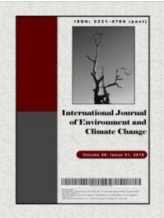

International Journal of Environment and Climate Change

8(4): 269-282, 2018; Article no.IJECC.2018.016
Previously known as British Journal of Environment & Climate Change
ISSN: 2231–4784

Adaptation Strategies of Farmers in a Drought-Prone Area of Rajshahi District

M. H. Uddin[1], M. A. Baten[2], M. Y. Uddin[3], M. J. Alam[4*], M. M. Haque[5] and M. G. Mostafa[6]

[1]Bangladesh Agricultural University, Mymensingh, Bangladesh.
[2]Department of Environmental Sciences, Bangladesh Agricultural University, Mymensingh, Bangladesh.
[3]Department of Agricultural Extension, Hajee Mohammad Danesh Science and Technology University, Dinajpur, Bangladesh.
[4]Tista Environmental Development Foundation, Dhaka, Bangladesh.
[5]Kamar Uddin Islamia College, Bogura, Bangladesh.
[6]Department of Agricultural Studies, Amir Hossain Zobeda Degree College, Brahmanpara, Cumilla, Bangladesh.

Authors' contributions

This work was carried out in collaboration between all authors. Authors MHU, MYU and MJA designed the study, managed the literature searches, developed the conceptual Framework, conducted survey and wrote the first draft of the manuscript. Authors MAB, MMH and MGM wrote the protocol, performed the statistical analysis and edited the manuscript of the study. All authors read and approved the final manuscript.

Article Information

DOI: 10.9734/IJECC/2018/v8i427176

Original Research Article

Received 24 August 2018
Accepted 02 November 2018
Published 03 December 2018

ABSTRACT

The study was conducted to determine the nature of adaptation strategies of the farmers in a drought-prone area of Rajshahi district. The locale of the study was drought-prone area of Tanore Upazila under Rajshahi district of Bangladesh. Data were collected from 200 households selected through a proportionate stratified random sampling technique from four villages namely Talopara and Jumerpara of Bhadair union and Kandopur and Dhebostoly of Kalma union under Tanore Upazila and analyzed with help of Microsoft Excel, SPPSS and Brasica program. The specific objectives of the study were to determine the adaptation strategies practiced by the farmers in drought period, to find out the relationship between some characteristics of the farmers and their adaptation strategies in drought prone area, to ascertain the contribution of selected characteristics of the farmers to their adaptation strategies in drought period, to explore factors that influences the farmer's characteristics in applying adaptation strategies and to explore problems faced by farmers

**Corresponding author: E-mail: poet.jahan@gmail.com;*

in a drought prone area. Both primary and secondary sources of data were used in the study. Questionnaire and checklists were used in conducting survey and Key Informants Interviews. The selected 19 characteristics of the farmers were considered as the independent variables and their adapted adaptation strategies constituted the dependent variable. Adaptation strategies of the farmers in drought prone area ranged from 20 to 50 against a possible range 16 to 64, with an average of 38.65 and standard deviation 4.391. The highest proportion of the respondents (74 percent) had adapted strategies moderately, 17 percent had adapted strategies strongly, 7 percent had adapted strategies slightly and only 2 percent had not adapted strategies. Education, farm size, drought affected area, household asset, annual family income, savings, water and sanitation, communication exposure, agricultural training received, cosmopoliteness, aspiration, planning orientation, environmental awareness were positive and significant relationship with their adaptation strategies in drought period. Path analysis indicates that the variation on farmers' adaptation strategies was mainly due to the contributions of five predictors *viz.* that age, household asset, credit received, agricultural training received, and environmental awareness. Adaptation strategies of the farmers' model indicate that 38.99 percent of total variation in farmers' adaptation strategies status has been explained by these predictors. The five relevant characteristics having significant effects improvise their contribution to adaptation status and among those, household assets activities alone contribution explaining 25.1 percent of the variation in practice adaptation strategies during in drought period followed by environmental awareness 3.9 percent, agricultural training received 2.8 percent, credit received 3.7 percent and age 1.6 percent. The major root causes of low adaptation strategies of the farmers in drought prone area were lack of rainfall, rising temperature, lack of moisture, lack of awareness and lack of soil management. Hence, provision of necessary measures by the concerned authority and progressive change in socio-economic-environmental structure of the society are desirable for improvement of the farmers' adaptation strategies in drought prone area.

Keywords: Adaptation; drought; Rajshahi.

1. INTRODUCTION

1.1 Background of the Study

Bangladesh is known for its proneness to disasters, specially drought and flood. Both natural and manmade disasters such as cyclones, flooding, riverbank, erosion, drought, earthquake, arsenic contamination, chemical pollutants, urban pollution, and fire and so on are typical to Bangladesh and a major challenge to her development. According to Benson and Clay [1] Bangladesh is one of the most disaster-prone countries in the world. As a result there are significant changes in agriculture, food security and economy growth. Climate change has brought Bangladesh at higher risks due to droughts [2]. Drought is often perceived as a creeping hazard as it develops slowly and has a prolonged duration and it is context-specific [3,4]. Droughts are regional events and their occurrences are governed by regional climatic parameters like precipitation, evapotranspiration and temperature. So, the characteristics and consequences of drought vary with respect to climatic regimes. Between 1960 and 1991, 19 droughts had been occurred in Bangladesh [5]. Since independence, Bangladesh has experienced droughts or major magnitude in 1973, 1978, 1979, 19782, 1994, 1995, 1996 and 2003 [6,7].

The continued drought in the northwestern districts of Bangladesh led to a shortfall of rice production of 3.5 million tons [2]. These districts are considered the granary of Bangladesh and produce surplus rice - the main staple of the country. However, by early 1995, the government food stock fall the lowest level in the last five years. The government had agreed to import million tons of rice to offset the shortage in government stock and meet the country's requirement on an emergency basis [8]. A significant quantity of food grain has already reached the country.

Drought is a difficult disaster to deal with. Unlike a flood or a cyclone, drought does not arrive dramatically. It creeps on slowly, almost unnoticed. Each day, a few more fields are affected. Always is the hope that it may rain tomorrow and that the problem will go away [9]. Since independence, Bangladesh has experienced droughts of major magnitude in 1973, 1978, 1979, 1981, 1982, 1989, 1992, 1994, and 1995 [10,11]. Although droughts are

not always continuous in any area, they do occur sometimes in the low rainfall zones of the country. As listed above, Bangladesh experienced consecutive droughts in 1978 and 1979, 1981 and 1982, and 1994 and 1995. The 1973 drought was labeled 'the worst in recent history,' 1979 drought was dubbed 'the worst in living memory,' [12] and 1994-95 drought 'the worst in this century' [8].

Drought adversely affects all three rice varieties *(A*man,*Aus*, and *Boro*) grown in three different cropping seasons in Bangladesh. It also causes damage to jute, the country's main cash crop, and other crops such as pulses, potatoes, oilseeds, minor grains, winter vegetables, and sugarcane. Rice alone accounts for more than 80% of the total cultivated land of the country. Droughts in March-April prevent land preparation and plowing activities from being conducted on time. As a result, broadcast *Aman*, *Aus,* and jute cannot be sown on schedule. Droughts in May and June destroy broadcast *Aman*, *Aus,* and jute plants. Inadequate rains in August delay transplantation of *Aman* in high land areas, while droughts in September and October reduce yield of both broadcast and transplanted *A*man and delay the sowing of pulses and potatoes. *Boro,* wheat, and other crops grown in the dry season are also periodically affected by drought. Fruit trees, such as jackfruit, litchi, and banana, often die during drought. But the loss of rice production is the most costly damage incurred by droughts in Bangladesh.

The impact of drought spreads disproportionately amongst regions of Bangladesh. There is a popular impression in Bangladesh that the northwestern districts of Rajshahi, Dinajpur, Rangpur, Bogra, and Pabna are particularly drought-prone [12]. The northwestern districts are relatively dry, receiving only 50 inches of rainfall annually. The eastern districts, in contrast, receive more than 80 inches of rainfall. But drought can hit both drought-prone and non drought-prone areas [12,13].

Climate change adaptation strategies and sustainable agricultural practices need to be mutually supportive (complementary). For instance, farmers' current practices of adopting groundwater irrigation to cope with the growing water scarcity in the north-west region of Bangladesh resulted in the drawdown of groundwater tables, land subsidence and tube wells failing during dry seasons; [14]. The main focus of the study is to determine adaptation strategies of farmers in drought prone-areas in Rajshahi district. In the contexts of Bangladesh, drought adversely affects all three rice seasons (*Aus, Aman* and *Boro*). It also causes damage to jute and other crops. So, drought plays a vital role in practicing adaptation strategies by the farmers and unfortunately the study areas frequently hit by natural disasters like drought.

The study areas in every year are more or less affected by droughts. So, the livelihoods of the farmers in these areas are greatly affected by drought. The drought areas farmers have suffering from scarcity of food and the quality of drinking water. It is not only the picture of the study area but most of the part of Northwest Bangladesh is almost same. Farmers' vulnerability due drought has been explored in this study and measures coping ability to strengthen the adaptation strategies of affected farmers. The findings of the study are applicable to other drought affected districts as Rajshahi, Nagaon, Natore, Pabna etc. and help the government policy makers, extension workers, development planners, and NGO community of the country. On the other hands, the study may enhance the intellectual competence of the livelihood improvement of drought affected farmers at the national level.

1.2 Research Questions and Study Objectives

Bangladesh is an agricultural country. The irrigation system is not much developed. There are heavy rain falls in rainy season in our country but the rainfall occurrence in other season is very low. Thus the rainfall distribution throughout the region and year is non uniform. This non uniform rainfall very often causes droughts in every year. Drought causes severe stresses to crops as well as animals. Therefore the adaptation strategies of farmers and to find out the prevention measure for it are very important in our country.

The southwest and northwest regions of Bangladesh are the country's predominantly drought prone areas. A study on the effect of drought on certain major crop in Bangladesh has revealed that 62 percent of T. *Aman* yield reduction has occurred in Rajshahi, 50 percent wheat yield reduction at Rajshahi, Bogra and Jessore, and 14-32 per cent of *B. Aus* yield losses are apprehended in a few districts due to drought. However, after studying soil, agronomic and meteorological data of over 20 years, it has been assessed that the national yield loss of

crops like *B. Aus,* L. T. *Aman* and 8 HYV *Aman* are 12, 8 and 13 per cent, respectively. Since agriculture contributes around 50 percent GDP of the country, this situation is a major factor contributing to its deteriorating economic situation. However, information on economic effects of drought and its impact on social changes very scare.

During the last 50 years, Bangladesh suffered about 20 drought conditions. Drought is a recurrent phenomenon in some parts of the country. Despite the recurrent and divesting nature of droughts in Bangladesh, it has attracted far less scientific attention than floods or cyclones [15,16]. However, losses from drought are likely to be more severe than from floods in Bangladesh [17]. In Bangladesh, a number of studies have been carried out on the impact of droughts on agriculture [18,19,20,21,22], food production [23,24], Land degradation [25,20]. Economy [24] and society [24,13] in Bangladesh. WARPO-EGIC (1996) [26,27] prepared maps of winter and pre-monsoon drought prone areas of Bangladesh the agro ecological zones database and land resources inventory map.

Previous studies explored only causes of droughts and yield loss due to drought but farmers' adaptation strategies of farm households due to drought was not analyzed. Therefore, a detailed assessment is essential of how farm households are affected by drought shocks and what strategies they practice during in drought period. Considering these facts in view, the study entitled adaptation strategies of farmers in a drought prone-areas in Rajshahi district. In light of the above discussion and the background information, the present study has been undertaken with the research questions:

- What extent the adaptation strategies practiced by farmers in drought prone area?
- What are relationship between farmer's characteristics and adaptation strategies in drought?
- What are the contributions of farmer's characteristics to their adaptation strategies during drought period?
- What extent the factors influence farmers in applying adaptation strategies in drought? and

The specific objectives of the research were as follows:

1. To determine the adaptation strategies practiced by the farmers in drought period.
2. To find out the relationship between some characteristics of the farmers and their adaptation strategies in drought prone area.
3. To ascertain the contribution of selected characteristics of the farmers to their adaptation strategies during drought period.
4. To explore factors that influences the farmer's characteristics in applying adaptation strategies.

1.3 Scope of the Study

The main focus of the study was to determine adaptation strategies of farmers in drought prone-areas in Rajshahi district. In the contexts of Bangladesh, drought adversely affects all three rice seasons (*Aus, Aman* and *Boro*). It also causes damage to jute and other crops. So, drought plays a vital role in our livelihood strategies. Unfortunately, the country is frequently hit by various natural disasters like drought. Historically, Bangladesh is one of the most disaster prone countries in the world with the cyclones, devastating floods, riverbank erosion, earthquake, arsenic contamination, chemical pollutants, urban pollution, fire, roadside accidents and drought.

The study area affected by droughts every year more or less. So the livelihoods of the people in these areas are greatly affected by drought. The drought areas people have suffering from scarcity of food, pure drinking water. It is not only the picture of the study area but most of the part of Northwest Bangladesh is almost same. Farmers' vulnerability due drought has been explored in this study and measures coping ability to strengthen the adaptation strategies of affected farmers. The findings of the study will be especially applicable to drought affected districts as Rajshahi, Nagaon, Natore, Pabna etc. It is expected the findings of the study will help to the government policy makers, extension workers, development planners and NGO community of the country. That is why, it is now very important to conduct a study on drought prone areas and farmers adaptation strategies during drought period in Bangladesh.

2. MATERIALS AND METHODS

2.1 Locale of the Study

The locale of the study was TanoreUpazila of Rajshahi district. Two unions of Tanore were selected purposively for this study and the Unions are Kalma and Badhair. These are the most severe drought prone areas of Rajshahi district. The study was conducted in four villages namely Talupara, Jumerpara, Kandopur and Dhebostoli of Tanore Upazila. These villages are situated in the northwest part of Tanore Upazila nearby Mondomala municipality.

2.2 Sampling Procedure

Simple random sampling procedure was followed to obtain the desired sample. Tanore Upazila was selected purposively of Rajshahi district and out of seven unions two unions were selected. The four villages were namely Thalupara and Jumerpara of Badhairr union and Kandopur and Dhebostoli of Kalma union. A list of affected farmers due to drought were prepared and then 10 percent of the affected farmers were selected randomly from the list (200 respondents was fixed). The selected respondents were constituted the sample size of the study. A reserve list of respondents (2 percent of the total farmers) from the selected unions was made to meet up the absent of the respondents.

Adaptation strategies of farmers in a drought prone area of Rajshahi district was the dependent variable of the study. The characteristics of the farmers' i. e., age, years of schooling, household size, farm size,Land area was affected by drought by the last time, household asset, annual income, savings, credit received, water & sanitation, communication exposure, agricultural training received, cosmopoliteness, organizational participation, perception of climate change, risk orientation, planning orientation, environmental awareness, and aspiration were the independent variables of the study. The selection of independent variables was made on the basis of expert opinion, peer group discussion, literature related and also consultation with learned supervisors, that seems better matching relationship with the dependent variables.

2.3 Measurement of Variables

Nineteen selected characteristics of the farmers were the independent variables which were measured by appropriate statistical scores and scales. Adaptation strategies of farmers in a drought-prone area were the dependent variable of the study. The study mainly concentrated on formulating adaptation strategies to reduce drought vulnerability of the farmers. The farmers adapted various kinds of strategies in drought affected areas e.g. integrated farming system, cultivating short duration crops, homestead gardening, crop diversification, crop rotation, mixed cultivation, zero tillage, mulching, use of drought tolerant varieties, water harvest, setting up deep tube-well, pipe irrigation uses, fruit gardening, find off- farm jobs, agro forestry, moved to non-farm activities etc.

A four-point rating scale was used to measure the extent of adaptation strategies practiced on livelihood. A total of 16 statements were kept for final data collection. The statements were arranged in the rating format, requiring respondents to indicate their sincere feelings and opinions along the given 4-point rating scales as follows: Strongly adapted = 4, Moderately adapted = 3, Slightly adapted= 2 and Not adapted= 1. Thus, practice of adaptation strategies score ranged from 20 to 50; 20 indicating very less practice of adaptation strategies and 50 indicating highly practice of adaptation strategies in drought period.

For ranking the statement of adaptation strategies index of individual statement have also been computed by using the following formula:

Adaptation Strategies Index (ASI) = A_n x1+ A_s x2+ A_m x3+ A_s x4

Where,

A_n= Adaptation strategy is not adapted
A_s = Adaptation strategy is slightly adapted
Am= Adaptation strategy is moderately adapted
E_s= Adaptation strategy is strongly adapted

Table 1. Distribution of population and sample of farmers in selected villages of two unions

Upazila	Union	Village	Total listed farmers	Interviewee	Reserved list
	Badhair	Talupara	590	50	5
Tanore		Jumerpara	410	50	5
		Kandopur	650	50	5
	Kalma	Dhebostoli	350	50	5
Total			2000	200	20

Thus, the practice of adaptation strategies index ranged from 200-800; 200 indicating very less practice of adaptation strategies while 200 indicating very high practice of adaptation strategies in drought prone area.

2.4 Instrument for Collection of Data

In order to collect valid and reliable information an interview schedule was prepared keeping the objectives of the study in mind. The interview schedule was contained both open and closed form of questions. Very simple, direct questions and statements were included in the schedule for collecting information regarding drought and the selected characteristics of the respondents were also be taken into consideration for preparing the interview schedule**.** Based on pre-test results necessary correction, alteration, deletions and adjustments was made to finalize the interview schedule for final data collection.

2.5 Data Collection

Data for this study was collected by the researcher himself. The data was collected from the respondents with the help of an interview schedule through Face- to- face interview, Focus Group Discussions (FGDs) and Scored Causal Diagram (SCD) of the respondents. Matrix ranking is a participatory tool usually will be used for ranking more than one subjects/items according to their importance (Huda, 2005). Practiced adaptation strategies were selected through matrix ranking on the basis of their severity. Interviews with key informants like Upazila Agriculture Officer (UAO), Agriculture Extension Officer (AEO), Sub-assistant Agriculture Officer (SAAO) and One Model Farmer of the locality helped the researcher to identify drought consequences of the farmers, ranking adaptation strategies, basic facts about agriculture and strategies for mitigating drought problems*.*

2.6 Data Processing and Analysis

The primary data were collected from the drought affected farmers by using structured interview schedule having open form of questions. Collected primary data were coded, recoded a transferred into SPSS (Statistical Package for Social Science) software package (20.0 Version) in the month of January 2015. Besides primary data the researcher collected information from different relevant sources, such as books, journals, theses, abstracts, scientific and research reports from library and from internet. Descriptive statistical measures such as frequency, range, mean, percentage distribution, standard deviation, rank order, categories and indices etc. were used to describe and interpret the data. For exploring relationships between any two variables Pearson's Product Moment Correlation (r) was used. Linear regression analysis was also employed to determine the contribution of independent variables to the dependent variables. Regression analysis usually deals with the explanation and prediction of a given variable based on one or more variables. The step-wise multiple regression analysis was used to determine the amount of variation in dependent variables due to per unit change in independent variables, with only those variables which contributed significantly. Path analysis was also computed through use of standardized partial regression coefficient known as beta coefficient in order to determine the extent of direct and indirect influence of the independent variables towards the dependent variable. The predictive power of multiple regression equation was evaluated by the help of multiple correlation coefficient (R) and coefficient of multiple determination (R^2) analysis.

3. RESULTS AND DISCUSSION

3.1 Adaptations Strategies Practiced by the Farmers in Drought Prone Area

Overall categories of adaptation strategies in drought prone area was measured by computing adaptation strategies score, which could range from 4 to 64. However, the observed scores ranged from 20 to 50 with an average of 38.65 and standard deviation of 4.391. Based on their possible scores, the practice of adaptation strategies in drought prone area were classified into four categories (Table 2).

Analyzed data indicated that highest proportion (74 per cent) of the respondents adapted adaptation strategies as medium practices in drought prone area while 2 per cent of the farmers not adapted, 7 per cent farmers slightly adapted and 17 per cent of them farmers adapted as strongly respectively. The extent of practice adaptation strategies against each statement was assessed. Adaptation strategies score for each statement was calculated by using Adaptation Strategies Index (ASI) and it had been arranged in rank order according to their extent of practice adaptation strategies which appears in Table 3. Adaptation Strategies Index (ASI) was found to vary from 249 to 706 against the possible index ranging from 200 to 800.

Table 2. Practice adaptation strategies in drought prone area

Categories of adaptation strategies in drought	Respondents(N=200)		Mean	SD
	Number	Percent		
Not adapted (≤26)	4	2	38.65	4.391
Slightly adapted (27-33)	14	7		
Moderately adapted (34-42)	148	74		
Strongly adapted (≥43)	34	17		
Total	200	100		

Probable range: 16-64; Observed range: 20-50

Table 3. Item-wise adaptation strategies scores in drought prone area

Statements of adaptation strategies adapted by farmers	Extent of practice of adaptation strategies in drought prone area				ASI	Rank
	Strongly adapted	Moderately adapted	Slightly adapted	Not adapted		
Introducing integrated farming for water conservation	80	60	40	20	600	2
Practicing short duration crops to minimize drought	65	50	45	50	550	4
Homestead gardening	22	20	15	143	321	11
Practicing crop diversification	65	45	35	55	520	6
Practicing crop rotation	56	42	38	64	571	3
Mixed cultivation	22	18	15	145	347	10
Zero tillage methods	14	10	6	170	268	15
Mulching	61	42	25	72	492	7
Use of drought tolerant varieties	64	51	36	49	530	5
Water harvest	15	9	8	168	271	14
Setting up deep tube-well water for irrigation	140	36	14	10	706	1
Ribbon pipe irrigation uses	10	7	5	178	249	16
Practicing fruit gardening	22	16	8	154	306	12
Find off-farm job	51	38	19	92	448	9
Introduce agro forestry	18	12	9	161	287	13
Shift to non-farm activities	55	35	22	88	457	8

Data contained in Table 3 showed that “Setting up deep tube-well water for irrigation” got the 1st rank among the statements. It was found that 70 per cent of the respondents identified it as strongly adapted and 18 per cent of the respondents stated it as moderately adapted, 7 percent of the respondents stated it as slightly adapted and 5 percent of the respondents stated it as not adapted with the total ASI of 706. “Introducing integrated farming for water conservation” got the second highest score and thus, stood second in the rank order. It was found that 40 per cent of the respondents stated it as strongly adapted and 30 per cent of the respondents stated it as moderately adapted, 20 per cent of the respondents stated it as slightly adapted, 10 per cent of the respondents stated it as not adapted with the total ASI of 600. ”Pipe irrigation uses “obtained the least score and so got the last position in the rank order. It was found that 5 percent of the respondents stated it as very effective and 89 percent of the respondents stated it as less effective with the total ASI of 249.

3.2 Farmers’ Characteristic Profile

Age: Age of the farmers ranged from 22 to 75 years. The mean was 46.28 with standard deviation of 11.80 and co-efficient of variation of 25.50. The majority (58.0%) of the farmers were middle-aged compared to 22.0% being young and 20.0% were old. Majority (80.0%) of the farmers were young to middle aged.

Education: Education of the farmers was found to range from only can sign to 14 years of schooling. The average was 4.37 years with a standard deviation of 3.85 and co-efficient of variation of 88.21. The highest proportion

(37.0%) of the farmers only could sign, 34.0% had primary level of education, 22.0% had secondary level of education and only 6.5% had above secondary level of education.

Household size: Household size of the farmers ranged from 2 to 9. The average was 5.03 with a standard deviation of 1.22 and co-efficient of variation 24.41. The highest proportion (62.0%) of the farmers had medium households compared to 2.0% and 36.0% of them having large and small household respectively.

Farm size: Farm size of the farmers ranged from 0.01 to 5.86. The average was 1.14 with a standard deviation 0.75 and co-efficient of variation 64.91. The highest proportion (95.5%) of the farmers had marginal farmers compared to 3.5% and 1.0% of the farmers having medium farmers and large farmers respectively.

Drought affected area in the last time: Drought affected area of the farmers ranged from 0.00 to 1.34. The average was 0.25 with a standard deviation of 0.23 and co-efficient of variation 93.03. The highest proportion (89.0%) of the farmers had highly affected compared to 10.3% and 1.0% of the farmers having medium and large affected respectively.

Household asset: Household assets of the farmers ranged from 9.00 to 886.00. The average was 114.38 with a standard deviation 130.45 and co-efficient of variation 114.04. The highest proportion (95.5%) of the farmers had low assets compared to 1.5% and 3.0% of the farmers having medium and high household assets respectively.

Annual family income: Annual family income of the farmers was found to range from 30 thousand to 625 thousand taka with a mean of 135.90, standard deviation of 82.44 and co-efficient of variation of 60.66. The highest proportion (87.0%) of the farmers had low annual income, while 10.0% and 3.0% of the farmers had medium and high annual income respectively.

Savings: Savings of the farmers of the farmers was found to range from 0.00 thousand to 350.00 thousand taka with mean of 26.81thousand, standard deviation of 51.14 thousand and co-efficient of variation of 190.71. The highest proportion (56.0%) of the farmers had no savings, while 38.5% had poor savings, 3.5% had medium savings and 2.0% had good savings of the farmers.

Credit received: Credit received by the farmers was found to range from 0.00 thousand to 600.00 thousands taka with a mean of 22.06 thousand, standard deviation of 73.83 and co-efficient of variation of 334.60 percent. The highest proportion (63.0%) of the farmers had no amount of credit, while 33.5% had less amount of credit, 3.0% had medium amount of credit and 0.5% had high amount of credit received by the farmers.

Water and sanitation: Water & sanitation scores of the farmers were found to range from 12 to 15 with a mean of 13.16, standard deviation of 0.84 and co-efficient of variation of 6.43. The highest proportion (56.0%) of the farmers had low water & sanitation while 44.0% of the farmers had high water & sanitation respectively.

Communication exposure: Communication exposure scores of the farmers were found to range from 2 to 18 with a mean 6.50, standard deviation of 2.05 and co-efficient of variation of 31.64. The highest proportion (88.0%) of the farmers had low communication exposure, while 11.0% of the farmers had medium communication exposure and 1.0% of the farmers had high communication exposure.

Agricultural training received: Agricultural training received by the farmers was to range from 0 to 7 with a mean of 1.19, standard deviation of 1.75 and co-efficient of variation of 147.46 percent. The highest proportion (50.5%) of the farmers had no agricultural training received, while 35.5% of the farmers had low training received, 9.0% of the farmers had medium agricultural training and 5.5% of the farmers had high agricultural training respectively.

Cosmopoliteness: Cosmopoliteness scores of the farmers ranged from 2 to 12 with a mean of 4.75, standard deviation of 1.91 and co-efficient of variation of 7.53 percent. The highest proportion (25.0%) of the farmers had medium cosmopoliteness, while 73.0% and 2.0% of the farmers had high cosmopoliteness respectively.

Perception of climate change: Perception of climate change scores of the farmers ranged from 18 to 30 with a mean of 25.98, standard deviation of 1.95 and co-efficient of variance 7.53 percent. The highest proportion (73.0%) of the farmers had medium perception of climate change, while 23.0% of the farmers had high perception of climate change and 3.5% of the

farmers had low perception of climate change respectively.

Risk orientation: Risk orientation scores of the farmers of the study area ranged from 24 to 40. The observed mean, standard deviation and co-efficient of variation were 29.81, 2.62 and 8.81 per cent respectively. The highest proportion (53.0%) of the farmers had low risk orientation, while 43.0% of the farmers had medium risk orientation and 3.5% of the farmers had high orientation.

Aspiration: Aspiration scores of the farmers ranged from 12 to 35 with a mean of 24.16, standard deviation 4.48 and co-efficient of variation was 18.55. The highest proportion (54.0%) of the farmers had medium aspiration, while 25.5% of the farmers had low aspiration and 20.5% of the farmers had high aspiration.

Organizational participation: The organizational participation scores of the farmers of the study area were ranged from 0 to 3. The average score was 0.41 with a standard deviation of 0.71 and co-efficient of variation was 174.94 per cent. The majority (71.5%) of the farmers had no participation while, 27.5% of the farmers had medium organizational participation and only 1.0% of the farmers had high organizational participation.

Planning orientation: The planning orientation scores of the farmers were ranged from 17 to 33 with a mean of 23.77, standard deviation 2.58 and co-efficient of variation was 10.86. The majority (64.0%) of the farmers had medium planning orientation while, 29.0% of the farmers had low planning orientation and 7.0% of the farmers had high planning orientation.

Environmental awareness: Environmental awareness scores of the farmers in study area were ranged from ere ranged from ere ranged from ere ranged from 5 to 10 with mean of 7.56 and standard deviation of 1.30 per cent. The majority (59.5%) of the farmers had medium environmental awareness, 22.5% of the farmers had low environmental awareness and 18.0% of the farmers had high environmental awareness.

3.3 Relationship between the Selected Characteristics of the Farmers and Their Adaptation Strategies in Drought Prone Areas

The selected nineteen characteristics constituted the independent variables, while practice adaptation strategies in a drought prone were the dependent variable. To explore the relationship between the dependent and independent variables, Pearson's Product Moment Correlation Co-efficient (r) has been computed.

Table 4. Relationships between dependent and independent variables

Independent variables (Selected characteristics of the farmers)	Computed 'r' value
Age	0.104
Education	0.358**
Household size	0.124
Farm size	0.273**
Drought affected area in last year	0.466**
Household assets	0.501**
Family income	0.360**
Savings	0.266**
Credit received	-0.055
Water and sanitation	0.238**
Communication exposure	0.182*
Agricultural training	0.415**
Cosmopoliteness	0.221**
Perception of climate change	0.045
Risk orientation	0.097
Aspiration	0.263**
Organizational participation	-0.057
Planning orientation	-0.151*
Environmental awareness	-0.277**

*Dependent variable: farmers' adaptation strategies in a drought prone area, ** Correlation is significant at 1% level of probability, * Correlation is significant at 5% level of probability*

According to the computed correlation co-efficient (r) thirteenth characteristics of the farmers namely education, farm size, drought affected area, household asset, annual family income, savings, water and sanitation, communication exposure, agricultural training received, cosmopoliteness, aspiration, planning orientation, environmental awareness were positively correlated with their adaptation strategies in drought period.

3.4 Influence of the Farmers' Selected Characteristics on Their Practice Adaptation Strategies in Drought Period

In order to determine the effect of the selected characteristics of the farmers to their strategies, regression analysis was done. Path analysis was also conducted to know the direct and indirect effects of the individual variables on farmers' status of adaptation strategies.

Multiple regression analysis was carried out with the independent and dependent variables. 19 characteristics were entered into analysis for explaining the regression with significant level has been presented in Table 5. The variables falling at 5 and 1 percent level of probability with no multicollinearity problem have been selected as decisive characteristics on farmers' status of adaptation strategies and the selected characteristic were: Age, Level of schooling, household size, household assets, farm size, land area affected by drought, annual family income, savings, credit received, sanitation, communication exposure, agricultural training received, cosmopoliteness, perception of climate change, risk orientation, aspiration, organizational participation, planning orientation and environmental pollution awareness.

It was observed that out of the 19 independent variables, only five, namely age, household asset, credit received, agricultural training received and environmental awareness were entered into the best fitted model to be regression analysis and all these five variables were found to be significant. Hence, the concerned null hypotheses were rejected. Table 6 reveals the summarized results of the step-wise regression analysis.

The multiple R and R^2 values found in the step-wise regression were .609 and .371, while the corresponding F-ratio was 22.929 and also significant at .001 levels. The regression equation obtained is presented below.

$$\hat{Y} = 38.999 + .047\ X_{1} + .013\ X3 + -.012\ X_{9} + .635\ X_{12} + -.591X19$$

Data contained in Tables 5 and 6 indicate that the whole model of 19 variables explained 44.1 percent of the total variation in practiced adaptation strategies by the farmers in drought period, whereas only five variables explained 37.1 percent of the variation. But since the five variables formed the equation, it might be assumed that whatever contribution was there it was due to these five variables.

Table 5. Multiple regression on dependent and independent variables

Variable codes	Independent variables	Unstandardized coefficients		Standardized coefficients	t- values	Significance level
		B	Std. error	(β)		
X_2	Education	.075	.084	.066	.893	.373
X_4	Farm size	-.397	.566	-.068	-.701	.484
X_5	affected by drought	3.419	1.743	.184	1.961	.051
X_6	Household asset	.007	.003	.215	2.319	.021
X_7	Annual family income	.001	.006	.010	.095	.925
X_8	Savings	.005	.008	.055	.613	.541
X_{10}	Water and sanitation	.409	.335	.079	1.221	.223
X_{11}	Communication exposure	-.054	.161	-.025	-.336	.737
X_{12}	Agricultural training received	.358	.186	.143	1.927	.055
X_{13}	Cosmopoliteness	.017	.188	.007	.089	.929
X_{16}	Aspiration	.043	.067	.044	.649	.517
X_{18}	Planning orientation	-.148	.104	-.087	-1.424	.156
X_{19}	Environmental awareness	-.603	.207	-.179	-2.913	.004

*Constant, a = 38.391, R^2 = .366, F = 8.270, P value = .000, *Significant at 5% level of probability, **Significant at 1% level of probability*

Table 6. Regression coefficient of the farmers' practice adaptation strategies in drought with five significantly influencing independent variables entered in the regression model

Variables codes	Independent variables	Unstandardized coefficients		Standardized coefficients	t-value	Significance level
		B	Stderror	β		
X_6	Household asset	.008	.003	.232	2.684	.008
X_{19}	Environmental awareness	-.694	.199	-.206	-3.492	.001
X_5	Drt.area	3.916	1.538	.210	2.546	.012
X_{12}	Agricultural training received	.416	.175	.166	2.373	.019

*Multiple R = 0.605, R square = 0.366, Constant = 38.391, **Significant at .01 level or above*

Table 7. Step-wise multiple regression analysis showing contribution of the selected characteristics to the practice adaptation strategies in drought period

Variables entered	Multiple R^2	Change in R^2	Variance explained	Significance level
Household asset	.251	.251	25.1	.000
Environmental awareness	.291	.039	3.9	.001
Drt.area	.322	.031	3.1	.003
Agricultural training received	.341	.019	1.9	.019

It can be observed form the Table 7 that among the five variables household assets activities alone contributed the major proportion (25.1 percent) of the variation in practice adaptation strategies during in drought period followed by environmental awareness (3.9 percent), agricultural training received (2.8 percent), credit received (3.7 percent) and age (1.6 percent).

3.5 Path Analysis for Measuring Direct and Indirect Effects of Selected Independent Variables on Adaptation Strategies Practices in Drought Period

Path analysis is an extension of the regression model used to test the fit of the correlation matrix against two or more casual model which are being compared by the researchers. Datashown in Table 8 indicate that five variables namely age of farmers, household assets of farmers, credit received by farmers, agricultural training received by farmers and environmental awareness of farmers.

The mentioned also indicate that among the independent variables household assets had the highest direct positive value (0.3842) on adaptation strategies practices and its total indirect effect was 0.1168, which was exerted through environmental awareness (0.0286), agricultural training received (0.1366), credit received (-0.0450) and age (-0.0034). Agricultural training received activities had the second highest direct positive effect (0.2544) on adaptation strategies practices. The total indirect effect of agricultural training received activities was 0.1607 which was exerted through environmental awareness (0.0197), credit received (-0.0580), household assets (0.2063) and age (-0.0073). Credit received activities had the third highest direct negative effect (-0.2073) on adaptation strategies practices. The total indirect effect of credit received activities was 0.1523 which was exerted through environmental awareness (-0.0046), agricultural training received (0.0712), household assets (0.0834) and age (0.0023). Environmental awareness activities had the fourth highest negative effect (-0.1755) on adaptation strategies practices. The total indirect effect of environmental awareness was (-0.1315) which exerted through agricultural training (-0.0585), credit received (-0.0054), household assets (-0.0626) and age (-0.0050). Age had the last activities on adaptation strategies and its direct effect was (0.1258). The total indirect effect of age was (–0.0219) which was exerted through environmental awareness was (0.0286), agricultural training received (-0.0148), credit received (-0.0037) and house hold assets (-0.0104) (Table 8).

Table 8. Path analysis for measuring direct and indirect effects of selected independent variables on adaptation strategies practices in drought period

Independent variables	Effect of independent variable			Variable through which substantial indirect effects were channelized*	
	Direct	Indirect	Total		
Drought affected area (X_1)	0.211	0.255	0.466	0.161	Household assets (X_2)
				0.080	Agricultural training (X_3)
				0.014	Environmental awareness (X_4)
Household assets (X_2)	0.231	0.270	0.501	0.147	Drought affected area (X_1)
				0.089	Agricultural training (X_3)
				0.034	Environmental awareness (X_4)
Agricultural training (X_3)	0.167	0.248	0.415	0.101	Drought affected area (X_1)
				0.124	Household assets (X_2)
				0.023	Environmental awareness (X_4)
Environmental awareness (X_4)	-0.206	-0.072	-0.278	-0.015	Drought affected area (X_1)
				-0.038	Household assets (X_2)
				-0.019	Agricultural training (X_3)

4. POLICY IMPLICATIONS

It is evident from the study that in drought prone area the farmers try to practice better adaptation strategies of their own interest. Therefore, it may be recommended that extension service providers should motivate the farmers to practice adaptation strategies in drought. Farmers having higher level of agricultural knowledge are likely to be able to take quick and appropriate decisions. Agricultural training also had positive influence on adaptation strategies in drought. The existing level (highest proportion, 50.5%) of agricultural knowledge of the farmers indicated that they might face problem to practice adaptation strategies in drought. Therefore, it may be recommended that the concerned GOs and NGOs should develop the farmers' agricultural knowledge by arranging training programs on different farm technique and technologies with special attention to the farmers. To achieve this goal more and more informal and field oriented adult education programs should be launched in the villages by the concerned agencies. Planned strategic communication campaign is necessary involving different types of media such as personal contact by development workers, printed materials like leaflets, folders, booklets, posters etc. However, mass communication media can play a vital role in increasing the awareness of farmers. Majority 88.0% of the farmers had low communication exposure. Communication had a significant and positive influence on their adapted strategies in drought prone area. So, the increase of communication exposure by the farmers might be an important determinant for their practice adaptation strategies in drought prone area. Therefore, it may be recommended that concerned extension service providers such as Department of Agricultural Extension (DAE), others GOs and NGOs should undertake special extension programs for the farmers and have regular communication with them. BMDA, DAE and other leading GOs and NGOS can play their key role in this regard. In drought prone areas to set up more deep tube well, water for irrigation. A number of farmers of the study area, who were small in farm size, had low annual income (87.0%) and regularly affected by drought. Steps should be taken for those farmers that they can take practice adaptation strategies. To overcome the adverse situation, GOs and NGOs should be taken initiatives during drought period.

5. CONCLUSIONS

Overwhelming majority (91 per cent) of the farmers had medium to high practice adaptation strategies in drought prone area. So, it could be depicted that adaptation strategies level of farmers was very good which might be adapted for the better improvement of adaptation strategies. It is a good sign that farmers of the study area had a good mentality to practice adaptation strategies in drought period. Communication exposure of the farmers had significant positive relationship with their adaptation strategies in drought prone area. Moreover, remarkable proportion (88%) of the farmers was not affiliated with any media and they had low communication exposure. Thus, it could be concluded that increased level of communication exposure might be helpful for them to form better practice of adaptation strategies in drought prone area. Some other characteristics of the farmers namely education,

farm size, drought affected area, household asset, annual family income, savings, water and sanitation, agricultural training received, cosmopoliteness, aspiration, planning orientation, environmental awareness were also significantly and positively correlated with their practice of adaptation strategies in drought period. Therefore, these characteristics were also important indicators in formulating any development programs regarding adaptation strategies in drought period. Regression and path analysis indicate that age, household asset, credit received, agricultural training received, and environmental awareness were the effective predictors having significant contribution farmers' adaptation strategies in positive direction. Proper agricultural trainings, supply inputs regarding drought tolerant varieties and seeds, provide more loan support, ensure availability of water for irrigation on overcoming the consequences of drought.

However, this study was confined to TanoreUpazila under Rajshahi District only. Findings of the study may verified by similar studies in other parts of Bangladesh. This study investigated the relationship of nineteenth characteristics of the farmers with their adaptation strategies in drought prone area as focus variable. Therefore, it is recommended that further research should be conducted to asses' relationship of other characteristics of the farmers with adaptation strategies in drought prone area. Correlation indicated that age, household size, credit received, perception of climate change, risk orientation and organizational participation did not have any significant relationship with their adaptation strategies in drought prone area. Verification of findings is necessary by conducting further research. The study deals with drought affected people only; however, separate study can be conducted with other disasters occurred in Bangladesh to find out their adaptation strategies against disaster.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

REFERENCES

1. Benson C, Clay E. Bangladesh: Disasters and Public Finance. Disaster Risk Management working paper series no. 6, The World Bank. Washington, DC; 2002.
2. WB. Karnataka crop insurance study, South Asia Region. Washington, D.C. (USA): The World Bank; 2003.
3. Smith K. Environmental Hazards: Assessing Risk and Reducing Disaster, 3rd edition. Rout ledge, Taylor and Francis Group, London and New York; 2000.
4. Iglesias A, Garrote L, Cancelliere A, Cubillo F, Wilhite AD. Coping with drought risk in agriculture and water supply systems, Drought Management and Policy Development in the Mediterranean, Advances in Natural and Technological Hazards Research. 2009;26.
5. Mirza MQ, Paul S. Prakritikdurgojob of Bangladesh Paribesh (Natural disaster and environment in Bangladesh), Centre for Environmental Studies and Research, Dhanmondi, Dhaka; 1992.
6. Adnan S. Living without floods: Lessons from the drought of 1992. Dhaka: Research and Advisory Services; 2003.
7. Hossain M. Natural calamities, Instability in production and Food policy in Bangladesh, the Bangladesh Institute of Development Studies. 2004;18(1).
8. Rahman A, Biswas PR. Devours resources. Dhaka Courier. 1995;11(42): 7-8.
9. Brammer H. Agricultural disaster management in Bangladesh. The University Press Limited, Dhaka. 1999; 273-290.
10. Hossain M. Natural calamities, instability in production and food policy in Bangladesh. The Bangladesh Development Studies. 1990;18(1):33-54.
11. Adnan S. Living without floods: Lessons from the drought of 1992. Dhaka: Research and Advisory Services; 1993.
12. Murshid KAS. Weather, new technology and instability in food grain production in Bangladesh. The Bangladesh Development Studies. 1987;15(1):31-56.
13. Paul BK. Coping mechanisms practiced by drought victims (1994/95) in North Bengal, Bangladesh, Applied Geography. 1998; 18(4):355-373.
14. Adhikary SK, Das SK, Saha GC, Chaki T. Groundwater drought assessment for Barrind Irrigation Project in North-western Bangladesh. Paper Presented to the 20th International Congress on Modeling and Simulation, Adelaide, Australia. 2013;1-6.
15. Brammer H. Drought in Bangladesh: Lessons for planners and administrators. Disasters. 1987;11(1):21-29.

16. Alexander D. Changing perspectives on natural hazards in Bangladesh. Natural Hazards Observer. 1995;10(1):1-2.
17. Shahid S, Behrawan H. Drought risk assessment in the western part of Bangladesh, J. of Natural Disaster. 2008; 46(3):391-413.
18. Jabbar MA, Choudhury MU, Huda MHQ. Causes and effect of drought aridity in northwest of Bangladesh, in proceedings of the first thematic conference on remote sensing of arid and semi-arid lands, Cairo. Egypt; 1982.
19. Jabbar MA. Causes and effect of drought/aridity in Bangladesh using remote sensing technology, in proceedings of ESCAP workshop on remote sensing technology in application to desertification/ vegetation type mapping. Tehran; 1990.
20. Karim Z, Ibrahim A, Iqbal A, Ahmad M. Droughts in Bangladesh Agriculture and irrigation schedules for major crops. Bangladesh Agriculture Research Council, Dhaka; 1990.
21. Saleh AFM, Mazid MA, Bhuiyan SI. Agro-hydrologic and drought risks analyses of Rainfed Cultivation in North-West Bangladesh; 2000.
22. Mazid MA, Mortimer MA, Riches CR, Orr A, Karmaker B, Ali A, Jabbar MA, Wade LJ. Rice establishment in drought prone areas of Bangladesh. Int. Rice Research Institute, Manila, Philippines. 2005;193-195.
23. Ahmed R, Bernard A. Rice price fluctuation and an approach to price stabilization in Bangladesh. Washington, D.C.: International Food Policy Research Institute; 1989.
24. Erickson NJ, Ahmad QK, Chowdhury AR. Socio-economic implications of climate change for Bangladesh. Dhaka: Bangladesh Unnayan Parishad; 1993.
25. Government of Bangladesh 2005: Launched The National Adaptation Program of Action (NAPA); 2005.
26. World Bank. Bangladesh: Climate Change and Sustainable Development. Report No. 21104 BD, October 10, 2000. World Bank Office, Dhaka; 2000.
27. WARPO-EGIC. An atlas of selected maps and spatial data in Bangladesh. Emerald Group Publishing Limited, UK; 1996.