ISSN 0258-7122 (Print), 2408-8293 (Online)
Bangladesh J. Agril. Res. 43(2): 219-234, June 2018

# PROFITABILITY OF WINTER MAIZE CULTIVATION IN DROUGHT PRONE AREAS OF BANGLADESH

S. KHANDOKER[1], M. A. MONAYEM MIAH[2], M. A. RASHID[3]
M. KHATUN[4] AND M. Z. A. TALUKDER[5]

## Abstract

The study was conducted in four districts namely Rajshahi, Chuadanga, Comilla and Rangpur during 2015-2016 to estimate the effect of drought in maize production, technical efficiency and adaptation strategy of maize farmers, and explore related problems of maize cultivation in the study areas.Rajshahi and Chuadanga were selected as drought prone areas whereas Rangpur and Comilla were selected as favorable environment. A total of 200 farmers taking 50 from each district were selected randomly for the study. Per hectare total cost of maize cultivation in drought prone areas was found Tk. 92,582, whereas in normal environment it was Tk. 79,594. Per hectare average yield in drought prone and normal areas were 7576 kg and 8729kg, respectively. Per hectare net return of maize in drought prone and normal areas were Tk. 28,062 and Tk. 59, 871, respectively.On full cost basis benefit cost ratio (BCR) in drought prone and normal areas were 1.31 and 1.75, respectively. Result of semi-logarithmic regression model indicated that maize production was decreased by 22.4 percent in drought prone areas than normal environment. Loss of yield (70%), loss of plant growth (55%) and problem in flowering stage (43%) were reported to be the major effects of drought.The major adaptation strategies in the drought prone areas were increase number of irrigation (77%), increase amount of fertilizer (42%) and seed (31%) and change of planting date (30%). Higher price of irrigation (70%), lack of drought tolerant variety (48%) and lack of quality seed (31%) were the major problem in drought prone areas. Again,disease infestation (64%), lack of quality seed (41%) and high price of seed (36%) were the major problem in normal environment. Scientists should take attempt to develop drought tolerant maize variety.

Keywords: Consequence, drought, maize, net return and adaptation strategy.

## 1. Introduction

Bangladesh is an agriculture based country. It is recognized as one of the most vulnerable areas to the impacts of global warming and climate change. This is due to its unique geographic location, dominance of floodplains, low elevation, high population density, and overwhelming dependence on nature for its resources and services. Many of the anticipated adverse effect of climate change, such as sea level rise, higher temperature, enhanced monsoon precipitation and an increase in drought intensity, will aggravate the existing

[1&4]Scientific Officer and [2&3]Principal Scientific Officer, Agricultural Economics Division, BARI, Joydebpur, Gazipur, [5]Senior Scientific Officer, Plant Breeding Division, BARI, Joydebpur, Gazipur.

stresses that already impede the development of Bangladesh, particularly by reducing food security (Quazi and Quddus,2010). For ensuring food security, production of maize can play a vital role. The importance of maize crop cannot be over-emphasized. Maize is the third most important cereal crop in Bangladesh. It is much better than rice in terms of nutrients like protein, fat, minerals, phosphorus, carotene and thiamine (INFS, 2003). More than 90% of maize is used as poultry feed and the remaining in fish sector and as human food products (Hasan, 2008). The area under maize cultivation during 2013-2014 was about 3.07 lakh hectares with a total production of about 2.12 million metric tons and yield of 6.60 ton/ha (BBS, 2014). The area, production and yield of maize are increasing day by day (Table 1). If optimal irrigation and other inputs are given in appropriate way then it may be possible to obtain an average yield of 8 to 10 tons per hectare.

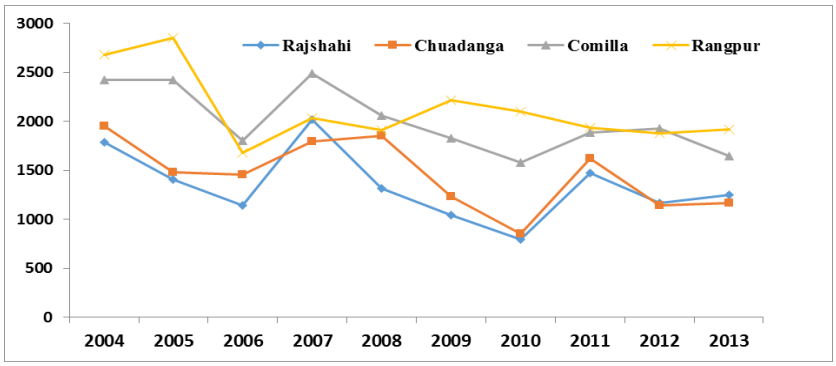
Drought is one of the crucial problems for many countries and the severity of such issue goes gigantic when it comes as obstacle to ensure an optimum agricultural production for a country like Bangladesh. Droughts are becoming more frequent, more intense, more spatially extensive, and of longer duration (IPCC, 2010). It is one of the major abiotic stresses which adversely affect crop growth and yield and thus a constraint for productivity worldwide (Jaleel *et al.*, 2009). This problem occupied an extreme position in the northwest region of Bangladesh. In the northwest region, drought can have devastating impacts on maize production. Further, every year farmers in this areas incurred high cost as well as a huge crop loss due to drought. The impact of drought not only leads to the shortage of water and food but also have a long-term environmental, socio-economic and health impact on the population (Sheffield *et al.*, 2009; WHO, 2011). At present, the phenomenon is causing enormous difficulties towards maintaining livelihoods and has become a severe problem in the northwestern parts of Bangladesh. Keeping this in mind, the present attempt has been made to focus the effect of drought on maize production and adaptation strategy of the farmers in Bangladesh.

**Table 1. Area, production and yield of maize in Bangladesh**

| Year | Area | Production | Yield |
|---|---|---|---|
| 2009-10 | 1.52 | 0.89 | 5.84 |
| 2010-11 | 1.66 | 1.02 | 6.15 |
| 2011-12 | 1.97 | 1.30 | 6.59 |
| 2012-13 | 2.35 | 1.55 | 6.59 |
| 2013-14 | 3.07 | 2.12 | 6.91 |

Source: BBS, 2014.

**Figure 1. Average annual rainfall in selected areas**




Source: BBS, 2013.

Fig. 1 reveals the average annual rainfall of four districts from 2004 to 2013. In 2004, average annual rainfall was found higher in Rangpur district and lowest in Rajshahi district. In Rajshahi district, highest rainfall was found in 2007 which was 2018 millimeter and lowest in 2010 which was 792millimeter. Similarly, in Chuadanga district, highest rainfall was found in 2004 which was 1951 millimeter and lowest in 2010 which was 852millimeter. Among four districts highest rainfall was found in Rangpur in 2005 and lowest in Rajshahi in 2010.During the period (from 2004 to 2013), annual rainfall of Rangpur and Comilla was found higher than Rajshahi and Chuadanga district.

### 1.1 Objectives

i. To estimate the cost and return of maize in drought prone and normal environment;

ii. To assess the effect of drought in maize production and adaptation strategies of the farmers in drought prone areas;

iii. To identify problems of cultivating maize in the study areas.

## 2. Methodology

### 2.1 Sampling Procedure and Sample Size

Purposive sampling and multistage stratified random sampling technique were followed to collect sample farmers for this study. The study was conducted in four districts of Bangladesh. At first stage, two production environments namely drought prone and normal environment were purposively selected in consultation with the scientists of Plant Breeding Division of BARI. In order to capture two production environments, two districts under each environment were selected in this study. Rajshahi and Chuadanga were selected as drought prone areas, whereas Rangpur and Comilla were selected as favorable areas. Then one upazila from each four districts and two blocks from each upazila were purposively

selected in consultation with DAE personnel and maize scientists. Godagari upazila from Rajshahi district, Sadar upazila from Chuadanga, Daudkandi from Comilla and Mithapukur upazila from Rangpur district were selected for administering questionnaire survey. Finally, a total of 200 farmers taking 50 from each district were randomly selected for the study.

### 2.2 Data Collection

The study was mainly based on primary data collected through face to face interview during the month of January to April 2016. Field investigators under the direct supervision of the researcher collected field level cross-sectional data using pre-tested interview schedule. Necessary information regarding this study was collected based on input costs, price, yields etc.

### 2.3 Analytical Techniques

Collected data were edited, summarized, tabulated and analyzed to fulfill the objectives of the study. Descriptive statistics using different statistical tools like averages, percentages and ratios were used in presenting the results of the study. The profitability of maize production was examined on the basis of gross return, gross margin and benefit cost ratio analysis. Besides, the opportunity cost of family supplied labour was taken into consideration in estimating total cost. Land use cost was calculated on the basis of per year lease value of land.Semi-logarithmic regression model with dummy variable was used. A z- test for the two sample mean with known variance was conducted to test the mean difference between two groups of farmers i.e. drought prone and normal environment.

#### 2.3.1 Profitability analysis

Profitability of maize was analyzed to compare the return received by the farmers.

**Measurement on profitability of crop cultivation**

Equations for cost analysis are as follows

$$\text{Variable Cost} = VC_i = \sum (X_i P_i)$$

$TVC_i = VC_i + 10C_i$

$TC_i = TVC_i + TFC_i$

Where, $TC_i$= Total cost for $i^{th}$ farmer (Tk/ha)
$TVC_i$ = Total variable cost (Tk/ha)
$TFC_i$ = Total fixed cost (Tk/ha)
$VC_i$ = Variable cost (Tk/ha)
$IOC_i$ = Interest of operating capital (Tk/ha)
$X_i$ = Quantity of inputs (kg)

$P_i$ = Price of inputs (Tk/kg)
i = Number of farmers (1.2.3……..n)

Equations for profitability analysis
Gross return = $GR_i = Y_iP_i$
Net return = $GR_i - TC_i$
Gross margin = $GR_i = VC_i$

Where,

$GR_i$ = Gross return (Tk/ha)
$P_i$ = Price (Tk/ha) received by $i^{th}$ farmer
$Y_i$ = Quantity (kg/ha) produced

### 2.3.2 Functional analysis

**Production variability analysis**

Semi-logarithmic regression model with dummy variable was used to estimate production variability of maize between drought prone and normal environment. In this regression model, production was considered as the dependent variable and the drought considered as independent variable. Production of maize varied extremely due to drought. To estimate the production variability of maize the following semi-logarithmic regression model was employed:

$\ln Y = \beta 0 + \beta_1 D_1 + U$

Where, ln = Natural logarithm;

Y = Output of maize (kg/ha);

$D_1$ = Dummy for drought (1 = drought; 0 = otherwise);

$\beta_1$ = Slope coefficient of dummy for drought;

U = Random error term.

### 3.1 Technology Used in Maize Cultivation

**Land preparation:**Land preparation for maize production included ploughing, laddering and other activities needed to make the soil suitable for sowing seeds (Karim *et al.,* 2010). The number of ploughing varies from location to locations (Table 2). In the study areas cent percent farmers used Power tiller for land preparation which is mostly done on hire basis. Majority of farmers (35%) of drought prone areas ploughed their maize plot four times whereas in normal areas highest percentage of farmers (40%) ploughed two times.

**Variety used by maize farmers**: A total of 13 hybrid maize varieties were found in the study areas (Table 3). Among the varieties, Elite was the highly adopted variety (30%) in drought prone areas. On the other hand, innormal areas NK-40 was the mostly adopted varieties (53%). In normal areas the second and third

positions were secured by Miracle (26%)and Pioneer-3396 (12%). Responded farmers of Comilla district cultivated NK-40 and Miracle. Farmers of drought prone areas cultivated more varieties. Farmers in this areas also cultivated, Nk-40,981 and Super-999, CP-383 etc. BARI has developed some improved maize varieties, but these varieties could not found in the study areas. The main reason for non-adoption of BARI varieties mightbe the non-availability of seeds. The extent of using maize variety depends on the availability of seed at local level.

**Table 2. Number of ploughing done by maize farmers**

| Number of ploughing | % farmers responded | | | | | |
|---|---|---|---|---|---|---|
| | Drought prone area | | | Normal area | | |
| | Rajshahi | Chuadanga | All areas | Comilla | Rangpur | All areas |
| 1 | - | 2 | 1 | 10 | 16 | 13 |
| 2 | 10 | 22 | 16 | 34 | 46 | 40 |
| 3 | 30 | 10 | 20 | 40 | 32 | 36 |
| 4 | 44 | 26 | 35 | 14 | 6 | 10 |
| 5 | 16 | 38 | 27 | - | - | - |
| 6 | - | 2 | 1 | 2 | - | 1 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 |

Source: Field survey, 2016

**Table 3.Variety used by maize farmers**

| Varieties | % farmers responded | | | | | |
|---|---|---|---|---|---|---|
| | Drought prone area | | | Normal area | | |
| | Rajshahi | Chuadanga | All areas | Comilla | Rangpur | All areas |
| NK-40 | 18 | 4 | 11 | 54 | 52 | 53 |
| Miracle | 12 | 14 | 13 | 46 | 6 | 26 |
| Elite | 6 | 54 | 30 | - | 2 | 1 |
| Pioneer-3396 | 32 | - | 16 | - | 24 | 12 |
| 981 | 2 | 20 | 11 | - | 4 | 2 |
| Pacific Super-999 | 12 | - | 6 | - | 6 | 3 |
| CP-838 | 10 | - | 5 | - | - | - |
| Uttaran | - | 8 | 4 | - | - | - |
| 740 | - | - | - | - | 4 | 2 |
| Kissanvutta | 4 | - | 2 | - | - | - |
| 962 | 2 | - | 1 | - | - | - |
| Vision agro | 2 | - | 1 | - | - | - |
| Kanok | - | - | - | - | 2 | 1 |
| Total | 100 | 100 | 100 | 100 | 100 | 100 |

Source: Field survey, 2016

**Irrigation:**For maize cultivation, four irrigations are recommended by BARI. Variations were found among the responded farmers in irrigation application

(Table 4). In normal environment, highest percent of farmers (49%) irrigated two times followed by three times (33%). About 14% farmers in Comilla district irrigated their crop once a season. In Rangpur district, 26% farmer irrigated 3 times. However, farmers of drought prone areas irrigated 4-7 times. The highest percent of farmers (38%) irrigated 5 times followed by 6 times (36%). Sixteen percent farmers irrigated 7 times and 10% irrigated 4 times. Farmers of Rajshahi district provided more irrigation.

**Table 4. Percent responses on the number of irrigation given to maize**

| Number of Irrigation | % farmers responded | | | | | |
|---|---|---|---|---|---|---|
| | Drought prone area | | | Normal area | | |
| | Rajshahi | Chuadanga | All areas | Comilla | Rangpur | All areas |
| 1 | - | - | - | 14 | - | 7 |
| 2 | - | - | - | 56 | 42 | 49 |
| 3 | - | - | - | 30 | 36 | 33 |
| 4 | - | 20 | 10 | - | 26 | 13 |
| 5 | 22 | 54 | 38 | - | - | - |
| 6 | 52 | 20 | 36 | - | - | - |
| 7 | 26 | 6 | 16 | - | - | - |
| Total | 100 | 100 | 100 | 100 | 100 | 100 |

Source: Field survey, 2016

### Level of input use in Maize Cultivation

The account of input use by the farmers in different areas is presented in Table 5. Human labour was required for plantation of seed, application of manures and fertilizers, spraying, weeding, irrigation, and harvesting. Farmers of drought prone areas used 163 man-days of human labour per hectare of which 36% were family supplied and 64% were hired. On the other hand, in normal environment farmers used 144 man-days of human labour out of which 40% were family supplied and 60% were hired. Farmers of drought prone areas used more seed which was 20 kg per hectare than normal areas (18 kg). Per hectare manures used in maize cultivation was 2906 kg in drought prone areas whereas in normal areas it was 2450 kg. Farmers of drought prone areas used 335 kg urea, 188 kg TSP, 114 kg MoP etc. per hectare which was higher than normal environment. Farmers of drought prone areas also used slightly higher dose of other chemical fertilizers than normal environment.

## 3.2 Cost of Maize Cultivation

The cost of production included different variable cost items like land preparation, human labour, seed, manures, fertilizer, irrigation, insecticides etc. Both cash expenditure and imputed value of family supplied inputs were included in the analysis. Besides, interest on operating capital was also considered for the estimation of cost of maize cultivation.

**Table 5. Per hectare input use pattern for maize cultivation**

| Inputs | Drought prone area | Normal area | t- test values | Results |
|---|---|---|---|---|
| Human labour (man-day) | | | | |
| Family labour | 58 (36) | 57 (40) | 0.1881 | No difference |
| Hired labour | 103 (64) | 87 (60) | 0.0000 | Difference |
| Total human labour | 161 (100) | 144 (100) | 0.0000 | Difference |
| Seed (kg) | 20.48 | 18.47 | 0.0000 | Difference |
| Manures (kg) | 2906 | 2450 | 0.0000 | Difference |
| Chemical fertilizers(Kg) | | | | |
| Urea | 335 | 276 | 0.0000 | Difference |
| TSP | 188 | 158 | 0.0000 | Difference |
| MoP | 114 | 88 | 0.0000 | Difference |
| Zipsum | 4 | 0.84 | 0.0000 | Difference |
| Zinc | 98 | 77 | 0.0000 | Difference |
| DAP | 76 | 41 | 0.0000 | Difference |
| Boron | 8 | 2 | 0.0000 | Difference |

Source: Field survey, 2016

Note: Figures in the parenthesis indicate percentage

Table 6 represents the cost of maize cultivation in the study areas. Per hectare total cost of maize cultivation in drought prone areas was found Tk. 92,582 of which 70% were variable cost and the rest 30% were fixed cost. On the other hand, average total cost of maize cultivation in favourable environments was Tk. 79,594 per hectare of which 64% were variable cost and the rest 36% were fixed cost. Human labour was the major cost items incurred in both areas, which covered about 37% of the total cost in drought prone area and 39% in normal environment. Among the variable cost items, the second important cost item in drought prone areas was irrigation which occupied 9% of the total cost. Farmers of drought prone areas incurred Tk. 7,932 for irrigation whereas in normal environment it was Tk. 4,112 per hectare. The cost of seed and land preparation were 8% and 6% of the total cost, respectively. Land use cost occupied about 16% and 21% of the total cost in drought prone and normal environment. The cost of chemical fertilizers shared more than 15% of the total cost. Farmers of drought prone and favorable areas spent Tk. 3,331 and Tk. 2,652 per hectare, respectively for manures. The cost of insecticides occupied 2% of the total cost in the study areas.

**Table 6. Cost of maize cultivation in the study areas*(in Tk./ha)***

| Cost items | Drought prone area | Normal area | Z-test (p-values) | Results |
|---|---|---|---|---|
| A. Variable cost | | | | |
| Cost of land preparation | 5288 (5) | 5732 (7) | 0.0327 | No difference |
| Hired labour | 22064 (23) | 18621 (23) | 0.0251 | No difference |
| Cost of seed | 7904 (8) | 6987 (9) | 0.0000 | Difference |
| Manures | 3331 (3) | 2652 (3) | 0.0000 | Difference |
| Chemical fertilizers | | | | |
| Urea | 5442 (6) | 4550 (6) | 0.0000 | Difference |
| TSP | 4281 (4) | 3554 (4) | 0.0000 | Difference |
| MoP | 1913 (2) | 1417 (2) | 0.0000 | Difference |
| Zinc | 612 (0.65) | 126 (0.15) | 0.0000 | Difference |
| Zipsum | 626 (0.67) | 474 (0.60) | 0.0000 | Difference |
| DAP | 1659 (2) | 1091 (1) | 0.0000 | Difference |
| Boron | 1362 (1) | 282 (0.35) | 0.0000 | Difference |
| Cost of irrigation | 7932 (9) | 4112 (5) | 0.0000 | Difference |
| Cost of insecticides | 2001 (2) | 1539 (2) | 0.0286 | No difference |
| IOC@ 6% for 4 months | 692 (0.74) | 537 (0.67) | | |
| Total variable cost | 65107 (70) | 50874 (64) | | |
| B. Fixed cost | | | | |
| Family labour | 12450 (14) | 12793 (16) | 0.1085 | No difference |
| Land use cost | 15025 (16) | 16427 (20) | 0.0582 | No difference |
| Total fixed cost | 27475 (30) | 28719 (36) | | |
| C. Total cost (A+B) | 92582 (100) | 79594(100) | | |

Source: Field survey, 2016

Note: Figures in the parenthesis indicate percentage

### 3.3 Profitability of Maize Cultivation

The return from maize cultivation in different district is presented in Table 7. Farmers in the drought prone areas obtained an average yield of7576 kg per hectare. In the favorable areas, per hectare average yield was found 8729 kg. The higher gross return of maize was found in favourable environment (Tk. 1, 39,465/ha) and lower in drought prone environment (Tk.1, 20,644/ha). Similarly,higher net return of maize was found in favourable environment (Tk. 59,871/ha) and lower in drought prone environment (Tk.280, 62/ha). Benefit cost ratio (BCR) on full cost basis in drought prone and normal areas were 1.31 and 1.75, respectively. In drought prone areas, farmers spent on an average Tk. 12 for

producing 1 kg of maize whereas farmers of normal areas spent Tk. 9. Finally, it was revealed that the farmers of drought prone areas used more inputs but received less output from maize cultivation compared to the farmers of normal area which might be the consequences of drought.

### 3.4 Effect of Drought in Maize Plant

Farmers of drought prone areas were asked what type of effect they found in maize plant due to drought. About 79% farmers reported that serious problem occurred in maize plant and the remaining 21% mentioned that problem was not significant (Table 8).Reduction of yield was the major effect of drought.Fifty five percent farmers said that due to drought plant growth hampered (Table 9). Problem in flowering stage (43%), dryness of cob (42%), leaf rolling (37%) and loss of grain (29%) were reported to be the major effect of drought in maize cultivation.

**Table 7. Profitability of maize cultivation**

| Particulars | Drought prone area | Normal area | Z-test (p-values) | Results |
|---|---|---|---|---|
| A. Total cost (Tk./ha) | 92582 | 79594 | | |
| Total variable cost (Tk./ha) | 65107 | 50874 | | |
| Total fixed cost (Tk./ha) | 27475 | 29719 | | |
| B. Yield (kg/ha) | 7576 | 8729 | 0.0000 | Difference |
| C. Price (kg) | 16 | 16 | 0.1250 | No difference |
| D. Gross return (Tk./ha) | 120644 | 139465 | 0.0000 | Difference |
| E. Gross Margin (Tk./ha) | 55537 | 88590 | 0.0000 | Difference |
| F. Net Return (Tk./ha) | 28062 | 59871 | 0.0000 | Difference |
| G. Benefit cost ratio (BCR) | | | | |
| BCR on full cost basis | 1.31 | 1.75 | 0.0000 | Difference |
| BCR on cash cost basis | 1.85 | 2.74 | 0.0000 | Difference |
| H. Production cost (Tk./kg) | 12 | 9 | | |

Source: Field survey, 2016

**Table 8. Severity of the effects of drought in maize plant**

| Items | Rajshahi | Chuadanga | All areas |
|---|---|---|---|
| Serious problem | 82 | 76 | 79 |
| Problem was not significant | 18 | 24 | 21 |

Source: Field survey, 2016

### 3.5 Production Variability of Maize

In order to estimate the production variability of maize due to drought occurrence, semi-logarithmic regression model with dummy variable was employed. Drought greatly affects maize production in some areas of

Bangladesh. Maize is grown during the dry season (November to March), usually after the Aman harvest when drought occurs in some areas. Drought negatively affects the growth of maize in all stages, but the reproductive stage is the most sensitive to drought stress (Grant *et al.,* 1989). Drought stress occurred during this period result in a significant reduction of grain yield (Bolanos et al., 1993).

**Table 9. Types of effects of drought in the study areas**

| Types of effects | Rajshahi | Chuadanga | All areas |
|---|---|---|---|
| Reduced yield | 76 | 64 | 70 |
| Stagnant of plant growth | 52 | 58 | 55 |
| Problem in flowering stage | 62 | 24 | 43 |
| Dryness of cob | 34 | 50 | 42 |
| Leaf rolling | 42 | 32 | 37 |
| Loss of grain | 36 | 22 | 29 |
| Plant die | 6 | 14 | 10 |

Source: Field survey, 2016

Table 10 revealed that maize production decreased by 22.4 percent in the drought prone area compared to normal environment. In normal environment maize production increased due to favourable climate. This reduction of yield is consistent with (Miah, 2010).Miah found that in Bangladesh due to drought yield of maize decreased from 30% to 60%.

**Table 10. Effect of drought on maize production**

| Variable | Coefficient | Standard error | t-value | Significant |
|---|---|---|---|---|
| Constant | 9.104 | 0.007 | 1379.417 | 0.000 |
| Drought dummy | -0.224 | 0.009 | -23.958 | 0.000 |

### 3.6 Farmer's Perceptions about the Effect of Drought on Maize Yield

The study examined farmer's perception about the effect of drought on maize yield which is presented in Table 11. Highest percent of farmers (61%) in drought prone areas mentioned that due to drought their maize production decreased to a large extent and 25% said that the reduction of yield was moderate. Some farmers also mentioned that yield reduced slightly and some did not find any effect.

### 3.7 Farmer's Opinion about the Effect of Drought on Cost of Maize Cultivation

Hundred percent farmers in drought prone areas reported that due to drought their production cost increased to a large extent. Among them 41% farmers mentioned that cost increased highly and 26% reported that cost increased moderately (Table 12). About 33% farmers said that cost increased slightly.

**Table 11. Farmer's perceptions about the effect of drought on maize yield**

| Acuteness of the effect | % farmers responded | | |
|---|---|---|---|
| | Rajshahi | Chuadanga | All areas |
| Highly | 64 | 58 | 61 |
| Moderately | 22 | 28 | 25 |
| Slightly | 10 | 8 | 9 |
| Don't know | 4 | 2 | 3 |
| No effect | - | 4 | 2 |
| Total | 100 | 100 | 100 |

Source: Field survey, 2016

**Table 12. Farmer's perception about effect of drought on cost of maize**

| Acuteness of the effect | % farmers responded | | |
|---|---|---|---|
| | Rajshahi | Chuadanga | All areas |
| Highly | 54 | 28 | 41 |
| Moderately | 20 | 32 | 26 |
| Slightly | 26 | 40 | 33 |
| Total | 100 | 100 | 100 |

Source: Field survey, 2016

### 3.8 Adaptation Strategy of the Farmers

Farmers of the drought prone areas follow some strategies to cope up with the environment for cultivating maize which is presented in Tables 13 and 14. About 84% farmers reported that they took some strategiesin maize cultivation for mitigating drought. The main reasons for not taking strategy were lack of knowledge about strategy, unavailability of strategies and unwillingness.

Majority of the farmers (77%) reported that they increased number of irrigation for cultivating maize in drought prone areas. The highest 7 number of irrigation was found in those areas. About 42% farmers mentioned that they use more doses of fertilizer which was highest in Rajshahi district. Increasing amount of seed (31%) was also important strategy in both areas. About 30% farmers opined that they changed the date of planting for mitigating drought problem. Farmers of drought prone areas planted seed in 2$^{nd}$ week of October which they thought as vital strategy.

**Table 13. Percent of drought affected farmers adopted adaptation strategy in maize cultivation**

| Items | Rajshahi | Chuadanga | All areas |
|---|---|---|---|
| Taking adaptation strategy | 86 | 82 | 84 |
| No strategy | 14 | 18 | 16 |
| Total | 100 | 100 | 100 |

Source: Field survey, 2016

**Table 14. Different adaptation strategies adopted by the farmers in drought prone areas**

| Strategies | % farmers responded | | |
|---|---|---|---|
| | Rajshahi | Chuadanga | All areas |
| 1. Increase in the number of irrigation | 76 | 78 | 77 |
| 2. Use more fertilizer | 58 | 36 | 42 |
| 3. Increase of seed rate | 24 | 38 | 31 |
| 4. Change sowing date | 38 | 22 | 30 |
| 5. Cultivate maize near water bodies | 18 | - | 9 |
| 6. Set up shallow tube well in pond | 10 | - | 5 |

Source: Field survey, 2016

**Table 15. Problems of maize cultivation in the study areas**

| Type of problems | % farmers responded | | | | | |
|---|---|---|---|---|---|---|
| | Drought prone area | | | Normal area | | |
| | Rajshahi | Chuadanga | All areas | Comilla | Rangpur | All areas |
| High price of irrigation | 76 | 64 | 70 | - | - | - |
| Lack of quality seed | 12 | 50 | 31 | 60 | 68 | 64 |
| Disease infestation | 20 | 38 | 29 | 50 | 32 | 41 |
| High price of seed | 16 | 48 | 32 | 34 | 38 | 36 |
| Non availability of quality insecticides | 12 | 28 | 20 | 8 | 26 | 17 |
| High price of fertilizers | - | 6 | 6 | 2 | 36 | 19 |
| Lack of drought tolerant variety | 54 | 42 | 48 | - | - | - |
| Bird cause disturbance | 16 | 34 | 25 | 20 | 14 | 17 |
| Dominance of intermediaries | - | 8 | 4 | - | 28 | 14 |
| Weighted loss | - | - | | - | 46 | 23 |
| Water logging | - | - | - | 20 | 6 | 13 |
| High price of land preparation | - | 12 | 12 | 4 | 18 | 11 |
| Lack of training facility | 18 | 2 | 10 | 4 | 10 | 7 |
| Lack of credit | | 8 | 4 | | 6 | 3 |
| Lack of irrigation facility | 4 | - | 2 | - | - | - |

Source: Field survey, 2016

### 3.9 Problems of Maize Cultivation

Although maize is a profitable crop in the study areas, there are some constraints to its higher production. The first and foremost constraint of maize cultivation in drought prone areas was high price of irrigation (70%). Due to low water aquifers, low discharge of water and high price of labour irrigation cost was high. Lack of quality seed (64%) was the main constraint of maize cultivation in

normal areas. About 31% farmers of drought prone areas also reported this problem. Farmers of all areas said that the price of seed was also very high. Infestation of diseases was the important problem for farmers of all districts which hampered higher yield of maize. Non availability of pure insecticides, high price of fertilizers, lack of training facility and facing disturbance for bird were opined to be the important constraints for farmers of all areas. About 48% farmers of drought prone areas reported that lack of drought tolerant variety was one of the major problems. Dominance of intermediaries and weighted loss were major problem for the farmers of Rangpur district (Table 15).

**Table 16. Facility demanded by the maize farmers**

| Facilities | % farmers responded | | | | |
|---|---|---|---|---|---|
| | Rajshahi | Chuadanga | Comilla | Rangpur | All areas |
| Timely supply of quality seed | 22 | 36 | 58 | 52 | 42 |
| Reasonable price of seed | 28 | 46 | 32 | 36 | 35 |
| Provide drought tolerant variety | 78 | 54 | - | - | 33 |
| Provide irrigation facility at low price | 46 | 32 | - | 4 | 20 |
| Timely supply of quality insecticides | 4 | 26 | 12 | 22 | 16 |
| Reduce dominance of intermediaries | - | 4 | - | 36 | 10 |
| Monitoring system for quality seed | - | 12 | 14 | 26 | 13 |
| Arrange training facility | 18 | 4 | 6 | 12 | 10 |
| Provide credit facility | 8 | 16 | 2 | 10 | 9 |
| Improve irrigation system | 16 | 4 | - | - | 5 |
| Increase market demand | - | 2 | 6 | 2 | 3 |

Source: Field survey, 2016

### 3.10 Facility Demanded by the Maize Farmers

Respondent farmers in the study areas wanted some facilities for cultivating maize. All of their demands are presented in Table 16. Majority (42%) of the farmers wanted quality seed because good quality seed is a pre-requisite for higher yield. Some farmers reported that they were cheated by seed dealers and experienced with low seed germination resulting in decline of production. Therefore, farmers wanted monitoring system for quality seed (13%) and also reasonable price (36%). In the study areas, farmers were very much enthusiastic to cultivate BARI hybrid maize. About 16% farmers wanted timely supply of pure insecticides. Reducing dominance of intermediaries was demanded by 13% farmers which was higher in Rangpur district (36%). A good number of farmers of drought prone areas wanted drought tolerant variety and low price of irrigation. Arranging training facility (10%), providing credit facility (9%), improving irrigation system (5%), and increasing market demand (3%) were also required for increasing maize production in the study area.

## 4. Conclusions and Recommendations

### 4.1. Conclusions

The study assessed the effect of drought in maize cultivation. Profitability indicators clearly indicate that maize is a remunerative crop both in drought prone and normal environment. The production of maize in drought prone areas was lower than normal areas. But the cost of production in drought prone areas was found higher than normal areas due to higher cost of irrigation and more use of inputs. The farmers in drought prone areas received less produce but incurred higher costs compared to normal environment which may be due to drought. Loss of yield, loss of plant growth and dryness of cob were the major effects of drought. About 100% farmers have taken some strategy to cope up with drought. Although maize is a profitable crop, due to some setbacks few farmers showed negative attitudes toward its production. High price of irrigation, lack of quality seed, disease infestation and high price of seed were the major problem in the study areas. Farmers also wanted some facilities for increasing maize production and improving livelihood status of maize farmers in study areas.

### 4.2 Recommendations

- Quality seed should be made available to the farmers at reasonable price. For this, Government should encourage BADC and private seed companies to produce quality maize seed.
- Scientists should take attempt to developdrought tolerant maize variety.
- High price of fertilizers affected the yield of maize. In this regard, government should take necessary step for supplying fertilizers to the farmers at reasonable price.

## References

BBS. 2013. Yearbook of Agricultural Statistics, Bangladesh Bureau of Statistics, Statistics and Information Division, Ministry of Planning, Government of the People's Republic of Bangladesh.

BBS. 2014. Yearbook of Agricultural Statistics, Bangladesh Bureau of Statistics, Statistics and Information Division, Ministry of Planning, Government of the People's Republic of Bangladesh

Bolanos, J., G. O.Emeades, and L. Martinez. 1993. Eight ccles of selection for drought tolerance in tropical maize. III. Responses in drought adaptive physiological and morphological traits. Field Crops Res. **31:** 269-286.

Jaleel, C.A., P. Manivannan, A. Wahid, M. Farooq, R. Somasundaram, R. Panneerselvam. 2009. Drought stress in plants: a review on morphological characteristics and pigments composition. *Int. J. Agric. Bio.* **11:**100–105.

Grant, R. F., Jackson, B. S., Kiniry, J. R., and Arkin G. F. 1989. Water deficit timing effects on yield components in maize. Agron. J. **81:**61-65.

Hasan F.M. 2008. Economic Efficiency and Constraints of Maize Production in the Northern Region of Bangladesh. j. innov.dev.strategy. **2**(1): 18-32 (April 2008).

INFS. 2003. Nutritive Survey of Bangladesh, Institute of Nutrition and Food Science, Dhaka University, Bangladesh.

IPCC. 2010. World climate report-global drought pattern. Retrieved February 2011 from www.worldclimaterepor.com/indexphp/2010/02/24/update on-global-drought-patterns-ipcc-take-note

Karim, M. R., Moniruzzaman, Alam, Q. M. 2010. Economics of Hybrid Maize Production in Some Selected Areas of Bangladesh. Bangladesh J. Agril. Res. **35**(1): 83-93, March 2010.

Miah, M. M. U. 2010. Assessing long term impacts of vulnerabilities on crop production due to climate change in the coastal areas of Bangladesh, Final Report PR #100/08, National Food Policy Capacity Strengthening program, Food planning and monitoring Uit, Ministr of Food and Diseaster Management , FAO, Bangladesh.

Quazi, N. U., &Quddus, K. M. G. 2010. 'Climate Chenge in Bangladesh (Term Paper). StudyMode.com. Retrieved from http://www.studymode.com/essays/Climate-Chenge-In-Bangladesh-1164777.html

Sheffield, J, K.M. Andreadis, E.F. Wood and D.P. Lettenmaier. 2009. Global and continental drought in the second half of the twentieth century: severity–area–duration analysis and temporal variability of large-scale events. J. Climate, **22:** 1962-81.

WHO (World Health Organization). 2011. Health action in crisis-drought-natural disaster profiles. WHO. Retrieved from August 2011.

## Appendix Table

**Table 1. Average annual rainfall in selected areas**

| Year | Rajshahi | Chuadanga | Comilla | Rangpur |
|---|---|---|---|---|
| 2004 | 1786 | 1951 | 2424 | 2680 |
| 2005 | 1405 | 1482 | 2424 | 2853 |
| 2006 | 1145 | 1452 | 1803 | 1682 |
| 2007 | 2018 | 1797 | 2491 | 2037 |
| 2008 | 1315 | 1851 | 2057 | 1907 |
| 2009 | 1043 | 1234 | 1824 | 2217 |
| 2010 | 792 | 852 | 1578 | 2102 |
| 2011 | 1475 | 1622 | 1884 | 1932 |
| 2012 | 1164 | 1138 | 1929 | 1877 |
| 2013 | 1248 | 1165 | 1643 | 1916 |

Source: BBS, 2013