing intervention plan for intensification. For example if a particular area is dominated by single crop then it is necessary to know the reasons and design plans for intensification accordingly. In the present impact study data on area under single crop, double crop and triple crop was collected from 14 upazila agriculture offices and subsequently compared with baseline survey data presented in the Table 14 below.

From these data, it revealed that the highest cropping intensity (247.93) was observed in Jessore Sadar upazila due to adoption of double and triple cropping patterns in most of the land which was slightly higher than baseline (245.35) status. This was followed by Cox's Bazar Sadar upazila (230.98), Baliakandi upazila (226.77) of Rajbari district, Gangni (221.49), and Rajbari Sadar upazila (218.55). On the other hand, the lowest (161.58%) cropping intensity was observed in Companiganj Upazila of Sylhet district due to growing of only one crop in maximum land specially Boro rice which was slightly higher than the baseline (160.69) information**.** There was the highest (2.17%) increase in cropping intensity was found in Barisal Sadar upazila followed by Meherpur Sadar upazila (2.14%) as compared with cropping intensity found in Baseline study before project implementation, while no change in cropping intensity was found in Ukhia upazila (0.0%) of Cox's Bazar district and the lowest (0.35%) was found in Cox's Bazar Sadar upazila. The overall 1.04% increase in cropping intensity was found in the study upazilas as compared with cropping intensity found in Baseline study before project implementation. Cropping intensity has been determined by using the following formula:

$$\text{Cropping intensity} = \frac{\text{Total cropped area}}{\text{Net cropped area}} \times 100$$

Where**,**
Net cropped area= single cropped area+ double cropped area+ triple cropped area
Total cropped area= single cropped area×1+ double cropped area ×2+ triple cropped area×3

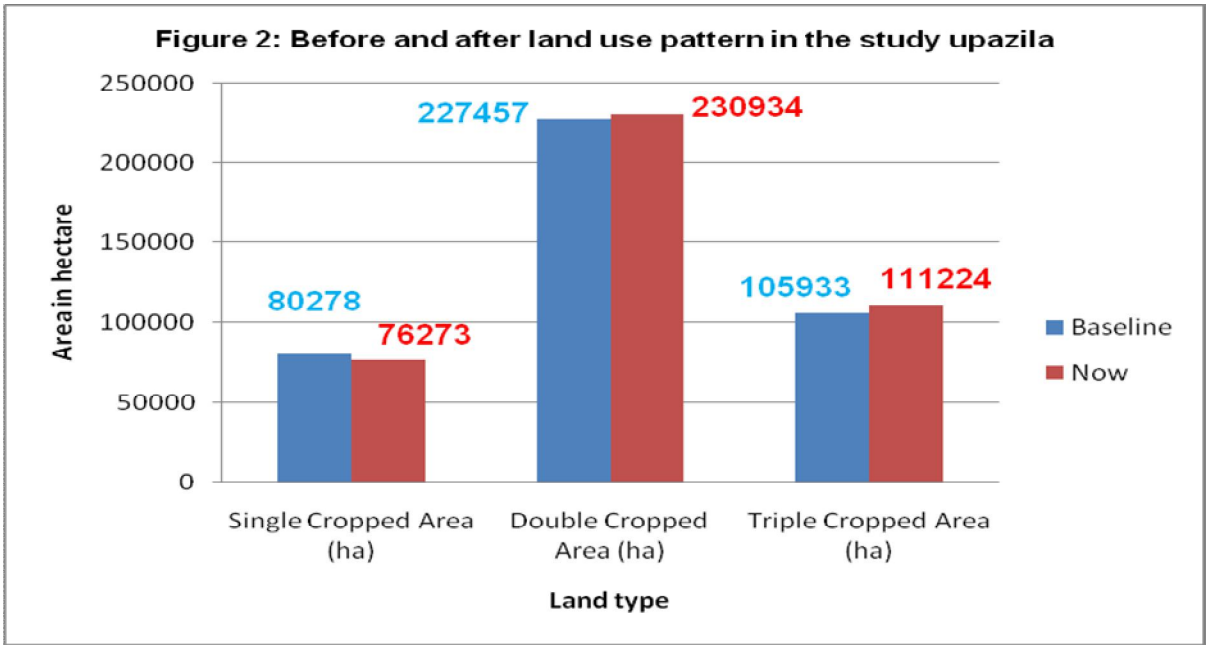
The percent increase over baseline data has been calculated by using the following formula:

$$\textbf{Percent change} = \frac{\text{Value during impact study} - \text{Value of baseline data}}{\text{Value of baseline data}} \times 100$$

Table 13: Land use pattern of the study upazila

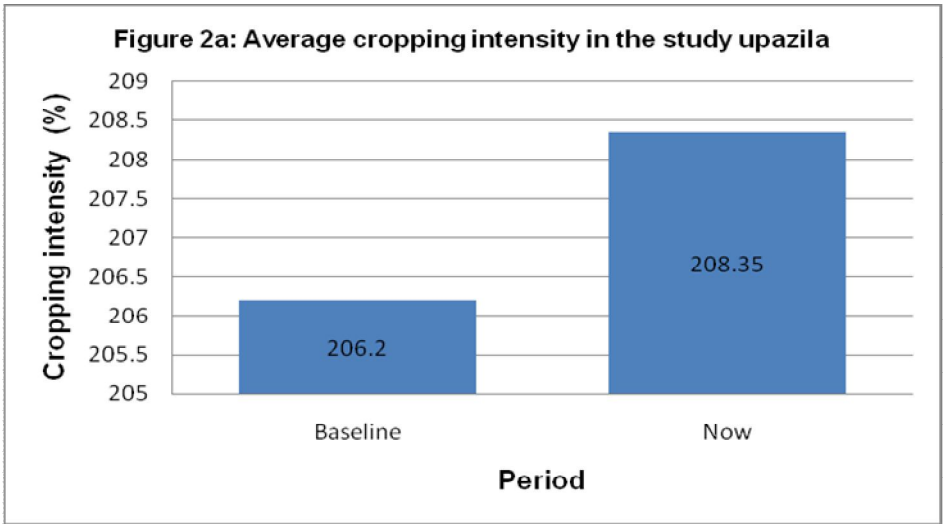
Study Upazila	Baseline status before project				Presented status after project				% Increase
	Single Cropped Area (ha)	Double Cropped Area	Triple Cropped Area	Crop Intensity	Single Cropped Area (ha)	Double Cropped Area	Triple Cropped Area	Crop Intensity	
Sylhet sadar	4727	16200	2550	190.73	4427	16400	2800	193.11	1.25
Companiganj	7500	5630	1679	160.69	7400	5630	1729	161.58	0.55
Cox's bazar sadar	5000	16408	16408	230.17	4800	**16500**	**16516**	**230.98**	0.35
Ukhia	615	11254	843	201.79	615	11321	843	201.78	0.00
Rajbari sadar	5879	31344	15017	217.49	5679	**31344**	**15403**	218.55	0.49
Baliakandi	2850	6408	7114	**226.04**	2850	6501	7311	**226.77**	0.32
Gopalganj sadar	6320	6408	7600	206.30	6110	6801	7950	208.82	1.22
Maksudpur	2727	17200	330	188.17	2521	17300	602	190.60	1.29
Barisal sadar	14795	24093	9386	188.80	13214	**24709**	9824	192.90	**2.17**
Banaripara	4900	29911	975	189.03	4900	30121	1125	189.56	0.28
Jessore sadar	8904	4200	27170	**245.35**	8523	4345	**28210**	**247.93**	1.05
Monirampur	4210	26397	5871	204.55	4115	**26854**	6521	206.42	0.91
Meherpur sadar	9929	14181	4240	179.93	9216	15150	4530	183.78	**2.14**
Gangni	1922	17823	6750	218.22	1903	**17958**	7860	221.49	1.50
14 Upazilas	**80278**	**227457**	**105933**	206.20	**76273**	**230934**	**111224**	208.35	**1.04**

Single-cropped area comprised 76273 hectare which was slightly lower than the baseline data (80,278 ha) as depicted in Figure 2. However, the double-cropped area comprised 230,934 ha which was slightly higher than the baseline data. The similar trend was also reported in case of triple-cropped area that comprised 111,224 ha which was 105933 ha recorded in baseline survey.



3.6.1. Cropping intensity

Cropping intensity was reported 206.20 during baseline survey which was found 208.35% during the impact evaluation study period (figure 2a).



3.7 Total area and production of major crops

Due to location specific environmental characteristics, some crops were grown well in one area than other. Attempt was made to collect crop wise area production and yield of crops commonly grown in the 14 study Upazilas. The findings are presented in **Table 14.**

Among the crops, HYV Boro rice covered highest area (158789 hectares) followed by transplanted HYV Aman (117215 hectares) and wheat (62223 hectares) which was slightly higher than the baseline data. These three crops were also grown in all most all the study Upazilas. The total production from HYV Boro, transplanted HYV Aman and wheat was 800297, 370399 and 117601 metric tons, respectively. Among rice, the highest yield was obtained from HYV Boro rice (5.04 mt/ha) followed by transplanted HYV Aman rice (3.48 mt/ha). Yield of HYV Boro was highest due to application of more amount of fertilizer per unit area compared to other types of rice due to grown in favorable weather condition using control irrigation water. But chilli covered the lowest area (3476 ha) followed by potato (5874) and maize (6954 ha) which was also slightly higher than the baseline data. Among these crops, the highest per hectares yield was obtained from potato (19.9 mt/ha), maize (6.87 mt/ha) and chilli (4.09 mt/ha). The lowest per hectare among crops was obtained from mustard (1.05 mt/ha) followed by B.Aus (1.34 mt/ha) which was remained same with baseline data.

Table 14: Total area and production of major crops in the study upazilas

Description	% Upazila	Baseline status of crop production before project			Current crop production status after project		
		Area (Ha)	Production (MT)	Yield/ha	Area (Ha)	Production (MT)	Yield/ha
T. Aman (local)	92.86	30795	71752	2.33	28556	67963	2.38
T. Aman (HYV)	100	116495	359970	3.09	117215	370399	3.16
Deep Water Aman	42.86	5392	9166	1.7	4215	6323	1.50
T. Aus (Local)	42.86	7232	11644	1.61	6895	12273	1.78
T Aus HYV	50	19970	60709	3.04	22321	77677	3.48
B. Aus	50	17902	23631	1.32	15452	20706	1.34
Boro rice (HYV)	100	127173	628235	4.94	158789	800297	5.04
Wheat	85.71	60774	99669	1.64	62223	117601	1.89
Maize	92.86	4413	27670	6.27	6954	47774	6.87
Jute	71.43	33611	73944	2.2	30611	67344	2.20
Potato	100	4763	94307	19.8	5874	116893	19.90
Sugarcane	71.43	8090	243914	30.15	8090	243914	30.15
Mustard	92.86	13115	13771	1.05	13115	13771	1.05
Chilli	92.86	3466	14176	4.09	3476	14176	4.09
Pulse	92.86	22942	27989	1.22	22942	27989	1.22
Vegetable	92.86	25387	384867	15.16	29654	473871	15.98

CHAPTER 4

FARM MACHINERY

4.1 General

It is inevitable that production process must be modernized in order to maintain sustainable economic growth. From the early age of farming, different types of equipment are being used. At the initial stage most of the equipment were traditional in nature and manually operated. Presently due to scientific advancement different types of farm equipment are being used which are mechanically operated using fossil fuel directly or indirectly. They are capital intensive as well as labor saving. In this study an inventory of this farm machinery is made which was provided from the project with 30% subsidized price and presented in this chapter.

4.2 Use of farm machinery

The use of farm machinery was started in Bangladesh with the objective of applying modern engineering knowledge to increase agricultural productivity, improve product quality and minimize losses through utilization of machine tools. The data related to use of farm machinery was collected from primary and secondary sources and meticulously examined. It revealed from the Figure-1 that 98.6% farmers reported that they are currently using farm machinery for their agriculture related activities while only 1.4% farmer reported that they did not use farm machinery.

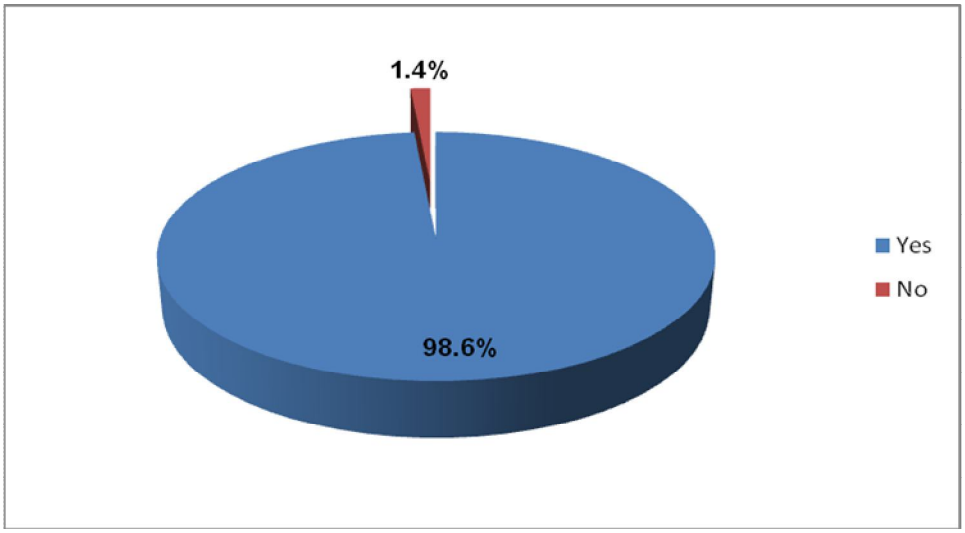


Figure 3: Response on the use of farm machinery

4.2.1 Types of farm machinery used

Among diverse farm machineries used by the farmers, the most popular machineries are power tiller, thresher, seeder, weeder, sprayer etc. The results also showed that there is an increase trend in use of different types of farm machineries as compared to before the project implementation.

The highest percent increase (42.56%) of farm machinery used after implementation of project was found in case of sprayer, which was close to the weeder (41.32%) as compared to before project implementation. These results were followed by the percent increase of the use of power tiller (36.50%) and power thresher for rice and wheat (21.76%) over the use of farm machineries before project implementation. However, the negligible percentage of increase was found for self-propelled reaper (1.10%), power winnower (1.38%), power tiller operated reaper (1.52%), drier (1.52%), sprinkler irrigation machine (2.89%) and power

thresher for maize (5.65%). The use of farm machineries might be increased due to arrangement of training and demonstration on farm machinery which created great awareness among the farmers regarding advantage in use of farm machinery.

Table 15: Types of farm machineries are used in the study upazilas

Type of farm machinery	Before project	During study	% increased
	Equipment №	Equipment №	
Power tiller	367	632	72.21
Seeder	123	301	144.72
Weeder	24	324	**1250.00**
Sprayer	219	528	141.10
Reaper (self propelled)	3	11	266.67
Reaper (power tiller operated)	0	11	1100.00
Power thresher (rice & wheat)	376	534	42.02
Power thresher (maize)	10	51	410.00
Power winnower	0	10	1000.00
Drier	0	11	1100.00
Sprinkler irrigation machine	1	22	**2100.00**

Source: Upazila Agriculture Office

Chi-Square Test:

Association between before and after farm machineries:

HO: There is association between before and after project implementation on the use of farm machineries.

Conclusion: The Chi-square analysis shows that the calculated value of Chi-square is 0.509 at 5% level with 10 degree of freedom where the tabulated value is 18.31.

Therefore, we accept the hypothesis as the calculated value is lower than tabulated value. In this case, we can conclude that that there is significant effect on the use of farm machineries on the production.

4.3 Present conditions of farm machinery supplied by the project

Migration of farm-labor force to more attractive non-farm jobs has already created negative pressure on the crop productivity. Therefore, land and labor productivity in Bangladesh has to be increased. Focusing on the complementary agriculture, agricultural machinery sectors provides a powerful opportunity to do so.

In general agricultural mechanization has gained popularity among farmers for its multi-dimensional benefits such as reduction of operational cost and human drudgery, timeliness of operation, increase labour productivity and efficiency. Limited agricultural activities such as land preparation, irrigation, weeding, spraying and threshing of crops have been mechanized at least partially in Bangladesh. It needs to be extended horizontally throughout the country to harness more benefits out of it. Other labour intensive agricultural activities such as sowing seed & seedling, fertilizer applicator, drying, winnowers, harvesters, water saving technology & water management, storing and processing are equally demanding areas of mechanization.

Traditional method is being used for production using cattle and human power. Due to decline in cattle population and human power, currently it is not possible to perform required tillage, pest control and post-harvest processing operation in time. On the other hand, due to intensification of cropping in many cases it is needed to prepare the land within a very short

time to maintain optimum time of planting for specific crops. In addition, application of on-time spraying, seeding, weeding, harvesting, threshing, winnowing, and drying are very important for cost-effective quality production. To ease the situation farm machinery are being used. In this study an attempt is made to quantify the numbers of farm machinery supplied from the project at the study Upazilas and its present conditions and extent of use through physical observation.

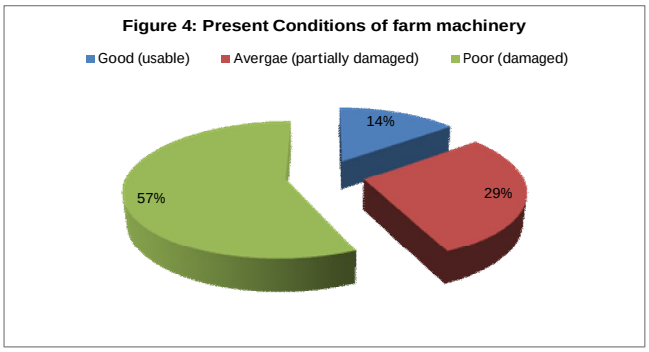
The data showed in Table 16 depicted that 113 different types of agriculture machinery including 5 sprinkler irrigation machines were supplied by the project with 30% subsidized price during 2007 to 2009. The highest (29) number of power tiller were supplied by the project while the lowest (3) number of reaper (self-propelled). In addition, 5 multipurpose use of deep tube-well was supplied by the project which was an excellent intervention of the project to supply irrigation water through buried pipe and drinking water.

The results also showed that majority (56.78%) of the equipments are completely damaged/poor condition. More than two third (80%) of the multipurpose use of deep tubewell only is in good conditions while highest (100%) of the reaper (self-propelled) are in bad conditions followed by power thresher-maize (75%), power winnower (75%), reaper-power tiller operated (75%) and power tiller (62.07%). The lowest (40%) of the sprinkler irrigation set and drier is in bad conditions followed power thresher (rice & wheat) 52%, seeder 55%, sprayer 55.56%, and weeder 60%. Most (85.59%) of the equipments (101 out of 118) are either completely damaged (poor condition) or partially damaged (average condition), which is usual as reported by the farmers considering 3-4 years life cycle of the equipments.

Table 16. Present conditions of machinery supplied by the project in the study upzilas

Farm machinery Name	Present conditions of the equipments							
	Good		Average		Poor		Total	
	№	%	№	%	№		№	%
Power tiller	2	6.90	9	31.03	18	62.07	29	100
Seeder	1	9.09	4	36.36	6	54.55	11	100
Weeder	1	10.00	3	30.00	6	60.00	10	100
Sprayer	1	11.11	3	33.33	5	55.56	9	100
Drier	1	20.00	2	40.00	2	40.00	5	100
Reaper (self-propelled)	1	33.33	-	-	3	100.00	3	100
Reaper (power tiller operated)	-	-	1	25.00	3	75.00	4	100
Power thresher (rice & wheat)	5	20.00	7	28.00	13	52.00	25	100
Power thresher (maize)		0.00	1	25.00	3	75.00	4	100
Power winnower	-	-	1	12.50	6	75.00	8	100
Sprinkler Irrigation Machine	1	20.00	2	40.00	2	40.00	5	100
Multipurpose use of DTW	4	80.00	1	20.00	-	-	5	100
Total	**17**	**14.41**	**34**	**28.81**	**67**	**56.78**	**118**	**100**

It depicted from the figure that around 57% of the supplied equipments are completely damaged while 29% are in partially damaged which can be used with repair and maintenance. Only 14% of the supplied equipments are in working condition which was supplied in 2010.



4.4. Extent of use of farm machinery

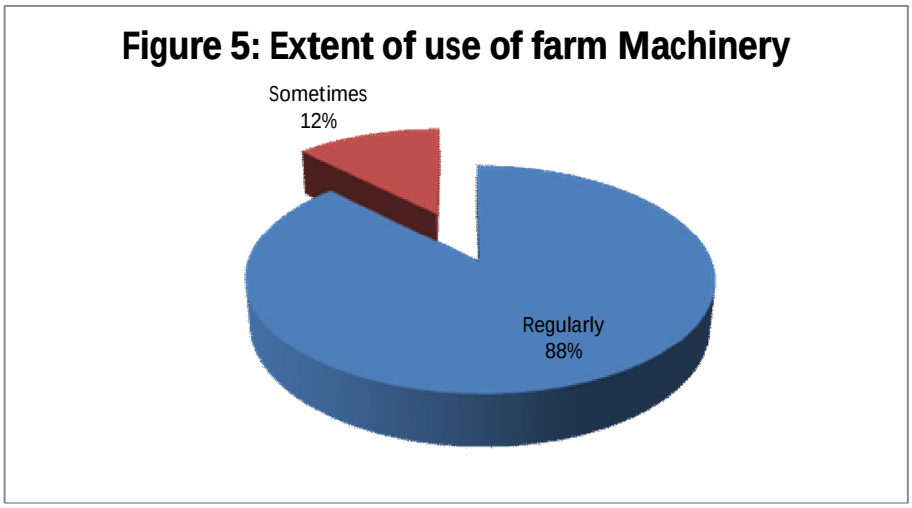
Bangladesh agriculture has been facing serious challenges of scarcity of agricultural labour not only in peak working seasons but also in normal time. Agricultural mechanization is quite capable to fill the gap of labour shortage. Keeping in mind the importance of the farm machinery use, the data related to extent of use of farm machinery were collected from the field and analyzed.

The results of the table showed that all (100%) of the power tiller and power thresher owners reported to have regular use in their agricultural tillage and post-harvest processing activities. This results followed by seeder (72.73%), weeder (70%), power thresher-maize and power winnower (50%). However the lowest (40%) of the sprinkler irrigation users reported to have regular use followed by reaper in case of self-propelled (33.33%) and reaper in case of power tiller operated (33.33%). The widely use farm machinery are power tiller and power thresher as well as weeder, sparyer, and seeder. While rest of the equipments are used in regular and sometimes basis as recorded during physical observation visit. This is mainly due to availability and necessary knowledge of the products.

Table 17. Extent of use of farm machinery supplied by the project in the study upzilas

Farm Machinery Name	Extent of use of equipments					
	Regularly		Sometimes		Total	
	№	%	№	%	№	%
Power tiller	29	100.00	-	-	29	100
Seeder	8	72.73	3	27.27	11	100
Weeder	7	70.00	3	30.00	10	100
Sprayer	9	100.00	-	-	9	100
Drier	3	60.00	2	40.00	5	100
Reaper (self-propelled)	2	66.67	1	33.33	3	100
Reaper (power tiller operated)	2	50.00	2	50.00	4	100
Power thresher (rice & wheat)	25	100.00	-	-	25	100
Power thresher (maize)	4	100.00	-	-	4	100
Power Winnower	6	75.00	2	25.00	8	100
Sprinkler Irrigation Machine	4	80.00	1	20.00	5	100
Total	**99**	**87.61**	**14**	**12.39**	**113**	**100**

The highest (88%) of the farm machineries are currently using for agricultural activities while only 12% of the equipments are not using regularly which is using sometimes basis due to lack of operators and less knowledge on the use of the equipments. This is mainly due to create new user of the farm machinery and re-purchase of the project beneficiaries in the study upazilas.



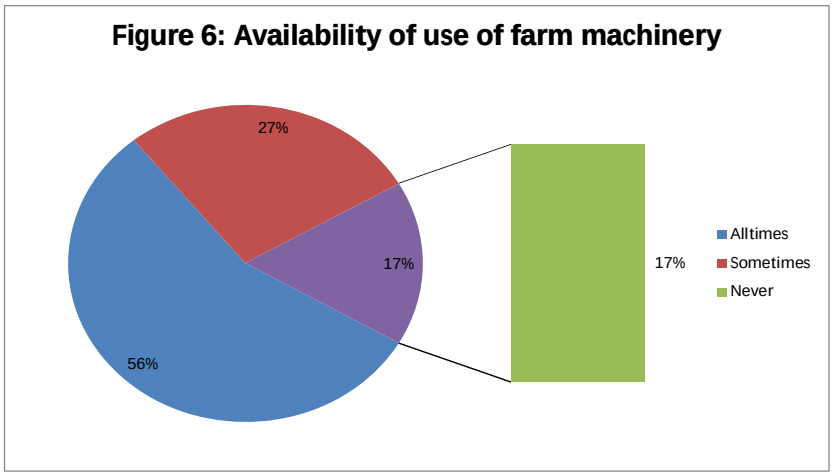
4.5. Availability of use of farm machinery

Most of the farmers were small, marginal and landless categories. The purchase affordability of the farm machinery was very limited to the farmers. Therefore, most of the farmers depended on rented equipments for their field as price was out of their financial ability. Usually rich farmers bought the farm machineries and rent these to the other farmers. The data regarding availability of farm machinery collected from the farmers and these were examined. The results showed that most (80%) of the owners of the equipment reported that power thresher (rice and wheat) was most available equipment used in post-harvest activities followed by power tiller (78.27%), seeder (50%), drier (40%), seeder (27.22%), and sprayer (22.22%).

Table 18: Availability of different type of farm machineries in the study upzilas

Name of equipment	Availability of use of farm machineries							
	All times		Sometimes		Never		Total	
	№	%	№	%	№	%	№	%
Power tiller	17	58.62	8	27.59	4	13.79	29	100
Seeder	3	27.27	4	36.36	4	36.36	11	100
Weeder	5	50.00	1	10.00	4	40.00	10	100
Sprayer	2	22.22	4	44.44	3	33.33	9	100
Drier	2	40.00	1	20.00	2	40.00	5	100
Reaper (self-propelled)	2	66.67	1	33.33	-	-	3	100
Reaper (power tiller operated)	2	50.00	2	50.00	-	-	4	100
Power thresher (rice & wheat)	20	80.00	5	20.00	-	-	25	100
Power thresher (maize)	2	50.00	2	50.00	-	-	4	100
Power Winnower	3	37.50	3	37.50	2	25.00	8	100
Sprinkler Irrigation Machine	5	100.00	-	-	-	-	5	100
Total	**63**	**55.75**	**31**	**27.43**	**19**	**16.81**	**113**	

The results showed that 56% equipments are available to use all times other than the owners while 30% equipments are available to use on occasional basis other than the owners. The rest 24% equipments are no longer available to use which either is using by the owners or lack of operators to rent it.



4.6. Repair and maintenance

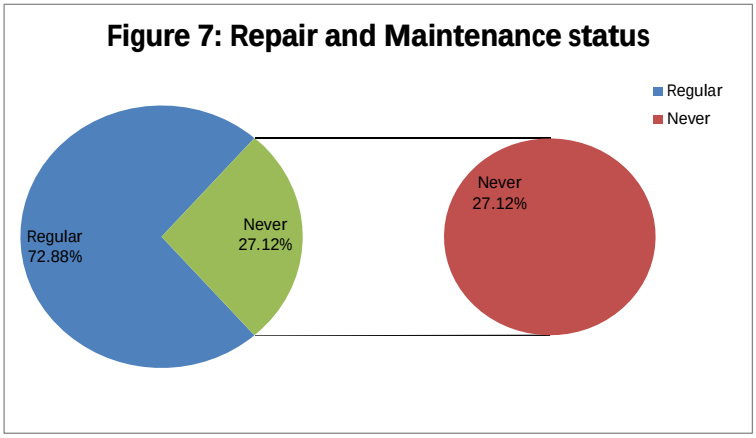
Repair and maintenance is very crucial for any kind of equipments to increase its longevity. It is understood from the project that farm machinery equipments longevity can be calculated maximum of 4-5 years subject to regular repair and maintenance. During field visit and focus group discussion, it revealed that repair and maintenance facilities like, spare parts, workshop and skilled technical persons are limited to get this service in the door step of the farmers. Hence, it is always difficult to properly repair and maintain the equipments. In addition, high cost of accessories also another obstacle as reported by the farmers.

The results showed in Table 19 depicted that 100% owners of the equipment reported that the power thresher for maize and multipurpose use of deep tube well were repaired and maintained regularly by the farmers followed by power thresher for rice and wheat (92.00) and weeder (80.00%) and power tiller operated reaper (75%). On the other hand, the lowest (33,33%) of self-propelled reaper was regularly repaired and maintained by the farmers followed by drier (40%), and power winnower (50.00%) and it is due to non-availability of adequate facilities and spare parts nearest to the farmers. However, the multipurpose use of deep tube well was maintained regularly (100%) as it is generating revenue for the water pump owners as well as to supply drinking water to the rural family.

Table 19: Repair and maintenance status of the different type of machineries

Name of equipment	Repair & maintenance status of the equipments					
	Regularly		Never		Total	
	№	%	№	%	№	%
Power tiller	21	72.41	8	27.59	29	100
Seeder	7	63.64	4	36.36	11	100
Weeder	8	80.00	2	20.00	10	100
Sprayer	5	55.56	4	44.44	9	100
Drier	2	40.00	3	60.00	5	100
Reaper (self-propelled)	1	33.33	2	66.67	3	100
Reaper (power tiller operated)	3	75.00	1	25.00	4	100
Power thresher (rice & wheat)	23	92.00	2	8.00	25	100
Power thresher (maize)	4	100.00	-	-	4	100
Power Winnower	4	50.00	4	50.00	8	100
Sprinkler Irrigation Machine	3	60.00	2	40.00	5	100
Multipurpose use of DTW	5	100.00	-	-	5	100
Total	**86**	**72.88**	**32**	**27.12**	**118**	**100**

The results depicted that two third (72.88%) of the supplied equipments were regularly repaired and maintained by the owners while 27.12% equipments were not regularly or never repair and maintained by the farmers due to non-availability of the spare parts and its associated cost.



4.7 Overall quality of the supplied equipment in the study upazilas

Quality of the supplied equipments is very vital. But quality is always related to the cost. If project has adequate budget, highest quality of equipments can be ensured. Due to lengthy process of selection, price of equipments during supply become higher than the quoted price, thus it become difficult to provide quality products within the estimated price. Adequate price adjustment provision in the DPP is needed to address this problem. During discussion with the project director, it was ascertained that project authority had taken all measures to ensure highest quality of the equipments. In spite of this, farmers sometimes are not happy until they receive their preferred branded products even if it's better brand than their desired one. In view of this, data were collected and examined to know their view on quality of the supplied equipments.

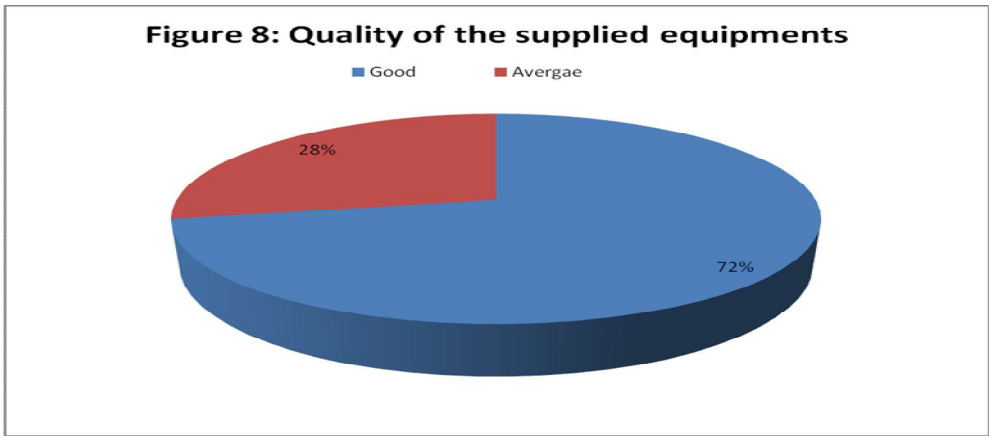
The results showed that two third (85) of the supplied equipments were in very good quality while only 33 number of the supplied equipments were in average quality. The average quality equipments used to create problem during operation compared to good quality. Two types of power tiller were supplied in the study upazila which are Donfeng and Sipheng. The Sipheng brand power tiller was very good and popular to the farmers but donfeng was not good or popular to the farmers as reported during physical observation.

The results showed in the Table 20 depicted that the all the owners (100%) reported that project had supplied good quality of self propelled reaper, power thresher for maize, sprinkler irrigation machine and multipurpose use of deep tube well followed by power thresher for rice and wheat (84%), weeder (80.00%), and power tiller operated reaper (75%).

Table 20: Overall quality of the supplied equipments in the study upazilas

Name of equipment	Quality of the equipments					
	Good		Average		Total	
	№	%	№	%	№	%
Power tiller	15	51.72	14	48.28	29	100
Seeder	7	63.64	4	36.36	11	100
Weeder	8	80.00	2	20.00	10	100
Sprayer	5	55.56	4	44.44	9	100
Drier	3	60.00	2	40.00	5	100
Reaper (self-propelled)	3	100.00	-	-	3	100
Reaper (power tiller operated)	3	75.00	1	25.00	4	100
Power thresher (rice & wheat)	21	84.00	4	16.00	25	100
Power thresher (maize)	4	100.00	-	-	4	100
Power Winnower	6	75.00	2	25.00	8	100
Sprinkler Irrigation Machine	5	100.00	-	-	5	100
Multipurpose use of DTW	5	100.00	-	-	5	100
Total	**85**	**72.03**	**33**	**27.97**	**118**	**100**

It depicted that more than two third (72%) of the supplied equipments were in good quality while only 28% equipments were in average standard of quality which was mainly due to power tiller. It is due to better performance of the sifeng brand than the donfeng brand among two brands of the power tiller supplied in the project.



View of Farm Machinery

Plate-1: View of Power tiller (condemned), Manirampur, Jessore

Plate-2: View of Power thresher (maize) under repair & maintenance, Rajbari sadar

Plate-3: View of power tiller (not in use) Rajba sadar

Plate-4: Power tiller is in bad conditions (Jessore)

CHAPTER 5

IRRIGATION AND WATER MANAGEMENT

5.1 General

In Bangladesh systematic irrigation started in the early 1960s, with the introduction of deep tube wells and low-lift pumps. Before that period, farmers used to grow crops under rainfed conditions. Shallow tube wells came into operation after 1980. Bangladesh has a land area of about 8.731 million ha of which 8.520 million ha (97.58%) are under cultivation. At present about 82.86% of the cultivable land (7.059% million ha) has irrigation facilities. This amounts to about 47% of the total cropped area[1].

The demand for irrigation water is increasing day by day and the cost is increasing accordingly. By minimizing losses of irrigation water, more area can be irrigated with the same volume of water. If a proper water management technology is practiced agricultural production can be increased through either higher yield or larger irrigated areas.

Improvement in agricultural production required major modification in the cropping environment in the country. At the center of this effort to increase agricultural productivity and intensification of agriculture were the advancements in irrigation and water control technology. Introduction of irrigation facilities assured production of crops in the dry season as well stabilized production through supplemental irrigation that ensured greater productivity and created employment in the crops sector. This chapter provides information on efficiency in use of irrigation by improved means of irrigation.

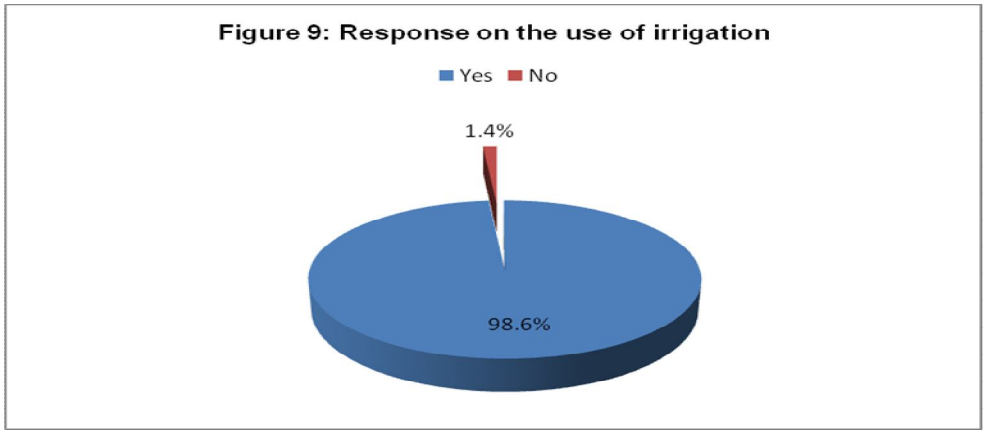
5.2 Response on the use of irrigation water and its source

A wide variety of crops are grown in Bangladesh during Kharif and Rabi seasons. Kharif crops are grown in the summer season and harvested in late summer or early winter. In this season crops are mostly grown under rainfed condition and supplemental irrigation assured for higher production. On the other hand, Rabi crops are grown in winter and harvested in the early summer. Almost the whole of Rabi season is dry and most of the crops especially cereals and vegetables are grown using irrigation water. The following sections of this chapter provide information on area under irrigation by season and by means of irrigation.

5.2.1 Response on the use of irrigation

Around all (98.6%) of the respondents reported that they used irrigation water in their agriculture production activities especially in rabi season (Figure 9). Due to use of high yielding varieties and higher crop intensity for production of more food grain, the farmers depended more on underground water than the surface water which is decreasing every year.

[1] BBS and MOA 2013



5.2.2 Source of irrigation water

From the Figure-10, similar trend of results found where most (84.57%) of the respondents reported that they used underground water such as deep-tube well and shallow tube well while only (15.43%) of the respondents reported they used surface water for their agriculture production activities.

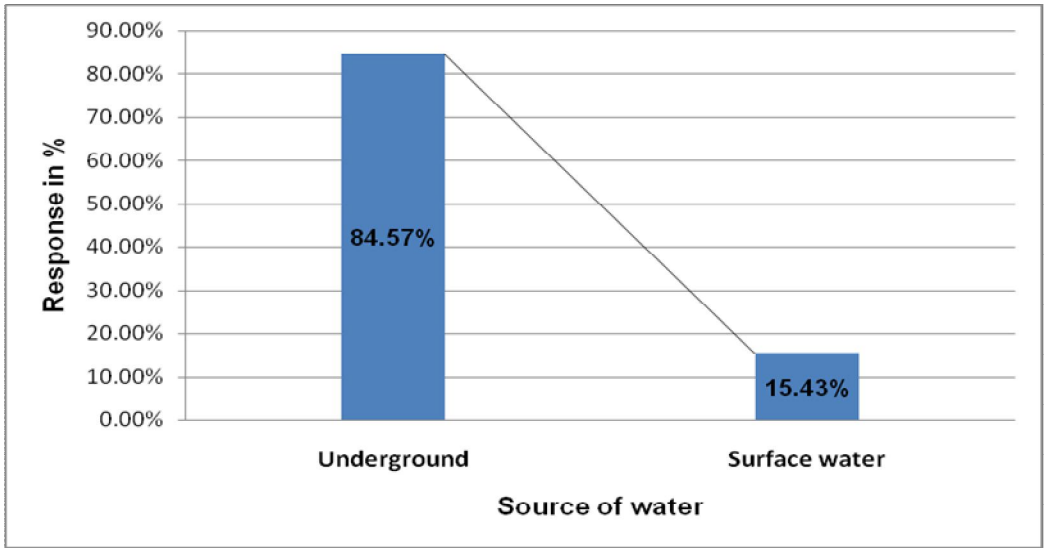
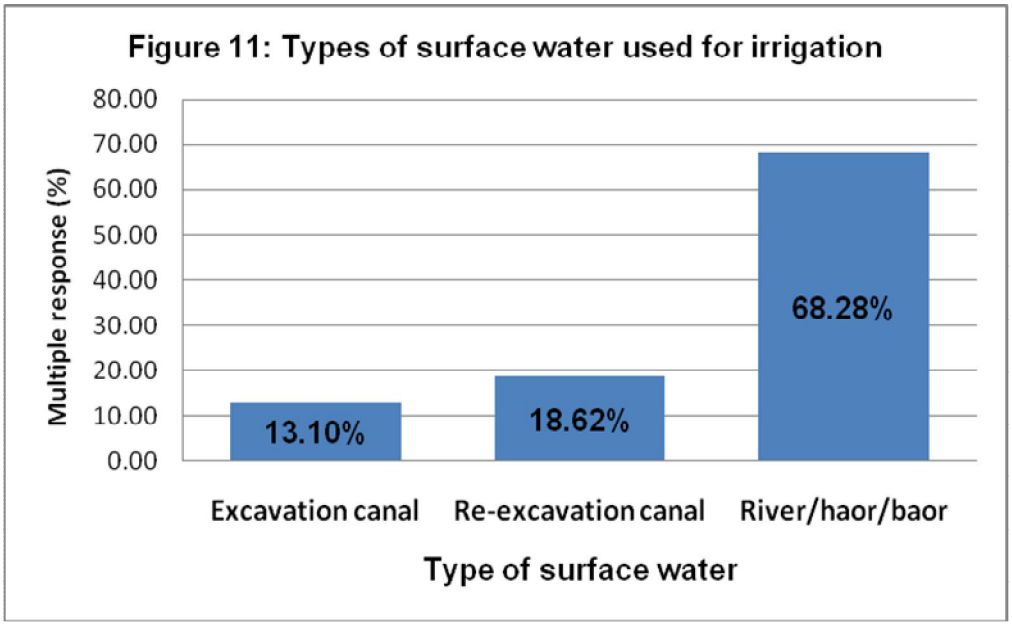


Figure 10: Source of irrigation water

5.2.3 Types of surface water used

As for the sources of surface water use for irrigation, more than two third (68.28%) of the farmers reported that they were being used river/haor/baor water followed by re-excavation canal (18.62%). However, the lowest (13.10%) respondents reported they used the excavation canal water for their agriculture activities. It is due to increase the water retention area through excavation and re-excavation in the project area including availability of river/haor/baor water in most of the study districts.



5.3 Methods of irrigation facilities

Groundwater is the main source of irrigation for increasing crop production in Bangladesh. Knowledge of the groundwater-surface water interaction reveals that changes in one affect the other. Availability of groundwater for irrigation has contributed to manifold increases in crop productivity of Bangladesh, particularly in northwest region. However, the overwhelming population, food insecurity, poor water management and below average rainfall are putting unprecedented pressure on groundwater. Very often it is a common concern that groundwater table in the northwest region is gradually declining causing anxiety for the expanded irrigation system in the area. On the other hand, Bangladesh Water Development Board (BWDB) is responsible for large-scale irrigation through construction of dams, barrages, embankments, regulators and other structures. Some Upazilas of Southern and Western region under the study are located under the jurisdiction of large-scale irrigation projects of BWDB. The methods of irrigation data were collected and in the fourteen study upazila and analyzed.

The results showed in the Table 21 depicted that the highest (50.83%) respondents reported that they used improved earth canal irrigation method for crop cultivation, while it was only 1.79% before project implementation. As a result, the increase of irrigation facilities calculated over the baseline data is 2738.46%. This increase was achieved only due to training and demonstration on improved irrigation facilities in the project upazila. This increase was followed by buried pipe method (945.45%), drip irrigation (707.14%), precast canal method (584.62%) and sprinkler irrigation method (500.00%). On the other hand, lower increase of irrigation facilities over baseline data is 80.65% for plastic or thread pipe irrigation method followed by pressure pump or hand shower method (87.27%). Conversely, 17.04% decreasing trend in use of irrigation facilities/method was observed for others categories of irrigation method such as earthen canal as recorded compared to the baseline data. This is due to improvement of facilities like pre-cast canal, buried pipe, drip irrigation, improved earthen canal etc in the project area through training and demonstration to create awareness for efficient use of irrigation water.

These irrigation facilities are very efficient and cost effective and also environment friendly as it need at 1/3 less water to irrigate crop field. Though initial investment is high which is not possible to bear by the marginal, landless and small farmers thus government support is very much important to expand such types of irrigation which will save underground water, access

fuel/ electricity and ensure adequate irrigation to produce more quality food.

Table 21: Irrigation method used for cultivation in the study upazilas

Name of Irrigation Method	Total number of respondents (N=726)				
	Before project		During impact study		Percent change
	Response	Percent	Response	Percent	
Buried pipe	11	1.52	115	15.84	945.45
Sprinkler irrigation	17	2.34	102	14.05	500.00
Improved earthen canal	13	1.79	369	50.83	**2738.46**
Precast canal	26	3.58	178	24.52	584.62
Drip irrigation	14	1.93	113	15.56	707.14
Pressure pump/hand shower	55	7.58	103	14.19	87.27
Plastic /thread pipe	31	4.27	56	7.71	80.65
Others/Earthen canal	587	80.85	487	67.08	-17.04
Multiple response					

Chi-square test:

Association between before and after irrigation methods and their uses:

HO: There is association between before and after project implementation on the use of irrigation method.

Conclusion: The Chi-square analysis shows that the value of Chi-square is 0.602 at 5% level with 7 degree of freedom where the tabulated value is 14.07.

Therefore, we accept the hypothesis as the calculated value is lower than tabulated value. In this case, we can conclude that that there is significant effect on the use of improved irrigation method to reduce wastage of irrigated water.

Some Photographs of Irrigation Methods

Plate-5: View of pre-cast Canal at Manirampur, Jessore

Plate-6: View of earth canal, Rajbari Sadar

Plate 7: View of buried pipe irrigation at manirampur, Jessore

Plate-8: View of Plastic thread pipe at Rajbari sadar

Plate-9: View of unused earth canal, Rajbari

Plate-10: Pre-cast canal is partially damaged at Rajbari

5.4 Extent of irrigation coverage

Improvement in agricultural production required major modification in the cropping environment in the country. At the center of this effort to increase agricultural productivity and intensification of agriculture were the advancements in irrigation and water control technology. Introduction of irrigation facilities assured production of crops in the dry season as well stabilized production through supplemental irrigation, ensured greater productivity and created employment in the crops sector. This chapter provides information on area under irrigation by season and by means of irrigation.

A wide variety of crops are grown in Bangladesh during Kharif and Rabi seasons. Kharif crops are grown in the summer season and harvested in late summer or in early winter. In this season crops are mostly grown under rainfed condition and supplemental irrigation assured higher production. On the other hand Rabi crops are grown in winter and harvested in the early summer. Almost the whole of Rabi season is dry and most of the crops specially cereals and vegetables are grown using irrigation water.

The results showed in the Table 22 depicted that area under Shallow tube well (STW) have been increased by 7.79% followed by area under Deep tube well (4.97%) as compared to the baseline data due to crop intensification and use of HYV varieties as well as decreasing trend of large scale irrigation in rabi season. However, area under local device has been decreased by 18.67% followed by area under large scale irrigation (8.11%) as compared to the baseline data which is mainly due to advantage in use of improved irrigation methods and scarcity of surface water irrigation. But still local device system covered highest (189876 ha) area under rabi season followed by STW area (163735 ha).

Table 22: Extent of irrigation coverage by season

Description	Before project				During impact study (2014)				% Change
	Rabi	Kharif-1	Kharif-2	Total	Rabi	Kharif-1	Kharif-2	Total	
Area under large scale irrigation	57994	162	1305	59461	52765	198	1678	54641	-8.11
Area under DTW	20894	0	831	21725	21725	0	1080	22805	4.97
Area under LLP	20384	45	479	20908	20908	40	412	21360	2.16
Area under STW	152249	785	10701	163735	163735	990	11770	176495	7.79
Area under local device	233430	5	30	233465	189876	5	5	189886	-18.67

Note: DTW=*Deep tube well used for underground water,* ***LLP****=Low lift pump used for surface water irrigation;* ***STW****=Shallow tube well used for underground water;* ***Local device*** *or traditional device used for lifting surface as well as ground water such as* Done

CHAPTER 6

TRAINING AND DEMONSTRATION

6.1 General

The Government of Bangladesh (GoB) has given utmost importance on human resource development and seemingly created innovative policies and practices aimed at capacity development of the public and private sector personnel. However, despite considerable progress made so far, significant problems persist including the slow rate of technological development. Human resources both from public and private sector with adequate skills and knowledge are central to achieving equitable and sustainable development. Importance of manpower development for overall socio-economic up-liftmen of any nation should be emphasized.

Modernization of farming system in Bangladesh is at the initial stage. Operation and maintenance of the machinery is very complex and very new to many of the owners, operators as well as users. Training - an important means of skill development - is very essential for diffusing all these complex technical knowledge among the farmers. Therefore, an attempt was made to determine the number and types of training received from the project in the study area.

6.2 Training Programs

Training was an important component of the project. A brief of the total training activities has been presented in Table-23. It appeared that a total of 297,258 participants such as farmers, SAAO officer of DAE, mechanic and technical staff and officers of the project and private sector were trained during the project period in the topic of farm machinery and modern irrigation technologies and its unit demonstration program. The highest (92.30%) participants training and workshop was organized for farmers followed by SAAO officer (4.89%) whereas lowest (0.59%) participants were attended from technical officers/staff from public and private sector.

Table 23: Training programs of the project

SL	Trainee Category	№ of Participants	Percent
1	**Farmers** training for unit demonstration of farm mechanization	274372	92.301
2	**SAAO** training for unit demonstration of farm mechanization	14555	4.896
3	**Mechanic** training for irrigation and agricultural machinery	6448	2.169
4	**Technical staff**/officer training	1770	0.595
	Total	**297,258**	**100**

***Source**: DPP and PCR of the project*

6.3. Demonstration Programs

Besides, a large number of demonstration programs were organized on improved water management related activities (Table 24). There is a total 7024 demonstration program was conducted under the project in different improved method of irrigation such as improved earth canal (1464), buried pipe (224), sprinkler irrigation (693), drip irrigation (1647), hand shower irrigation with pressure pump (2327), and mechanized farm (641). The highest and lowest demonstrations were organized for hand shower irrigation with pressure pump and sprinkler irrigation which is 33.139% and 0.399% respectively.

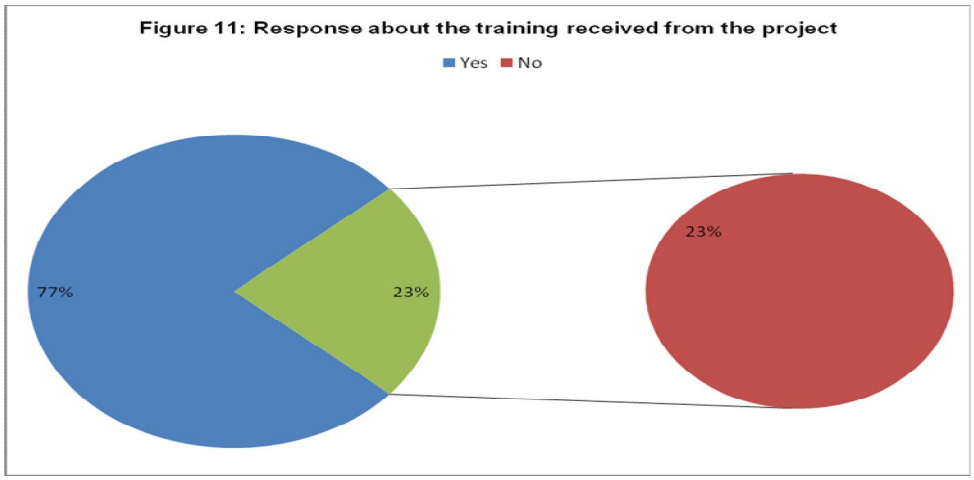
Table 24: Demonstration program of the project

SL	Description of item	№ of Demonstration Program	Percent
1	Improved earth canal- STW command area	1464	20.843
2	Buried pipe irrigation-STW command area	224	3.189
3	Pre-cast canal	693	9.866
4	Sprinkler irrigation	28	0.399
5	Drip irrigation	1647	23.448
6	Hand shower irrigation with pressure pump	2327	33.129
7	Mechanized farm (seed & others)	641	9.126
	Total	**7024**	**100**

***Source**: DPP and PCR of the project*

6.4. Number of the respondents received training

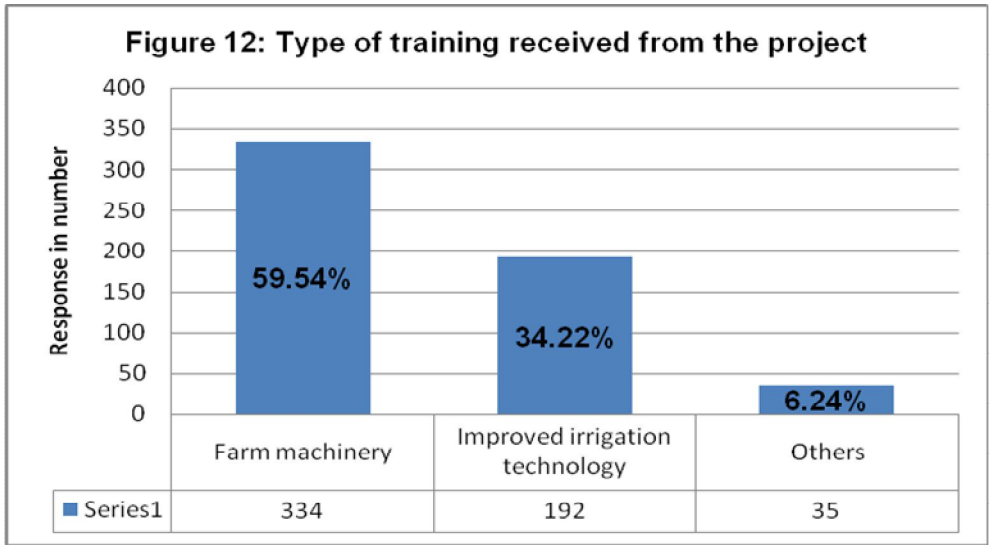
Training has been provided on different topics. Study data indicated from the Figure-11 that around (77%) of the respondents reported that they received training from the project.



6.5. Types of training received

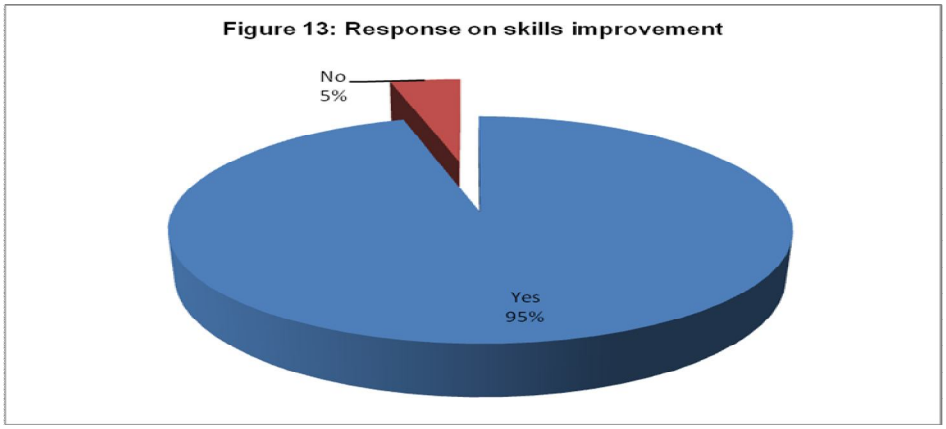
Knowledge about the training was more spread among the farm machinery, improve irrigation technology and others. About 59.54% participants reported to have received training on farm machinery followed by improved irrigation technology (34.22%) while lowest 6.24% participants reported to have received training neither farm machinery nor improved irrigation technology but others such as operators and repair and maintenance. The training duration was 1-2 days without any follow-up training.

Training has increased their knowledge and skill of farm machinery and improved irrigation technology. The beneficiaries were asked about the problems of the training program. Main problem related to training was of very short duration and that has been stopped after the phasing out of the project. In all cases follow-up training was virtually absent. On being asked about the ways of improvement of training, it was suggested to have more practical demonstration and allocation of more time, preferably 3-5 days and provision of adequate fund on a continuous basis.



6.6. Impact of training in skills development

The results relating to the impact on the improvement of participant's skills and efficiency has been summarized in figure 13**.** The results showed that highest number of participants (95.43%) reported to have positive change in skills development due to training and demonstration by the project authority. Only 4.57% participants responded negatively.



6.7. Level of skill improved

The highest (61.68%) participants reported that the skills have been improved at satisfactory level followed by average (29.89%). However, the lowest (0.435%) participants reported the improvement of skills at non-satisfactory level due to training and demonstration programs provided by the project. While only 7.98% participants expressed their highest level of satisfaction over training and demonstration in respect of skills development.

Table 25: Level of skill improved due to the training

Skill level	Total number of respondents (N=689)	
	Response	Percentage
Very satisfactory	55	7.983
Satisfactory	425	61.684
Average	206	29.898
Non-satisfactory	3	0.435
Total	**689**	**100**

CHAPTER 7

SOCIO-ECONOMIC IMPACT OF FARM MECHANIZATION

7.1 General

Modern irrigation systems are needed to ensure optimal use of irrigation water through avoiding wastage and water loss. This will enable the farmers to maximize the use of irrigated water towards increasing the crop yields. Introduction of modern irrigation facilities associated with mechanization of farming generates national as well as farm level impacts. In this study an attempt was made to quantify the impact of farm mechanization including irrigation at the farm level in respect of ownership of land, reduction of irrigation and crop loss, land use pattern, cropping intensity, crop production, income, quality of food, and employment etc. The owners of the farm machinery derived benefits in two ways: by using in his/her own production process and by providing services to others/renting out to others. It is expected that income generated from these will be invested in various productive as well as other purposes, which will improve their assets or standard of living. It is also expected that the users of the farm machinery will be benefited and this will improve their assets or standard of living as well. This chapter provides information on impact of farm mechanization at the farmer household level.

7.2 Impact on ownership of land

Land is the key factor of agricultural production and its ownership is a significant determinant of poverty in rural Bangladesh. Change in ownership pattern of homestead, own land under own cultivation and pond was quantified. There is no significant change observed in the ownership of land. There has been very small (1.527%) increase in the size of homestead garden which used to remains more or less same for longer period of time. In case of urgent need due to division of a joint family new house is constructed developing new homestead area. There has been a slight (2.608%) increase in own land under own cultivation and area under mortgage (1.691%). This may be either for increased the purchase ability of the farmers or more coverage of fellow land. Areas of pond and lease land are reduced by 4.667% and 2.771% respectively (Table-26). It is mainly to decrease of surface water in water channel.

Table 26: Extent of changes of ownership of land resources

Description	Average Area (acre)	
	Baseline	Impact study
Own homestead	0.131	0.133
Own land under cultivation	0.997	1.023
Lease land	0.433	0.421
Mortgage land	0.414	0.421
Pond	0.15	0.143

t-test (two mean test) to investigate for extent of changes of ownership of land resources

To see the extent of changes of ownership of land resources between baseline and impact evaluation survey two mean tests (t-test) were performed. The result suggests that there is no significant difference between land ownership pattern before and after implementation of the project with 4 degree of freedom where tabulated value is 2.776 but the calculated value is
-0.485.

7.3 Impact on the reduction of irrigation cost

Irrigation is one of the major inputs that has direct influence to increase yield, food grain production and plays a vital role in ensuring food security in Bangladesh. Bangladesh has almost become self-sufficient in food grain production and this was achieved through agricultural mechanization and modernization. But still our per hectare irrigation cost is higher than those of the world as well as the neighboring countries which is due to inefficiency in supply channel. This study determined impact of modern irrigation technologies such as improved earthen canal, pre-cast canal, buried pipe, sprinkler irrigation, and drip irrigation etc for reduction of per hectare cost of irrigation.

7.3.1 Types of response

The results showed that most (88.56%) respondents reported to have positive changes in regards of reduction of irrigation cost, which is due to adoption of modern irrigation technologies which is mostly adoption of pre-cast canal, plastic thread pipe, improved earthen canal and buried pipe.

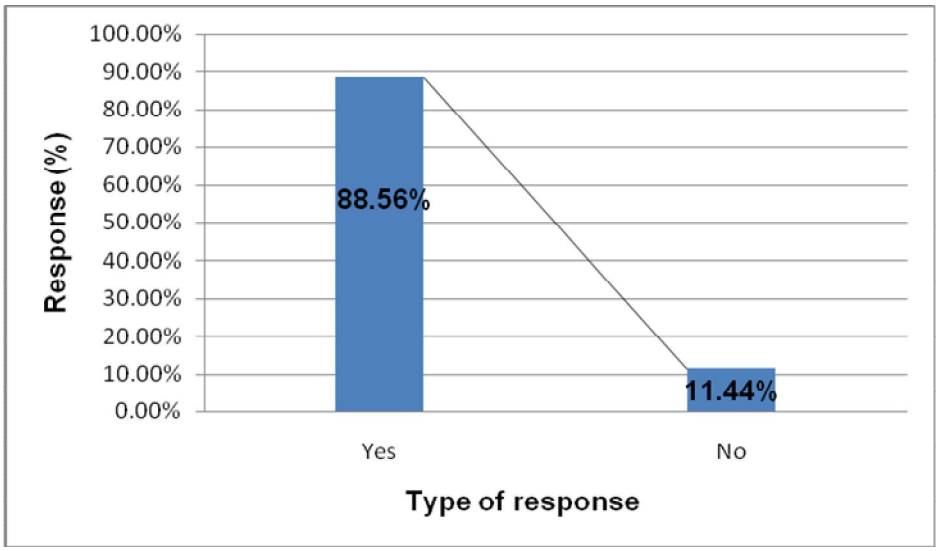
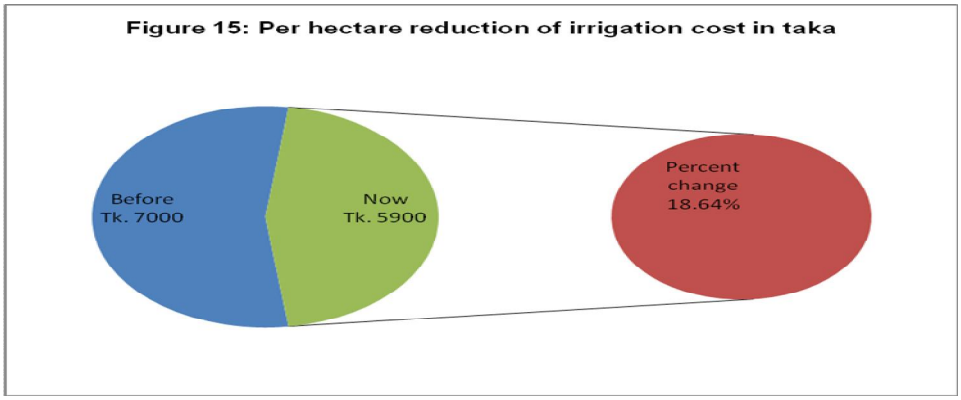


Figure 14: Respondents response on the reduction of irrigation cost

7.3.2 Reduction of irrigation cost in taka

The study found that introduction of modern irrigation technologies has reduced losses of water about 18.64 percent which would ultimately save cultivation cost by at least Taka 1,100 per hectare of land.

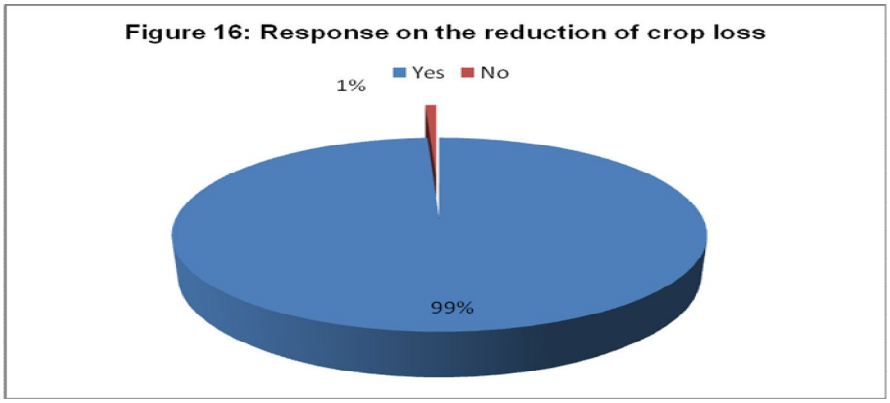


7.4 Impact on the reduction of crop loss

Pre- and post-harvest operations are very critical for many crops. These operations are needed to be performed in specific time and any delay may cause yield loss, loss of quality even damage of whole crop. For minimizing the recent problem of labor shortage in Bangladesh and reducing the turnaround time between two crops, mechanization in harvesting and post harvest operation is necessary. In this study an attempt was made to examine the changes relating to reduction of crop loss.

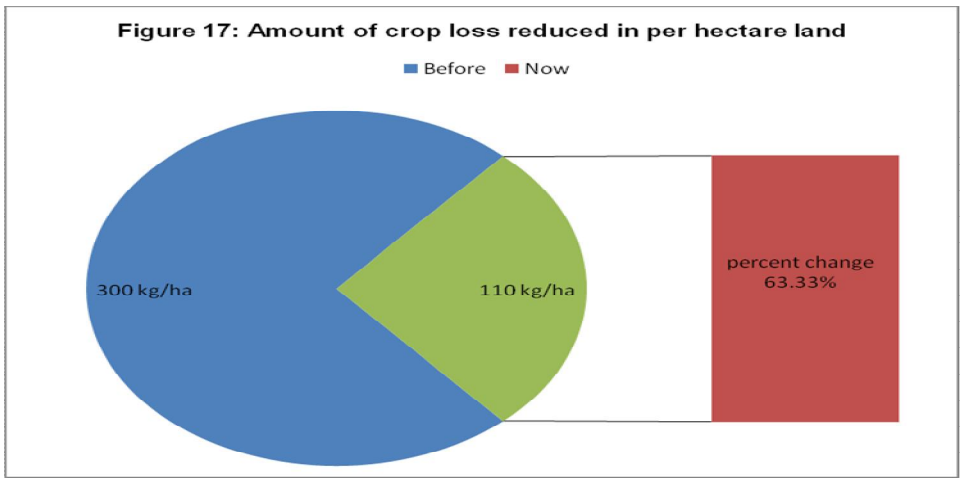
7.4.1 Respondents response on the reduction of crop loss

The results depicted that around all (99.2%) of the respondents reported to have positive changes in respect of reduction of crop loss which is due to adoption of farm machinery technologies in agricultural activities.



7.4.2 Amount of crop loss reduced

It revealed from the figure 17 that introduction of modern irrigation technologies has reduced losses of crop about 63.33 percent which would ultimately increase income by at least Taka 5,320 per hectare of land by saving of 190 kg per hectare of land with 28 taka/kg cost.



7.5 Extent of changes in land use pattern and cropping intensity

It is expected that there will be increase in cropping intensity due to use of farm machinery. To quantify the change of cropping intensity data on single crop, double crop and triple crop were collected and analyzed. The results ascertained that there is 0.96% reduction in single

cropped area, 0.84% and 1.27% increase in double and triple cropped area due to more coverage of irrigation facilities in rabi season. This ultimately increased cropping intensity by 1.04%. Out of 14 upazilas, respondents from 13 upazilas reported to have positive changes in cropping intensity; although respondents from one upazila disagreed. Out of 726 respondents of 14 upazilas, 540 respondents of 13 upazilas reported to have 100% positive change in cropping intensity.

Table 27: Change of land use pattern and cropping intensity

Description	Average area (ha)		Change
	Before project	During impact study (2014)	
Single crop area	80278	76273	-0.96%
Double crop area	227457	230934	0.84%
Triple crop area	105933	111224	1.27%
Total	413668	418431	1.15%
Cropping intensity	206.20	208.35	1.04%

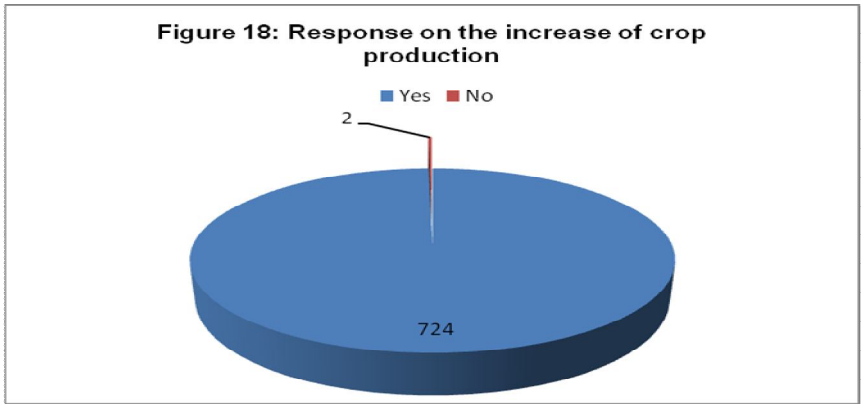
Source: Upazila Agriculture Office

7.6 Extent of changes in crop production

Agricultural development could not be achieved without the proper utilization of agricultural inputs in the form of HYV of seeds, fertilizers, irrigation water either individually or in suitable combination. The suitable combination of HYV of seeds, fertilizers, pesticides and irrigation water with modern farm machinery can increase agricultural output considerably. In a land starved economy such as Bangladesh, the adoption of modern technology has opened up opportunities of increasing food production and employment facilities. The last few decades have witnessed major transformation of agriculture including change in its technology, resource base, structure and production process. Now agricultural sector is much more diversified. An attempt has been made to analyze the impact of modern technology on increase of food grain production in the study area.

7.6.1 Respondents response on the increase of crop production

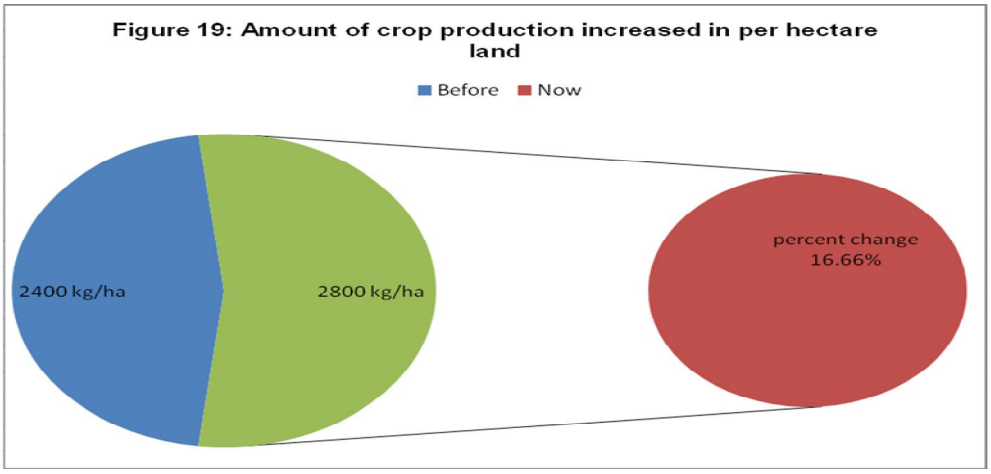
The results showed that around all (99.7%) of the respondents (724) reported to have positive change in respect of increase of per hectare crop production which is due to adoption of modern farm machinery and irrigation technologies that ensured on time use of improved method of irrigation, pre and post-harvest management of crops.



7.6.2 Amount of crop production increased

The study has found that introduction of modern technologies can increase crop production

about 16.666% which would ultimately increase farmers income by at least Taka 11,200 from per hectare of land. This is due to production of 400 kg more from per hectare of land. According to the government purchase rate of 28 taka in per kg paddy, the total amount is 11,200 taka.



7.7 Impact on the source of income

Agricultural mechanization implies the use of various power sources and improved farm tools and equipment, with a view to reduce the drudgery of the human beings and draught animals, enhance the cropping intensity, precision and timelines of efficiency of utilization of various crop inputs and reduce the losses at different stages of crop production. The contribution of agricultural mechanization has been well recognized in enhancing the production together with irrigation, biological and chemical inputs of high yielding seed varieties, fertilizers, pesticides and mechanical energy thus increase per hectare income of the farmers. Different researchers have concluded that farm mechanization enhances the production and productivity of different crops due to timeliness of operations, better quality of operations and precision in the application of the inputs. These productivity increases, thus, were attributed to increase income of the farmers.

7.7.1 Respondents response on the changes of income

Therefore, extent of change of income source was examined in this study. Agriculture which includes crops, livestock and poultry, and fish culture, and non-agriculture that includes business rental of farm machinery, operators, mechanics, dealers, service and day labor/rickshaw pulling are the major source of income of the sample respondents. Around (99.45%) respondents reported to have positive changes on increase of income due to adoption of modern technologies in agricultural activities.

Table 28: Response on the changes of income

Type of response	Total number of respondents (N=726)	
	Response of the respondents	Percent
Yes	722	99.449
No	4	0.551

7.7.2 Amount of income increased by source

The study found that introduction of modern technologies has increased income from agriculture and non-agriculture about 63.33% and 30.55% respectively which would ultimately increase farmers income by at least Taka 65,360 and 11,000 from agriculture and non-agriculture respectively per annum.

Table 29: Amount (Tk) of income increased by source

Source of income	Before project Tk/annum	During impact study (2014) (Tk/annum)	% Change
Agriculture	103,200	168,560	63.22
Non-agriculture	36,000	47,000	30.57

7.7.3: Change of income by farm holdings

Income from agriculture: The results showed that income has increased in case of all type of farmers under the agriculture sector where highest (82.22%) income has increased per annum in case of large farmer followed by medium farmers (71.43%) and small farmers (62.04%). It is due to increase efficiency in irrigation and water management, crop production, and crop intensity by farm mechanization. However, lowest (45.45%) income has increased per annum in case of landless farmers followed by marginal farmers (48.39%).

Table 30: Extent of changes of income from agriculture by farm holdings

Type of farmers	Income from Agriculture		% Change
	Baseline (Tk/year)	During study (Tk/year)	
Landless	49500	72000	45.45
Marginal	62000	92000	48.39
Small	103000	166900	62.04
Medium	280000	480000	71.43
Large	450000	820000	82.22
Average	**103276.9**	**168568.73**	**63.22**

t-test between changes of sources of income (agriculture) by farm holdings

Extent of change in income by farm holdings of the respondents was investigated by using two mean tests (t-test).

The analysis shows that there is a significant difference between farm holdings and income from agriculture at the 5% level of significance with 4 degree of freedom where tabulated value is 2.7764 but the calculated value is 2.068.

Income from non-agriculture: In case of non-agriculture sector per annum income, the highest (57.50%) income has increased in case of small farmers. It is due to use of improved irrigation canal such as pre-cast canal, plastic thread pipe, improved earth canal and buried pipe that has reduced electricity and fuel uses cost of STW/DTW operated mostly by small farmers hence increase income. In addition, small farmers are mainly engaged in rental business of agricultural machinery which is also contributing to increase their income from non-agricultural sector. On the other hand, almost similar income incremental has found in case of landless, marginal, medium and large farmers, which is 20.00%, 22.22%, 26.67%, 27.36% respectively under the same non-agricultural sector.

Table 31: Extent of changes of income from non-agriculture by farm holdings

Type of farmers	Income from Non-Agriculture		% Change
	Baseline (Tk/year)	During study (Tk/year)	
Landless	15000	18000	20.00
Marginal	18000	22000	22.22
Small	20000	31500	57.50
Medium	150000	190000	26.67
Large	212000	270000	27.36
Average	**36017.08**	**47028.51**	**30.57**

t-test between changes of sources of income (non-agriculture) by farm holdings

Extent of change in income by farm holdings of the respondents was investigated by using two mean tests (t-test).

The analysis shows that there is a significant difference between farm holdings and income from non-agriculture at the 5% level of significance with 4 degree of freedom where tabulated value is 2.776 but the calculated value (t) is 2.124.

7.8 Extent of changes in quality food production

Consumers worldwide always demand to have their foods of higher standards or better quality. However, the term standard or quality is more often than not unclear. In many cases quality means different things to different people. Food quality may be its sensory property (appearance, taste), nutritional value (nutrient content), health benefit (functional ingredient) or safety (chemical, physical, biological). There is general consensus that food safety is the very basic right of people and various efforts have been devoted by all sectors to ensure that the goal of safer food for all would be attained. As food quality covers a wide range of attributes of which many can be recognized through labeling, this study thus focuses mainly on those related to appearance, weight and taste issues.

7.8.1 Respondents response on the improvement of food quality

The changes in quality of food production were examined in this study. The results depicted that around (99.45%) respondents reported to have positive changes in quality production of food which is due to adoption of modern irrigation and farm machinery technologies.

Table 32: Response on the improvement of food quality

Type of response	Total number of respondents (N=726)	
	Response of the respondents	Percent
Yes	722	99.449
No	4	0.551

7.8.2 Reasons of food quality improvement

The highest results has found in case of use of farm machinery which is 69.42% followed by use of on-time adequate amount of irrigation (67.91%). However, the lowest (4.68%) respondents have reported in case of others which include traditional method of agricultural practices in pre and post-harvest practice of agriculture.

Table 33: Reasons for improvement of food quality

	Total number of respondents (N=726)	
Reasons	**Response of the respondents**	**Percent**
Application of on-time adequate irrigation	493	67.91
Use of farm machinery	504	69.42
Others (traditional device)	34	4.68
Multiple response		

7.9 Impact on the employment generation

Employment in rural areas consists of mainly self-employment and most of the agricultural workers are hired on a daily basis. The modern technology would affect the agricultural labor market by changing the labor intensity of cultivation, the productivity of labor, which in turn would influence the wage rate, and income of farmers, which would affect his labor/leisure choice. The technology could indirectly affect the non-agricultural labor market, since the expenditure of the increased agricultural income would generate additional demand for non-agricultural goods and services, some of which might be produced within the locality. Apart, there would be positive trend to create new employment opportunities in modern irrigation and farm machinery related activities. Due to acute shortage of labor and global market competitiveness of the agricultural commodities, there is no alternative to adopt modern technology in agricultural sector to sustain the food security of the country.

7.9.1 Respondents response of employment generation

The impact on creation of employment opportunities under the study was examined. The maximum (66%) respondents reported to have positive changes of employment generation due to adoption of modern and improved irrigation and farm machinery technologies. Only 34% of the respondents reported to have negative changes of employment generation.

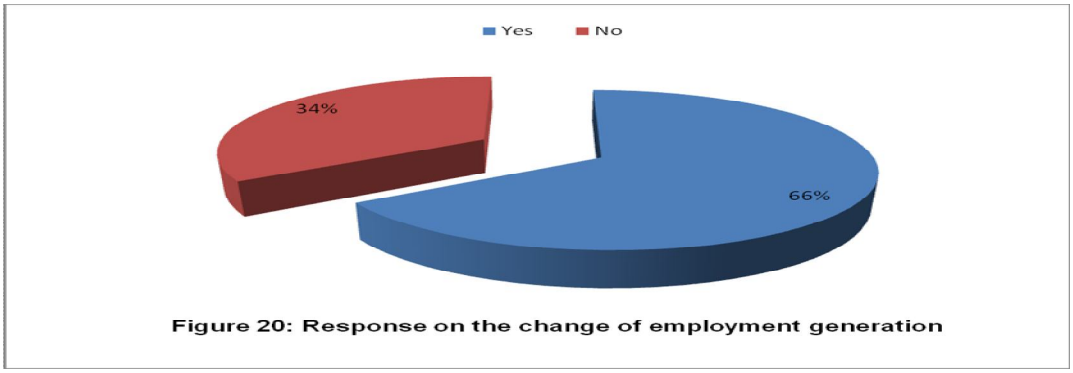


Figure 20: Response on the change of employment generation

7.9.2 Type of changes occurred

Out of 479 respondents reported to have types of changes occurred, the highest (90.81%) response was recorded in case of employment opportunities increased due to adoption of modern technology followed by employment opportunities decreased (7.72%). However, the lowest (1.46%) response was reported in case of no changes in employment. The mix response has come due to overall decrease the requirement of agriculture labour due to adoption of farm machinery as the efficiency of farm machinery is 3-6 times more than the human power. Conversely, the new areas of farm machinery job have created due to introduction of farm machinery such as operators, dealers, repair and maintenance,

manufactures etc.

Table 34: Type of changes occurred in the employment generation

Type	Total number of respondents (N=479)	
	Response of the respondents	Percent
Employment opportunities increased	435	90.814
Employment opportunities decreased	37	7.724
No change	7	1.461
Total	**479**	**100**

7.9.3 Categories of job created

While asking the categories of job created due to creation of employment opportunities in the study area, the maximum (65.97%) response was recorded in case of rental business of farm machinery and irrigation followed by farm machinery repair and maintenance related job (58.62%), farm machinery operators (53.79%), and agricultural day labor (30.80%). Conversely, the lowest (0.69%) response was reported in case of others category followed by NGOs job (3.21%), dealer business (15.402%), crop carrying related job (16.09%), and crop processing (16.78%).

Table 35: Categories of job created in the study areas

Job categories	Total Number of Respondents (N=435)	
	Response of the respondents	Percent
Farm machinery operators	234	53.793
Farm machinery R & M	255	58.621
Dealer business	67	15.402
Rental business	287	65.977
NGOs job	14	3.218
Crop carrying related job	70	16.092
Crop processing related job	73	16.782
Agricultural day labor	134	30.805
Others	3	0.690
Multiple response		

Multiple Regressions for Production:

A multiple regression line was also considered to identify the factors those influence the **production** from agriculture. For this, dependent variable is the production (y) and the independent variables are farm machinery (x_1), irrigation (x_2), training (x_3), cropping intensity (x_4) b is the slope (Beta co-efficient) and *a* is the constant or intercept.

Thus, the multiple regression line will be, $y=a+b_1x_1+b_2x_2+ b_3x_3+ b_4x_4 +e$

SPSS version 21 was utilized to co-efficient a, b_1, b_2, b_3, b_4

Using the value of co-efficients, the multiple regression line is:

Production (y) = $11.90+1.32x_1+0.70x_2+0.10x_3+0.30x_4$

The adjusted R^2=0.417 indicating that about 42% of the variation in production is explained by independent variables crop intensity, machinery, irrigation and training. The sign of the regression co-efficients show that they have positive effects on the production. The regression coefficients are statistically significant. The result suggests that increasing efficiency of cropping intensity, machinery, irrigation as well as training of farmers will increase their production from agriculture.

Multiple Regressions for Income:

A multiple regression line was considered to identify the facts as that influence the **income** from agriculture. For this, dependent variable is the income (y) and the independent variables are production (x_1), machinery (x_2), irrigation (x_3), training (x_4), *b* is the slope (Beta co-efficient) and *a* is the constant or intercept.

Thus, the multiple regression line will be, $y=a+b_1x_1+b_2x_2+ b_3x_3+ b_4x_4 +e$

SPSS version 21 was utilized to estimate the co-efficients a, b_1, b_2, b_3, b_4

Using the values of co-efficient, the multiple regression line is:

Income (y) = $27423.529+82.353x_1+17.647x_2+11.765x_3+ 17.647x_4$

The adjusted R^2=0.559 indicating that around 56% of the variation in income is explain by production, machinery, irrigation and training by the variables considered in the analysis The regression co-efficient are statistically significant. The result suggests that increasing efficiency of production, machinery, irrigation and training of farmers will be able to increase their income from agriculture.

CHAPTER 8
MAJOR FINDINGS, RECOMMENDATIONS AND CONCLUSION

8.1 General

In Bangladesh, record keeping is very poor either by an organization or by an individual. Therefore, quantification of various parameters in relation to farming is really a difficult task. Keeping this difficulty in mind, a sincere attempt has been made to quantify various parameters of this study. The results visualized widespread mechanization in various aspects of farming. This happened due to training and demonstration of farm mechanization, supply of farm machinery including construction and improvement of water management structures and overall government's liberal importation of agricultural machinery. The study also quantified socio-economic impact generated due to various efforts of mechanization. In spite of positive gains, the problems such as shortage of skilled operators, limited support in case of farm machinery and water management structures, and repair and maintenance facilities including spare parts availability of the farm machinery are widespread in the project upazilas. Proper planning and adoption of similar interventions on a continuous basis to improve these will help sustaining the positives gains achieved so far and generating more benefits in future.

Major Findings:

Component-wise major findings of the study are highlighted below:

8.2 General Feature of the Project

8.2.1 Project implementation status

The actual implementation of the project was July 2005 to June 2011 with a total cost of 5777.44 lakh taka instead of July 2005 to June 2010 with a total cost of 5298.97 lakh taka.

8.2.2. Target and achievement of finance

Around 99.04% fund of the project was utilized while only 0.96% fund was remained unutilized. The maximum (23.68%) fund was utilized under the item of demonstration followed by manpower (22.80%), and re-excavation of canal and water bodies (16.30%).

8.2.3. Rationale of the project concept and design

On-farm water management and mechanization are the most important but less attended sub sectors. Irrigation efficiency in Bangladesh is about 30% which is 45% in neighboring and 65% in developed countries (DPP-2005). Under this vast need project was undertaken to save 30% water in farm level. Equally, mechanization is a vital item for reduction of production cost, increasing productivity and cropping intensity. Cattle population is decreasing and labor shortage in planting and harvesting season is acute. In time finish of cultural practices is prerequisite for increasing cropping intensity. Appropriate mechanization can ensure higher cropping intensity. Project was implemented with these two important components where machinery can reduce the harvesting loss from 13%-14% to 5%-7% (DPP-AETP-2005), which was very relevant to the agricultural sector development.

8.2.4. About appointment of Project Director

Three (3) Project Directors were recruited in 4 spells of the project period. This should be avoided in future project in recruiting mid-level competent person. In addition, there is a need to make provision of project period PD in the DPP.

8.2.5. Procurement

All procurements carried out under the project followed the PPR rules and regulations as verified by the consultant. The members of the TEC and TSC ensured all type of procurement as per specification of the bid document. The three types of procurement were completed in the project which are procurement of transport (1 jeep, 112 motor cycles), office and field equipments. All procurement was completed within year 2006-2009. The country's three renowned organizations were selected to supply agriculture machinery which is: Bangladesh Machines Tools Factory, Alim Industries and Mallick group.

8.2.6. Quality testing of the equipment

Technical sub-committee was analyzed and tested the quality of the equipments before award of the contract.

8.2.7. Land utilization pattern

Single-cropped area comprised 18.22% which is slightly lower (19.40%) than the baseline data. However the double-cropped area comprised 55.19% which is slightly higher (54.98%) than the baseline data. The similar trend has also reported in case of triple-cropped area that comprised 26.58% which was 25.60% in baseline survey. Cropping intensity was reported 206.20 during baseline survey which is now 208.35%.

8.3. Findings of farm machinery

8.3.1. Overall response on the use of farm machinery

Most (98.6%) farmers reported that they are currently using farm machinery for their agricultural related activities while only 1.4% farmer reported that they did not use farm machinery. Among them most popular farm machineries are power tiller, thresher, seeder, weeder, and sprayer.

8.3.2. Present conditions of farm machinery

Total 113 different types of agriculture machinery were supplied by the project in the study upazilas with 30% subsidized price during 2007 to 2010. In addition, 5 multipurpose use of deep tube-well was supplied for irrigation and drinking water. Around 57% of the supplied equipments are completely damaged while 29% are in partially damaged which can be used with repair and maintenance. Only 14% of the supplied equipments are in working condition which was supplied in 2010.

8.3.3. Extent of use of farm machinery and its availability

The highest (88%) of the supplied farm machineries are currently using for agricultural activities while only 12% of the supplied equipments are not using regularly which is using sometimes basis due to lack of operators and less knowledge on the use of the equipments

8.3.4. Availability of use of farm machinery

Majority (56%) of the equipments are available to use all times other than the owners while 30% equipments are available to use on occasional basis other than the owners. The rest 24% equipments are no longer available to use which either is using by the owners or lack of operators to rent it.

8.3.5. Repair and maintenance

Two third (72.88%) of the supplied equipments were regularly repaired and maintained by the owners while 27.12% equipments were not regularly or never repaired and maintained by the farmers due to non-availability of the spare parts and its associated cost.

8.3.6. Overall quality of the supplied equipment

Two third (85) of the supplied equipments were in very good quality while only 33 number of the supplied equipments were in average quality. This is mainly due to non popular dongfeng brand of power tiller.

8.4. Findings of Irrigation and Water Management

8.4.1. Response on the use of irrigation water and its source

Around all (98.6%) of the respondents reported that they used irrigation water in their agriculture production activities especially in rabi season where most (84.57%) of the respondents reported that they used underground water and rest (15.43%) used surface water.

8.4.2. Methods of irrigation facilities

The highest (50.83%) respondents reported to have increase of irrigation facilities compared to baseline data under the improved earth canal and the increase of irrigation facilities calculated over the baseline data is 2738.46%. This increase was followed by buried pipe method (945.45%), drip irrigation (707.14%), precast canal method (584.62%) and sprinkler irrigation method (500.00%). Conversely, 17.04% decreasing trend in use of irrigation facilities/method was observed for others categories of irrigation method such as earthen canal compared to the baseline data. This is due to improvement of irrigation facilities in the project area through training and demonstration.

In addition, All (100%) of the respondents reported that multipurpose use of deep tube wells for supply of irrigation water and drinking has created enormous positive impact to the farmers

8.5. Training and Demonstration Programs

Total of 297,258 participants such as farmers, SAAO officer of DAE, mechanic and technical staff and officers of the project and private sector were trained during the project period in the topic of farm machinery and modern irrigation technologies and its unit demonstration program. The highest (92.30%) participants training and workshop was organized for farmers followed by SAAO officer (4.89%) whereas lowest (0.59%) participants attended from technical officers/staff from public and private sector. Besides, a large number of demonstration programs were organized on improved water management related activities. There is a total 7024 demonstration programs that were conducted under the project on different improved methods of irrigation.

8.5.1. Number of respondents received training

Around (77%) of the respondents reported that they received training from the project. The training duration was 1-2 days without any follow-up training.

8.5.2. Types of training received

Majority (59.54%) of the participants reported that they have received training on farm machinery followed by improved irrigation technology (34.22%) while lowest 6.24% in case of others such as operators and repair and maintenance.

8.5.3. Impact of training in skills development

The highest (95.43%) participants reported to have positive change in skills development due to training and demonstration while only 4.57% participants responded negatively

8.5.4. Level of skill improved

Majority (61.68%) participants reported that the skills have been improved at satisfactory level followed by average (29.89%) and very satisfactory (7.89%). Only negligible (0.435%) participants reported the improvement of skills at non-satisfactory level.

8.5.5. Impact of training in skills development

Highest (95.429%) participants reported that their skills improved due to training and demonstration. Most (61.68%) participants opined that training and demonstration was of satisfactory level to improve skills followed by average (29.89%).

8.6. Socio-economic impact due to farm mechanization

8.6.1 Impact on ownership of land

No significant change is observed in the ownership of land where only (1.527%) increase in the size of homestead garden which used to remains more or less same for longer period of time. There has been a slight (2.608%) increase in own land under own cultivation and area under mortgage (1.691%). This may be either for increased the purchase ability of the farmers or more coverage of fellow land. Areas of pond and lease land are reduced by 4.667% and 2.771% respectively. It is mainly to decrease of surface water in water channel.

8.6.2. Impact on the reduction of irrigation cost

Types of response: Most (88.6%) respondents reported to have positive changes in regards of reduction of irrigation cost, which is due to adoption of modern irrigation technologies.

Reduction of irrigation cost in taka: The study found that introduction of modern irrigation technologies can reduce losses of water about 18.64% which would ultimately save cultivation cost by at least Taka 1,100 per hectare of land.

8.6.3. Impact on the reduction of crop loss

Response on the reduction of crop loss: Around all (99.2%) of the respondents reported that crop loss has reduced due to adoption of farm machinery technology

Amount of crop loss reduced: around 63.33% crop losses has been reduced which would ultimately increase income by at least Taka 5,320 by saving of 190 kg per hectare of land with 28 taka/kg cost.

8.6.4. Extent of changes in land use pattern and cropping intensity

There is 0.96% reduction in single cropped area, 0.84% and 1.27% increase in double and

triple cropped area due to more coverage of irrigation facilities in rabi season. This ultimately increased cropping intensity by 1.04%.

8.6.5. Extent of changes in crop production

Response on the increase of crop production: Around all (99.7%) reported to have positive change in respect of per hectare increase of crop production.

Amount of crop production increased: Around 16.66% crop production has increased which would ultimately increase farmer income by at least BDT 11,200 from per hectare of land. This is due to production of 400 kg more from per hectare of land.

8.6.6. Impact on Source of Income

Around all (99.449%) respondents reported that 63.33% and 30.55% income from agriculture and non-agriculture has increased which would ultimately increase farmer income by at least Taka 65,360 and 11,000 from agriculture and non-agriculture respectively per annum.

8.6.7. Extent of changes in quality food production

Response of quality improvement: Almost all (99.45%) of the respondents reported that quality of food has increased due to timely cultivation, irrigation, and post-harvest management through modern irrigation and farm machinery technologies.

Reasons of food quality improvement: The highest results has found in case of use of farm machinery which is 69.42% followed by use of on-time adequate amount of irrigation (67.91%) under multiple response.

8.6.8. Impact on Employment Generation

Response of employment generation: Majority (66%) of the respondents reported that employment opportunities have been created

Type of changes occurred: The highest (90.81%) response was recorded in case of employment opportunities increased due to adoption of modern technology followed by employment opportunities decreased (7.72%). However, the lowest (1.46%) response was reported in case of no changes in employment.

Categories of job created: Majority (65.97%) of the respondents reported in case of rental business followed by repair and maintenance (58.62%), operators (53.79%), and day labor (30.80%). However, the lowest (0.69%) was reported in case of others category followed by NGOs job (3.21%), dealer business (15.402%), crop carrying related job (16.09%), and crop processing (16.78%).

8.7. Strengths

- Training and demonstration on the farm machinery and water management has been able to improve skills and awareness among the farmers. Similarly, Agriculture engineers posted at upazila level have been able to facilitate farmers to learn more about farm mechanization technology.

- Use of farm machinery such as power tiller, thresher, sprayer, weeder and seeder contributing timely cultivation, plant protection and post-harvest management has increased crop productivity and crop quality. In face of shortage of labor in

agricultural activities, farm mechanization has ensured continuous production to ensure food security with less input cost.

- Water management and irrigation facilities such as improved earthen canal, pre-cast canal, buried pipe, and drip irrigation are contributing to efficient use of irrigation water, thereby reducing irrigation cost and wastage of underground water. In addition the use of multipurpose deep tube-well has ensured rationale use of irrigation water and pure drinking water of the rural people.

8.8. Weakness

- Project has also lost 170 skilled personnel due to discontinuation of the project. This has interrupted the dissemination of agricultural engineering technology at the field level.
- Absence of training on a continuous basis which was only once in the project period. This need to be continued to disseminate farm mechanization like specialized technology.
- Lack of skilled operators, spare parts and repair and maintenance facilities. Therefore the owners of the machineries are unable to get maximum benefit of the modern technology.

8.9. Recommendations

- More farm machinery especially power tiller, weeder, seeder, thresher, reaper, sprayer etc. need to be provided with 30% subsidized price for mechanized crop production. Adequate policy and strategy need to be formulated to expand the use of mechanized farming for cost-competitive production.
- Continuation of project like farm mechanization is needed to meet the increasing demand for food staffs in the country.
- Upazila level post of agriculture engineer need to be created for dissemination of agricultural engineering technology on a continuous basis.
- Regular training both for DAE field level officials and farmers on various aspects of farm mechanization along with improved water management practices need to be organized.
- Farm machinery fair to be organized at upazila level annually by DAE for disseminating and promoting locally made/improved/imported farm machinery and irrigation equipments.
- Continuous research to invent more economic and cost-effective farm machinery and water management technology is required.
- Institutional credit to be arranged for the resource-poor farmers to purchase farm machinery.
- Private repair service providers and small manufacturing enterprises to work together to increase mechanization.
- More awareness and demonstration program on judicious use of water, fertilizer, pesticides and other inputs in the farmer field is required to be organized by DAE in order to safeguard environmental need.
- Integrated and comprehensive agricultural sector development project is needed to attain all priorities issues of the sector together. Ministry of Agriculture needs to take such initiatives involving all relevant departments and agencies.

8.10. Conclusion

The study has following broad conclusions regarding agricultural engineering technologies project:

- Farm mechanization leads to increase in inputs on account of higher average cropping intensity and larger area and increased productivity of farm labour;
- Farm mechanization increases agricultural production and profitability on account of timeliness of operation, better quality of work done and more efficient utilization of inputs;
- Farm mechanization increases on-farm human labour marginally, whereas the increase in off- farm labour such as industrial production of tractors and ancillaries such as repair, servicing and sales of tractors; and
- Farm mechanization displaces lesser time for farm works.

Therefore it can be concluded that the project is playing a significant role in national agriculture and water environment by providing farm machinery technologies and establishing judicious water management practices which able to ensure cost-competitiveness of agricultural commodities and food security of the country. Continuation of farm mechanization project is needed including marketing support.

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Appendices

Appendix 1	Beneficiary farmers questionnaire
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Appendix 3	Key informant interview- checklist
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Appendix 5	List of KIIs participants
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Appendix 7	Minutes of the national workshop with correction note