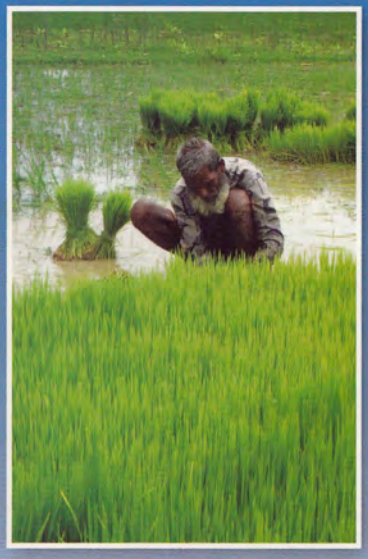
Development of Climate-Resilient Agricultural Technology Suitable for Chars



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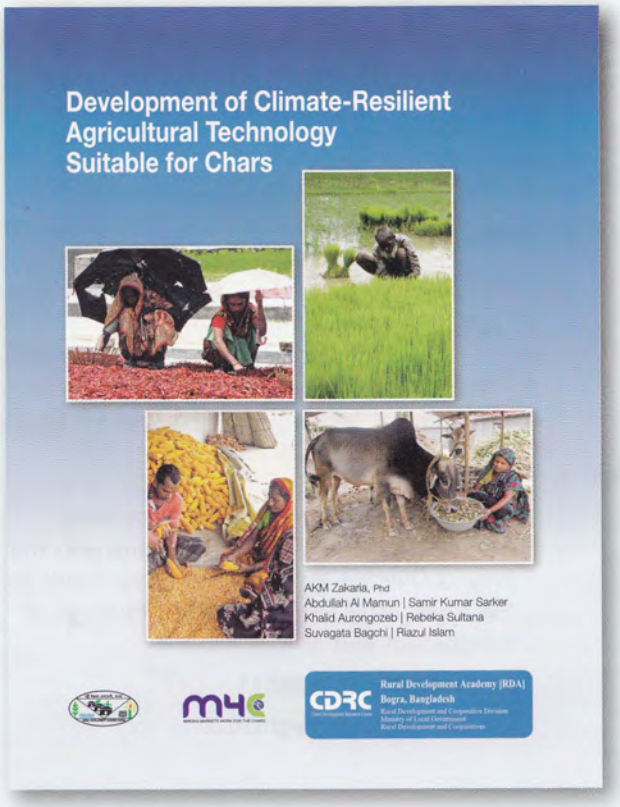
Suvagata Bagchi | Riazul Islam

MAKING MARKETS WORK FOR THE CHARS

CDRC Chars Development Research Centre

Rural Development Academy [RDA]
Bogra, Bangladesh
Rural Development and Cooperative Division
Ministry of Local Government
Rural Development and Cooperatives

Development of Climate-Resilient Agricultural Technology Suitable for Chars



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Rural Development and Cooperatives

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Preface

Rural Development Academy (RDA), Bogra has been successfully carrying out a number of field action researches on agricultural technology. Recently, RDA has completed 4 action researches on the chars of Northern Bangladesh to develop climate resilient agricultural technology suitable for char areas. The study was supported by M4C project of RDA.

There are around 900 chars in northern Bangladesh formed by Jamuna, Padma and Teesta rivers where nearly 2 million poor people live. Economic opportunities for the char dwellers, which mainly depend on agriculture for their livelihoods, are impeded due to geographic vulnerability, climate change and isolation from mainland. Chars could transform into prominent production zone due to higher soil productivity and land availability but their potential are not fully realize due to suitable agricultural technologies and market system.

The report is an outcome of some aspect of action research i.e chilli seed treatment for minimizing production cost and better yield, maize variety screening , maize stover silage for cattle feed and modern rice production technologies which are suitable for chars. From the study we can say that these char suitable agricultural technologies has the ability to contribute more in char agriculture under climate change situation as well as national economy.

I express thanks and gratitude to Ms. Fouzia Nasreen, General Manager, M4C project for her guidance and support and other M4C project personnel for their support and monitoring the research activities.

Finally, I express my deepest thanks to Dr. AKM Zakaria, Project Director, M4C and team leader of RDA research team for his leadership effort for the research and all researchers namely Mr. Md. Abdulla Al Mamun, Mr. Samir Kumar Sarker, Mr. Khalid Aurongozeb, Ms. Rebeka Sultana, Mr. Suvagata Bagchi and Dr. Muhammad Riazul Islam for their sincere effort for completion this useful piece of work.

M. A. Matin

Director General

Rural Development Academy, Bogra

Preface

The publication of Rural Development Academy(RDA) compiles the agricultural researches conducted on the chars of Northern Bangladesh. The outcomes of these researches supported the Making Markets Work for the Jamuna, Padma and Teesta Chars (M4C) project in its interventions for the maize, chilli and rice sectors.

M4C is a 5-year project, mandated by the Swiss Agency for Development and Cooperation (SDC) and Ministry of Local Government, Rural Development and Cooperatives, and implemented by Swisscontact and Practical Action in collaboration with Rural Development Academy, Bogra. M4C aims to reduce poverty and vulnerability of char households in ten districts of northern Bangladesh (Bogra, Gaibandha, Jamalpur, Sirajganj, Pabna, Tangail, Kurigram, Lalmonirhat, Nilphamari, and Rangpur) by facilitating market systems that enhances opportunities for employment and income generation. The project office is based in the Rural Development Academy Campus, Bogra.

The designated research activities of RDA on maize variety screening, chilli seed treatment methods, maize stover silage preparation method and rice cultivation practice are the first of its kind to be conducted that addresses the situation of the chars and the capability of poor char households with respect to the above topics.In partnership with the private sector, M4C has used the above research outcomes in designing and disseminating information to the char households.

I thank Dr. AKM Zakaria, Director, Agriculture Sciences, RDA for his leadership efforts for the researches. I would also like to thank his team including Md. Khalid Augrongozeb, Rebeka Sultana, Samir Kumar Sarkar, Muhammad Riazul Islam, Abdullh Al Mamun and Suvagata Bagchi for their dedication and efforts.

We are pleased to have collaborated with RDA experts on these topics and look forward to further collaboration in the future.

Fouzia Nasreen
General Manager, M4C project
Swisscontact

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Organic treatments of chilli seed suitable for chars

A study was conducted in selected char of Shariakandi upazilla of Bogra district, Kazipur upazilla of Sirajgonj district and Fulsori upazilla of Gaibandha district to gather knowledge on seed quality of farmers retained chilli seed in char areas, to study chemical and organic seed treatment as means of minimizing cost and yield gap, to generate data on seed treatment of chilli as a basis for selecting appropriate seed treatment product, to select and recommend most suitable product for chilli seed treatment for char area. The study had three parts. First part was a survey conducted on randomly selected 60 chilli producing farmers for collecting data about farmer's practice in chilli seed production, processing and preservation technique. Second part was farmer participatory research conducted in the same location and third part was a laboratory experiment conducted with farm retained chilli seed to support the field experiment at RDA seed technology laboratory. Most of the farmers (98.33%) of the study area have no training experience and no extension contract about chilli seed production and preservation. Majority of the farmers in the study area having marginal farm size (36.7%) with low annual income and 62% farmers depend upon chilli production. Most of the respondent used local varieties (38%) followed by Bhari (28%). Majority of the respondent (92%) of the study area were used own produced chilli seed. Cost involved in chilli production is weeding (41%) followed by fertilizer (22%). An additional 14 percent cost is incured for fungicide* Among the 8 seed treatment products i.e. Provax-200, Balck berry leaves extract, Garlic extract, Neem leaves extract, Hot water treatment, Trichoderma suspension, Black pepper extract, mixture of zinger and cow urine and untreated control, the effect of Trichoderma suspension and Provax-200 on yield and yield contributing characters were the best two options which can minimize 14% cost used for fungicide. On the other hand, in the laboratory test seed treatment with Trichoderma suspension and Provax-200 performed significantly better in respect of germination, seedling vigour and vigour index. In the field day most of the farmers were choosen the same.

* Eight seed treatment materials were used in farmers' participatory research over an untreated control.

Authors:
Dr. AKM Zakaria, Khalid Aurongozeb and Rebeka Sultana

Abstract

Variety screening of maize suitable for chars

An experiment was carried out in three chars of Bogra, Gaibandha & Sirajgong district under the upazila of Shariakandi, Fulsori and Kazipur. The experiments were conducted during the rabi season from October, 2012 to April, 2013. Twelve available varieties of maize were cultivated in the selected chars to study the yield performance and to screen the best suited variety. Maize varieties were planted under two seperate experiments for each char maintaining 70 cm × 25 cm and 60 cm × 22 cm spacing respectively.

No significant difference observed in both the experiments for days to emergence, days to six leaf stages, days to tassel emergence & flowering, days to bud emergence, days to maturity but the difference was found for plant height due to spacing and soil characteristics in three chars. It was also found that the yield of all the varieties were higher under research compared to farmers yield in both the experiments. In case of 60 cm×22 cm spacing based experiment, 12 varieties gained yield 8.6-12.45 t/ha which was higher than farmers yield. The yield was found higher (8.18-10.45 t/ha) in 70 cm×25 cm spacing based experiment. Due to higher plant population (60399 no/ha), higher yield was observed for 60 cm×22 cm spacing based experiment than 70 cm×25 cm spacing based experiment. It is concluded that 987k, Elite, Hera-101, PAC-984 & Uttaran-2 varieties may be recommended considering yield and yield contributing characters according to farmer's choice as well as experimental findings. In this perspective 60 cm×22 cm spacing based experiment may be conducted further in char areas. In char areas, another research i.e. maize based mixed cropping (maize+chilli, maize+pulse, maize+groundnut etc). may be conducted to reduce single crop dependency as well as to minimize economic vulnerability

Authors:

Dr. AKM Zakaria, Abdullah Al Mamun and Suvagata Bagchi


M4C
Making Market Works for Jamuna, Padma and Teesta Char
চরাঞ্চলের উপযোগী ভুট্টার জাত নির্বাচন
[Variety Screening of Maize for Char]
পল্লী উন্নয়ন একাডেমী, বগুড়া [RDA]
SwissContact, Bangladesh

Abstract

Maize stover silage technology suitable for chars

The study was aimed to know the potentials of maize stover silage production on livestock rearing in three selected chars of Shariakandi upazilla of Bogra district, Kazipur upazilla of Sirajgonj district and Fulchari upazilla of Gaibandha district. A survey was conducted to know the farmers' perception about using maize stover for different purpose and results were shown that about 33% of the farmers in chars areas use maize stover as fuel, 12% as cattle feed and 39% use both as fuel and cattle feed and only 16% burn in the field. Maize stover may contribute significantly as ruminant feed particularly during the dry and flooding seasons because at that time the accute scarcity of cattle feed persists in chars. For overcoming the feed scarcity and ensuring the use of maize stover in chars a study was conducted to identify the best production practice to capture high economic performance of maize stover. Three methods were used to produce maize stover silage such as Pit silo (T_1) , Bunker silo (T_2) and Bag silo (T_3). Maize stovers were distributed randomly into three different treatments having three replications in each. Out of three methods used for the production of maize stover silage in the experiment, Bag silo (T_3) method was found the most suitable for chars as these areas are more vulnerable to natural calamities like flood. The best ensiling time was found 42 days and above. The production cost per kilogram maize stover silage was found the lowest in Bag silo (Tk. 1.83/kg) out of the three methods. In maize stover silage, the low DM (27.88%) and high CP (6.95%) were present in comparison to rice straw where the DM content was very high (92.80%) and low CP (4.20%) i.e. the nutritional status was very good in maize stover and maize stover silage comparison to rice straw. Again, the price of per kg rice straw, maize stover and maize stover silage were Tk. 6.00, 1.00 and 1.83 respectively. So, maize stover and maize stover silage was comparatively cheeper than rice straw. The highest opinion was also given during field days about maize stover silage produced in Bag (T_3 :70.83%) because bag silos are easily transferable and low cost. So, Bag silo method can be recommended for the production of maize stover silage in char areas.

Authors:
Dr. AKM Zakaria, Samir Kumar Sarker, Muhammad Riazul Islam


বাংকার সাইলো
[Bunker Silo]


মাঠ দিবস

Abstract

Adoption of modern rice technology suitable for chars

The farmers' participatory experiments and demonstrations were carried out in the farmers' field in 2 chars under Shariakandi upazilla of Bogra district and Kazipur upazilla of Sirajgonj district for BRRI dhan 28 & BRRI dhan 29 to disseminate recommended rice production technology through action research and result demonstration and to motivate farmers' adapting recommended rice production technology for char areas. The farmers' practice plot was treated as check plot for experiment and demonstration plot. Data were collected from 29 January to 08 May 2014 through direct observation and field survey. T- test was preformed to calculate the mean difference and p value at the significant level $\alpha = 0.05$ to conclude that if there is any significant influence of recommended rice technology on rice yield in char areas.

There was significant difference of rice yield and yield contributing characters including plant height(cm), no of effective tiller, days to flowering, panicle length(cm) panicle per/hill, grain /panicle, thousand grain weight(gm), seed quality, pest pressure, grain yield between experimental plot and farmers' plot due to recommended technology of Bangladesh Rice Research Institute (BRRI) for both rice variety BRRI dhan-28 and BRRI dhan-29. It was observed that the average yield of BRRI dhan-28 in experimental plot was 5.02 ton/ha whereas in farmers practice plot (control) yield was 3.33 ton/ha which was significantly lower than experiment plot and at the same time national rice yield as well. The yield gap/ha was 1.69 ton. Same result was observed in case of BRRI dhan-29 which yield was 6.95 ton/ha in experimental plot and 5.26 ton/ha in farmers plot thus yield gap/ha was 1.69 ton . Farmers' plots were infested by stem borer and brown spot diseases but in case of experiment plots and demonstration plots pest pressure was comparatively low. Therefore, the average grain yield of recommended rice technology applied plot was higher than farmers practiced plot without increasing any significant production cost. Besides, higher yield, recommended rice technology has some extra benefits such as this technology conserves soil health, reduce the use of hazardous agrochemicals due to less pest pressure, less labour intensive and saves water .

Authors:

Dr. AKM Zakaria, Khalid Aurongozeb and Rebeka Sultana

CDRC CHARS DEVELOPMENT RESEARCH CENTRE

Poverty alleviation constituted the basic theme of all five year development plans of Bangladesh since its independence and considerable efforts have been made to alleviate poverty. But the incidence of poverty remains high in Bangladesh. Analysis of national data show that the incidence of poverty are not evenly distributed across the region. High concentration exists in specific areas, such as along the major rivers (char lands). Such poverty persists because of increasing inequality between regions as well as people. It has been found that the riverine chars are amongst the poorest areas in Bangladesh. Char areas are characterized by a set of specific features that set them apart from other parts of Bangladesh and that justify different approach.

In physical terms, riverine chars are nearly accreted from the river and are consequently low lying .This makes chars dwellers vulnerable to frequant flood and erosions. Individual and household displacement is common in char areas. A fragile physical environment, limited assets, reduced income opportunities, remoteness and absence of mainland institutions and services together make char dwellers' livelihoods particularly vulnerable to extreme poverty and destitutions (CLP,2003). Government of Bangladesh also designated chars as pockets of extreme poverty. Over 5% of the total population of the country lives in these chars.

This situation captured government attention for better integration of the regions into wider socio-economic development. Keeping this in view, Rural Development and Cooperative Division (RDCD), M/O LGRD and Cooperatives in collaboration with DFID and AUSAID initiated the Chars Livelihood Programme (CLP-1) in 2004 and run for seven years. Further, RDCD has initiated Making Markets Work for the Jamuna, Padma and Teesta Chars (M4C) in May, 2013 in collaboration with SDC. RDA is the implementing partner for both CLP M4C and programme. The CLP-1 successfully lifted 2.5 million people out of poverty and made substantial contribution making good impact on overall well being of the chars dwellers.

Reveling the success of RDA initiated several development initiatives in chars, the concept of setting the Chars Development Research Centre (CDRC) has been evolved and finally established after having policy support and approval of the Board of Governors (BOG) of RDA in its 41st regular meeting in 2012 to cater and host chars related research and development programs and sustain the positive impacts of previous out comes. The centre is being operated under the administrative umbrella of RDA on self-financed basis

CDRC Strategic Goal

CDRC works to accelerate progress in improving income and livelihoods of the char dwellers by exploiting and enhancing their potentials.

CDRC Strategic Objectives

CDRC strategic objectives across the different components are:

1. Generate knowledge and technologies to improve the livelihoods of chars dwellers.
2. Develop methods and tools for making effective intervention in the chars.
3. Bring good practices in chars.
4. Empower and mainstream the existing efforts of chars dwellers.
5. Establish national and international linkage for development partnership.
6. Undertake cutting-edge research including gender, education, health, financial and social issues to meet emerging challenges.
7. Facilitate better market access, improve business services in selected market systems relevant for the char dwellers.
8. Mainstreame women and DRR.

CDRC Competencies

CDRC inherited unique competency within the areas of poverty reduction, livelihood improvement, green technology genertion and overall rural development from RDA, which has been serving rural development sector for the last 4 decades as a national centre.

Innovation, HRD action research, diagnostic survey, digital documentation and effective communication are other important key competences of CDRC. With all these strong background CDRC has started earning national and international recognitions as leading centre for chars development in Bangladesh.

CDRC Vision

CDRC is a rural development centre particularly dedicated to improve the livelihoods of the poor and extreme poor char dwellers. The Government of Bangladesh which has 4 major strategic target, reducing poverty, improving livelihood and food security, empowering women and reducing climate change vulnerability, while CDRC contributes to the achievement of all those targets, its primary focus is energizing and empowering people-women, men and children.

CDRC Management

The governance and management of CDRC follow the guidelines set out in the 41st BOG meeting of RDA outcome. CDRC is considered as the lead centre for chars related development activities in Bangladesh, and will have overall fiduciary and operational responsibility. RDA will play a strong supporting role, providing the chair of advisory committee to the Director General. The planning and management committee headed by the Director CDRC will oversee planning, management, implantation, monitoring and evaluation of CDRC activities.

Chars Releted Programmes @ RDA

Current programmes include:

Chars Livelihood Programmer (CLP-2)

Making Markets Works for the Chars (M4C)

Women in Seed Entrepreneurship (WiSE)

Trichodarma Enhanced Composting (TEC)

Action Research on Chars Agriculture

MAKING MARKETS WORK FOR THE CHARS

Making Markets Work for the Jamuna, Padma and Teesta Chars (M4C) project aims to unlock the potential of the chars by facilitating the growth of sectors relevant for the poor char households in terms of productivity, profitability and employment generation. The project partners with a range of private and public sector organizations to facilitate local market systems ensuring sustainable and pro-poor impact on the chars. During its five year period, the project intend to work in selected chars of ten N-W districts M4C's current portfolio includes product sectors such as maize, chili, jute and cross-cutting sector such as char transport. During the project period, new sectors will be added based on further assessments and learning from the field.

M4C is funded by the Swiss Agency for Development and Cooperation (SDC) and GoB. The project is being implemented by the Rural Development Academy (RDA), Bogra on behalf of Rural Development and Cooperative Division of the Ministry of LGRD and Coopeatives.

Farmer Participatory Research

Organic treatments of chilli seed suitable for chars

AKM Zakaria, Phd
Md. Khalid Aurongozeb
Rebeka Sultana

Introduction

Chilli (Capsicum annuum) is the most important condiment crop in Bangladesh and is being widely cultivated throughout temperate, tropical and subtropical countries. But the average yield of chili in Bangladesh is very low compared to other leading chili growing countries in the world (FAO, 2007) due to diseases and improper cultivation practices. Green fruits as well as dried ripen fruits are used as spice for preparing curries, salad etc. Chilli is famous for its pleasant aromatic flavour, pungency and high colouring substance. It is used widely in culinary, pharmaceutical and beverage industries throughout the world. It is an important condiment used for imparting pungency and colour to the food being rich in vitamin C, A, B, oleresin and red pigment.

In Bangladesh chilli is being grown on an area of 0.89 lakh hectares with the production of 1.09 lakh tons (BBS, 2010). Chilli is grown round the year in all parts of the country while winter chilli is grown between the months of October to April and accounts for about 70% of total production. At least 32 local varieties are cultivated in Bangladesh (BBS, 2005). The average yield of dry chilli was 997.89 kg/ha in 2005-2006, this is quite low to meet the internal demand of Bangladesh (BBS, 2007) and is low compared to the yield of other chili growing countries of the world (Anonymous, 2003).

Chilli is one of the most important cash crops for char dwellers, and is well suited to char soils. It is highly profitable; many char dwellers are involved in chilli cultivation, harvesting and processing. It is a short duration crop can be harvested within three to four months after sowing. Chilli can survive on char soil and climatic change conditions well. But there is lack of information about efficient use of inputs in chilli production. The average yield of chilli is very low in comparison to other field crop which is 1.26 ton ha-1, (BBS, 2008).

Delayed and erratic germination of chilli seed is one of the reasons of low yield of chilli. There are many factors responsible for the delayed and erratic germination of chilli seed. Among various reasons diseases are predominant. Fungal diseases play a detrimental role in reducing the germination of chilli. Chilli suffers from many diseases caused by fungi, bacteria, viruses, nematodes and also abiotic stresses. Among the fungal diseases damping off, anthracnose or fruit rot, powdery mildew and leaf spots are the most prevalent. Anthracnose or fruit rot caused by Colletotrichum capsici. The disease has been observed to occur in three phases viz., (i) seedling blight or damping off at seedling stage, prevalent in the nursery, (ii) leaf spotting and die back stage which initiate at different stages of growth and (iii) fruit rot in productive stage in which the ripe fruits are infected. The last

phase causes extensive damage to the fruits since the lesions on the fruits considerably reduce the market value of the produce. The market value and nutritive value is degraded in infected fruits resulting in poor quality seed. Certain biochemical constitutes of chilli fruits are also known to be reduced by infection (Azad, 1991). Alternaria fruit rot is seed borne, widespread and highly destructive disease that infects chilli plants, and yield loss caused by these diseases has been recorded up to 100 percent under congenial environment conditions. Harbant Singh and Korpraditskul (1999) studied the use of crude plant extracts as an alternative to commercial fungicides in the control of chilli anthracnose. To increase the production of chilli qualitatively and quantitatively farmer requires healthy and quality seeds, with high percentage of germination and purity. Hence, it is imperative that seed must be tested before they are sown in the field. The disease causes both pre- and post-harvest fruit decay (Bosland and Votava, 2003). Chilli anthracnose usually develops under high humid conditions when rain occurs after the fruits have started to ripen with reported losses of up to 84% (Thind and Jhooty, 1985). Economic losses caused by the disease are mainly attributed to lower fruit quality and marketability. Although infected fruits are not toxic to human or animal, severely affected fruits show blemishes are generally considered unfit for human consumption. This is because the anthracnose causes an unpleasant colour and taste in chilli products. Management of the disease under the prevailing farming systems in Bangladesh has become a recurrent problem to chilli growers. Application of fungicide is the effective methods of diseases control but chilli grower's needs to pay the largest investment which leads them to little benefits sometimes may looser. Seed treatment may be a supplementary activity to minimize the production cost of chilli.

In this context, field experiment as well lab experiment were undertaken to find out the cost effective method of improving seed quality of farm retained chilli seeds, to minimize yield gap.

Objectives

1. Generate knowledge on seed quality of farm retained chilli seed in chars areas.
2. Study chemical and organic seed treatment as means of minimizing cost and yield gap
3. Generate data on seed treatment of chilli as a basis for selecting appropriate seed treatment product
4. Select and recommend most suitable chilli seed treatment product for chars areas.

Justification of the study

Agricultural activities are the main livelihood options of char dwellers. Chilli is a major cash crop of the villagers of Chars, but they are facing many constraints which incurred yield losses. Due to lack of knowledge they were not able get more benefit from this crop. The crop-based problems found in earlier scoping studies revealed that the main cash crop (chilli) is affected with soil borne and seed borne diseases every year. Char dwellers could

not make their farming cost effective. Due to lack of technical know-how to solve the existing problems they could not diversify the cropping pattern in the sub-fertile soil. The char people prioritized to reduce the risk and vulnerability in chilli farming by introducing an appropriate alternative disease management practices i.e. seed treatment.

Scope of the study

The finding of the study will in particularly be applicable to the chars areas of Bogra, Sirajgonj and Ghaibandha district. However, the finding may also be applicable to the other areas of Bangladesh where the physical, socio-economic and cultural conditions do not differ much with those of the study area. Thus, the findings of the study are expected to be useful for different non government organizations, government organizations, researchers, planners, policy makers and extension workers to design their future programs, formulating strategies to improve the chilli production in chars areas.

Assumption of the study

An assumption is the supposition that an apparent fact or principle is true in the light of the available evidences (Goode and Hatt, 1952). The researcher had the following assumptions in mind while undertaking this study.

- The respondents were capable of furnishing proper responses to the questions contained in the interview schedule.
- The responses furnishing by the respondent were valid and reliable and expressed the truth about their conviction and opinions.
- Views and opinions furnished by the respondents include in the sample were representative opinion of the whole population of the study area.
- The researchers team who acted as interviewer was well adjusted to the social environment of the study area. Hence, the data collected by team from the respondents were free from bias.
- The findings of the study are expected to be helpful for different non government organizations, government organizations, researchers, planners, policy makers and extension workers for planning and execution of various programs in connection to chilli cultivation of the country.

The researcher was capable of rating the responses of the respondents with adequate precision.

Limitations of the study

In order to keep the study under manageable limit and meaningful considering the time, money and other necessary resources available to the researcher, the following limitations were recognized.

- The study was confined to three chars of Shariakandi upazila of Bogra district, three chars of Kazipur upazila of Sirajgonj district and three chars of Fulsori upazila of Gaibandha district. Therefore, generalization of the study findings for the whole country may not be appropriate.
- There are many technologies/aspects related to chilli seed but only some selected technologies/aspects were undertaken.
- Illiteracy of the respondents was a great hindrance for data collection. They cannot sometimes answer to the questions accurately and to the point.
- The researcher depends on the data as furnished by the selected respondent during data collection.
- Facts and figures collected by the investigator applied to the situation prevailing during the year 2013.
- For collection of information, the researcher had to depend on the data furnished by the respondents during their interview. As none of the farmers kept records of their activities, they furnished information to the different questions by recall.
- There were many seed treatments materials occur but only eight of them were selected for this study.
- There were many people in the study area, but only 60 people were considered for this study.

Definition of terms

Certain key terms used throughout the study are defined in this section for clarity of understanding.

Age: Age of farmer has been defined as the period of time from her birth day to the time of interview.

Annual income: Annual income referred to the net income of the respondents' by subtracting the livelihood expenses or expenditure for subsistence from her family's annual earning from different agricultural as well as other sources during a year.

Farm size: It referred to the total area on which a respondent's family carry on farming operations, the area being estimated in terms of full benefit to the respondent's family.

Level of education: It referred to the development of desirable knowledge, skill and attitude in an individual through reading, writing, working, observing and other related activities.

Training experience: Training referred to organized instruction aimed at improving knowledge, skill and attitude of an individual so that she can perform her functions and responsibility more effectively. Training experience referred to number of days the respondents received training in different aspects of agriculture.

Extension contact

This term referred to one's becoming accessible to the influence of extension education through different extension teaching methods.

Decision-making role

A decision may be conceived simply as a choice to undertake a course of action on significant matters of the family concern of the decision maker. Usually the head of the family acts as a decision-maker or he/she may have in such activities with other family members e.g. spouse, sons, daughters etc. and also with relatives, neighbors and friends. The decision-making role in the study refers to activeness of the respondents in the selected matters of the family.

Material and Method

The research issue and objectives indicate that this work is unfolding in nature to gain novel arguments that contribute to discover scientific as well as social benefit. Therefore, the study was carried out in three parts.

The first part dealt with a field survey in selected char of Shariakandi upazilla of Bogra district, Kazipur upazilla of Sirajgonj district and Fulsori upazilla of Gaibandha district. Second part covered the farmers' participatory research in farmers' field. Third part dealt with farm retained chilli seed. Seed samples were collected from all the respondents and passed under several seed testing process to judge the quality of farm retained chilli seed and lab. experiment to support the field experiments.

Population and sample

A survey was conducted in the selected three chars (river island). A total of 60 chilli producing farmers were randomly select for collecting data about farmers' practice in chilli seed production, processing and preservation technique. From each upazilla 20 farmers were selected.

After field survey seed samples were collected from the farmers stock and a set of lab. experiments were conducted at RDA Seed Technology Laboratory to validate of field experiments.

Data collection instruments

One set of data gathering instruments were prepared for data collection. In order to make the instrument valid and reliable, it was tested and validated in actual field situation. After piloting the instruments, the final version of baseline questionire was prepared.

Data and seed sample collection

Data were collected through face to face interview using structured interview questionnaire by researcher. In addition, study of available records and observation of group activities were recorded. Seed samples were collected to examine the seed health as well as other seed quality components. In addition to baseline data from 60 respondents 100 gm seed samples were collected from each of them for testing quality of farm retained seed.

Variables of the study

The selected personal, social and economic characteristics of the respondents of the study were age, education, farm size, annual income, decision making abilities, seed management knowledge and attitude towards seed management practices. Appropriate scores and scaling techniques were used to measure the independent variable as described below:

Age

Age of a respondent was measured in terms of complete years from her birth to the time of interview. A score of 1 was given for each year of age.

Education

Education of a respondent was measured by the number of years of formal schooling completion. An education score was computed for each respondent by giving one point for each year of schooling. If the respondent does not have any education, he/she was given a score of '0' but if he/she could sign his/her name only he/she was given a score of 0.5.

Farm size

The farm size of a respondent referred to the total area of land in hectare on which his/her family carried out farming operations, the area being estimated in terms of full benefit to his/her family. It was measured (in hectare) by using the following formula: This procedure was followed by Mia (2002).

$$FS = A1 + A2 + A3 + 1/2\,(A4 + A5)$$

Where,
FS = Farm size
A1 = Homestead area with pond
A2 = Cultivated area owned by a respondent
A3 = Cultivated area taken as lease by a respondent from others
A4 = Area given by a respondent to others on Borga system
A5 = Area taken by a respondent from other on Borga system
The total area, thus, obtained considered as farm size score

Family income

The total yearly earning from agriculture (field crops, vegetables, fruits, spices, livestock and fisheries) and non-agricultural sources (service, business, day labour and others) by a respondent and other members of his/her family were determined. Thus, yearly earnings from agricultural and non-agricultural sources were added together to obtain family income.

Family income of an individual was expressed in thousand taka. A score of one was given for each Tk. 1000 to compute the family income of the respondents.

Extension media contact

Extension media contact of a respondent was measured by computing an 'extension media contact score' on the basis of his/her frequency of contact with twelve selected extension media related to seed. Each respondent was asked to indicate his/her frequency of contact regarding seed with a particular media within a specified time frame, the frequency of contact being scored as follows:

Extension Media	Score				
1. Government Workers (Sub-Assistant Agriculture Officer)	0 = no contact	1= 1/2 times a year	2=1/2 times every six months	3=1/2 times in a quarter	4=1/2 times in a month
2. NGO workers	0 = no contact	1= 1/2 times a year	2=1/2 times every six months	3=1/2 times in a quarter	4=1/2 times in a month
3. Local leaders	0 = no contact	1= 1/2 times a year	2=1/2 times every six months	3=1/2 times in a quarter	4=1/2 times in a month
4. Fellow farmers	0 = no contact	1= 1/2 times a year	2=1/2 times every six months	3=1/2 times in a quarter	4=1/2 times in a month
5. Local seed traders	0 = no contact	1= 1/2 times a year	2=1/2 times every six months	3=1/2 times in a quarter	4=1/2 times in a month
6. Field demonstration/field day	0 = no contact	1= 1/2 times a year	2=1/2 times every six months	3=1/2 times in a quarter	4=1/2 times in a month
7. Farmer's meeting	0 = no contact	1= 1/2 times a year	2=1/2 times every six months	3=1/2 times in a quarter	4=1/2 times in a month
8. Poster	0 = no contact	1= 1/2 times a year	2=1/2 times every six months	3=1/2 times in a quarter	4=1/2 or times in a month
9. Leaflet / Booklet	0 = no contact	1= 1/2 times a year	2=1/2 times every six months	3=1/2 times in a quarter	4=1/2 or times in a month

Extension Media	Score				
10. Newspaper	0 = no contact	1= 1/2 times a year	2=1/2 times every six months	3=1/2 times in a quarter	4=1/2 times in a month
11. Radio	0 = no contact	1= 1/2 times a year	2=1/2 times every six months	3=1/2 times in a quarter	4=1/2 times in a month
12. TV	0 = no contact	1= 1/2 times a year	2=1/2 times every six months	3=1/2 times in a quarter	4=1/2 times in a month

The extension media contact score of a respondent would, therefore, be obtained by adding his/her scores against all the selected 12 extension media. The range of extension media contact score of the respondents could thus vary from 0 to 48, where 0 indicated no extension contact and 48, the highest level of extension contact.

Training experience

Training experience of a respondent was measured by the total number of days a respondent received training on different subject matters in his/her life time. A score of 1 was assigned for each day of training attended. Data obtained were used to determine the training experience of the respondent.

Decision making ability

It refers to the role of a respondent in making decisions about various aspects of his/her family affairs. Various authors measured the matter in various ways. Akter (2000) made a 3 point modified Likert scale as 'no role', 'passive role' and 'active role' to see the decision making matter of the family by the respondent. Begum et al. (1999), measured the decision making process of respondent in the family through a 5 point Likert scale as 'nobody takes the decision', 'decision taken by other members of the family', 'decision by husband alone', 'joint decision by husband and wife' and 'decision by wife alone'. In another study for impact assessment of ASA, Bruntrup *et al.*, (1997) measured the decision making matter in a quite different way as did by Begum *et al.* (1999). They also used a 5 point modified Likert scale as 'can not influence on the decision', can discuss with husband', 'joint decision with husband', 'partial decision with husband' and 'decision taken by wife alone'.

Based on the literature review and field experience, the researchers made a 3 point response category as 'decision taken by wife alone', 'joint decision' and 'decision by husband alone' and the corresponding score given as 3,2 and 1 respectively. A total of 17 statements on various family affairs were selected e.g. seed management like rouging chilli seed crop,

chilli seed sorting and grading, chilli seed harvesting and threshing, chilli seed drying and chilli seed preservation etc. Similar statements were also selected by Jeffrey and Lisa (2001). The decision making ability was computed against each of 17 statements and finally added together to get a decision making score. The score ranged from 17 to 51, where 17 indicating no decision or 'no influence can be made on the decision by a respondent, while 51 indicating the decision taken by the wife alone in the family.

Seed management knowledge

Seed management knowledge of a respondent was ascertained by computing a seed management knowledge score which was measured by asking 20 seed related questions regarding seed characteristics, seed sorting, seed moisture content, seed drying, seed harvesting technique, seed collection, seed preservation, container preparation, seed preservatives and related aspects on seed management to ensure quality. Each of the questions carries 2 marks. If a respondent was able to answer correctly, he/she was given a full score of 2. For partial answer he/she was given a score of 1, for non-answer and wrong answer he/she was given a score of 0. Therefore, the range of score could vary between 0 to 40, where 0 indicating the lowest level of knowledge and 40 for the highest level of knowledge of seed management.

Attitude towards seed management practices

Attitude towards seed management practices of a respondent was measured by computing a 'attitude towards seed management practice score' using a modified Likert scale, consisting of 10 statements [five (+) positive and five (-) negative] expressing feeling, belief, action and tendency towards seed management practices. A respondent was asked to give his/her opinion against each of the 10 statements whether she "agreed", "no opinion", or "disagreed". For positive statements the highest score 3 was assigned for "agreed", 2 for "neutral or no opinion" and 1 for "disagreed". In case of the negative statements the scoring system was just reverse. Thus, attitude towards seed management practice score of a res was computed by summing up scores for all the 10 statements. The attitude scores of the respondent could range from 10 to 30, 10 indicating negative and 30 indicating positive attitude towards seed management practices of the respondents.

Data collection

Data were collected by means of interviewing the selected sampled of the respondents. The researcher collected data for this study. Before going to the respondents' home for interview they were informed verbally to ensure their availability at home as per scheduled date and time. If any respondent failed to understand any question, the researcher took great care to explain the issue. Ten respondents from the reserve list were interviewed because the respondents were repeatedly unavailable for data collection. In some cases

the respondents felt shy to give answer at some aspect of questioning. Data were collected during 15 September –15 October 2012.

Data processing

To facilitate tabulation, the collected data were properly coded and transferred from interview schedule to a master sheet. Qualitative data were converted into quantitative forms by means of suitable scoring whenever necessary. Tabulation and cross tabulation was done on the basis of categorization developed by the researchers.

Data analysis procedure

The analysis was performed using statistical treatment with SPSS (Statistical Package for Social Sciences) computer package.

Descriptive analysis

Statistical measures such as number, frequency counts, percentage, range, mean, standard deviation and rank order were used in describing the variables wherever applicable.

Field experiment

Second part was the farmer participatory research in the farmers' field. Three chars were selected purposively and discussion with M4C project. Three experiments were conducted in association and/ or cooperation with the selected farmers of each chars.

Location

The farmers' participatory researches were carried out in the farmers' field in 3 chars (river islands) under Shariakandi upazilla of Bogra district, Kazipur upazilla of Sirajgonj district and Fulshori upazilla of Gaibandha district.

Duration of the experiments

The field experiments were conducted at three chars during the rabi season from September, 2012 to May, 2013.

Soil

The land belongs to silt clay soil type with some areas of soil mixture with sand. The analysis of the soil also contains sandy in nature.

Land preparation

The selected land for the experiment was first opened on last week of September, 2012 by power tiller in 3 chars with leveling of uneven lands. The lands were then ploughed three times by power tiller. Each ploughing was followed by leveling to break the soil into pieces. The land was levelled and in some cases deposited sand were removed. During the final stage of cultivation, weeds were removed and the land was finally prepared adding basal doses of manures and fertilizers. Irrigation channels were prepared around the plots and between the parts before sowing the seed.

Seed rate

The seed rate was used by the partner farmers was 7.5 kg/ha in every locations.

Sowing

Seed were sown on 19 September at Shariakandi, 20 September at Kazipur and 21 September 2012 at Fulsori char following broadcasting method. Before sowing the seed was treated with seed treating agents for two hours.

Manure and fertilizer

The crop was fertilized with 5000 kg/ ha of cowdung, 550 kg/ ha of urea, 250 kg/ ha of TSP, 230 kg / ha of MP, 250 kg / ha of Gypsum, 20 kg/ ha Zinc Sulphate and 12 kg/ ha of Borax. Well decomposed cowdung was applied 7 days before final land preparation. Full doses of fertilizers except urea were applied at the time of final land preparation. Urea was applied six times as top dresse in 15-20 days intervals.

Intercultural operations

Thinning was done periodically whenever necessary. Weeding was done several times once just after emergence 2nd at 20 DAS, 3rd at 35 DAS, 4th at 50 DAS and 5th at 65 DAS and other management practices fertilization, irrigation and pest management etc. were done uniformly in all the plots.

Seed treatment materials

Effect of the following 8 seed treating agents was studied on chilli against an untreated control in farmer's field.

T_1= Provax -200 (5 gm/kg seed)

Organic [T_2-T_8]

- T_2= Black berry leaves extract (60-70 leaves extract for /kg seeds)
- T_3= Garlic extract (100gm garlic clove extract/ kg seed)
- T_4= Neem leaves extract (100 gm leaves extract/ kg seeds)
- T_5= Hot water treatment (50o C for 10 minutes)
- T_6= Trichoderma Suspension (2 lit solution-2 /kg seed)
- T_7= Juice of black pepper (75 gm black pepper)
- T_8= Zinger + cow urine

T_9= Control (Farmer's practice)

Design of the experiment

The lab experiment was arranged under three replications where as the field experiments were arranged under Randomized Complete Block Design (RCBD) with three replications in each site. The plot size was 15 x 10 m^2. Seven organic, one inorganic treatments and an untreated check were randomly placed in the blocks.

Layout of the experiment

R1	R2	R3
T_7	T_1	T_5
T_4	T_8	T_2
T_8	T_4	T_6
T_1	T_7	T_9
T_5	T_2	T_1
T_9	T_9	T_3
T_3	T_5	T_8
T_2	T_6	T_4
T_6	T_3	T_7

Data collection procedure

For data collection 10 representative sample plants were selected and dugout carefully with parts of their root systems which was washed with a jet of water to remove adhering soil particles keeping the root portion of each individual plant in a sieve. The plants were divided into root; shoot and root nodule and the data were collected at 50 DAS. The

similar procedure was followed at 75 DAS except yield contributing characters. For yield parameters mature chilli was collected time to time from previously selected plants.

The mean value of each parameter was calculated manually. Multiplying the mean value by plant population of plot and hectare. The value of each parameter was obtained as per plot and per hectare.

Data collection

Data on the following parameters were recorded from each experiment. The parameters were as follows:

Parameters studied in farmers' field

1. Days to 50% field emergence
2. Days to 50% flowering
3. Plant population at emergence
4. Established plant
5. Plant vigour at seedling, vegetative and flowering stage
6. No. of disease infected plants (7 days interval)
7. Average plant height cm (mean 10 plants/plot at harvesting)
8. No. of primary branches/plant (mean 10 plants/plot at harvesting)
9. No. of fruits/ plant (mean of 10 plants)
10. Fruit length in cm (mean of 10 fruit)
11. Plant vigour at seedling, vegetative and flowering stage (scale :1-10)
12. Resistant to insect (scale :1-10)
13. Resistant to diseases (scale :1-10)
14. Yield- green chilli (Kg/ ha)
15. Yield- red chilli (Kg/ha)

Data analysis

The analysis of variance for each character of the experiments was studied by F (variance ratio) test following Randomized Complete Block Design (RCBD). These data were analyzed statistically following ANOVA technique and means separations were adjudged by DMRT test at 1% and 5% level of significance.

Laboratory experiment

Third part was the laboratory experiments details presented as follows:

Seed sample collection

From each of the selected respondents under study chilli seed samples were collected during the survey. Seed samples were procured from them following *ISTA* (1985) sampling procedure. From each respondent 100 gm of samples were purchased. For easy identification of samples the cloth bags used for procuring the samples were collected marked with code number. For collection of each sample, following materials were used:

(1) One clothe bag for 100 grams of seed
(2) One polythene cover bag for moisture protection
(3) One tag cards having same identifying code number
(4) One survey format.

During collection of samples, the survey format and the tag cards were filled up. The sample bags were opened and tag cards were placed one in each bag. Finally the cloth bag was tied.

Seed samples were collected as close to sowing time of chilli. This was done to assess quality of the stored seed at a stage when farmer would be sowing the seed in the field; or in other words, to assess quality-wise, what kind of chilli seed farmers were really using for cultivation.

Seed sample test

Each of the seed samples was divided by a riffle divider into two equal samples. One part (50gm) was preserved separately in the lab as original seed stock and the other portion (50gm) was used for various tests.

Status of the farm retained chilli seed was judge at RDA Seed Technology Laboratory during the period from November to December, 2012.

The samples were tested for different quality components following standard seed testing procedure in the Seed Technology Laboratory of RDA, Bogra. The samples were tested immediately after arrival. This was done apprehending obvious deterioration of seed with time. The following major seed quality tests were conducted in 3 replications.

(i) Determination of moisture content
(ii) Germination test
(iii) Seedling vigour (Shoot length, Root length, Dry weight, Speed of germination, Vigour index)

Germination test

Germination test was done in petridish at the Seed Technology Laboratory, RDA, Bogra. Blotter paper was used as germination media which was collected and dipping with some moisture (Figure 1). Adequate moisture level was maintained in the germination

media. Germination test for nine treatments was carried out taking 100 seeds at every sampling stage.

During germination test normal seedling, abnormal seedling, fresh seed, hard seed and dead seed were carefully identified from each replicate of 25 seeds and then counted and recorded at the date of final count (10th day of setting for germination). A seed was considered to be germinated as seed coat ruptured, plumule and radicle came up to 5 mm in length. The normal seedling was identified by following the International Seed Testing Association (ISTA) Seedling Evaluation Guide (ISTA, 1979). Germination percentage was calculated using the following formula (ISTA, 1985). The replicated results were averaged to give the mean percentage of normal germination.

$$\text{Germination (\%)} = \frac{\text{Number of normal seedling}}{\text{Number of seed tested}} \times 100$$

Moisture content test

Moisture content was determined by using high constant temperature oven method following International Rules for Seed Testing (Ansari *et al.*, 1996) in the Seed Technology Lab of RDA. Around 2 g of seed from each sample were taken and weighed. After weighing of seeds, were poured in a small container with cover and kept in an oven maintained at a temperature of 130°C for a period of 4 hours. Similar procedure was performed for every fifteen day from the beginning of storage.

$$MC\ (\%) = \frac{M_2 - M_3}{M_2 - M_1} \times 100$$

MC= Moisture content

M_1 = Wt. of container + cover

M_2 = Wt. of container + cover + Chilli seed before drying

M_3 = Wt. of container + cover + Chilli seed after drying

Seedling vigor Index (VI)

The vigour index of seedling was calculated by the line of the method suggested by Abdul-Baki and Anderson (1973), as mentioned below:

Seedling vigour Index (VI) = Germination (%) x Seedling Length (cm)..... (1)

The measurement was done at 7th to 14th day dominating the medium pant length (MPL) and the mean value was taken.

Experimental treatment

A. Seed Treatments: 9

T_1= Provax -200 (5 gm/kg seed)

Organic [T_2-T_8]

- T_2= Black berry leaves extract (60-70 leaves extract for /kg seeds)
- T_3= Garlic extract (100 gm garlic clove extract/ kg seed)
- T_4= Neem leaves extract (100 gm leaves extract/ kg seeds)
- T_5= Hot water treatment (50° C for 10 minutes)
- T_6= Trichoderma suspension (2lit solution-2 /kg seed)
- T_7= Juice of black pepper (75 gm black pepper)
- T_8= Zinger + cow urine

T_9= Control (Farmers' practice)

Experimental design

The farmers' participatory experiment was laid out in Randomized Complete Block Design (RCBD) with three replications in each site and Laboratory experiment was laid out in Completely Randomized Design (CRD) with three replications. Eight treatments and an untreated check will randomly be placed in the blocks.

Statistical analysis

The recorded and calculated data were statistically analyzed using a MSTAT-C Statistical Computer Package Program in accordance with the principles of Completely Randomized Design, Duncan's Multiple Range test (DMRT) was performed to compare variations among treatments.

Results and Discussion

Data collected from the respondents were carefully, coded, computed, tabulated and analyzed in accordance with the objectives of the study. After completion of those processes this chapter was written carefully. The data have been presented in table(s), figure(s) and a summary of the analysis of variance in respect of all the parameter. The result of each parameter has been discussed and possible interpretation where ever necessary.

Selected characteristics of the respondents

Thirteen characteristics of the respondents were selected for the present study. These selected characteristics included age, level of education, farm size and family annual income, chilli cultivation land, extension contact, training exposure, decision making role, knowledge on chilli seed technologies, attitude on chilli seed technologies, chilli seed management practices, cost involve in chilli cultivation and problems in chilli production. The salient features of the nine characteristics of the subjects, each of which constituted an independent variable, have been presented in Table-1

Table 1: Respondent's Characteristics Profile

Sl. No.	Characteristics	Measuring unit	Possible range	Observed range	Mean	Standard deviation
1.	Age	Actual years	Unknown	20-70	42.43	11.56
2.	Level of Education	Years of schooling	Unknown	0-12	2.41	3.35
3.	Farm Size	Hectare	Unknown	0.014-5.01	0.49	0.40
4.	Chilli cultivation land size	Hectare	Unknown	0.01-1.57	0.28	0.129
5.	Family Annual Income	In Tk.1000	Unknown	43.60-628.95	156.97	98.56
6.	Knowledge on chilli seed technologies	Score	0-40	1-23	11.82	76
7.	Attitude on chilli seed technologies	Score	10-30	0-20	16.30	3.76
8.	Chilli seed management practics	Score	0-72	1-23	32.88	8.37

Sl. No.	Characteristics	Measuring unit	Possible range	Observed range	Mean	Standard deviation
9.	Training Exposure	Score	Unknown	0-1	0.0167	0.129
10.	Extension Contact	Score	0-48	0-7	2.00	1.904
11.	Decision Making Role	Score	9-27	11-20	15.76	1.60
12.	Cost involve in chilli cultivation	Taka	Unknown	14930-32500	22169.17	4348.084

Age

The observed age scores of the Respondents ranged from 25 to 50 having an average of 321 with a standard deviation of 6.10. On the basis of the age scores of the Respondents, they were classified into three categories: "young" (up to 33), "middle aged" (34-44) and "old" (45 and above). The highest proportion (51%) of the Respondents fell in the "young" category while 39% of them fell in the "middle aged" category and only 10% fell in the "old" category. The distribution of the respondents according to their age is shown in Table-2.

Table 2: Distribution of the respondents according to age

Categories	Respondents	
	Number	Percent
Young (up to 33)	15	25
Middle aged (34-44)	18	30
Old (45 and above)	27	45
Total	60	100

Data present in the Table -2 shows that the largest portion (45 percent) of the respondents were old while young were the lowest (25 percent) and middle aged constituted 18 percent. It is express that old and middle aged respondents (75 percent of the respondents) are more active in chilli cultivation. Thus decision-making regarding the chilli cultivation and seed production in the study area might be influenced by the middle and older aged respondents.

Level of education

Observed level of education scores of respondents ranged from 0 to 12. The average score was 3.03 with a standard deviation of 3.46. Based on their level of education scores, the respondents were classified into five categories as shown in Table -3.

Table 3: Distribution of respondents according to their level of education

Categories	Respondents	
	Number	Percent
Illiterate (0)	15	25
Can sign only (0.5)	24	40
Primary level (1-5)	11	18.3
Secondary level (6-10)	9	15
Higher secondary & above (>10)	1	1.7
Total	60	100

It is evident from Table-3 that 40 percent of respondents can sign only while 25 percent were illiterate. Among the respondents 18.3, 15 and 1.7 percent had primary level, secondary level and higher secondary & above education level respectively. Thus most (75 percent) of the respondents were literate. The present literacy rate of the country is 78 percent (BBS 2011). The findings indicate that the literacy rate in the study area was lower than the national average. It is assumed that literate persons are more progressive and innovative than those of illiterate with respect to both farming and non-farming activities.

Farm size

Observed farm size of the respondents in the study area varied from 0.02 to 1.75 hectares. The average farm size was 0.49 hectare with standard deviation of 0.40. Based on farm size the respondents were classified (DAE, 1999) into three categories as shown in Table -4.

Table 4: Distribution of respondents according to their farm size

Categories	Respondents	
	Number	Percent
Marginal farm (0.02-0.50)	21	35
Small farm (0.051-1.00)	14	23.3
Medium farm (1.01-3.00)	22	36.7

Categories	Respondents	
	Number	Percent
Large farm (Above 3.00)	3	5
Total	60	100

The Table-4 shows that the highest proportion (36.7 percent) of the respondents belonged to medium farm size compared to 35 and 23.3 percent to marginal and small farm size respectively. This finding indicates that the majority of the respondent of the study area had either marginal or medium farm. It indicates that majority of the families possesses small sized cultivable land. In Bangladesh at present, farmers are becoming small to marginal and then landless for various reasons of which fragmentation of land due to inheritance is the most important. The farm families of the study area were survived with various types of jobs and business in and outside of villages. Small and marginal farmers are usually reluctant to adopt new agricultural technologies though striving hard to increase their income. So, an appropriate extension programme is needed depending on the farm size to increase skill of respondents in different productive activities and to improve income.

Annual family income

Observed range of family annual income scores was 10.50 to 181.50 with an average of 62.08 and standard deviation 328. On the basis of family annual family income, the respondents were divided into three categories as shown in table-5.

Table 5: Distribution of respondents according to their family annual income

Annual family income based categories (in '000' Taka)	Respondents	
	Number	Percent
Low income (up to 60)	33	55
Medium income (60.1to 112)	21	35
High income (> 112)	6	10
Total	60	100

Data presented in Table-5 shows that the lowest proportion (10 percent) of the respondents had high family annual income compared to 35 percent having medium income and 55 percent having low income. As a result, most (90 percent) of the respondents in the study area were in low to medium income group. Because this study was conducted in an area

where there was unavailability of necessary agricultural land due to natural vulnerability like flood.

Income sources

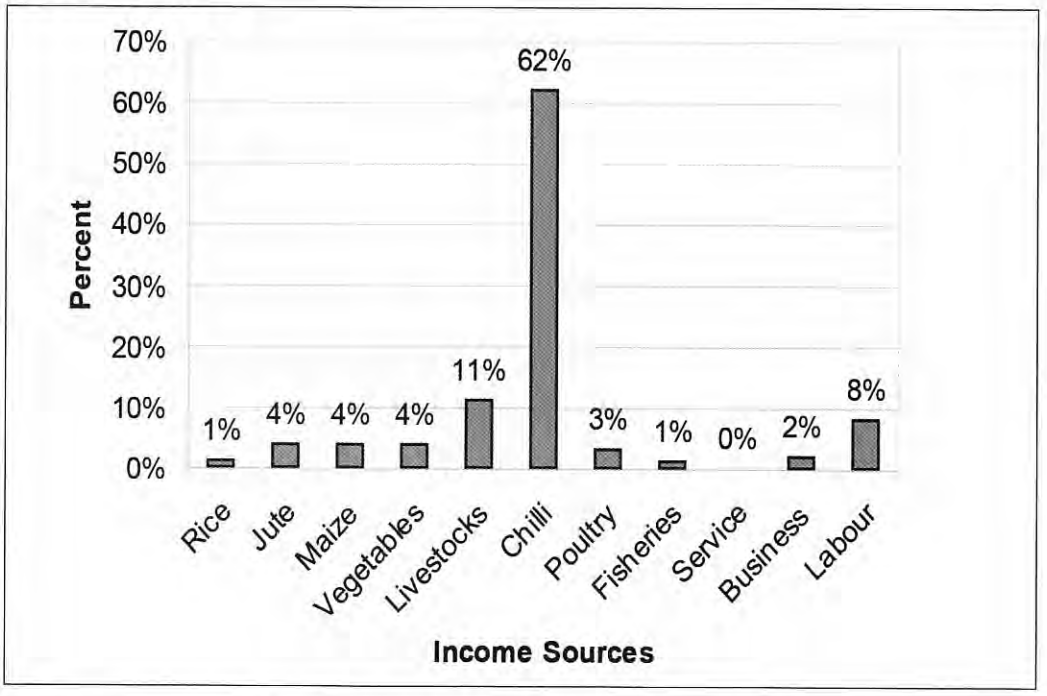

Fig 1: Income sources of the respondents

Figure 1 shows that the main income sources of the respondents was chilli cultivation (62%) whereas 11 percent income source were livestock rearing 8 percent labour and rest come from other crops (maize, jute , vegetable etc.) and some other income generating activities like business, service etc. As their livelihoods mostly depend on chilli cultivation so that different improve chilli cultivation technologies and marketing facilities of the products need to provide through the interventions of GOs and NGOs.

Extension contact

The scores obtained for extension contact of the respondent ranged from 3 to 18 against the possible range of 0-40 being an average of 9.79 and standard deviation of 2.83. The respondents were grouped into four categories on the basis of their scores for extension contact as presented in Table -6.

Table 6 : Distribution of respondents according to extension contact

Categories	Respondents	
	Number	Percent
Low contact (up to 9)	60	100
Medium contact (9-18)	0	0
High Contact(> 18)	0	0
Total	60	100

Data presented in the Table-6 show that none of the respondents had high extension contact whereas cent percent of respondents had low extension contact. As the highest proportion of the respondents was illiterate/can sign only they had low exposure to various extension contact. Practically there is very little extension programme in char areas. The situation is changing through the interventions of GOs and NGOs but more attention is needed.

Training exposure

The computed training exposure scores of the respondents ranged from 0 to 1 being an average of 0.0167 and standard deviation of 0.0129. Based on their training experience scores, the respondents were grouped into four categories as shown in Table-7.

Table 7: Distribution of the respondents according to their agricultural training exposure

Categories	Respondents	
	Number	Percent
No training (0)	59	98.33
Low training (up to 6)	1	1.67
Medium training (7-12)	0	0
High training (>12)	0	0
Total	60	100

Majority of the respondent of the study area did not receive any training. Only 1.67 percent respondents had low training exposure while only 98.33 percent had no training exposure. There were very little training programme available for respondents in the study area. So, there is an urgent need to take appropriate programme by GOs and NGOs to improve

skill of respondents in different productive activities of chilli cultivation as well as chilli seed production.

Use of chilli varieties

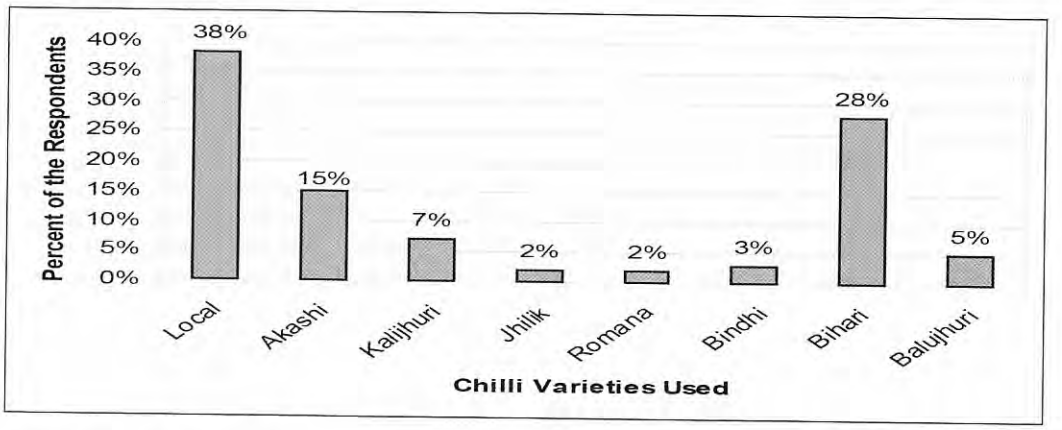

Figure 2: Distribution of respondents according to chilli varieties used

The figure-2 shows that most of the respondent used local varieties (38%) followed by Bhari (28%). Only 15 percent variety used Akashi, 7 percent used Kalijhuri, 3 percent used Bindhi, 2 percent used Jhilik and 2 percent used variety Romana. There was found little intension to use improved chilli varieties and they used indigenous varieties of chilli.

Seed source

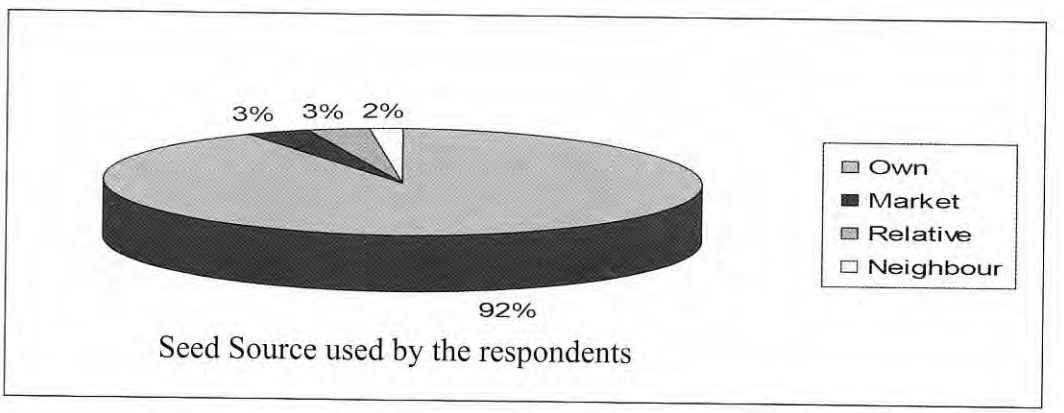

Figure 3: Distribution of respondents according to their seed source.

Figure 3 shows that majority of the respondent of the study area used own produced chilli seed. Only 3 percent respondents collected seed from local market followed by relatives (3%) and 2 percent from neighbour. As they use indigenous varieties and own produced seed and most of them have no training experiences so the seed quality were not up to the standard. So, there is an urgent need to take appropriate training programmes by various GOs and NGOs to increase skill of respondents in different productive activities of chilli cultivation as well as chilli seed production.

Cost involve in chilli production

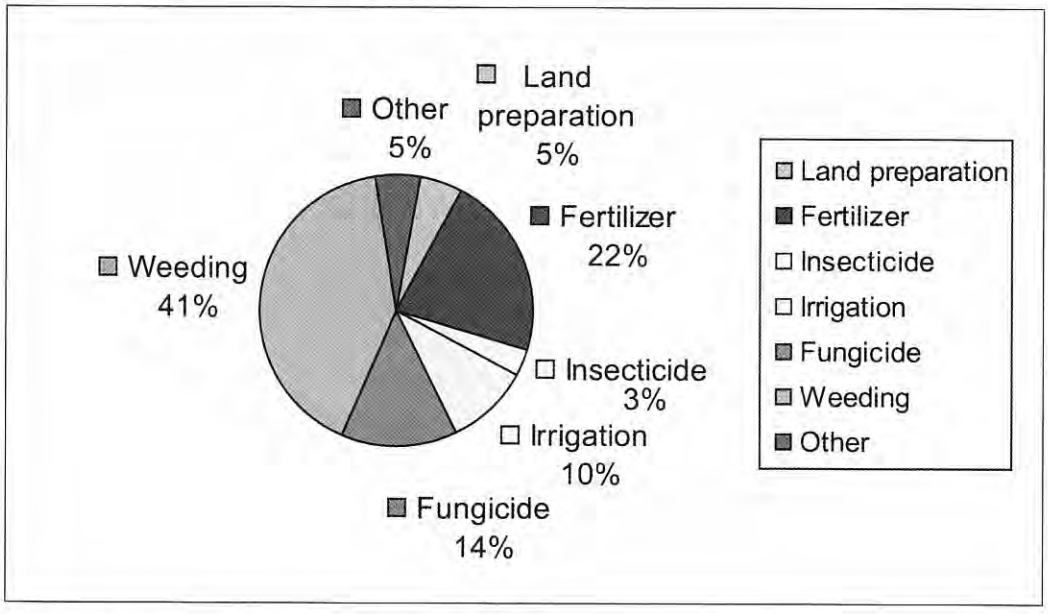

Figure 4: Cost involved in chilli cultivation

Figure 4 shows that most of the cost involved in chilli production were weeding (41%) followed by fertilizer (22%) but extra 14 percent cost increase for fungicide use which may be control through pre sowing seed treatment and proper seed management.

Field experiment

Results of field experiment on various parameters on chilli seed treatment are presented in Table 8 and Table 9. Agronomic characteristics of different seed treatment products have been presented in table 8- 9. Plant vigour at different stages and resistant to insect and diseases have been presented in Table 10.

Days to 50% emergence and 50% flowering

There was a significant variation among the treatment in respect with days to 50% emergence and no significant difference in case of 50% flowering presented in Table 9. The highest (12) days required in 50% seedling emergence in case of untreated control (T_9) where treatment T_3, T_4, T_5 and T_7 was statistically identical which require (9-10) days. On the other hand T_1, T_2 and T_6 was statistically identical which required lowest (8) days.

Plant population of emergence

The highest plant population was observed in T_1 and T_6 which was 2.369 and 2.495 thousand respectively and lowest plant population was recorded in untreated control (T_9) which was 0.795 thousand where T_2, T_3 T_4, T_5, T_7 and T_8 was statistically identical in case of plant population in emergence which has been presented in the Table 8.

Established plant population

The maximum number of established plant population observed in T_6 (10.27 hundred/plot) followed by T_1 (8.82 hundred/plot). T_3, T_4, T_5 and T_7 were statistically identical where established plant population was 7.12, 5.49, 5.88 and 7.37 hundred/plot respectively. Lowest established plant population observed in T_9 (3.50 hundred/plot). On the other hand medium established obtained in T_2 and T_8 which was 7.12 and 7.37 hundred/plot respectively presented in Table-8.

Field germination percentage

There was a significant statistical variation in respect of field germination under different seed treatment products. The highest field germination was observed in T_6 (68.33%) followed by T_1 (66.67%) and lowest germination percent was obtained in untreated control which was 37.67%. The other treatments are statistically identical as presented in Table-8.

Table 8: Effect of various seed treatments on days to emergence, flowering and field emergence of chilli seed.

Treatments	Days to		Plant Population		Field emergence (Percentage)
	Emergence (50%)	Flowering (50%)	Emergence (Thousands)	Harvesting (Hundreds)	
T_1 (Provax -200)	8 c	58	2.369 a	8.82 b	66.67 a
Organic [T_2-T_8] T_2 (Black berry leaves extract)	8 c	59	1.599 b	7.12 c	58.33 b
T_3 (Garlic extract)	9 bc	56	1.152 bc	5.49 d	51.00 c

	Treatments	Days to		Plant Population		Field emergence (Percentage)
		Emergence (50%)	Flowering (50%)	Emergence (Thousands)	Harvesting (Hundreds)	
Organic [T_2-T_8]	T_4 (Neem leaves extract)	10 b	57	1.254 bc	5.88 d	50.00 c
	T_5 (Hot water treatment)	10 b	58	1.159 bc	5.56 d	50.11 c
	T_6 (Trichoderma suspension)	8 c	56	2.495 a	10.27a	68.33 a
	T_7 (Juice of black pepper)	10 b	56	1.358 bc	5.86 d	52.33 bc
	T_8 (Zinger + cow urine)	8 c	58	1.533 b	7.37 c	55.44 bc
	T_9 Control (Farmer's practice)	12 a	58	.0795 c	3.50 e	37.67 d
	LSD (0.01)	1.167	NS	0.5998	1.023	6.404

Plant height

Significant variations were found among the treatments regarding plant height (Table 9). The tallest plant type (89.71 cm) was found where seed treated with *Trichoderma* suspension (T_6) followed by 85.20cm seed treated with Provax-200 (T_1) and 79.68 cm obtained the seed treated with mixture of zinger extract and cow urine (T_8). On the other hand the shortest plant type (527 cm) observed where seed was untreated (T_9). Statistically identical plant type was observed 756 cm the seed treated with black berry leaves extract (T_2), 70.62 cm in Garlic extract (T_3), 71.87 cm neem leaves extract (T_4) and 71.56 cm seed treated with black pepper extract (T_7).

Number of branches/ plant

Table 9 shows that there were a significant differences among the treatments in producing of branches/plant. The highest number of branches/plant observed seed treated with Trichoderma suspensions (T_6) which was 18 and lowest branches/plant 8 observed in untreated control (T_9). On the other hand T_2, T_3, T_4, T_5, T_6, T_7 and T_8 were statistically identical in number of branches/plant which was 11.34, 10.44, 10.59, 10.89, 10.44, and 12.67 respectively.

Number of fruit/ plant

Table 9 shows that the chilli grown from seed treated with Provax-200 and Trichoderma hand the height number of fruits/plant which is 76 and 75 respectively followed by seed treated with mixture of zinger extract and cow urine(T_8) was 68 whereas the chilli grown from untreated control chilli plant produced the lowest 47 fruits. Seed treatments T_2, T_3,

T_4, T_5 and T_7 produced statistically identical number of fruit which was 63, 59, 58 and 57 respectively.

Fruit length

There was significant difference among the treatments in respect of fruit length (Table 9). The height fruit length observed (8.79 cm) in T_6 followed by T_1 (7.70 cm) and the lowest fruit length observed in untreated control (T_9) 20 cm. Fruit length in respect of other seed treatment products was statistically identical.

Table 9: Effect of seed treatments on the yield contributing characteristics of chilli.

Treatments	Plant Height (cm)	No of Branches	No of fruits	Fruit Length (cm)	Fruit Diameter (cm)	Yield Green Chilli (Kg/ plot)	Yield Red Chilli (Kg/Plot)
T_1 (Provax -200)	85.20 b	139 b	76 a	7.70 b	3.48 b	7.21 b	1.88 a
T_2 (Black berry leaves)	756 d	11.34 cd	63 bc	6.49 cd	2.47 c	6.12 cd	1.27 b
T_3 (Garlic extract)	70.62 d	10.44 d	59 c	6.21 d	2.74 bc	5.55 d	1.34 b
T_4 (Neem leaves extract)	71.87 d	10.56 d	58 c	6.58 cd	2.49 c	5.65 d	1.34 b
T_5 (Hot water treatment)	70.58 d	10.89 cd	57 c	6.43 cd	2.29 c	5.77 cd	1.37 b
T_6 (Trichoderma suspension)	89.71 a	18.33 a	75 a	8.79 a	56 a	8.75 a	2.07 a
T_7 (Juice of black pepper)	71.56 d	10.44d	58 c	6.41 cd	2.40 c	5.41 d	1.25 b
T_8 (Zinger + cow urine)	79.68 c	12.67 bc	68 b	7.27 bc	2.29 bc	6.66 bc	1.76 a
T_9 Control(Farmers' practice)	527 e	6.778 e	47 d	20 e	1.71 d	3 .79 e	0.78 c
Level of significance	**	**	**	**	**	**	**
LSD (0.01)	272	1.729	6.468	0.8896	0.7063	0.8923	0.3393

Fruit diameter

Significantly the highest fruit diameter was observed in T_6 which was 56 cm followed by T_1 (3.48 cm) and the lowest fruit diameter recorded in T_9 (1.71 cm) the untreated control. Other fruit diameter was statistically identical in respect of fruit diameter presented in the table 9.

Yield green chilli (kg/ plot):

There was a significant variation among the treatments in case of yield/ plot. The yield range was found from 3.79 to 8.75 kg/plot. The height green chilli harvested from T_6 (8.75kg/ plot) and lowest green chilli harvested from T_9 the untreated control 3.79 kg/plot. Green chillis harvested from other treated plots were statistically identical which was presented in the table 9.

Yield red chilli (kg/ plot):

The effect of seed treatments on yield of red chilli was statistically significant. The yield of red chilli ranged from 0.78 to 2.07kg/plot. The highest yield of red chilli 2.08 kg/plot occurred in seed treated with *Trichoderma* suspension (T_6) followed by 1.88 kg/plot from seed treated with Provax-200 and lowest yield of red chilli 0.798 kg/ plot was occurred from T_9 the un treated control. Red chilli yield in respect of other seed treatment was statistically identical presented in the Table 9.

Table 10: Effect of different seed treatment products on plant vigour and resistance capability of chilli.

Treatments	Plant vigour at			Resistance to		
	Seedling	Vegetative	Flowering	Lodging	Insects	Diseases
T_1 (Provax -200) chemical	Good	V. Good	v. Good	Resistant	Resistant	Resistant
T_2 (Black berry leaves extract)	Good	Good	Good	Resistant	Resistant	Resistant
T_3 (Garlic extract)	Poor	Good	Good	Resistant	Resistant	Resistant
T_4 (Neem leaves extract)	Good	Good	Good	Resistant	Resistant	Resistant
T_5 (Hot water treatment)	Poor	Good	v. Good	Resistant	Resistant	Resistant
T_6 (Trichoderma suspension)	Excellent	Excellent	Excellent	Resistant	Resistant	Resistant
T_7 (Juice of black pepper)	v. Good	Good	Good	Resistant	Resistant	Resistant

Treatments	Plant vigour at			Resistance to		
	Seedling	Vegetative	Flowering	Lodging	Insects	Diseases
T_8 (Zinger + cow urine)	V. Good	V. Good	V. Good	Resistant	Resistant	Resistant
T_9 Control (Farmer's practice)	Poor	Poorest	Poorest	Resistant	Susceptible	Susceptible
Rating Scale: 1-10	Excellent = 9-10 Very Good = 08-09 Good = 05-08 Poor = 01-05 Poorest = 1			Excellent = 9-10 Very Good = 08-09 Good = 05-08 Poor = 01-05 Poorest = 1		

Laboratory experiment

Result of Laboratory experiment has been presented below:

Moisture content (per cent):

There was no significant variation among the treatments in respect of moisture content presented in the table-11

Germination percentage

The results on the germination test showed a significant difference among the seed treatments (Table -11). The highest germination percentage (69) was found in T_6 followed by T_1 (66) which were statistically identical to each other and the least germination percentage was recorded in T_9 (40.00%). On the other hand, T_2 (63), T_3 (60%) , T_4 (63%) T_5 (60%), T_7 (62%) and T_8 (60%) was statistically identical with each other.

Seedling evaluation test

The results on seedling evaluation test (root length, shoot length and dry weight) of chilli seed under different seed treatments showed a significant difference among the sources.

Shoot length (cm)

The results of shoot length were presented in Table 11. The highest shoot length (5.83 cm) was found in T_6, and the lowest shoot length found in 2.13cm. Seed treated with Provax-200 (4.92 cm) T_1 was statistically identical with T_8 (5.07 cm). On the other hand,

seedling shoot length 3.14 cm was found in T_2 followed by T_4 (3.24 cm), and T_5 (3.13) which were statistically identical to each other.

According to Agrawal (1996), a seed lot with a greater shoot length is of greater seed vigor than a seed lot with less shoot length. So, the present result indicated that T_6 had the greatest seed vigor while it was the least in the in the case of T_9.

Root length (cm)

The results of root length showed a great variation among the seed treatments and those are presented in the Table 11. The highest seedling root length (12.86 cm) was found in T_1 followed by T_2 (10.60 cm). On the other hand, the shortest root length was recorded in T_9 (8.13 cm). Seed treated with black berry leaves extract (T_2), Garlic extract (T_3), Neem leaves extract (T_4), hot water treatment (T_5) and black pepper extract (T_7) were statistically identical. According to Huda (2001), higher length of radicle and plumule of the seedling indicate higher vigor of the seed. The present result indicated that T_6 had the greatest seed vigor while the lowest was in case of T_9.

Dry weight (mg)

The results of dry weight showed a significant difference among the treatment (Table 11). The highest dry weight was recorded from T_6 (0.362 mg) which was superior to other seed treatments and statistically identical with T_1 (0.357 mg). The least dry weight was obtained from T_9 (0.115 mg). The seed treated with other seed treating product was statistically identical with each other. Similar to seedling length (root and shoot length), a seed lot with a greater dry weight is of greater seed vigor than a seed lot with less dry weight (Agrawal, 1996).

The overall result on seedling evaluation test (seedling shoot length, root length and dry weight) showed that T_6 and T_1 was most vigorous among the seed treatments and T_9 were least vigorous.

Table 11: Effect of seed treatment on germination and seedling vigour of chilli seed.

Treatments	Lab Germination (Percent)	Shoot length (cm)	Root length (cm)	Seedling dry weight (mg)	Moisture (Percent)	Vigour index	Speed of germination
T_1 (Provax -200)	66 b	4.92 b	10.60 b	0.357 a	13.67 a	1169 a	29.89 d
T_2 (Black berry leaves)	63 b	3.14 d	9.33 c	0.263 b	13.60 a	786 cd	29.70 d

Treatments	Lab Germination (Percent)	Shoot length (cm)	Root length (cm)	Seedling dry weight (mg)	Moisture (Percent)	Vigour index	Speed of germination
T_3 (Garlic extract)	60 b	3.24 d	9.28 cd	0.201 b	13.87a	793 cd	37.03 ab
T_4 (Neem leaves extract)	63 b	3.31 d	9.22 de	0.231 b	13.67 a	832 c	32.91 c
T_5 (Hot water treatment)	60 b	3.13 d	9.17 e	0.211 b	13.73a	800 cd	29.80 d
T_6 (Trichoderma suspension)	69 a	5.83 a	12.86 a	0.362 a	14.03a	1350 a	38.41 a
T_7 (Juice of black pepper)	62 b	32 c	9.25 cde	0.190 b	117a	883 c	34.92 bc
T_8 (Zinger + cow urine)	60 b	5.07 b	10.61 b	0.228 b	13.60a	987 bc	38.19 a
T_9 Control (Farmers' practice)	40 c	2.13 e	8.13 f	0.115 c	13.67a	585 d	25.06 e
LSD (0.01)	5.768	0.4414	0.09749	0.06894	NS	216.3	2.290
Level of significance	**	**	**	**	**	*	**

Farmers' perception about the chilli seed treatment in the field day

During the research period three field day were organized in three chars to seek farmers' opinion about different treatments. The average opinion of the farmers of three char are presented in the figure 5.

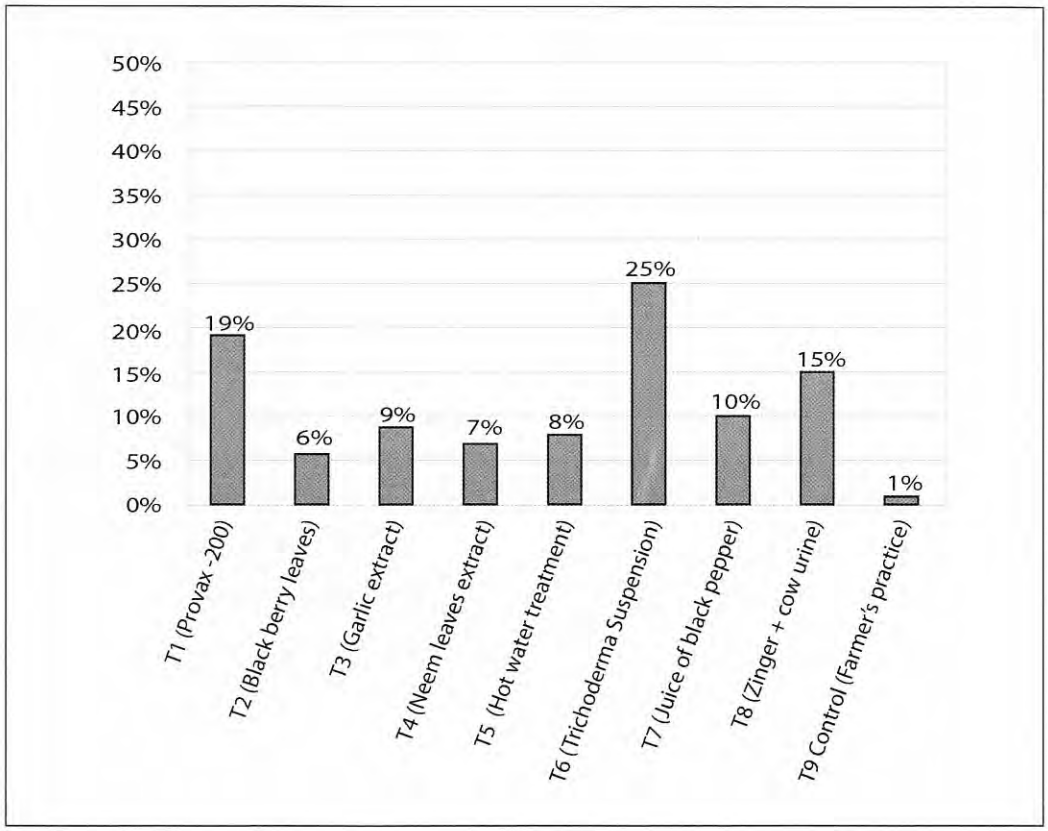

Figure 6: Farmer preference about different seed treatment material

Conclusion and Recommendations

Among the 7 organic and one inorganic seed treatment products i.e. Provax-200, Balck berry leaves extract, Garlic extract, Neem leaves extract, Hot water treatment, *Trichoderma* suspension, Black pepper extract, mixture of zinger and cow urine and untreated control, the effect of *Trichoderma* suspension and Provax-200 on yield and yield contributing characters was found the best. On the other hand, in the laboratory test seed treatment with *Trichoderma* suspension and Provax-200 performed significantly better in respect of germination, seedling vigor and vigor index. In the field day most of the farmers had the same opinion.

From the finding, it is clear that *Trichoderma* suspension and Provax-200 played effective role to establish higher plant population, protecting diseases and therefore, gave higher yield than the other six treatments and over the control. Therefore *Trichoderma* suspension and Provax-200 may be considered as the suitable seed treatment products for chilli cultivation in char areas of Bangladesh. Other promising seed treatment products are Black berry leaves and mixture of Zinger extract and Cow urines.

Further, Provax-200 is a poisonous chemical fungicide which contains harmful ingredients for human, animal and over all environments. Moreover, Provex-200 incurse higher extra cost (Tk 70/- for one kg seed treatment.

On the other hand, *Tricoderma* suspension is a natural fungicide incurse very little extra cost (10/-) compared to any chemicals and free from creating harmful effect on human, animal and nature.

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Farmer Participatory Research

Variety screening of maize suitable for chars

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Introdution

Maize is grown as Rabi as well as Kharif crop in Bangladesh. The cereal is not widely used as a staple food like other cereals, i, e., rice and wheat. Now its importance as a cereal food like those two cereals is being realized in Bangladesh.

Maize has high nutritional value. High quality corn oil is extracted from maize embryo. The embryo contains about 35% semidrying oil, 20% protein and 10% ash. The high quality oil is used for cooking purposes and for preparation of salads. Maize kernel is one of the efficient capsules of food designed by nature. It is a high energy food having highly digestible carbohydrate, high protein content composed of amino acid essentials for human nutrition, cholesterol free oil and good quantity of trace materials. Production of corn oil from maize with no cholesterol can help heart patients in many ways through consuming the corn oil. Maize is fairly rich in Vitamin B and the yellow kernel contains higher amount of Vitamin-A and carotene which can prevent blindness (http://en.wikipedia.org/wiki/Maize).

The favorable soil, climate and topographic conditions are suitable for maize cultivation in char areas. Maize can tolerate high temperatures and it requires less irrigation and keeps farmers' cultivation cost lower than rice and can be grown round the year. Yield of maize is double than that of wheat. Maize has a very high potential of yield, can produce 9.0-12.50 t/ ha (Krishi diary, 2012). In other study revealed that maize planted in the Rabi season can produce about 10 t/ha of grain and 12 t/ha non-grain biomass. To produce such high yield, maize plants must take up about 200 kg N, 30 Kg P , 167 Kg K, and 42 Kg S ha-1 (BARC, 2005).On the other side, net return per hectare on the basis of full cost, cash cost and variable cost were estimated at Tk. 11739, Tk. 26887 and Tk. 18047 respectively. It was found that the average returns to labour were Tk. 109.52/man-day on full cost basis, Tk. 291.80/man-day on cash cost basis and Tk.135.06/man-day on variable cost basis, respectively. On full cost basis, benefit cost ratio (BCR) was 1.37 found that In another study it was on the basis of cash cost and variable cost, the BCR were 2.66 and 1.72 respectively for maize production (Mohiuddin *et al*, 2007). So information regarding maize indicates that maize is more profitable. In the environmental point of view, maize is less detrimental than rice (Heikens et.al. 2007). Maize needs only around 850 litre water per kg grain production (with 2-4 irrigations) compared to 1,000 litre/kg wheat grain (1-3 irrigations) and over 3,000 l/kg rice grain (with 20-35 irrigations) for Boro rice (ageconsearch.umn.edu).

Farmers in char areas are highly eager about maize cultivation and now a days they are extending maize cultivation. But the yield is low (5 ton/hectare) due to unavailability of quality inputs as well as lack of technical knowledge of farmers. In this perspective an on farm research has been conducted under the financial assistance of M4C project to screen suitable maize varieties for char. The specific objectives of the project are-

Objectives:

i. to study the performance of different varieties (hybrids) of maize which are available in the market
ii. to assess the plant spacing effect on yield performance and
iii. to recommend suitable varieties for commercial cultivation in chars.

Material and Method

Experimental site

The experiments were conducted in three chars during Rabi season from October, 2012 to April, 2013.Three chars were selected purposively. Six experiments were implemented in close cooperation with the selected farmers of each char i.e. these were farmer participatory research. All the experiments were laid out in 3 disperse location. Before conducting the experiment, FGD and few individual interviews were followed in each char for better understanding of the farmer's practice. List of the experiment sites is shown in the following table.

Table - 1: List of maize variety screening experiment sites

Name of Char	Upazila	District
Deluabari char	Fulsori	Gaibandha
Nayapara char	Sariakandi	Bogra
Natuarpara char	Kazipur	Sirajgonj

Soil

The experiment plots belong to sandy textural class. Soils of some patches were mixed with clay.

Plant materials

During the experiment period Market available maize varieties were procured as planting material for variety screening. Altogether 12 hybrid varieties of maize were collected from different maize dealer and coded as V_1-V_{12}. The collected varieties in coded form and their sources are presented in the following table 2.2. List of varieties can be seen in Appendix-A

Table- 2: List (code) of hybrid maize varieties used in the experiment

Variety code	Source
V_1	Dealer
V_2	Dealer
V_3	Dealer
V_4	Dealer
V_5	Dealer
V_6	Dealer
V_7	Dealer
V_8	Dealer
V_9	Dealer
V_{10}	Dealer
V_{11}	Dealer
V_{12}	Dealer

Experiment Design

In each of the sites 0.75 ha of farmers' field were brought under the research. The land was divided into two equal parts to create two sets of experiment parallel by maintaining unit plot size 1.37 decimal (54.8 m^2) for each variety.

Experiment A: Twelve selected maize varieties were planted maintaining 70 cm line to line and 25 cm plant to plant spacing.

Experiment B: Twelve selected (same) maize varieties were planted maintaining 60 cm line to line distance and 20 cm plant to plant spacing.

Land preparation

The selected land for the experiments were first opened in last week of October, 2012 by a power tiller. The lands were ploughed three times. Each ploughing was followed by leveling. During the final stage of land preparation weeds were removed and finally prepared with adding basal doses of manures and fertilizers. Irrigation channels were prepared around the plots and between the two experiments before sowing the seeds.

Manure and fertilizer

During the final land preparation as basal dose urea 185 kg/ ha, TSP 222 kg/ha, MP 222 kg / ha, Gypsum 185 kg / ha, Zinc Sulphate 15 kg/ ha, Borax 7 kg/ ha and Magnesium

Sulphate 15 kg / ha were applied. As top dress urea 185 kg/ha was applied in two splits first after 30-35 days of seed sowing (4-6 leaf stage) and second top dress after 50-55 days of seed sowing (8-12 leaf stage) and soluble Boron was sprayed at the rate of 370 g/ ha during kernel formation.

Sowing

Seed were sown on 01-03 November, 2012 at a depth of 2.5-3 cm with one seed per hill. After sowing, seed were covered with light soil. Two different plant spacing (70cm x 25cm) and (60cm x 20cm) were maintained in two separate experiments which were referred to as Experiment-A & Experiment-B.

Cultural operations

Cultural operations such as weeding, earthining up, irrigation, pest management etc were done uniformly in all the plots. Irrigation was practiced in the following schedule:

Table- 3: Schedule of irrigation in experiment plots

Irrigation	Days after showing	Method	Stage of crop
1st	30-35 days	Furrow	4-6 leaf stage followed by first top dress
2nd	50-55 days	Furrow	8-12 leaf stage followed second top dress
3rd	70-75 days	Furrow	total flowering stage
4th	85-90 days	Furrow	before kernel formation
5th	100-110 days	Furrow	kernel initiation

Harvesting

The crop was harvested plot wise when 80% plant showed distinct signs of drying. The husk cover was completely dried and the grains were fully matured. The grain maturity was identified by formation of a black layer at the junction of grain and placenta.

Post harvest drying and shelling

The harvested cobs were spreaded on the threshing floor for sun drying and were shelled by corn sheller when the cobs were completely dried up. After shelling, the grains were dried again, winnowed and weighed to record the grain yield per unit plant & plot and yield per hectare at 12% moisture level.

Data collection

Data on the following parameters were recorded from five plants in both the experiments

1. Days to emergence
2. Days to six leaf stage
3. Days to tassel emergence
4. Days to tassel flowering
5. Days to bud emergence
6. Days to maturity
7. Plant height
8. Cob length
9. Cob diameter
10. Number of cobs per plant
11. Number of kernel per cob
12. 1000 kernel weight
13. Disease incidence
14. Yield/plant (g)
15. Yield at 12% moisture

Analysis of data

The data in respect of yield, quality and yield contribution characters from Experiment A & Experiment B in three research sites were collected, recorded and analyzed.

Results and Discussion

The results obtained from the experiments are presented in this chapter. Yield and yield contributing characters and screening of better performance of maize varieties have been discussed. The results are presented under the following heads.

Farmer's practices

Farmers of chars follow traditional way of maize cultivation in three respective chars. One FGD in each char and randomly few individual farmers were interviewed for validating the FGD data. The FGD results showed that the farmers of 3 chars cultivate different varieties of maize and other parameters such as seed – seed distance, line – line distance, basal fertilizer dose, application of top dress of urea and the yield of maize were found different in 3 chars (Table-1)

Days to emergence

Experiment A

The mean longest time of emergence was recorded 7 days in case of V_1, V_{10} & V_{11}. All other varieties took 6 days to emergence (fig.1).

Experiment B

The mean longest time of emergence was recorded 7 days in case of V_1, V_2 & V_{10}. All other varieties took 6 days to emergence (fig. 2).

Inference: In both the experiment conducted parallel the mean days to emergence were in between 6-7 days. The emergence time of all most all the varieties were found similar. Variation of cold and soil quality might have created insignificant difference from one char to another char.

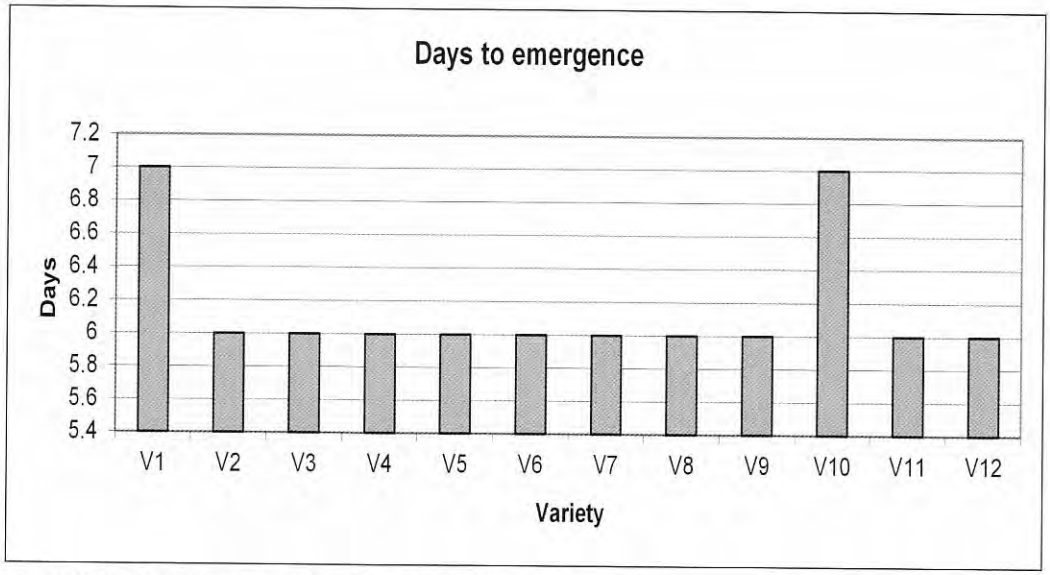

Fig-1: Days to emergence of maize varieties in Exp-A.

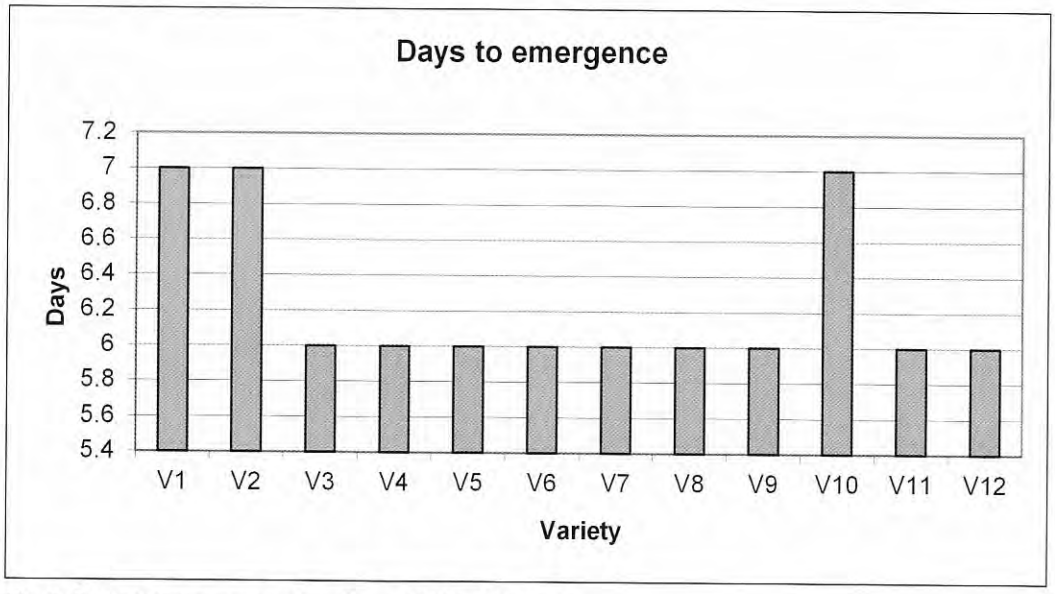

Fig-2: Days to emergence of maize varieties in Exp-B.

Days to six leaf stage

Experiment A

The mean longest & shortest time for appearing to six leaf stage was recorded 35 & 27 days in case of V_1 & V_3. All other varieties took 30-33 days to reach six leaf stage (fig-3).

Experiment B

The mean longest & shortest time of appearing six leaf was recorded 37 & 31 days in case of V_1, V_3 & V_8. All other varieties took 32-34 days to reach six leaf stages (fig-4).

Inference: Generally, all varieties reached six leaf stages within 30-34 days in both the experiment. Although the growth performances of this stage were found quite better but there was no significant difference in case of days to six leaf stage for both experiments. Data are shown in the following charts-

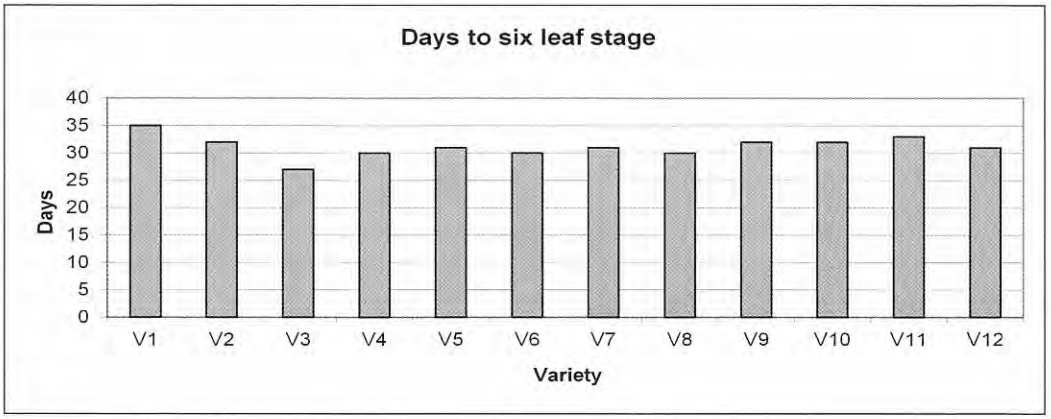

Fig-3: Days to six leaf stage of maize varieties in Exp-A.

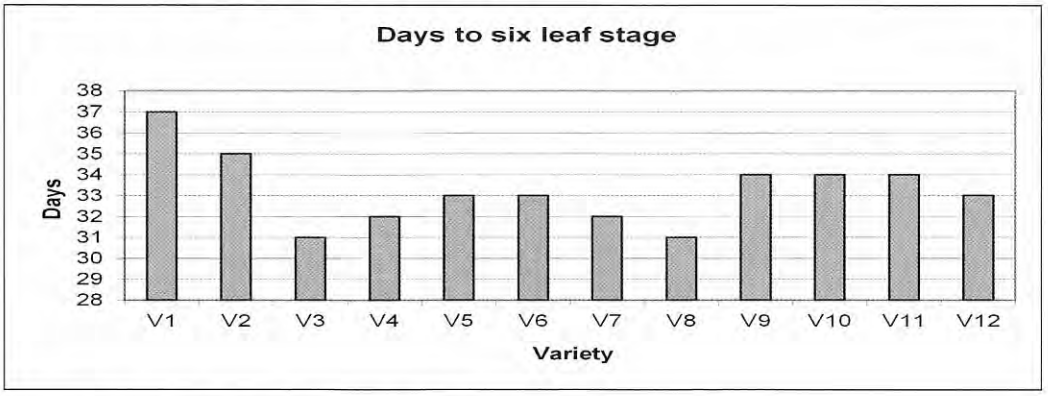

Fig-4: Days to six leaf stage of maize varieties in Exp-B.

Days to tassel emergence

Experiment A

The mean longest & shortest time for tassel emergence was recorded 83 & 80 days in case of V_1, V_{10}, V_5, & V_7. All other varieties took 81-82 days for tassel emergence (fig-5).

Experiment B

The mean longest & shortest time for tassel emergence was recorded 85 & 82 days in case of V_{10} & V_7. All other varieties took 83-84 days for tassel emergence (fig-6).

Inference: Generally, all varieties took 81-84 days for tassel emergence in both the experiments. So there was no significant difference in case of days to tassel emergence for both the experiments.

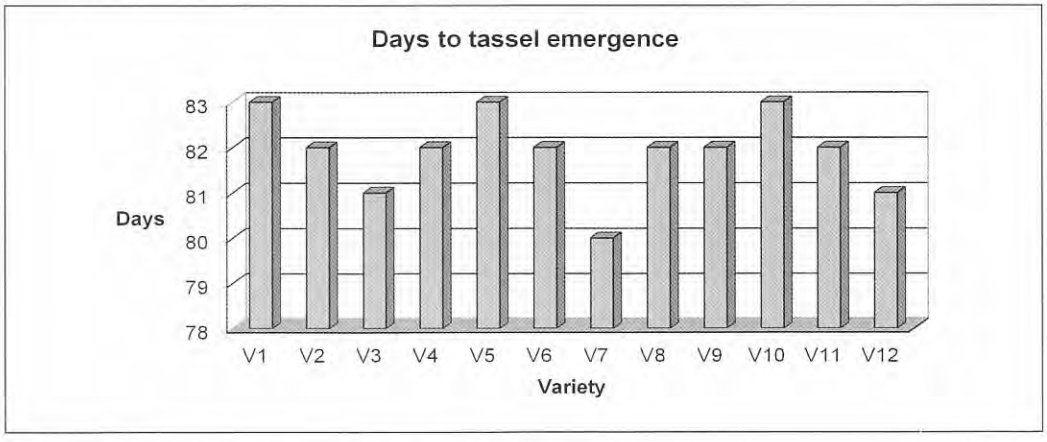

Fig-5: Days to tassel emergence of maize variety in Exp-A.

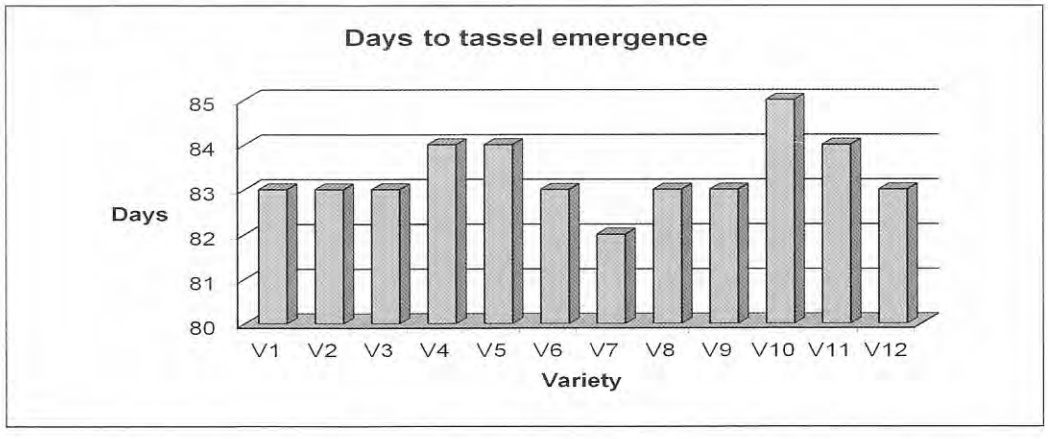

Fig-6: Days to tassel emergence of maize variety in Exp-B.

Days to tassel flowering

Experiment A

The mean longest & shortest time of days to tassel flowering was recorded 88 & 80 days in case of V_{10} & V_6. All other varieties took 85-87 days for tassel flowering (fig-7).

Experiment B

The mean longest & shortest time of days to tassel flowering was recorded 93 & 84 days in case of V_9 & V_{12}. All other varieties took 86-89 days for tassel flowering (fig-8).

Inference: Generally, all the varieties took tassel flowering within 85-89 days in both the experiments conducted parallely. 03-05 days is needed for tassel flowering from tassel emergence stage in case of all varieties. So there was no significant difference in case of days to tassel flowering for both experiments.

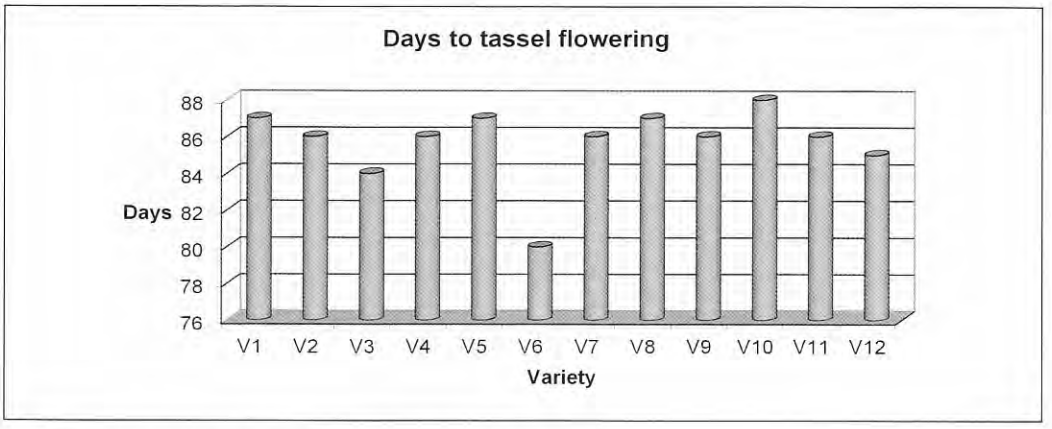

Fig-7: Days to tassel flowering of maize variety in Exp-A.

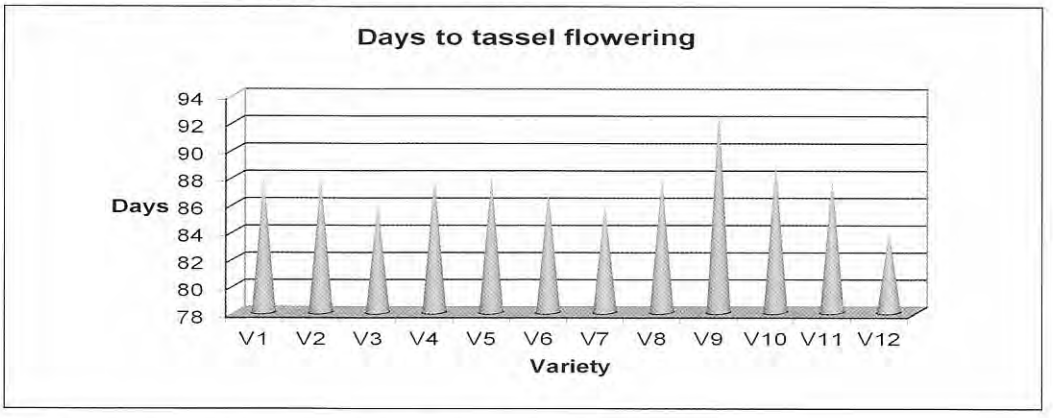

Fig-8: Days to tassel flowering of maize variety in Exp-B.

Days to bud emergence

Experiment A:

The mean longest & shortest time to bud emergence was recorded 90 & 82 days in case of V_{10} & V_6. All other varieties took 85-89 days for bud emergence (fig-9).

Experiment B

The mean longest & shortest time of days to bud emergence was recorded 95 & 86 days in case of V_9 & V_{12}. All other varieties took 88-90 days for bud emergence (fig-10).

Inference: Generally, all the varieties took time for days to bud emergence between 85-90 days in both the experiments conducted. There was no significant difference among the varieties for days to bud emergence.

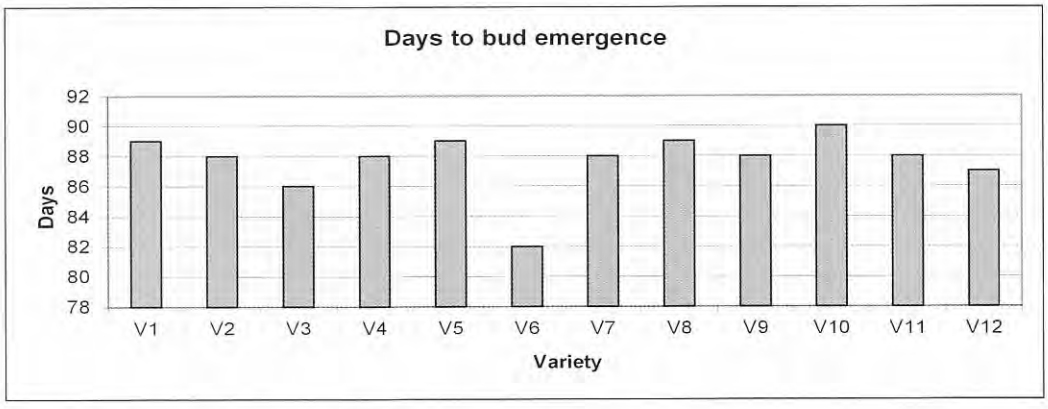

Fig-9: Days to bud emergence of maize variety in Exp-A.

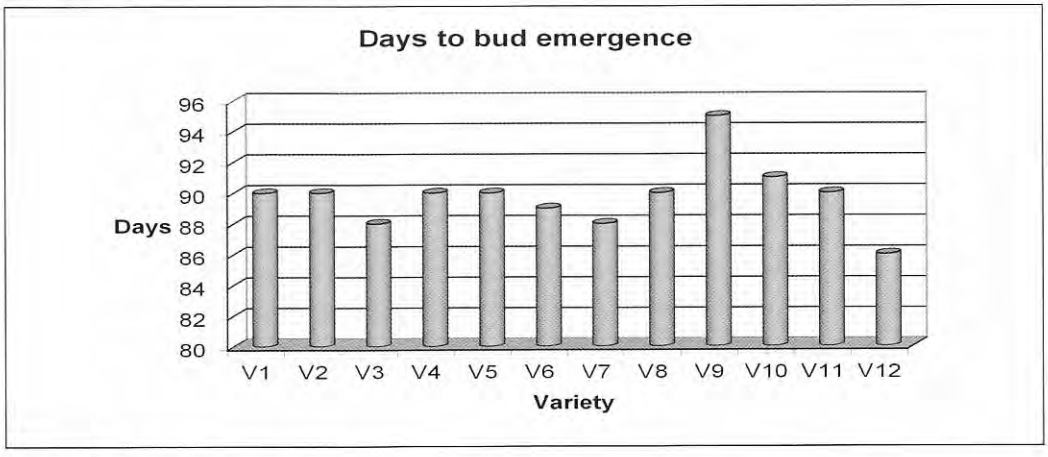

Fig-10: Days to bud emergence of maize variety in Exp-B.

Days to maturity

Experiment A

The mean longest & shortest time for maturity was recorded 152 & 148 days in case of V_{10} & V_3. All other varieties took 150-151 days to reach maturity (fig-11).

Experiment B

The mean longest & shortest time of days to maturity was recorded 153 & 149 days in case of V_{10}, V_9 & V_7. All other varieties took 150-152 days to reach maturity (fig-12).

Inference: All varieties took time in case of days to maturity with in 150-152 days in both the experiments conducted. There was no significant difference among the varieties for days to maturity.

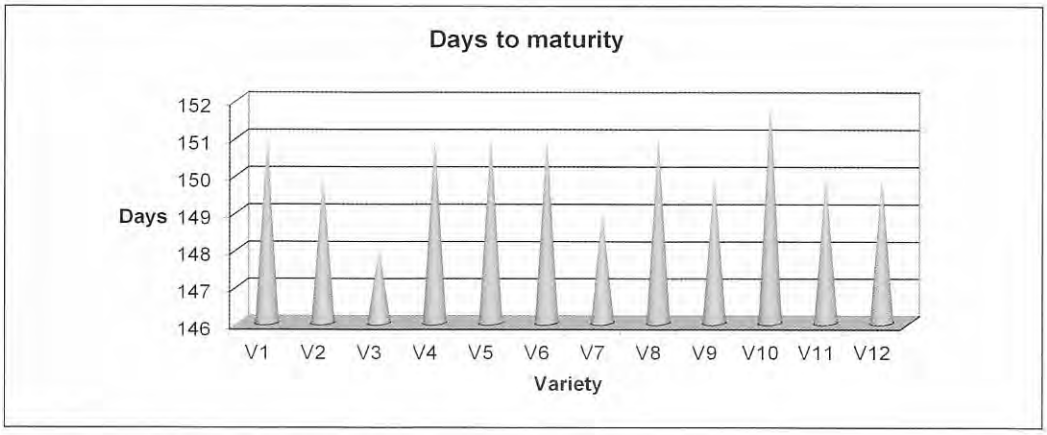

Fig-11: Days to maturity of maize variety in Exp-A.

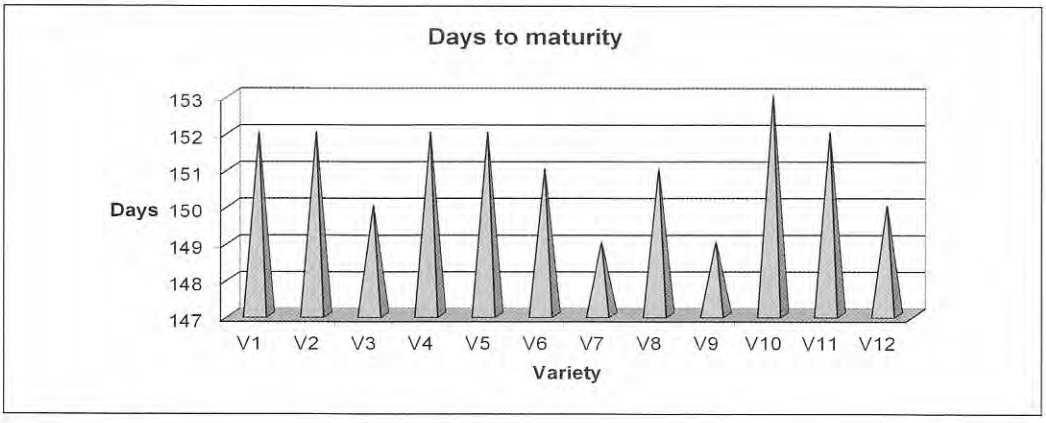

Fig-12: Days to maturity of maize variety in Exp-B.

Plant height

Experiment A

The mean tallest (193 cm) & shortest (155 cm) plant was obtained from V_6 & V_{11}. The plant height ranged from 152-192 cm for all other varieties (fig-13).

Experiment B

The mean tallest (190 cm) & shortest (152 cm) plant was obtained from V_6, V_{11} & V_1. The plant height ranged 157-189 cm for all other varieties (fig-14).

Inference: Generally, plant height range was with in 152-192 cm in both the experiment conducted parallel. Depending on the spacing and soil characteristics in 3 chars the plant height were varied in both experiment.

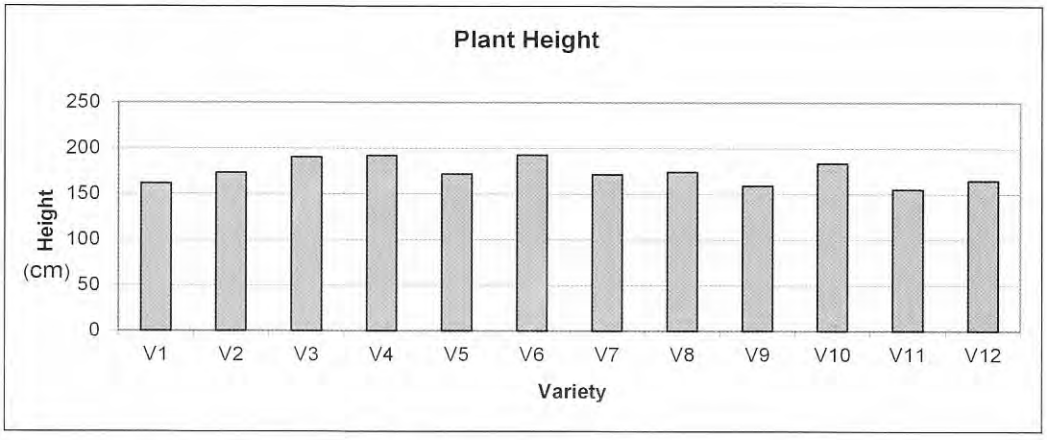

Fig-13: Plant height of maize variety in Exp-A.

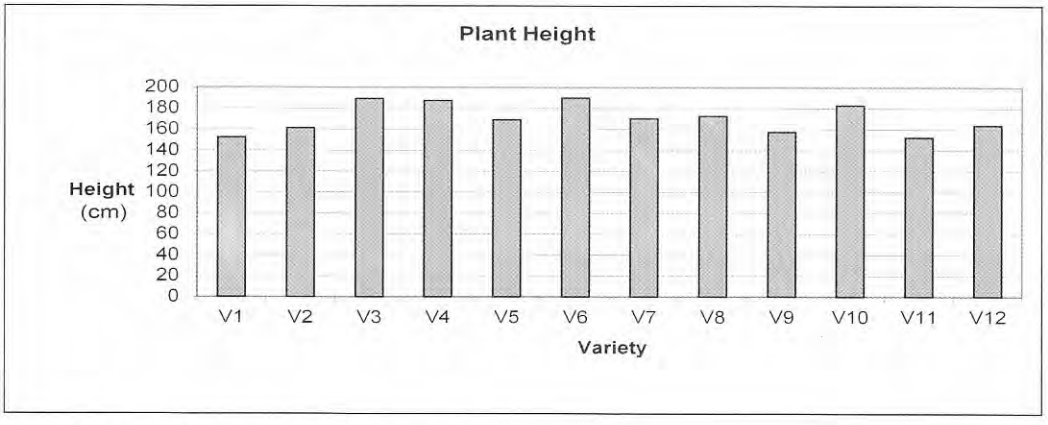

Fig-14: Plant height of maize variety in Exp-B.

Cob length

Experiment A

The maximum (19.5 cm) and minimum cob length (16.5 cm) was obtained from V_7 & V_{12} respectively. The cob length range was 16.9-19.3 cm for all other varieties (fig-15).

Experiment B

The maximum (17.6 cm) and minimum cob length (15.2 cm) was obtained from V_3 , V_9 & V_5. The cob length range was 15.2-16.4 cm for all other varieties (fig-16).

Inference: Generally, mean cob length range was found varied only 2-3 cm in both the experiment conducted. The cob length of all varieties decreases in experiment B than experiment A due to population density space and nutrient competition.

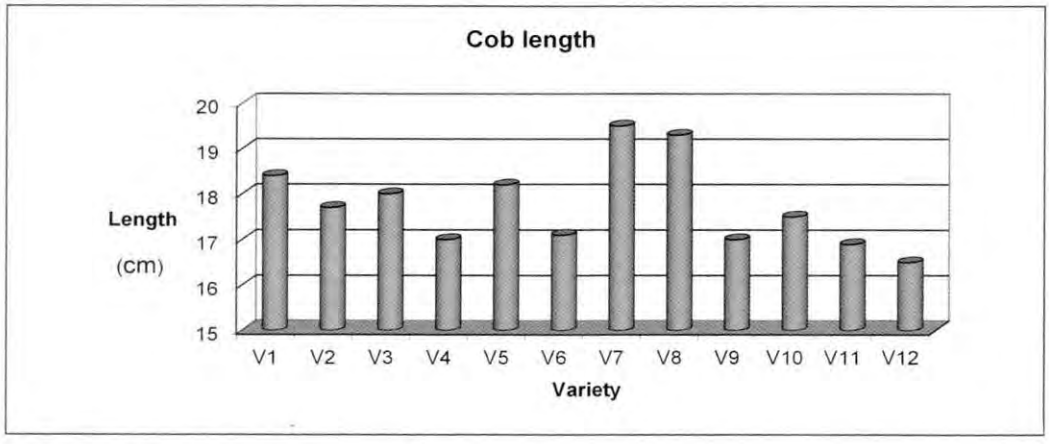

Fig-15: Cob length of maize variety in Exp-A.

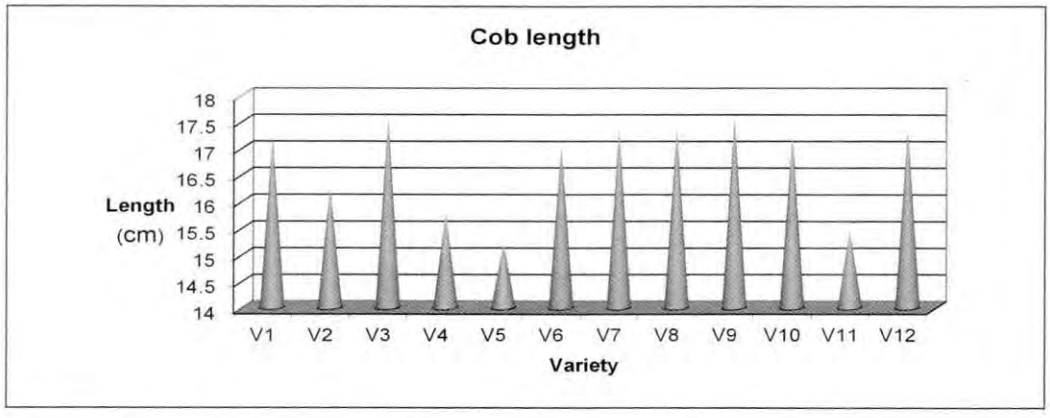

Fig-16: Cob length of maize variety in Exp-B.

Cob diameter

Experiment A

The maximum (18.4 cm) and minimum cob diameter (16 cm) was obtained from V_7 & V_{11} respectively. The cob diameter range was 16.1-18 cm for all other varieties (fig-17).

Experiment B

The maximum (18.7 cm) and minimum cob diameter (15.2 cm) was obtained from V_7 & V_8. The cob diameter range was 15.9-17.7 cm for all other varieties (fig-18).

Inference: Mean cob diameter range was found varied only 1-2 cm in both the experiments conducted parallely. The cob length of all varieties decreases in experiment B than experiment A due to density increased, space and nutrient competition.

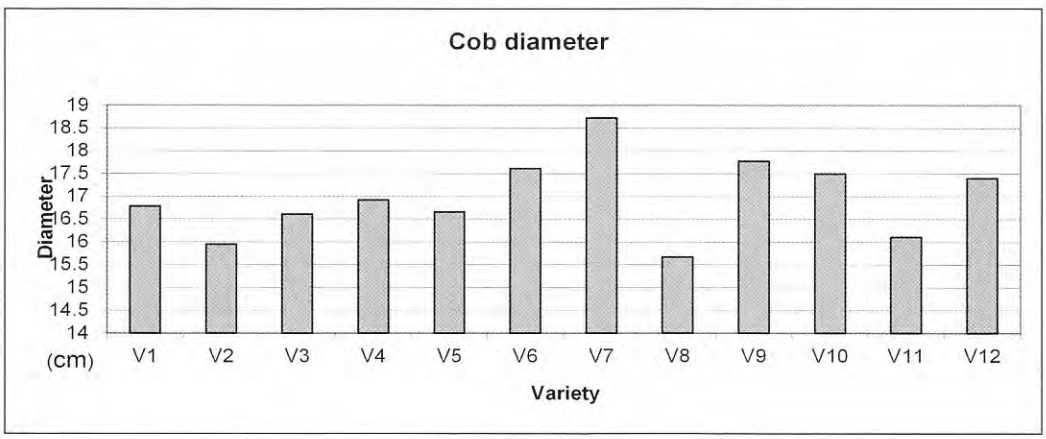

Fig-17: Cob diameter of maize variety in Exp-A.

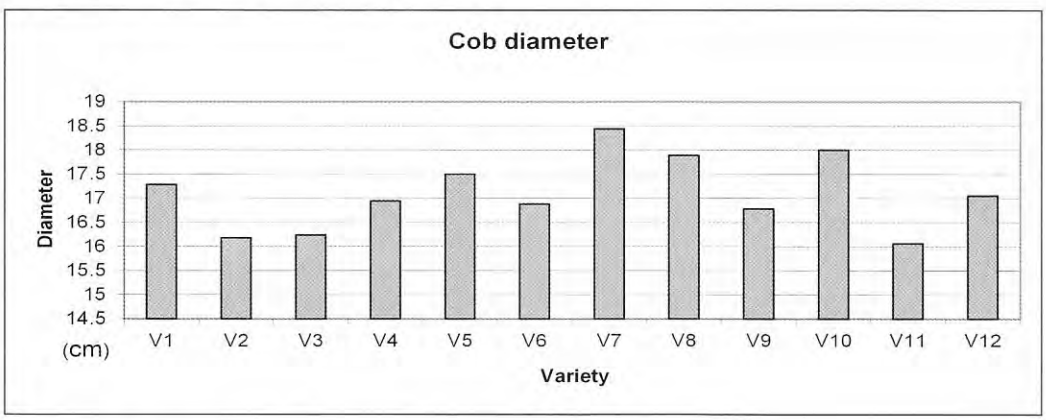

Fig-18: Cob diameter of maize variety in Exp-B.

Number of cobs per plant

Experiment A

The maximum number of cob (1.20) per plant was obtained from V_6 and the average (1.0) was obtained from most of the varieties (fig-19).

Experiment B

The maximum number of cob (1.13) per plant was obtained from V_7 & V_{12} and the average (1.0) was obtained from most of the varieties (fig-20).

Inference: Most of the varieties produced 1 cob per plant while some other varieties produced more than 1 cob in both experiments. In some varieties more than 1 cob formed due to late pollen shedding as well as pollen loading in the time of silk emergence of first cob formation. There was no significant difference among the varieties for number of cobs per plant.

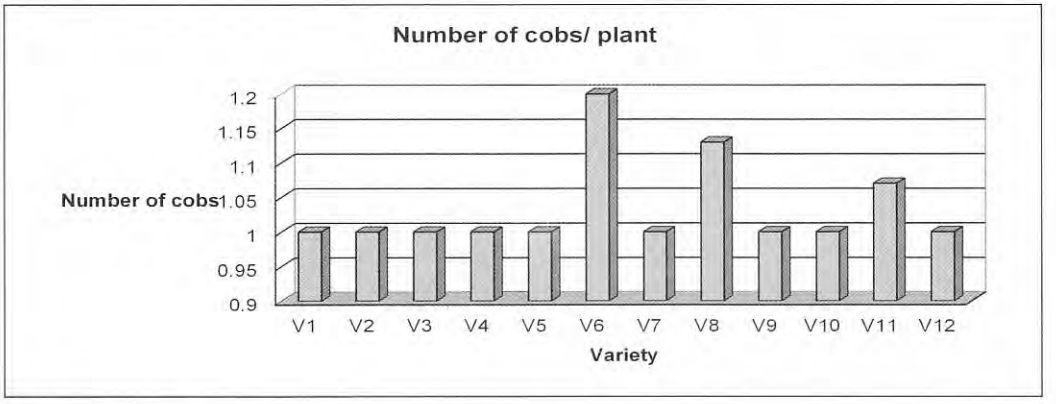

Fig-19: Number of cobs /plant of maize variety in Exp-A.

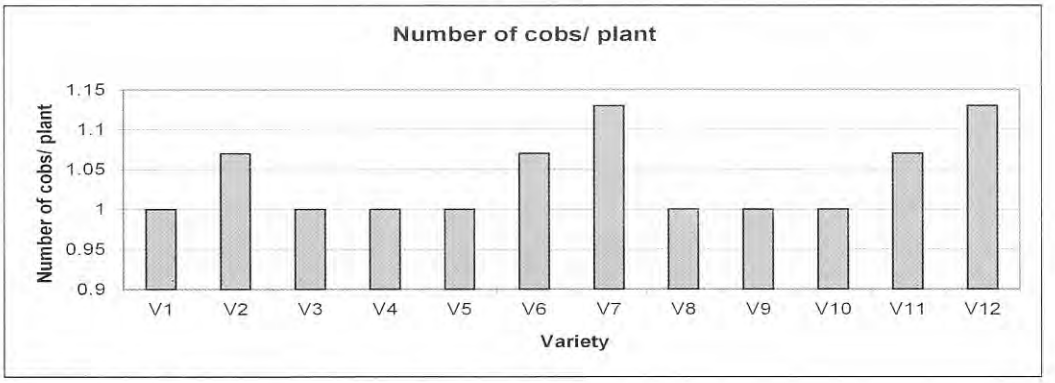

Fig-20: Number of cobs/plant of maize variety in Exp-B.

Number of kernel per cob

Experiment A

The maximum (571) & minimum number (379) of kernel per cob was obtained from V_2 & V_{11} respectively. The number of kernel per cob range was 475-550 for all other varieties (fig-21).

Experiment B

The maximum (534) & minimum number (366) of kernel per cob was obtained from V_2 & V_{11}. The number of kernel per cob range was 463-528 for other varieties (fig-22).

Inference: Number of kernel/cob ranged from 463-550 in both the experiments. The number of kernel/cob decreased in experiment B due to space and competition. There were little differences among the varieties for cob length in both the experiments.

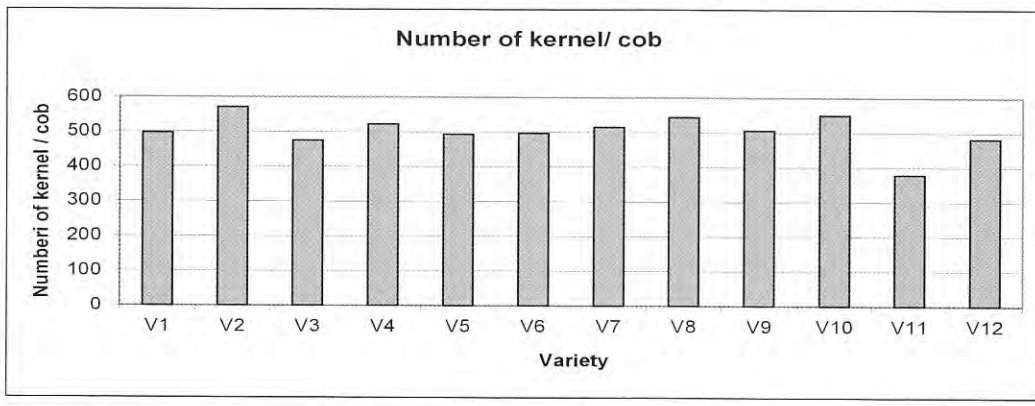

Fig-21: Number of kernel/cob of maize variety in Exp-A.

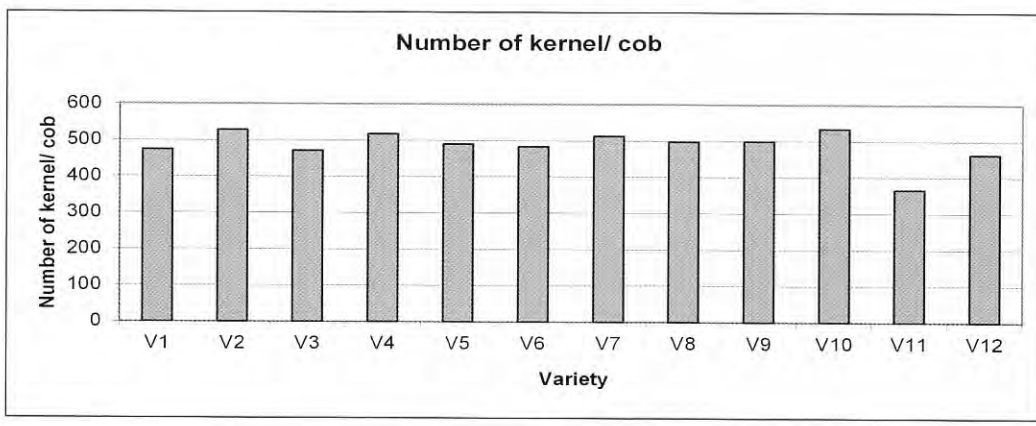

Fig-22: Number of kernel/cob of maize variety in Exp-B.

1000 -grain weight

Experiment A

The maximum (457 gm) & minimum weight (400 gm) was obtained from V_2 , V_{10} & V_9. 1000-seed weight range was 414 -450 gm for all other varieties (fig-23).

Experiment B

The maximum (439 gm) & minimum weight (375 gm) was obtained from V_7 & V_9. 1000-seed weight range was 388-427 gm for all other varieties (fig-24).

Inference: 1000-seed weight range was from 388-450 gm in both the experiment conducted.1000-seed weight was low in case of experiment B due to space & light competition. There was significant difference among the varieties spacing for 1000-seed weight (Table: 13). Data are represented in the following charts-

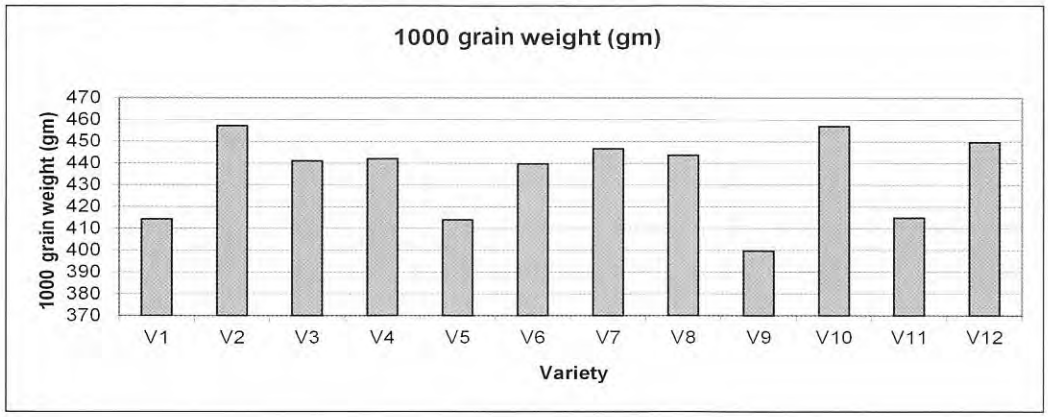

Fig-23: 1000 grain weight of maize variety in Exp-A.

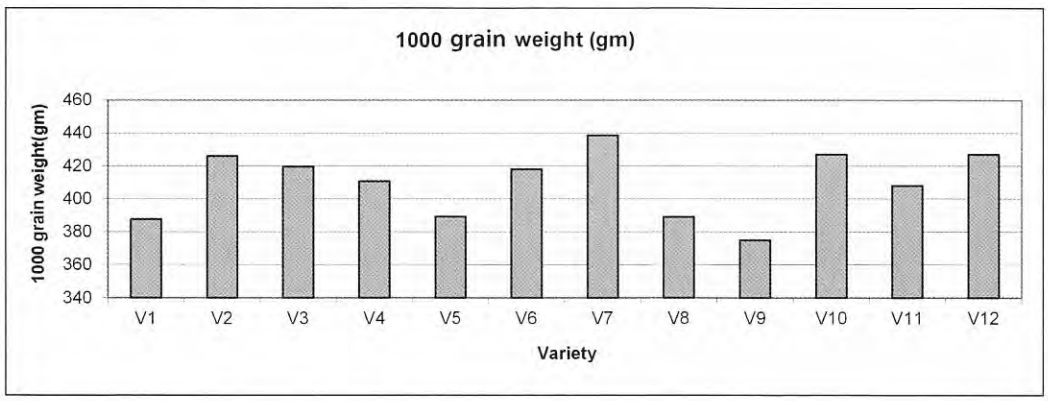

Fig-24: 1000 grain weight of maize variety in Exp-B.

Disease & insect incidence

Leaf blight disease incidence was found in V_4 but any other variety were not infested in both the experiments. To protect from leaf blight the crop was sprayed with Anti blight @ 2-3 gm/ litre in two experiment sites. Almost all the varieties were attacked by cutworm and the crop was protected from the attack of cutworm by spraying Dasbarn 20 EC in both of the experiment (Table: 14).

Yield per plant

Experiment A

V_2 produced the highest yield (265 g) per plant and the lowest yield per plant was found (198 gm) from V_{11}. The yield/ plant range was 200-253 gm for all other varieties (fig-25).

Experiment B

V_7 produced the highest yield (236 gm) per plant and the lowest yield per plant (162 gm) was found from V_8. The yield/ plant ranged 182-222 gm for all other variety (Table: 15).

Inference: The yield / plant range was 182-253 gm in both the experiment conducted.

There was significant difference among the varieties for yield per plant. Data are shown in the following charts-

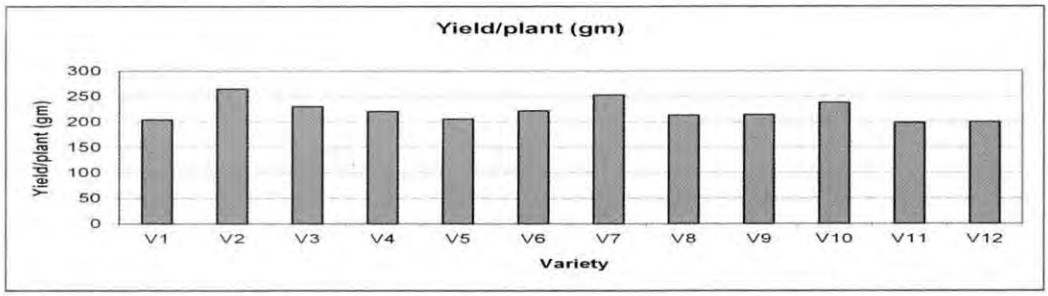

Fig-25: Yield/plant (gm) of maize variety in Exp-A

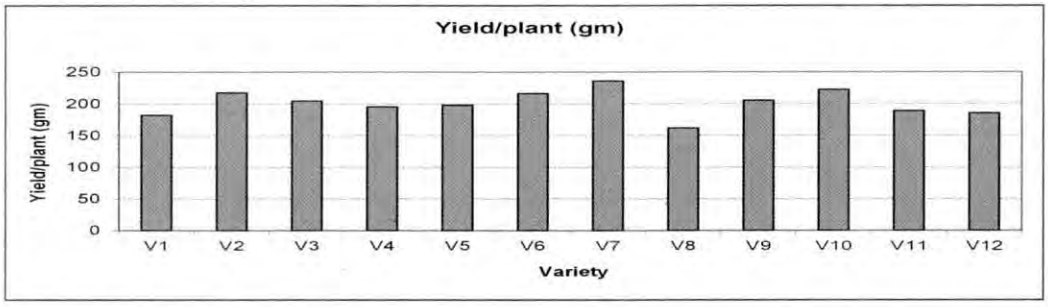

Fig-26: Yield/plant (gm) of maize variety in Exp-B

Yield (t/ha) at 12% moisture

The kernel yield of maize per plant was converted and expressed in ton/ha. Finally the yield was calculated at 12% moisture in t/ha. The results in two experiments are as follows:

Experiment A

The highest (10.45 t/ha) and lowest (8.18 t/ ha) yield was obtained from V_7 & V_{11} respectively. The yield range at 12% moisture was 8.26-10.39 t/ha for all other varieties (Table: 16).

Experiment B

The highest (12.53 t/ha) and lowest (8.6 t/ ha) yield was obtained from V_7 & V_8 respectively. The yield range at 12% moisture was 9.11-11.81 t/ha for all other varieties (Table: 16).

Inference: The yield at 12% moisture was 8.26-11.81 t/ha in both the experiment conducted parallel. There was significant difference among the varieties for yield at 12 % moisture due to different varieties and soil characteristics. Data are represented in the following charts-

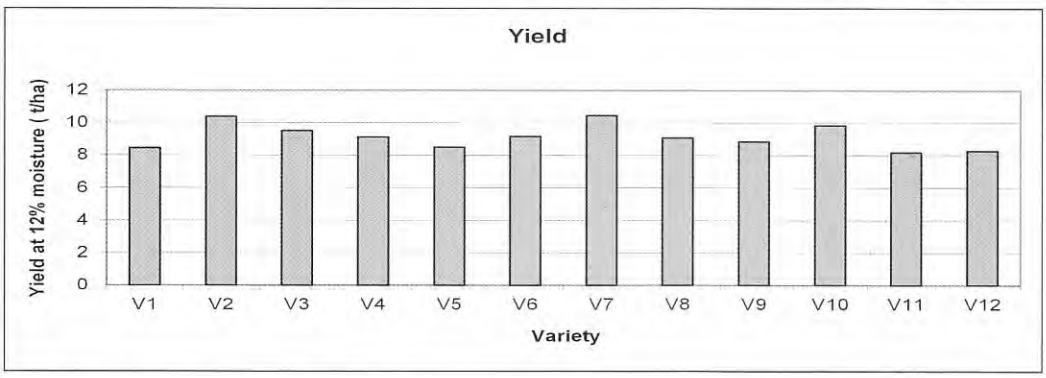

Fig-27: Yield at 12% moisture of maize variety in Exp-A

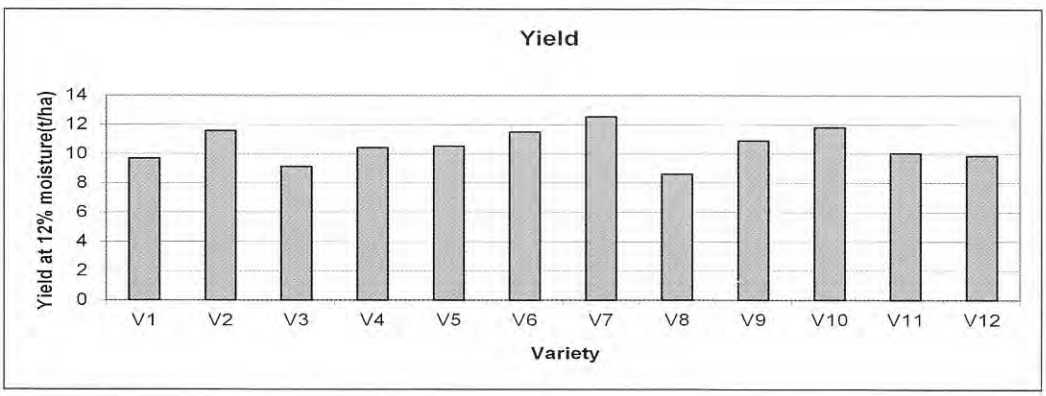

Fig-28: Yield at 12% moisture of maize variety in Exp-B

Farmer's preferred varieties

As a part of research work field day was organized on in Natuarpara, Deluabari, and in Nayapara Char of Sirajgonj, Gaibadha and Bogra District respectively. During discussion in the field day farmers informed that they are not getting sufficient yield due to lack of suitable variety of maize for char. They pointed out that in most cases they collect the seed from dealers and the dealer keep the price higher (350-400 tk/kg). After the discussion the farmers visited the field. Then they returned from the field and shared their views with the research team. Most of the farmers choose V_2 , V_3, V_{10} in Kazipur Char and V_3 ,V_9 ,V_2 and V_{10} variety in Deluabari Char and the farmers of Nayapara Char choose V_9 ,V_5 ,V_2 and V_4. The farmers in 3 chars choose the variety basis on kernel color, kernel uniformity and physical appearance of cob. (fig-29).

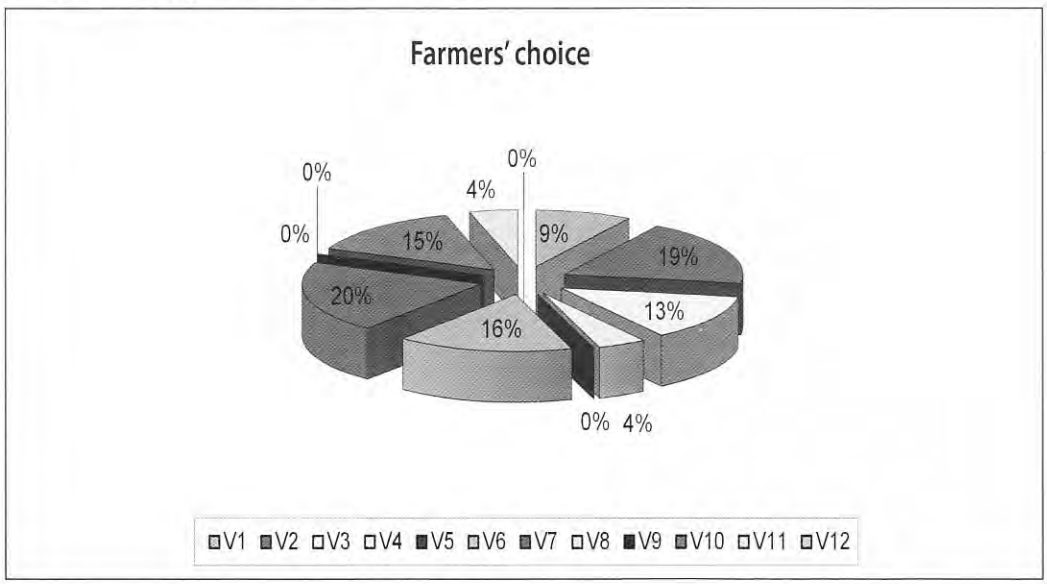

Fig-29: Farmer's choice of maize variety.

Conclusion and Recommendations

In the char areas maize cultivation is very promising and farmers are cultivating maize in different char areas but they don't get suitable seed variety and don't follow proper production technology. If the farmers get quality seed and are trained about the technology, the production of maize in char areas will be boost up quickly.

Based on the findings of the experiments, it was found that the yield of all the variety was higher under research compared to farmers yield in experiment. In case of experiment B, 12 varieties gave yield above 8 t/ha, much higher than farmers yield. The yield range at 12% moisture was 8.6-12.45 t/ha for all varieties which are almost similar yield of BARI maize varieties. The yield was higher in experiment B than experiment A. Although there was little difference between both the experiment in case of cob length, cob diameter, 1000 seed weight etc. Actually due to higher plant population (60399 no/ ha) showed higher yield in experiment B where as the plant population was lower (46950 no/ha) in experiment A.

It was found that the experiment B is suitable than experiment A for maize cultivation in char areas. But our research is actually carried out in local basis where the environment is suitable for maize cultivation. So it can be concluded that most of the varieties can be considered for cultivation based on genuine source of seed. It is to be mentioned were that deposition of sand in char land creates negative impact on growth and yield of maize. Therefore, farmers should be advised to avoid /remove sand deposition of plot fro maize cultivation.

For recommending spacing (line to line & plant to plant) the research should be repeated. Another research i.e. maize based mixed cropping (maize+chilli, maize+pulse, maize+groundnut etc.) may be conducted in char areas to reduce single crop dependency as well as minimize economic vulnerability.

For immediate use of the research findings the following varieties may be recommended considering yield and yield contributing characters and most importantly farmer's choice: V_7, V_2, V_6, V_{10} & V_3.

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Table-1: Summary of baseline survey about the maize farmers in char areas

Research site	Commonly used cultivar	Yield (t/ha)	Spacing (cm)	Basal dose (kg/ha)	Top dressing application of Urea (kg/ha)
Deluabari Char, Fulchori, Gaibandha	Uttaran-2, Elite, 260	4.5	65-126	Urea-148 kg/ha TSP-104 kg/ha MOP-104 kg/ha Gypsum-60 kg/ha	334 kg /ha (3 times)
Natuarpara ,Kazipur, Siranjgonj	NK-40, 60 (BRAC), Pacific, 900M Gold	5.0	68-125	DAP-82 kg/ha	244kg/ha (3 times)
Nayapara , Sariakandi, Bogra	BADC-5, 900 M Gold	5.0	61-127	Urea- 82 kg/ha TSP-82 kg/ha MOP-45 kg/ha Gypsum-75 kg/ha	100 kg/ha (2 times)

Table- 2: Days to emergence of maize under variety screening research in chars

Variety Code	Experiment: A				Experiment: B			
	Kazipur	Sariakandi	Fulchari	Mean	Kazipur	Sariakandi	Fulchari	Mean
V_1	6	7	7	7	6	7	7	7
V_2	5	8	6	6	6	7	7	7
V_3	5	6	6	6	6	6	7	6
V_4	6	6	7	6	6	6	7	6
V_5	5	6	6	6	6	6	7	6
V_6	5	6	6	6	6	6	6	6
V_7	6	6	6	6	6	6	7	6
V_8	6	6	7	6	6	6	7	6
V_9	6	6	6	6	7	6	7	6
V_{10}	7	6	7	7	7	6	7	7
V_{11}	6	6	7	6	6	6	7	6
V_{12}	6	6	6	6	5	6	8	6

Table-3: Days to six leaf stage of maize under variety screening research in chars

Variety Code	Experiment: A				Experiment: B			
	Kazipur	Sariakandi	Fulchari	Mean	Kazipur	Sariakandi	Fulchari	Mean
V_1	36	37	31	35	37	38	37	37
V_2	20	38	38	32	30	37	37	35
V_3	31	20	31	27	30	28	34	31
V_4	31	27	33	30	33	28	36	32
V_5	36	27	31	31	37	28	33	33
V_6	31	27	32	30	35	28	37	33
V_7	32	28	32	31	33	28	35	32
V_8	31	28	31	30	32	27	34	31
V_9	35	28	34	32	36	28	37	34
V_{10}	36	28	33	32	37	28	36	34
V_{11}	36	29	33	33	37	29	36	34
V_{12}	32	28	33	31	34	28	36	33

Table-4: Days to tassel emergence of maize under variety screening research in chars

Variety Code	Experiment : A				Experiment : B			
	Kazipur	Sariakandi	Fulchari	Mean	Kazipur	Sariakandi	Fulchari	Mean
V_1	78	96	74	83	78	96	76	83
V_2	78	93	74	82	78	93	78	83
V_3	78	93	71	81	78	94	76	83
V_4	78	95	73	82.	79	95	77	84
V_5	79	97	72	83	79	97	77	84
V_6	78	94	73	82	78	94	78	83

Variety Code	Experiment : A				Experiment : B			
	Kazipur	Sariakandi	Fulchari	Mean	Kazipur	Sariakandi	Fulchari	Mean
V_7	78	92	71	80	78	92	77	82
V_8	78	95	73	82	78	95	77	83
V_9	78	94	74	82	79	94	77	83
V_{10}	78	97	74	83	78	100	76	85
V_{11}	77	95	74	82	78	96	77	84
V_{12}	78	93	73	81	78	94	77	83

Table-5: Days to tassel flowering of maize under variety screening research in chars

Variety Code	Experiment : A				Experiment : B			
	Kazipur	Sariakandi	Fulchari	Mean	Kazipur	Sariakandi	Fulchari	Mean
V_1	81	104	77	87	81	104	79	88
V_2	83	100	75	86	83	101	79	88
V_3	81	97	75	84	83	98	77	86
V_4	83	100	76	86	83	101	79	88
V_5	82	102	76	87	82	104	79	88
V_6	83	78	78	80	81	100	79	87
V_7	82	96	79	86	82	96	79	86
V_8	84	101	76	87	83	102	78	88
V_9	81	101	77	86	81	100	98	93
V_{10}	81	105	77	88	82	105	80	89
V_{11}	81	102	76	86	81	103	79	88
V_{12}	83	98	75	85	82	93	78	84

Table-6: Days to bud emergence of maize under variety screening research in chars

Variety	Experiment : A				Experiment: B			
	Kazipur	Sariakandi	Fulchari	Mean	Kazipur	Sariakandi	Fulchari	Mean
V_1	85	102	81	89	86	102	83	90
V_2	86	100	77	88	86	102	83	90
V_3	86	92	80	86	85	98	82	88
V_4	87	98	80	88	87	102	82	90
V_5	86	100	80	89	87	102	82	90
V_6	87	77	81	82	86	99	83	89
V_7	87	94	82	88	87	95	82	88
V_8	87	100	81	89	87	100	83	90
V_9	86	98	81	88	90	107	86	95
V_{10}	86	104	81	90	86	105	83	91
V_{11}	85	100	80	88	85	102	83	90
V_{12}	88	94	80	87	87	90	82	86

Table-7: Days to maturity of maize under variety screening research in chars

Variety Code	Experiment: A				Experiment: B			
	Kazipur	Sariakandi	Fulchari	Mean	Kazipur	Sariakandi	Fulchari	Mean
V_1	154	162	137	151	154	162	139	152
V_2	156	157	136	150	156	159	140	152
V_3	155	154	136	148	157	155	138	150
V_4	157	158	137	151	157	159	140	152
V_5	155	160	137	151	156	161	139	152
V_6	157	156	139	151	155	157	140	151
V_7	155	154	139	149	156	154	137	149
V_8	157	159	137	151	157	159	137	151
V_9	154	159	138	150	154	158	136	149
V_{10}	155	163	137	152	155	163	140	153
V_{11}	155	160	136	150	155	160	140	152
V_{12}	157	156	136	150	156	156	139	150

Table-8: Plant height (cm) of maize under variety screening research in chars

Variety Code	Experiment : A				Experiment: B			
	Kazipur	Sariakandi	Fulchari	Mean	Kazipur	Sariakandi	Fulchari	Mean
V_1	158.4	139.8	186.4	161.53	156.4	114.6	185.8	152.27
V_2	167.8	168.2	184.6	173.53	168.3	133.6	181.6	161.17
V_3	192.6	184.8	194.4	190.60	194.2	182.6	191.4	189.40
V_4	193.1	188.2	195.4	192.23	195.1	185.6	181.6	187.43
V_5	171.5	170.8	173.2	171.83	170.4	167.6	169.2	169.07
V_6	192.8	191.6	193.4	192.60	191.4	187.4	191.2	190.00
V_7	175.3	160	178.6	171.30	177.2	158.1	175.4	170.23
V_8	177.6	184	161.2	174.27	178.2	183	157	172.73
V_9	157.4	149	171.6	159.33	156.8	149.2	166.6	157.53
V_{10}	188.2	170.6	192.2	183.67	186.7	169.6	192.4	182.90
V_{11}	168.3	127.8	170	155.37	167.3	128.2	160.8	152.10
V_{12}	172.4	148.4	173.6	164.80	170.2	148.8	172.2	163.73

Table-9: Cob length (cm) of maize under variety screening research in chars

Variety Code	Experiment : A				Experiment: B			
	Kazipur	Sariakandi	Fulchari	Mean	Kazipur	Sariakandi	Fulchari	Mean
V_1	18.2	16.8	20.2	18.4	17.2	15.6	19	17.27
V_2	18.5	17.6	17	17.7	17.9	14.6	16.4	16.30
V_3	18.8	17.4	17.8	18	17.2	17.2	18.4	17.60
V_4	18	17.6	15.4	17	16.2	16.6	14.6	15.80
V_5	16	20.6	18	18.2	15.4	16.2	14	15.20
V_6	19.3	15.8	16.2	17.1	17.4	17.4	16.4	17.07
V_7	21	19.6	17.8	19.5	18.2	16.6	17.4	17.40
V_8	19.2	19.4	19.4	19.3	17	17.4	17.8	17.40
V_9	17.6	18.8	14.6	17	18.2	18.2	16.4	17.60
V_{10}	19.6	16.2	16.8	17.5	18.4	15.2	18.2	17.27
V_{11}	17.8	17.6	15.4	16.9	14.2	15.6	16.6	15.47
V_{12}	17.4	17.4	14.8	16.5	18	18.2	16	17.40

Table-10: Cob diameter (cm) of maize under variety screening research in chars

Variety Code	Experiment: A				Experiment: B			
	Cob diameter			Mean	Cob diameter			Mean
	Kazipur	Sariakandi	Fulchari		Kazipur	Sariakandi	Fulchari	
V_1	16.17	15.33	20.33	17.28	16.33	15	19	16.78
V_2	13.87	18	16.67	16.18	16.5	13.67	17.67	15.95
V_3	16.17	14.67	17.87	16.24	16.17	16.67	17	16.61
V_4	14.83	17	19	16.94	16.1	17	17.67	16.92
V_5	16.5	15.67	20.33	17.50	15.17	18	16.8	16.66
V_6	16.83	17.33	16.47	16.88	17.17	18	17.67	17.61
V_7	17.33	19.33	18.67	18.44	17.83	18.67	19.67	18.72
V_8	17	15.33	21.33	17.89	17	14.67	15.33	15.67
V_9	17	15.33	18	16.78	19	17	17.33	17.78
V_{10}	18.33	14.67	21	18.00	17.17	16.67	18.67	17.50
V_{11}	16.17	13.67	18.33	16.06	17.67	14.67	16	16.11
V_{12}	16.5	18.33	16.33	17.05	17	18.33	16.87	17.40

Table-11: Number of cobs/ plant of maize under variety screening research in chars

Variety Code	Experiment: A				Experiment: B			
	Kazipur	Sariakandi	Fulchari	Average	Kazipur	Sariakandi	Fulchari	Average
V_1	1	1	1	1.00	1	1	1	1.00
V_2	1	1	1	1.00	1.2	1	1	1.07
V_3	1	1	1	1.00	1	1	1	1.00
V_4	1	1	1	1.00	1	1	1	1.00
V_5	1	1	1	1.00	1	1	1	1.00
V_6	1.4	1	1.2	1.20	1	1	1.2	1.07
V_7	1	1	1	1.00	1	1	1.4	1.13
V_8	1.2	1	1.2	1.13	1	1	1	1.00
V_9	1	1	1	1.00	1	1	1	1.00
V_{10}	1	1	1	1.00	1	1	1	1.00
V_{11}	1.2	1	1	1.07	1.2	1	1	1.07
V_{12}	1	1	1	1.00	1.4	1	1	1.13

Table-12: Number of kernels cob of maize under variety screening research in chars

Variety Code	Experiment: A				Experiment: B			
	Kazipur	Sariakandi	Fulchari	Mean	Kazipur	Sariakandi	Fulchari	Mean
V_1	505	465	520	497	467.4	434	519	474
V_2	573	536	503	571	565	509.2	442	528.46
V_3	484	502	439	475	485	501	415	471.57
V_4	570	542	454	522	538	536	458	517.14
V_5	463	478	543	494	529	468	455	490.00
V_6	505	465	520	497	557	481	412	483
V_7	592	410	542	515	530	483	522	513.43
V_8	595	418	520	544	517	455	432	497.29
V_9	519	490	508	506	503	508	461	499.29
V_{10}	583	509	559	550	563	514	460	534.00
V_{11}	375.4	404.8	355.2	378.47	330.8	396.6	320.2	365.92
V_{12}	562.8	401.6	482.4	482.27	474.6	417	421.8	463.21

Table-13: 1000 Seed weight (gm) of maize under variety screening research in chars

Variety Code	Experiment: A				Experiment: B			
	Kazipur	Sariakandi	Fulchari	Mean	Kazipur	Sariakandi	Fulchari	Mean
V_1	390	393	460	414.33	379	334	450	387.67
V_2	462	425	485	457.33	381	417	480	426.00
V_3	450	476	397	441.00	382	482	395	419.67
V_4	438	433	455	442.00	401	441	390	410.67
V_5	387	469	386	414.00	344	458	366	389.33
V_6	450	431	438	439.67	403	421	430	418.00
V_7	420	440	480	446.67	468	412	436	438.67
V_8	465	406	460	443.67	369	402	396	389.00
V_9	398	378	423	399.67	348	368	409	375.00
V_{10}	453	458	460	457.00	402	439	440	427.00
V_{11}	422	411	412	415.00	373	391	460	408.00
V_{12}	471	436	442	449.67	433	422	426	427.00

Table-14: Disease and insect incidence of maize under variety screening research in chars

Variety Code	Name of Disease	Disease Severity	Name of Insect	Insect Incidence
	Leaf Blight	0	Cut worm	1
V_1	Do	0	Do	1
V_2	Do	0	Do	1
V_3	Do	0	Do	1
V_4	Do	3	Do	1
V_5	Do	0	Do	1
V_6	Do	0	Do	1
V_7	Do	0	Do	1
V_8	Do	0	Do	1
V_9	Do	0	Do	1
V_{10}	Do	0	Do	1
V_{11}	Do	0	Do	1
V_{12}	Do	0	Do	1

- 0 = No disease
- 1 = low severity
- 2 = Medium severity
- 3 = Highest severity

Table-15: Yield/ plant (g) of maize under variety screening research in chars

Variety Code	Experiment: A				Experiment: B			
	Kazipur	Sariakandi	Fulchari	Mean	Kazipur	Sariakandi	Fulchari	Mean
V_1	198.8	180	234	204.27	139.8	182.4	224.8	182.33
V_2	245.8	258.2	290.4	264.80	202.8	238.2	212.4	217.80
V_3	229	237.4	224	230.13	173.8	260.6	179.8	204.73
V_4	216.4	236.4	209.2	220.67	173.6	218	195.2	195.60
V_5	188.2	220.6	208	205.60	178.8	220	195.2	198.00
V_6	213	237.4	215	221.80	219	227.6	202	216.20
V_7	231.6	239.2	287.8	252.87	230.2	231	246.2	235.80

Variety Code	Experiment: A				Experiment: B			
	Kazipur	Sariakandi	Fulchari	Mean	Kazipur	Sariakandi	Fulchari	Mean
V_8	254	164	220.4	212.80	180.8	130.2	174.2	161.73
V_9	215	208	218.4	213.80	209.8	204.4	201.2	205.13
V_{10}	218.8	245.4	249.4	237.87	207.2	238.2	221.2	222.20
V_{11}	191.8	220.4	181.8	198.00	180.6	205.6	179.6	188.60
V_{12}	212	219	168.6	199.87	191.2	209.2	155.4	185.27

Table-16: Yield (t/ha) at 12 % moisture of maize under variety screening research in chars

	Experiment: A				Experiment: B			
Variety Code	Yield / plant (g)	Yield/ plot (kg/ha)	Yield (t/ha)	Yield (t/ha) at 12% moisture	Yield/ plant	Yield/ plot (kg/ ha)	Yield (t/ha)	Yield (t/ha) at 12% moisture
V_1	204.27	9590	9.59	8.44	182.33	11013	11.01	9.69
V_2	251.47	11806	11.81	10.39	217.8	13155	13.15	11.58
V_3	230.13	10805	10.80	9.51	171.4	10352	10.35	9.11
V_4	220.67	10360	10.36	9.12	195.6	11814	11.81	10.40
V_5	205.6	9653	9.65	8.49	198	11959	11.96	10.52
V_6	221.8	10413	10.41	9.16	216.2	13058	13.06	11.49
V_7	252.87	11872	11.87	10.45	235.8	14242	14.24	12.53
V_8	219.47	10304	10.30	9.07	161.73	9768	9.77	8.60
V_9	213.8	10038	10.04	8.83	205.13	12390	12.39	10.90
V_{10}	237.87	11168	11.17	9.83	222.2	13421	13.42	11.81
V_{11}	198	9296	9.30	8.18	188.6	11391	11.39	10.02
V_{12}	199.87	9384	9.38	8.26	185.27	11190	11.19	9.85

Table- 17: Farmers preferred variety of maize under variety screening research in chars

Serial No	Variety Code	No of farmers out of 24 who preferred variety in kazipur	No of farmers out of 27 who preferred variety in Fulchari	No of farmers out of 22 who preferred variety in Sariakandi	Farmers preference mean
1.	V_1	02	03	01	02
2.	V_2	04	04	05	4.33
3.	V_3	03	03	03	3.0
4.	V_4	-	-	03	01
5.	V_5	02	03	-	-
6.	V_6	04	04	03	3.66
7.	V_7	04	05	05	4.66
8.	V_8	-	-	-	
9.	V_9	-	-	-	
10.	V_{10}	04	03	03	3.33
11.	V_{11}	01	02	-	01
12	V_{12}	-	-	-	

Table-18: List of maize varieties used in the experiments under variety screening research

Serial No	Variety code	Variety name	Source
1.	V_1	Mirakel	Dealer
2.	V_2	Elite	Dealer
3.	V_3	Uttaran-2	Dealer
4.	V_4	900 M Gold	Dealer
5.	V_5	PAC-313	Dealer
6.	V_6	Hera-101	Dealer
7.	V_7	987 K	Dealer
8.	V_8	PAC-224	Dealer
9.	V_9	CP-838	Dealer
10.	V_{10}	PAC-984	Dealer
11.	V_{11}	NK-40	Dealer
12.	V_{12}	X-92	Dealer

Farmer Participatory Research

Maize stover silage technology suitable for chars

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Introduction

Maize (Zea mays L.) is the third most important cereal crop in Bangladesh, after rice and wheat. It is a major cash crop, and is one of the major sources of income and employment of char dwellers, especially for smallholders and women. Amongst its use in numerous other sectors, maize is most commonly used in the poultry and fish feed industries, for baking and other foods for human consumption. The nutritional value of maize, its economic importance and its incredibly diverse uses is significant of the immense and transferable virtues of the crop, important not only in Bangladesh, but across every region of the world. Bangladesh produces on an average 1.2 million metric tons of maize annually. The data also demonstrates a notable trend of increasing annual domestic production in maize (GMark Consulting Limited, 2013). Besides being a potential source of food for human being, it is used for feeding cattle and poultry and as raw material in industry sector. Apart from the other potential areas of utilization may be explored one of such is maize stover silage, considered one of the cheapest source of cattle feed in Bangladesh.

The primary goal of making silage is to maximize preservation ability of original nutrients in the forage crop for feeding at a later date. Unfortunately, fermentation in the silo is a much uncontrolled process usually leading to less than optimal preservation of nutrients. In order to assist the fermentation process, various silage additives have been used to improve nutrient and energy recovery, often with subsequent improvements in animal performance.

Maize stover is usually handled and dried in the long, unchopped stage, often by stocking in, or on the boundary of, and stored by stacking or baling after field drying mainly for fuel purpose in Bangladesh. Maize stover possibly the best of all other cereal stovers among the livestock feed. Where very abundant in relation to the livestock, it can be grazed off; otherwise, on large enterprises, it can be ensiled or collected and dried. Many small-scale farm systems collect the stover when the cobs have been harvested and either dries it in the field or at the homestead. In some places of fuel scarcity, even the roots are dug up together with the stem bases and used as fuel. Cut stover can be ensiled if chopped, moistened, well compacted and filled in anaerobic condition considered as "maize stover silage".

The major constraint to cattle production is nutrition. Cattle are predominantly fed on natural pastures and crop residues. However, due to rising human population, traditional grazing lands are widely being converted to croplands and industrialization; forcing cattle to graze on marginal and overgrazed lands with poor quality forage (Kitaba and Tamir 2007). There is huge production of maize stover which is about 25-30 ton/ha/year (Sarker

et al., 2007). After maturity maize cobs are harvested and maize stover are left in the fields. It has been reported that over 90% of stovers are left in the fields, although only a fraction of this residue is needed to minimize soil erosion (Sokhansanj *et al.*, 2002). Less than 1% of stover is currently collected for industrial processing.

Maize stover is the portion of maize plant that remains after removing ears (husks+grains+cobs) and roots (Altaf, 1999). According to Renard (1997), the available feed resources for livestock in Pakistan include range grazing (39%), crop residues and forage crops (54%), feed grains and other concentrates (7%). Maize stover is most abundant crop residue in the world (FAO, 1985). Maize stover has a higher crude protein content of about 6% and metabolizable energy (ME) value of about 9 MJ/kg DM (McDonald *et al.*, 1995) than rice straw though maize stover is characterized by a low protein, high fibre content and structurally too hard compared to other high quality roughages. The stover may be chopped, ensiled and fed in a similar way to maize silage (McDonald *et al.*, 1995).

Different physicochemical and biological processing of maize stover may increase its nutritional and preservative quality and make it palatable to ruminants. Molasses is suitable for feeding ruminants as it is wholesome, easy to use, effective, palatable, dust free, promote fermentation and contain some concentrated nutrients. It helps in facilitating the natural preservation by lowering the pH and producing lactic acid bacteria (Premier Molasses, 2006). Addition of molasses, urea, probiotic and ensiling of chopped maize stover can be the effective means of improving the nutritive value for lacteting dairy cows.

Green fodder plays a very significant role in increasing the productivity of farm animals. In Bangladesh year-round availability of grass for large ruminants is about 1 kg per head per day (Tareque and Saadullah 1988), most of which comes from agricultural weeds and/or roadside grasses. Fodder preservation has the main objective of ensuring feed availability during periods of scarce feed supply (Mohd Najib *et al.* 1993). Silage is defined to be forages, crop residues or agricultural and industrial by-products preserved by acids, either added or produced by natural fermentation by anaerobic bacteria in the absence of air (Mannetje 1999). The main objective of silage making is to conserve feed reserve for feeding during times of feed shortage.

In the northern part of Bangladesh, different char's island of river Jamuna, Tista and Padma, most of the farmers are cultivating large quantities of hybrid maize. After harvesting of cobs farmers are used to leftover the maize plant (stover) in their filed in the month of March-May of each year, a few farmers are using leaves and tassel (top) as a cattle feed and most of the farmers are using them as fuel. Although at that time the scarcity of cattle feed is predominant in these areas and farmers fulfilling the demands of cattle feed after purchasing rice straw with high price. Therefore Rural Development Academy (RDA), Bogra has developed a production, preservation and utilization technology of maize stover

as a source of cattle feed which will help in minimizing scarcity of cattle feed in char areas as well throughout the country.

Considering the above facts, the present research work was undertaken by RDA in close collaboration with Making Markets Works for The Chars (M4C) project with the following objectives:

Objectives

The broad objective of the study was to identify the best production practice to capture high economic performance of maize stover silage production.

The specific objectives of the study were to:

1. determine suitable maize stover silage production technology for char areas;
2. findout the physical and chemical properties of maize stover silage and ensiling time;
3. asses the nutritive value of maize stover silage; and
4. determine economic feasibility of producing maize stover silage in char areas.

Justification of the study

Most of the feed ingredients are imported to fulfill the demand of concentrates diet for dairy cows. Prices of dairy feed are continuously rising. Production of maize stover silage may contribute to economic development of the livestock industry in Bangladesh by enabling higher use of local feed resources through conservation. This is particularly important regards to fresh/wet crop residues and agro-industrial by-products which otherwise will turned into wasted. Greater feed availability throughout the year will increase animal productivity and higher profitability to farmers. This intern will improve the income and social status of farmers. Another advantage of production and use of maize stover silage is the reduction of environmental pollution from certain crop residues and agro-industrial by-products, which, if not utilized, will have to be disposed of as waste material.

Material and Method

According to the research issue and objectives present study is recounting in nature to achieve new opinion that contribute to discover scientific as well as social benefit. Therefore, the study was carried out in two parts. The first part dealt with a field survey in selected chars of Shariakandi upazilla of Bogra district, Kazipur upazilla of Sirajgonj district and Fulchorri upazilla of Gaibandha district to estimate baseline performance of respondents in using maize stover as cattle feed and the second part dealt with production of maize stover silage in study area and at RDA demonstration farm.

Population and sample

A survey was conducted in the selected three river islands. A total of 60 maize cultivating farmers were randomly select for collecting data about farmers practice in maize stover use and silage production and preservation technique. From each upazilla 20 farmers were selected.

Collection of the experimental materials

The maize stovers were collected immediately after harvesting of corn cobs from the selected three Char areas, RDA and surrounding RDA campus. Commercial molasses was purchased from local market.

Making silos

In this experiment, three methods of silage production were used to prepare maize stover silage in three char areas to find out the suitable silage making technique and previously constructed concrete made pit silo was used in RDA demonstration farm. The silos are as follows;

Pit silo: The char areas are vulnerable, so pit silos were constructed in three char areas through earth excavation, and have dimensions of 10 feet length 4 feet width and 3 feet depth. The pit silos were lined with polythene sheet. Three pit silos were constructed in each of the three experimental sites.

Bunker silo: This type of silo was constructed with bamboo and polythene sheet. A bamboo made rectangular shape frame was constructed on the earth having dimensions of 10 feet length, 4 feet width and 3 feet depth. Three bunker silos were constructed in each of the three experimental sites.

Bag silo: This type of silo was made using a polythene bag. Ten (10) bag silos were prepared in each replication.

Preparation of maize stover silage

After harvesting cobs maize stovers were collected from the study areas and chopped, using a portable chopper machine into pieces up to 1-2 cm long. The stover was ensiled in silo pits, bunkers and bags. Weighed batches of chopped stover were placed in the pit and sprayed well with 4% molasses solution by using a garden watering can. The stover was mixed, compressed and compacted it to make airtight. More batches of stover were then added and treated until the pit was filled. Finally, the pit was covered with polythene sheets and a thick (about 45 cm) layer of soil. The ensiled maize stover should be ready for feeding either plain or ideally with a green fodder supplement, molasses or with concentrates.

Treatments

Treatment groups for the production of maize stover silage:

T_1 = Sample ensiled in pits
T_2 = Sample ensiled in bunkers
T_3 = Sample ensiled in bags

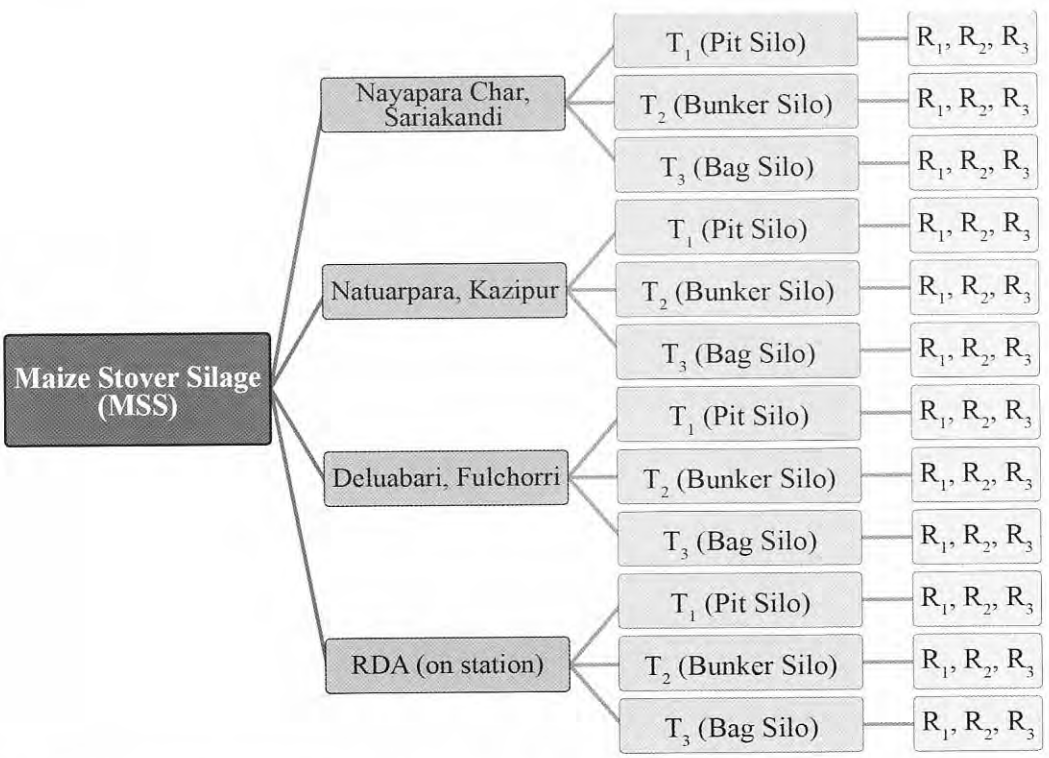

Figure-1. Schematic presentation of experiment design

Design

The field experiments were arranged under Randomized Complete Block Design (RCBD) where as the laboratory experiments were arranged under Complete Randomized Design (CRD) with three replications in each site. Three treatments were randomly placed in the blocks for the production of maize stover silage.

Observation and collection of samples

The ensiled sample of the each treatment was opened after 21, 42 and 60 days respectively. The physical changes of all ensiled samples were observed and documented. Fungus was detected with visual estimation. During the observation 100g of sample was taken out from each replication for chemical analysis. The DM and OM content was measured on fresh basis. All the samples were air dried and ground with the help of grinding machine of about 1mm in diameter for chemical analysis.

Chemical analysis

Collected maize stover silage samples were analyzed for DM, CP, Ash and ADF according to the methods of AOAC (1984).

Statistical analysis

The data of proximate components were analyzed using SPSS version 16.0, using descriptive experimental designs and means were compared using Duncan's Multiple Range Test (DMRT).

Results and Discussion

The experiment was conducted to study the potentials of maize stover silage on livestock rearing in char areas of Bangladesh. The results on farmers' perception, physical properties and nutritive status of maize stover silage are presented in different tables and figure and discussed under the following subheadings.

Farmers' perception in using maize stover

A survey was conducted to know the farmers' perception about using maize stover for different purpose in three char areas of Jamuna, Padma and Tista. The results (Table 1 and Figure 2) show that about 33% of the farmers in char's areas use maize stover as fuel, 12% as cattle feed and 39% use both as fuel and cattle feed and only 16% burn in the field. Maize stover may contribute significantly as ruminant feed particularly during the dry and flashing seasons because at that time the scarcity of cattle feed present in char areas and farmers fulfill the demand of cattle feed through purchasing rice straw with high price.

Table-1: Farmers' perception on using maize stover

Type of uses	No of Respondents			Total	
	Sariakandi	Kazipur	Fulchhori	Respondents	Percentages
Burning in Field	3	4	5	12	16
Fuel	9	8	7	24	33
Only Cattle Feed	2	4	3	9	12
Fuel+ Cattle Feed (Only Leafy part)	7	12	9	28	39
				Total (%)	100

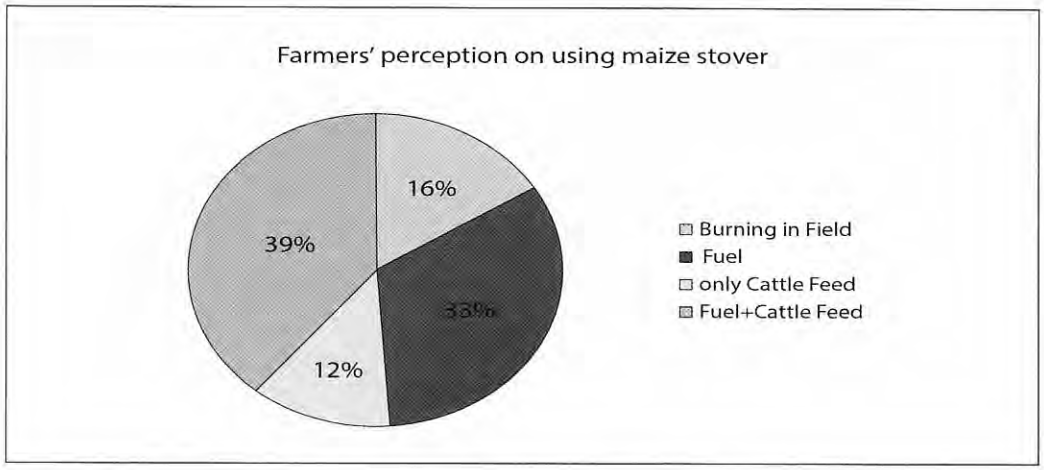

Figure-2: Farmers' perception on using maize stover at different char areas.

Physical properties of ensiled maize stover

The physical properties of ensiled maize stover at different periods were shown in table 2. Result indicates that ensiled maize stover (T_1, T_2 and T_3) had unacceptable colour, smell, softness at day 21. But at day 42 and 60 the ensiled maize stover under different treatments (T_1, T_2 and T_3) had good colour, smell and softness but some fungal growth was observed with T_1 and T_2. In the present experiment brown colour was observed in all treatments group. Man and Wiktorsson, 2003 reported that ensiling with 3, 6 and 9% molasses can produce acceptable brownish yellow or yellow brown color and typical smell but with 6 and 9% molasses there were some spoilage due to fungal growth. In the present study 3% level of molasses was used because it was considered to be acceptable than those of 6 and 9% levels in respect of cost involvement and quality.

The finding was supported earlier by Man and Wiktorsson, (2003) who reported that the low level of molasses (3%) was better than the high level (6 and 9%) of molasses in terms of color, softness and fungal growth. Snijders and Wouters (2004) reported that, addition of 3% molasses obtained good quality silage. Presence of fungus in silage is undesirable because it uses silage nutrients and toxins are sometimes produced (Man and Wiktorsson, 2003). Man and Wiktorsson, (2003) also found that ensiling of maize stover with molasses increased the degree of brown colour with increasing ensiling time (from 2 to 4 months) in the silage but fungus was observed after 4 months of ensiling. Changing in colour and improvement in brown colour from 20 to 50 days was also observed by Hiep and Man (2003) but fungal growth was increased with increasing the ensiling time. Spoiling increased with the long-term storage and with the high level of molasses (Man and Wiktorsson, 2003). Ensiling time may have effects on increasing in fungal growth (Petersson, 1988).

Table-2. Physical properties of maize stover silage and ensiling time

Parameters	Ensiling time (days)	Physical Properties		
		T_1 (Pit silo)	T_2 (Bunker silo)	T_3 (Bag silo)
Colour	21	Greenish	Greenish	Greenish
	42	Brownish	Brownish	Brownish
	60	Brownish	Brownish	Brownish
Smell	21	Natural smell	Natural smell	Natural smell
	42	Moderately good	Moderately good	Moderately good
	60	Good	Good	Good
Softness	21	Hard	Hard	Hard
	42	Moderately soft	Moderately soft	Moderately soft
	60	Soft	Soft	Soft
Fungus	21	Absent	Absent	Absent
	42	Present	Absent	Absent
	60	Absent	Present	Absent

Notes: T_1 = Silage ensiled in pit, T_2 = Silage ensiled in bunker, T_3 = Silage ensiled in bag, Hard indicating not acceptable by ruminants (cattle, sheep, goat etc). Soft indicating accepted by ruminants (cattle, sheep, goat etc)

Production performance of maize stover silage

The production performances of ensiled maize stover silage are shown in table 3. Result indicates that loss percentage was higher in Bunker silo (T_2, 21.13%) than Pit silo (T_1, 1.65%). Loss percentage was lowest in Bag silo (T_3, 0.52%) i.e. sample ensiled in bag. On the other hand, production performance was highest in Bag silo (T_3, 99.48%) followed by Pit silo (T_1, 98.35%) and Bunker silo (T_2, 78.88%). The lowest production performance was recorded in T_2, sample ensiled in bunker. The data of different treatment group varies significantly ($P<0.01$) from each other but there is no significant difference among four study areas of maize stover silage production. The average loss and good quality production performance of maize stover silage has been shown in figure 3.

Table-3: Production performance of maize stover silage in different techniques

Research Locations (chars)	% of Production Performance			% of Quality Performance		
	Pit silo (T_1)	Bunker silo (T_2)	Bag silo (T_3)	Pit silo (T_1)	Bunker silo (T_2)	Bag silo (T_3)
Sarikandi	2.67^{a}±0.29	24.33^{a}±0.58	0.83^{a}±0.14	97.33^{c}±0.29	75.67^{c}±0.58	99.17^{c}±0.14
Kazipur	2.17^{a}±0.29	23.67^{a}±1.15	0.50^{b}±0.00	97.83^{c}±0.29	76.33^{c}±1.15	99.50^{b}±0.00
Fulchhori	1.28^{b}±0.24	21.17^{b}±1.04	0.50^{b}±0.00	98.72^{b}±0.24	78.83^{b}±1.04	99.50^{b}±0.00
RDA	0.50^{c}±0.10	15.33^{c}±0.58	0.25^{c}±0.02	99.50^{a}±0.01	84.67^{a}±0.58	99.75^{a}±0.02
Mean	1.65±0.89	21.13±3.78	0.52±0.23	98.35±0.89	78.88±3.78	99.48±0.23
SEM	0.25	1.09	0.06	0.26	1.09	0.65
LS	**	**	**	**	**	**

Notes: ^{abc}, Means with dissimilar superscripts differ significantly (P<0.01); LS= Level of significance; # = Values indicated Mean ± SE (Standard error); SEM= Standard error of mean; **= Significant at 1% level (p<0.01);

T_1 = Silage ensiled in pit; T_2 = Silage ensiled in bunker; T_3 = Silage ensiled in bag.

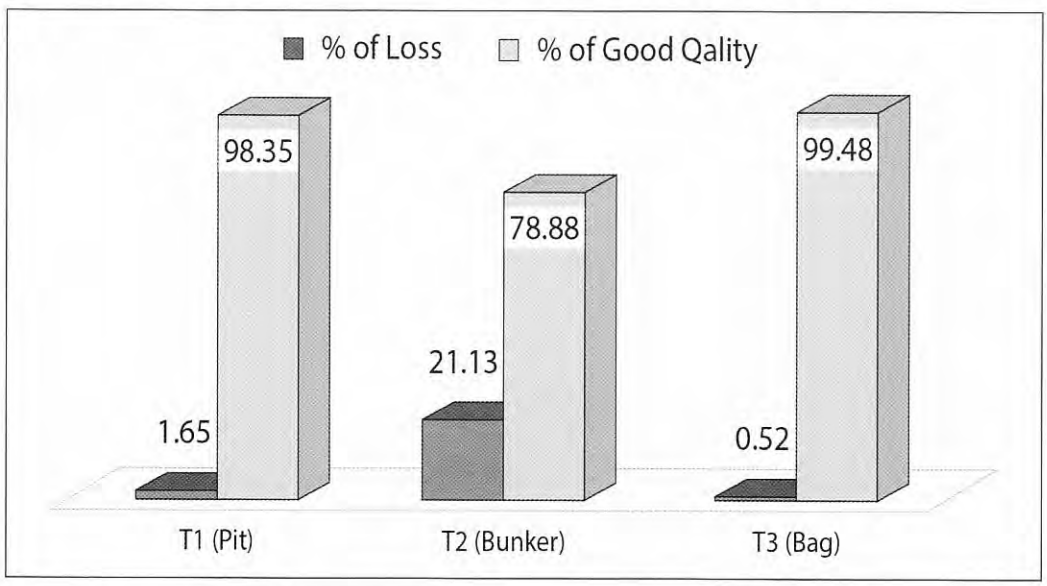

Figure 3: Avereage production performance of maize stover silage in different techniques.

Nutritional status of maize stover silage and fresh maize stover

The nutritional status of fresh maize stover and maize stover silage of different treatments groups and ensiling time are shown in table 4. The highest DM was (31.24%) found at day 21 and the lowest (26.07%) was found at 60 days of maize stover silage production ($P<0.01$) whereas the DM content of fresh maize stover was 21.34%. Sarker *et al.* (2012) observed that the DM content was 29.38% and 31.15% in BHM-5 and BHM-3 respectively of maize stover silage. The reason of decreasing the DM content in the present study may be due to proper compactness and ensiling time. In the present study, it was observed that DM content was decreased with ensiling time from 31.24% to 26.07% with the increase of duration from 21 to 60 days ($P>0.01$).

Table-4. Effect of different treatments and different ensiling time on the chemical composition (%DM basis) of maize stover silage and maize stover

Items	Ensiling time (days)	Chemical Composition of Silage and Fresh Stover			
		DM	CP	ADF	Ash
Maize stover silage	21	$31.24^{a}\pm0.66$	$6.50^{b}\pm0.19$	$39.34^{b}\pm1.19$	$14.16^{a}\pm0.97$
	42	$26.32^{b}\pm1.96$	$6.97^{ab}\pm0.13$	$48.91^{a}\pm2.52$	$13.36^{a}\pm2.09$
	60	$26.07^{b}\pm2.66$	$7.50^{a}\pm0.26$	$43.91^{ab}\pm1.50$	$12.77^{a}\pm1.60$
Maize stover	-	$21.34^{c}\pm0.71$	$6.46^{b}\pm0.18$	$40.52^{b}\pm4.10$	$13.75^{a}\pm2.37$
-	LS	**	**	**	NS

Notes: ^{abc} Means with dissimilar superscripts differ significantly ($P<0.01$); LS= Level of significance; # = Values indicated Mean ± SE (Standard error); **= Significant at 1% level ($p<0.01$); NS= Non significant;

This findings were supported by some other experiments where DM content decreased from 22.58 to 20.83% (Otieno *et al.*, 1986), from 29.1 to 26.5% (Hiep and Man, 2003) and from 28.0 to 26.4%, (Man and Wiktorsson, 2003) with increasing the ensiling time of the ensiled maize stover.

The CP content was highest (7.50%) at day 60 and lowest (6.46%) at day-O. So, the CP content increased from 6.46 to 7.50% with increasing the ensiling time. Similar result was also found by Sarker *et al.*, (2012). They found that a CP value was 7.52% DX in BHM-5 of maize stover. The CP content increased with increasing the ensiling time (from 21 to 60 days) during the present study ($P<0.01$). Parigi-Bini *et al.*, (1987) reported that ensiling time with molasses treatment increased the CP content of maize stover, which was also supported by Lanari *et al.*, (1987). The CP content increased with increasing ensiling

time (Man and Wiktorsson, 2003 and Snijders *et al.*, 2004) and with molasses increment (Snijders and Wouters, 2004).

The ADF content was highest 48.91% and lowest 39.34% at day 42 and 21 respectively. ADF was 43.91% at day 60. So, the ADF content decreased from 48.91 to 43.91% with increasing the ensiling time (from 42 to 60 days) in the present study (P>0.01). Similar result was observed by Sarker *et al.*, (2012) where they observed ADF content 42.72% in BHM-5 of maize stover silage. Slight variation may occur due to varietal variation of the cultivated maize.

The Ash content was highest 14.16% and lowest 12.77% at day 21 and 60 respectively. The Ash content decreased gradually from 14.16 to 12.77% with increasing the ensiling time but there were no significant differences among the Ash content (P>0.01).

It was revealed that DM, ADF and Ash content was decreased by 5.17, 5 and 1.39% respectively, where the CP content was increased by 1.04% (P<0.01). It was also found that, the change in the DM, CP and ADF content differ significantly (P<0.01) where as there was no significant difference (P>0.01) in Ash content with increasing the ensiling time from 21 to 60 days.

Structural comparison of different silos

Structural comparison of different silos is shown in table 5. The results indicate that Bag silos are easily transferable from one place to another as char areas are more vulnerable to food and other natural disaster. Bag silos were affordable by extreme poor and suitable for flood prone areas like chars.

Table 5: Structural Comparison among different silos

Items	Pit silo (n=1)	Bunker silo (n=1)	Bag silo (n=10)
Structure			
Portability	Static	Static	Portable
Longevity (year)	3 – 4	2 - 3	2 – 3
Volume (cft)	120	120	45
Maize stover silage holding capacity (Kg/cft)	10	8	7
Total Maize stover holding capacity (Kg)	1200	960	300
Size (lengthXwidthXheight or depth, in feet)	10 x 4 x 3	10 x 4 x 3	2 x 1.5 x 1.5
Space required (length X width, in feet)	10 x 4	10 x 4	2 x 1.5

Items	Pit silo (n=1)	Bunker silo (n=1)	Bag silo (n=10)
Structure			
Construction materials	Polythene sheet, mud and others	Bamboo poles, polythene sheet, rope and mud	Plastic bag, polythene bag, rope
Suitability			
Flood prone area	Not suitable	Not suitable	Suitable
Affordable by extreme poor	Yes	No	Yes
Use			
No of animals to be fed	3 for 2 months*	3 for 2 months*	1 for 1 months*

*=Estimated

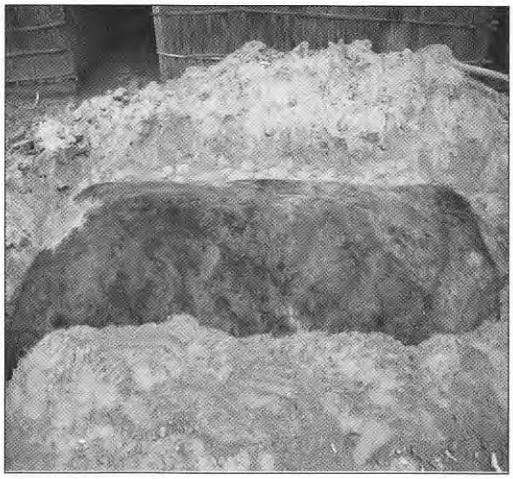

Figure 4a: Maize stover silage ensiled in Pit

Figure 4b: Maize stover silage ensiled in Bag

Figure 4c: Maize stover silage ensiled in Bunker

Cost of production

Comparison of production costs of maize stover silage under different treatments are shown in table 6. The result revealed that the production cost (Tk/Kg) of maize stover silage in Pit, Bunker and Bag methods were 2.14, 3.39 and 1.83 respectively. The maize stover silage production cost was the highest in Bunker silo and lowest in Bag silo. Among these three methods silage ensiled in Bags were more suitable for the char areas because this area is more vulnerable to flood and other natural calamities. During natural disaster poor farmers of this area can easily shift their cattle with Bag silage from one place to other places.

Table 6: Comparison of cost of production among Pit silo, Bunker silo and Bag silo

Items	Cost of Production		
	Pit silo (n=1)	Bunker silo (n=1)	Bag silo (n=10)
Silo construction (Taka/ Kg)	0.84	2.09	0.53
Maize stover silage preparation (Taka/ kg)	1.3	1.3	1.3
Total cost (Taka/ kg)	2.14	3.39	1.83

Comparison among nutrition status of maize stover, maize stover silage and rice straw

The comparison among nutritional status of rice straw, maize stover and maize stover silage are shown in table 7. The nutritional status is very good in maize stover and maize stover silage in comparison to rice straw. In rice straw, the DM content is very high (92.80%) and low CP (4.20%). On the other hand, low DM (27.88%) and high CP (6.95%) were present in maize stove silage. Again, the price of per Kg rice straw, maize stover and maize stover silage were Tk. 6.00, 1.00 and 1.83 respectively. So, by using maize stover or maize stover silage in char areas during the month of April to August of each year they can save the cost of cattle feed and this amount can be used for their livelihood change.

Table 7. Nutritional status of Maize Stover, Maize Stover Silage and Rice Straw

Parameters		Maize stover	Maize Stover Silage	Rice Straw
Nutritional status	DM	21.34	27.88	92.80
	CP	6.46	6.95	4.20
	ADF	40.52	44.05	42.40
	Ash	13.75	13.42	18.10
Price (Tk/Kg)		1.00	1.83	6.00
Data source		Present Study	Present Study	Feedipedia.org

Farmers' opinion about maize stover silage production in field day:

During the research, three field days were organized in three char and farmers' opinion about the production of maize stover silage was recorded following different techniques and shown in table 8. The average opinion of the farmers in three char is presented in the figure 5.

Table 8: Farmers' opinion about maize stover silage production in field days

Treatment	Kazipur (N=26)	Fulchari (N=22)	(Sariakandi) (N=24)	Farmers preference mean	Percentage
T_1 (Pit Silo)	03	04	02	03	12.50
T_2 (Bunker Silo)	05	04	03	04	16.67
T_3 (Bag Silo)	18	14	19	17	70.83
				Total (%)	100

The result shown that highest opinion was given about maize stover silage produced in Bag (T_3, 70.83%) because char areas are more vulnerable to flood and they can easily transfer their cattle with Bag silage to any suitable places during the flood time. The lowest opinion was given on Pit silo (T_1, 12.50%).

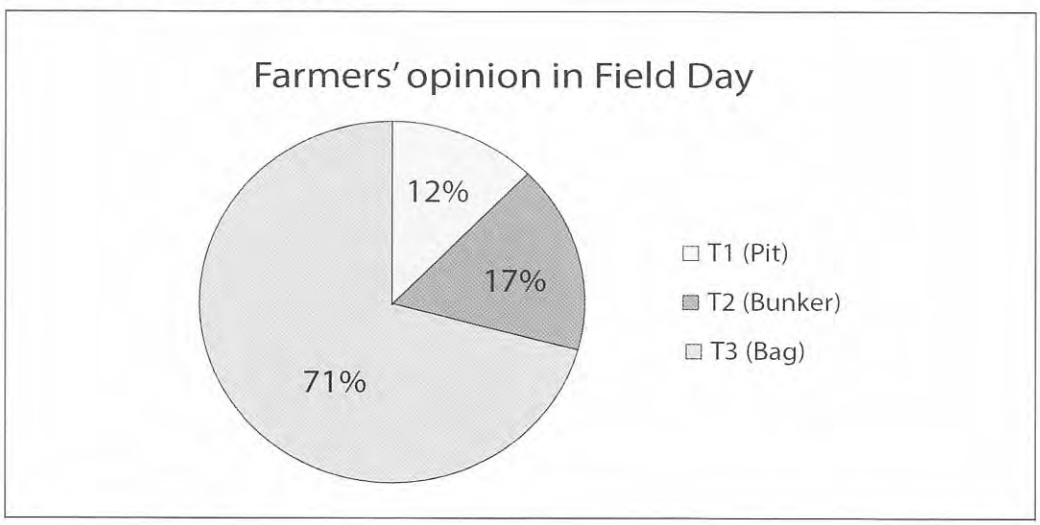

Figure 5: Pie graph showing farmers opinion on maize stover silage production in char areas.

Conclusion and Recommandations

The study was aimed to know the potentials of maize stover silage production on livestock rearing in three selected chars of Shariakandi upazilla of Bogra district, Kazipur upazilla of Sirajgonj district and Fulchori upazilla of Gaibandha district. A survey was conducted to know the farmers' perception about using maize stover for different purpose and results were shown that about 33% of the farmers in chars areas use maize stover as fuel, 12% as cattle feed and 39% use both as fuel and cattle feed and only 16% burn in the field. Maize stover may contribute significantly as ruminant feed particularly during the dry and flashing seasons because at that time the scarcity of cattle feed present in char. For overcoming the feed scarcity and ensuring the use of maize stover in this chars a study was conducted to identify the best production practice to capture high economic performance of maize stover. Three methods were used to produce maize stover silage such as Pit silo (T_1), Bunker silo (T_2) and Bag silo (T_3). Maize stovers were distributed randomly into three different treatments having three replications in each. The physical properties, production performance, nutritional status with ensiling time, structural composition of different silos and cost of production were recorded at the study period.

The physical properties of ensiled maize stover at different periods revealed that at day 21, ensiled maize stover (T_1, T_2 and T_3) had unacceptable colour, smell, softness but at day 42 and 60 the ensiled maize stover under different treatments (T_1, T_2 and T_3) had good colour, smell and softness.

The production of good quality silage was highest in Bag silo (T_3: 99.48%) followed by Pit silo (T_1: 98.35%) and Bunker silo (T_2, 78.88%). The lowest production performance was recorded in T_2, sample ensiled in bunker silo.

The highest DM was (31.24%) found at day 21 and the lowest (26.07%) was found at 60 days of maize stover silage production ($P<0.01$) whereas the DM content of fresh maize stover was 21.34%. The CP content was highest (7.50%) at day 60 and lowest (6.46%) at day-O. So, the CP content increased from 6.46 to 7.50% with increasing the ensiling time. The ADF content was highest 48.91% and lowest 39.34% at day 42 and 21 respectively. ADF was 43.91% at day 60. So, the ADF content decreased from 48.91 to 43.91% with increasing the ensiling time (from 42 to 60 days). The Ash content was highest 14.16% and lowest 12.77% at day 21 and 60 respectively. It was revealed that DM, ADF and Ash content was decreased by 5.17, 5 and 1.39% respectively, where the CP content was increased by 1.04% ($P<0.01$). It was also found that, the change in the DM, CP and ADF

content differ significantly (P<0.01) where as there was no significant difference (P>0.01) in Ash content with increasing the ensiling time from 21 to 60 days.

The production cost (Tk/Kg) of maize stover silage in Pit, Bunker and Bag methods were 2.14, 3.39 and 1.83 respectively. The maize stover silage production cost was the highest in Bunker silo (Tk. 3.39/kg) and lowest in Bag silo (Tk. 1.83/kg).

The nutritional status is very good in maize stover and maize stover silage in comparison to rice straw. In rice straw, the DM content is very high (92.80%) and low CP (4.20%). On the other hand, low DM (27.88%) and high CP (7.50%) were present in maize stove silage. Again, the price of per Kg rice straw, maize stover and maize stover silage were Tk. 6.00, 1.00 and 1.83 respectively.

During Field Days, the highest opinion was given about maize stover silage produced in Bag (T_3, 70.83%) and lowest opinion was given on Pit silo (T_1, 12.50%).

From the above findings of the present study it may be concluded that-

i. Maize stover may contribute significantly as ruminant feed particularly during the dry and flashing seasons because at that time the scarcity of cattle feed present in chars.

ii. Out of three methods i.e. Pit silo (T_1), Bunker silo (T_2) and Bag silo (T_3) were used for the production of maize stover silage in char areas, Bag silo (T3) method is most suitable as these areas are more vulnerable to natural calamities like flood and best ensiling time was 42 days to above.

iii. The production cost of per kilogram maize stover silage was lowest in Bag silo (Tk. 1.83/kg) out of the three methods.

iv. In rice straw, the DM content is very high (92.80%) and low CP (4.20%). On the other hand, low DM (27.88%) and high CP (7.50%) were present in maize stove silage i.e. the nutritional status is very good in maize stover and maize stover silage in comparison to rice straw.

v. Again, the price of per kg rice straw, maize stover and maize stover silage were Tk. 6.00, 1.00 and 1.83 respectively. So, maize stover and maize stover silage was comparatively cheeper than rice straw.

vi. The highest opinion was also given during field days about maize stover silage produced in Bag (T3 :70.83%) because bag silos are easily transferable and low cost.

vii. Bag silo method can be used for the production of maize stover silage in char areas.

There are some critical problems needed to be addressed for quicker dissemination of maize stover silage production technology in char areas. Major problems are:

- Most of the farmers are not aware of maize stover as a suitable cattle feed
- The farmers in chars do not known how to prepare maize stover silage
- Lack of training about processing and utilization of maize stover as ruminant feed
- Hand chopping is time consuming and involves higher labor costs for processing of maize stover
- Chopping machine is not available to the farmers and initial cost for purchasing chopper machine is very high.

For better production and utilization of maize stover silage as cattle feed in char areas, the following recommendation can be made:

1. Develop awareness among farmers in char areas about the benefits of utilizing maize stover as cattle feed during feed scarcity;
2. Farmers should be trained on maize stover silage production and utilization technology;
3. Time and cost may be saved by ensuring the use of portable forage chopper at low prices.
4. Employment opportunity may be generated by using portable chopper machine;
5. The maize stover silage production technology needs to disseminate at farmers level throughout the country, more particularly chars and other vulnerable areas.

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Table-1: Production performance of Maize Stover silage in different techniques

Research Areas	Replications	% of loss in different treatment groups			% of good quality in different treatment groups		
		T_1 (Pit)	T_2 (Bunker)	T_3 (Bag)	T_1 (Pit)	T_2 (Bunker)	T_3 (Bag)
Sarikandi	R_1	3.00	25.00	1.00	97.00	75.00	99.00
	R_2	2.50	24.00	0.75	97.50	76.00	99.25
	R_3	2.50	24.00	0.75	97.50	76.00	99.25
	Mean	2.67	24.33	0.83	97.33	75.67	99.17
Kazipur	R_1	2.50	23.00	0.50	97.50	77.00	99.50
	R_2	2.00	23.00	0.50	98.00	77.00	99.50
	R_3	2.00	23.00	0.50	98.00	77.00	99.50
	Mean	2.17	23.00	0.50	97.83	77.00	99.50
Fulchari	R_1	1.10	22.00	0.50	98.90	78.00	99.50
	R_2	1.20	20.00	0.50	98.80	80.00	99.50
	R_3	1.55	20.00	0.50	98.45	76.00	99.50
	Mean	1.28	20.67	0.50	98.72	78.00	99.50
RDA	R_1	0.51	15.00	0.24	99.75	85.00	99.76
	R_2	0.49	16.00	0.27	99.75	84.00	99.73
	R_3	0.50	15.00	0.23	99.50	85.00	99.77
	Mean	0.50	15.33	0.25	99.67	84.67	99.75

Table-2. Effect of different treatments and ensiling time on the chemical composition (% DM basis) of maize stover silage and maize stover

Items	Days	Treatments#	Parameters			
			DM	Ash	CP	ADF
Maize stover silage	21	T_1	30.59	15.13	6.35	40.48
		T_2	31.90	13.19	6.72	38.09
		T_3	31.22	14.16	6.45	39.44
		Mean	31.24^{a}±0.66	14.16^{a}±0.97	6.50^{b}±0.19	39.34^{b}±1.19
		SEM	0.38	0.56	0.11	0.69
		LS	**	NS	**	**
	42	T_1	28.30	11.16	6.95	51.68
		T_2	26.28	13.60	6.85	46.75
		T_3	24.38	15.32	7.12	48.30
		Mean	26.32^{b}±1.96	13.36^{a}±2.09	6.97^{ab}±0.13	48.91^{a}±2.52
		SEM	1.13	1.21	0.07	1.46
		LS	**	NS	**	**
	60	T_1	28.82	12.39	7.21	42.39
		T_2	23.50	11.39	7.70	45.39
		T_3	25.90	14.52	7.61	43.95
		Mean	26.07^{b}±2.66	12.77^{a}±1.60	7.50^{a}±0.26	$43.91a^{b}$±1.50
		SEM	1.54	0.92	0.15	2.56
		LS	**	NS	**	**
Maize stover	-	T_1	21.47	14.98	6.52	41.65
		T_2	21.98	15.26	6.26	43.95
		T_3	20.57	11.02	6.60	35.97
		Mean	21.34^{c}±0.71	13.75^{a}±2.37	6.46^{b}±0.18	40.52^{b}±4.10
		SEM	0.41	1.37	0.10	2.37
		LS	**	NS	**	**

Farmers' Participatory Research

Adoption of modern rice technology suitable for chars

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Introduction

Rice is the staple food of about 160 million people in Bangladesh, in a true sense; it is more than just an ordinary, everyday food item for many Bangladeshis which signifies both life and culture. It is deeply ingrained in Bangladesh culture and even the words 'food' and 'rice' are synonymous in Bengali. Besides many factors rice is the key factor for political stability and life blood of Bangladesh as well.

Over the last thousand years, rice has been the dominant crop in Bangladesh and it currently accounts for 77% of agricultural land use. There are about 13 million farm families, who grow different types of rice, which includes traditional, modern or hybrid rice varieties. Over 11.7 million hectares of land in Bangladesh is dedicated to rice production. It provides about 70% of direct human calorie intake, making it the most important food crop in Bangladesh. The country is also said to have among the highest per capita consumption of rice (about 170 kg annually), and its food security and economy largely depend on good harvests year after year.

With time, as the population increases at a rapid pace, the gap between rice production and food requirement for the millions widened. To feed the ever increasing population through radical change in rice production, replacement of the low-yielding traditional varieties and age old production practices of rice by high-yielding varieties and improved production technologies became essential. The country needs substantial increase in rice production to provide her teeming millions with food and other basic needs of life. There are not many options but to raise level of rice production from the limited land resources and diverse climatic conditions for improving the living standard of her common people. Total rice production in Bangladesh was 10.32 million tons in the year 1975-76 when the country's population was only 79.90 millions and cultivated rice area was 10.32 million ha (BBS and DAE, 2007). However, the country is producing 34.28 million tons rice in the year of 2008-09. Empirical data revealed that total rice production follows a increasing trend due to adoption of high yielding rice varieties, including modern rice cultivation technologies, improvement irrigation facilities and applications of fertilizer and pesticides.

According to empirical evidence now a days yield gap is a major constrain to increase rice production such as the yield potential of BRRI dhan-28 and BRRI dhan- 29 varieties are 6 ton/ha and 7.5 ton/ha respectively but in the farmers field it is not more than 3.5 ton/ha and 4.5 ton/ha. The national average of rice production in Bangladesh is in between 2.5 to 3 ton/ha but some remote areas like char land it is much less than the national average.

Among various causes of yield gap, production practice such as fertilizer management, irrigation management, pest management, transplanting time, age of seedling, spacing, transplanting method are not up to the mark with BRRI recommendation especially for the BRRI developed HYV varieties like BRRI dhan-28 and BRRI dhan-29 in the char land which are grown in Boro rice season.

There are three rice season in Bangladesh, Aus (mid February to mid August), Aman (mid June to mid December) and Boro (mid November to mid April). Boro rice contributes the lion share of rice grain about 55% (18.5 million tons). Among three seasons productivity of Boro season is highest which belongs to irrigated ecosystem. A reasonable amount of Boro rice production is hampered in every year due to lack of proper production practice over different scale in different locations including char areas of Bangladesh.

Bangladesh was, and continues to be, formed by sedimentation and accretion of three rivers the Jamuna, the Padma, the Brahmaputra and the Meghna as they flow from the Himalayas to the Bay of Bengal. Extensive char areas have been created along the bed or basin of these big rivers. Char lands are the sandbars that emerge as islands within the river channel or as attached land to the riverbanks. GIS, 2000 found that on an average 5% of Bangladeshi population as well as 6.5 million people live on the chars covering almost 5% of the total land area of the country and miserably it is narrowed as 7,200 square kilometers. The riverine sand and silt landmasses known as char in Bengali are home to over 5 million people in Bangladesh (Kelly and Chowdhury, 2002). Rice, maize, mustard, groundnut, chili are the major crop grown in char areas. Rice grown in the char areas mainly local varieties but now a days some high yielding varieties like BRRI dhan 28 and BRRI dhan 29 are also cultivated with traditional management practices. The yield potential of these varieties are 5.5 ton/ha and 7.5 ton/ha respectively but in char areas the yield of these varieties are significantly low due to lack of proper management practices and knowledge about modern rice production technology.

BRRI dhan 28 and BRRI dhan 29 has wide variations in yield from research station to farmers field. Variations in time and method of planting and cultural operations and level of input use might be causing such yield differences. Result demonstration is one of the classical approach to disseminate, motivate and adoption of recommended technology which can address the rice yield gap problem in char land. Therefore, the present study was under taken to

1. To disseminate recommended rice production technology through action research and result demonstration
2. To generate data on rice production using modern rice technology in chars land
3. To motivate farmers' adapt recommended rice production technology.

Material and Method

According to the research issue and objectives the study was carried as farmers' participatory research in the farmers' field.

Location

The farmers' participatory research was carried out in the farmers' field in 2 river islands Unions under Shariakandi upazilla of Bogra and Kazipur upazilla of Sirajgonj and farmers were selected as described in the following table.

District	Upazila	Name of unions	No of experiment/ demo plot	No of Control plots (Farmers practice)
Bogra	Sariakandi	Hatsherpur	1 Experiment plot with 3 replication	3
		Chaluabari	1 demo plot	1
		Kazla	1 demo plot	1
		Bohail	1 demo plot	1
Sirajganj	Kazipur	Nishchintopur	1 demo plot	1
		Tekani	1 demo plot	1
		Char Girish	1 demo plot	1
		Natuarpara	1 Experiment plot with 3 replication	3
		Total no. of Plots	12	12

Plot size

20 decimal of land in both Upazilla of char areas.

Rice Varieties used under research:

BRRI dhan 28 and BRRI dhan 29

Experiment and demonstration plot establishment

The research team provided the following recommended rice production technologies for both experiment plot and demonstration plot to achieve the mentioned objectives. The experiment and demonstration plots for BRRI dhan 28 & BRRI dhan 29 in 8 Char unions were established from 29 January to 03 February 2014 in presence of research team. The basic difference among experiment, demonstration and farmers practice field is the recommended rice production technologies. The farmers practice plot was treated as check plot for the experiment and demonstration plot.

Table.1: Recommended rice production technology and farmers practice at a glance.

Recommended technology		Farmers practice
	Fertilizer/ha	Fertilizer/ha
Urea	260 kg	280 kg
TSP	77 kg	55 kg
MOP	79 kg	60 kg
Gypsum	54 kg	45 kg
Zinc	05 kg	Nil
Boron	6.6 kg	Nil
Organic manure	1000 kg	200 kg
Seed: Certified seed		Seed: Farm retained seed
Transplanting method: Plant to plant distance (15cm) Line to line distance (25cm)	Line sowing	Haphazard sowing
Seedling age: 35-45 days		60-75 days
Number of seedling/hill	1-2 seedling/hill	3-4 seedling/hill
Weed management	3 days after transplanting use pre emergence herbicide followed by hand weeding	Hand weeding.

Parameters studied in experiment, farmers and demonstration plot.

1. Plant Height (cm)
2. No. of effective tiller (No.)
3. Date of flowering
4. Panicle length (cm)

5. Panicle per/hill (No.)
6. Grain /panicle (No.)
7. Thousand grain weight (gm)
8. Seed quality
9. Pest pressure
10. Grain yield (ton/ha)

The above yield contributing parameters were studied for in depth understanding of difference between recommended technology plot and farmers practice plot. Except flowering date and pest pressure rest eight parameters were expressed in average.

Data collection

The data were collected from 29 January to 08 May 2014 by direct observation and field survey method.

Data analysis

a. The data from the experiment and demo plots were together for BRRI dhan-28 to estimate the average yield of rice in farmers practice plot and recommended technology applied plot to determine yield gap between farmers practice and recommended technology applied plot due to production practice. T- test was preformed to calculate the mean difference and p value at the significant level $\propto = 0.05$ to conclude that if there is any significant influence of recommended rice technology on rice yield in char areas.

b. To get feed back and farmers' attitude towards recommended technologies, validation cum harvesting days organized in the selected locations to disseminate findings of the research in a participatory approach during research period from 01 May to 08 May 2014. During harvesting farmers' field day M4C representative also attended in those day.

Results and Discussion

This chapter focused on the objective of the study as mentioned earlier that to disseminate recommended rice production technology through action research and result demonstration to motivate farmer's adapting recommended rice production technology in a result focused "Seeing is believing" approach. The researchers analyzed the yield contributing parameters to compare experiment, demonstration and farmers plot to conclude that wheather there any significant difference of rice yield between experimental plot and farmers' plot due to technology intervention by performing paired t-test and descriptive statistics for rice variety BRRI dhan-28 and BRRI dhan-29.

Table.2: Comparison of yield contributing parameters among experimental plot, demonstration plot and farmers' practice plot.

Parameter	Experiment plot	Demonstration plot	Farmers' practice plot
Average plant height BRRI dhan28 (cm)	89	87	85
Average plant height BRRI dhan29 (cm)	93.8	92	90.87
Average no of effective tiller /hill BRRI dhan28	15	14.23	14
Average no of effective tiller /hill BRRI dhan29	18.59	17.80	16.85
Date of flowering	No significant difference	No significant difference	No significant difference
Average panicle length (cm) BRRI dhan28	23.5	23	21.5
Average panicle length (cm) BRRI dhan29	21.50	21	20.21
Average no of panicle/hill BRRI dhan28	15	14	13.2
Average no of panicle/hill BRRI dhan29	18	17	16.5
Average no of grain/panicle BRRI dhan28	125	123	120
Average no of grain/panicle BRRI dhan28	136	133	131
Average grain yield ton/ha for BRRIdhan28	5.02	4.95	3.33
Average grain yield ton/ha for BRRIdhan29	6.95	6.80	5.26

Parameter	Experiment plot	Demonstration plot	Farmers' practice plot
Thousand grain weight (gm) BRRI dhan28	22	20.5	19.8
Thousand grain weight (gm) BRRI dhan29	23.5	23	22.5
Seed class	Certified seed	Certified seed	Farm retained seed
Pest pressure	Low	Low	High

Plant height

Plant height is an important varietal characteristic that also contribute in yield. Table 2 show that for BRRI dhan 28 the highest average plant height 89 cm as observed in experimental plot followed by demonstration 87 cm and farmers' plot 85 cm. For BRRI dhan 29 it was also found that highest plant height observed in experimental plot than farmers plot.

No of effective tiller /hill

Average no. of effective tiller/hill directly influence yield of a variety which is influenced by fertilization, seedling age, seedling per hill and intercultural operations. Table 2 revealed that for both BRRI dhan 28 and 29 the experiment and demonstration plot shows increased no. of effective tiller than farmers' plot due to recommended technology as described in Table.1.

Date of flowering

Table 2 shows that there is no significant difference of date flowering among experiment, demonstration and farmers' plot for both BRRI dhan-28 and BRRI dhan-29. Date of flowering was influenced mostly by variety and seedling age.

Panicle length (cm)

It is observed from Table 2 that average panicle length was higher in experiment and demonstration plot than farmers' plot for both BRRI dhan-28 and BRRI dhan-29. Optimum panicle length provides higher yield than shorter panicle length.

No. of panicle/hill

From Table 2 it reveales that average no of panicle for BRRI dhan 28 was the highest in experiment plot followed by demonstration plot 14 and 13.2 respectively. On the other hand for BRRI dhan-29 also the highest average no of panicle was found in experiment plot.

No. of grain/panicle

Average no of grain /panicle influence the yield of a variety however this parameter influences by fertilizer, intercultural operation, pest management and irrigation. Especially, plant micro micronutrient Boron (Bo) deficiency caused less no of filled grain in panicle. In the char areas where regular flooding occurres, Boron deficiency is a common phenomenon. Boron is comparatively costly, so farmers are not interested to use it (Table 1). Both experimental and demonstration plot Boron was used as recommended dosages so it was observed from Table 2 that for both BRRI dhan-28 and BRRI dhan-29 average no grain/panicle was the highest in experiment plot followed by demonstration plot and the lowest in farmers' plot.

Pest pressure

Farmers' plots were infested by stem borer and brown spot diseases but in case of experiment plots and demonstration plots pest pressure was low compared to farmers plots because of preventive measure and use of balanced fertilizer.

Average grain yield

The data from the experiment and demo plots were gethered for BRRI dhan-28 to estimate the average yield of rice in farmers practice plot and recommended technology applied plot to determine yield gap between farmers practice and recommended technology applied plot due to production practices. T- test was preformed to calculate the mean difference and p value at the significant level $\propto$ =0.05 to conclude that if there is any significant influence of recommended rice technology on rice yield in char areas.

Table.3: Difference of grain yield production ton/ha between experimental plot and farmers practice plot

Variable Grain yield ton/ha	Observation	Mean	Sd. deviation	[95% Conf. Interval]	
Experimental and demo plot	11	5.021818	.3532936	4.784472	5.259164
Farmers prcatice plot	11	3.330909	.5375956	2.969747	3.692071
Difference	-	1.690909	.4457007	1.391483	1.990335

Mean (diff) = mean (experimental plot – farmers practice plot) t = 12.5827

Ho: mean(diff) = 0 degrees of freedom = 0

Ha: mean (diff)< 0 Ha: mean (diff) != 0 Ha: mean(diff) > 0

Pr (T < t) = 1.0000 Pr(|T| > |t|) = 0.0000 Pr(T > t) = 0.0000

It is reveales from the Table 3 that there is statistically significant difference of rice grain yield between experiment plot and farmers' practice plot. It was observed that the average yield of rice was 5.02 ton/ha in contrast to farmers practice plot yield was 3.33 ton/ha which is significantly lower than experimental plot and similar to national rice yield average. Experiment and demonstration plot rice yield/ha was closer to the yield potential of BRRI dhan-28 which is 6 ton/ha on the other hand farmers practice plot was significantly lower than the yield potential of experimental plot. As the (P-value < 0.01) so it can be concluded that the difference is significant at 0.01 level of significance.

Among 12 experiment as well as demonstration plot only one farmer chose BRRI dhan 29 so without paired t test only descriptive statistics was used to determine the mean yield gap/ha between experiment plot and farmers practice plot presentenced in table 2. It is found that in experiment plot the production/ha was 6.95 ton and in farmers practice the production was 5.26 ton and the yield gap/ha was 1.69 ton /ha. So we can conclude that the yield gap is significant and this is due to recommended rice production technology application.

Farmers' opinion

At the end of the crop season 4 farmers participatory field days were organized to know about the farmers opinion about the impact of recommended rice technology over farmers' practice. The following Table (4) depicts farmers opinion.

Table.4: Farmers' opinion about the impact of recommended rice technology

Parameters	Farmers Perception						
	No of farmers' agreed	%	No of farmers undecided	%	No of farmers had no comments	%	Total No of Farmers attended
Higher no of tiller/hill	285	91	15	5	13	4	313
Uniform crop growth	287	92	14	5	11	3	313
Less sterile panicle	283	90	16	5	14	5	313
Less pest pressure	276	88	10	3	27	8	313
Less weed	263	84	20	6.38	30	9.58	313
Less irrigation	235	75	45	14.3	33	10.5	313
Higher grain yield	280	89.4	20	6.38	13	4.15	313
Bright and uniform grain	269	85.9	16	5.11	28	8.94	313

Problems faced by the rice farmers in chars.

Rice farmers of the char areas faced some problems are presented in this following Table 5.

Table.5: Problems faced by rice farmers in char areas

Problems	Farmers Perception						
	No of farmers'	%	No of farmers undecided	%	No of farmers had no comments	%	Total No of Farmers attended
Lack of quality seed	290	92.6	10	3.19	13	4	313
Lack of quality agrochemicals	273	87.2	18	5.75	22	7.02	313
Lack of training	283	90	16	5	14	5	313
Less water holding capacity of soil.	279	89.1	15	4.79	19	6.07	313
Improper market price	296	94.5	9	2.8	8	2.55	313
Lack of extension service	235	75	28	8.94	50	15.9	313

Further research need

There is a need to refine rice farming especially for char areas, where the thrust is on improving rice production without increasing production cost. In light of the present study some issues should be addressed for further research and development for extension of the technology rapidly.

- Development of rice farming models specific to different char areas;
- Optimum fertilization rates and fertilization methods;
- Introduction of new rice variety;
- Strengthen extension service;
- Develop some communication materials (Leaflet and Poster) for farmers to farmer's extension of modern rice production technology in the char areas;
- To build up community capacity and make available the quality seed. RDA, Bogra developed Maria Seed Technology Model and WISE Model may be introduced in the char areas.

Conclusion and Recommandations

The following conclusions are drawn based on the findings of the study according to the objectives. Recommended rice production technology has a huge potential for the char areas rice production. There is a significant yield gap between recommended rice production technology applied plot and farmers practice plot. Average grain yield production of recommended rice technology applied plot is higher than farmers practiced plot. Without increasing any significant production cost recommended rice production technology can increase 50% rice production in the char areas. Besides higher rice yield recommended rice technology has some extra benefits such conserve soil health, reduce use of hazardous agrochemicals due to less pest pressure, less labour intensive, water saving and so on.

Recommended rice production technology offers tremendous potential for food security and poverty alleviation in char areas of Bangladesh. It is an efficient way of using the input to produce more rice than farmers practice. Farmers of the char areas showed very positive attitude towards recommended rice production technology. Ensuring proper extension service, availability of quality seed, agro chemicals and market linkage can unlock the production potential of char lands of Bangladesh. Extension of recommended rice production technology may contribute to improve the livelihoods and food security of the rural families of char land in Bangladesh.

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SUVAGATA BAGCHI has been working as an Assistant Director at RDA since November, 2011. He has completed graduation & post graduation in Biotechnology and Genetic Engineering from Islamic University Kushtia. From the beginning of his career he has been taking care of RDA Trichoderma Laboratory for producing Trichoderma pure culture, mother culture, Trichoderma conidial suspension and biopesticide and promoting biopesticide and suspension commercially to the farmers for control of soil borne diseases and compost preparation. He conducts researches on different Biotechnological, Agricultural and Social aspects besides conducting skill development trainings on Preparation and use of Trichocompost for different level of trainees ranging from professionals to farmers. He is also performing as unit in charge of Nursery unit of RDA Demo farm and instructor of the course "Biotechnology in income generation and poverty reduction" in the Post Graduate Diploma in Rural Development program. He also performed as a trainer of Local Governance Support Project -2 training courses. He has keen interest in implementation and exploration of potentials for Trichocompost technology in Bangladesh to enhance Agricultural production and ensure food security for the poor.

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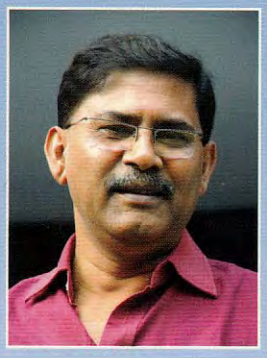

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DR. AKM ZAKARIA was born in March, 1959 in Bogra. He obtained B.Sc. Ag (Hons) and M.Sc. Ag (Agronomy) degree from Bangladesh Agricultural University, Mymensingh and obtained first class in M.Sc. (Agronomy). Later he attended several in service career development courses in Japan. Germany, Thailand, Philippines, United Kingdom Taiwan, Nepal and India. He has obtained Phd Degree from Hajee M. Danesh Science and Technology University, Dinajpur.

He has started his service career as Assistant Director in Rural Development Academy (RDA), Bogra in December, 1986 and promoted to Director of Agricultural Sciences Division in February, 2010. He has more than 26 years experience in researching and teaching nationally and internationally. He has more than 200 research articles/papers published in national and international journals including electronic journals. He has invented several rural and agricultural development replicable models including Rural Seed Technology (Maria) Model, Women in Seed Entrepreneurship (WISE) Model, Plant Doctor Model and many others. He has personally received the highest national award in agriculture sector, The Bangabandhu National Agricultural Award 1417 (B). Besides, he has also received HSBC-The Daily Star Climate Award 2011, Food and Agriculture Award 2011 from Oxfam GB, ITEB Leadership Award 2011, USAID Sponsored e.Ag ICT award, 2014 and South East Bank-Financial Express Green Award, 2014. Moreover, he has received International Communication Award, 2004 from IVCA, London for developing Women to Women Extension Model. In 2004, RDA received the highest National Award- the Independence Award, 2004 due to his endeavours. He worked in International Rice Research Institute (IRRI), Philippines, Helen Keller International, Cambodia and West Bengal Rural Development Board, India, Katalyst and Swisscontact, South Asian Regional Office in various capacity including Visiting Scientist, Consultant and Food Security Expert, respectively. His main professional interest is in the seed sector, food safety, Climate Change, rural innovation and communication.

He is the founder Director of chars Development Research Centre (CDRC) at RDA and also the Project Director for Making Markets work for the chars (M4C) Project funded by Govt. of Bangladesh and SDC.