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Mini pond technology for drought at Porsha Upazila of Naogoan district in Bangladesh

Obaydur Rahman[1], Nazmun Naher[2], A.K.M. Mahbubul Alam[3], Hosneara[4] and Bulbul Ahmed[5]*

[1]*Integrated Farm Management Component, DAE-DANIDA Project, Department of Agriculture Extension, Khamarbari, Dhaka-1215, Bangladesh*
[2]*Department of Agroforestry and Environmental Science, Sher-e-Bangla Agricultural University, Dhaka-1207, Bangladesh*
[3]*Pulse Research Sub-Centre, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur-1701, Bangladesh*
[4]*Plant Quarantine Wing, Department of Agriculture Extension, Khamarbari, Dhaka-1215, Bangladesh*
[5]*Plant Physiology Division, Bangladesh Agricultural Research Institute, Joydebpur, Gazipur-1701, Bangladesh*

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Corresponding Author

Name: Bulbul Ahmed
E-mail: kbdahmed@yahoo.com
Cell phone: +880-01737288897

ABSTRACT

Drought acts as a factor of low average agricultural production in North-West part of Bangladesh compared to other areas. The study was conducted to know the drought condition and impact of mini pond as a climate change adaptation technology in drought prone area. Total numbers of respondents were 50 selected considering 8% error by using Solving equation. To collect relevant information from the respondents, interview schedule was used. Technologies to support climate change adaptation were scored against nine criteria according to the evaluating model given by Asian Development Bank, 2014. Results revealed that most of the respondents (55%) were small farmers and 25% marginal farm category. In the study area, 62% respondents have less than 0.6 acre of homestead land and 76% was below 0.005acre of pond, but majority of the respondents (55%) taken Borga (lease) land. Most of the respondents (46%) belonged to the monthly income of Tk. 5001 to Tk.10000. All of the respondents (100%) cited that drought is the most terrific type of hazard and 80%were in favour of the statement of drought persist in April to May. Regarding the impact of drought on agriculture, 30% respondents referred that some crops damaged and 36% stated that their cropping intensity is dramatically reduced due to drought, 54% expressed the major crops that affected by drought and 80% believed that the cropping pattern Wheat-Fallow-T. Aman was highly affected by drought. Majority farmers (64%) had an idea on Minipond for supplementary irrigation. All the socio demographic characteristics of the respondent showed significant and positive relationships with their income except forest land. The study also revealed that the duration of drought has increased than that of past and some other hazards is posing new threat by changing their nature. The criteria, relative cost, co-benefits, feasibility of implementation were shown more desirable that is less than but effectiveness, co-costs and barriers were intermediate. Thus the establishment of mini ponds on their own or on sharecropped fields is a good option for small and marginal farmers with no or limited access to other ponds to harvest rainwater and provide supplementary (emergency) irrigation to their rice fields, in case urgently needed.

Introduction

Bangladesh is one of the most vulnerable countries to climate change in the world and will become even more susceptible in future. Now a days Floods, cyclones, storm surges and droughts are expected to become more frequent and severe (Saadat et al., 2009). It is further documented that many rivers and canals dry up during the dry season and make the people completely dependent on groundwater (Shahid, 2008). Declines of groundwater levels during the dry season in northwest Bangladesh has posed a major threat in irrigated agriculture system and recurrent drought is a common problem in this regard (Ahmed et al, 2014). Droughts are associated with the late arrival or an early withdrawal of monsoon rains and also due to intermittent dry spells coinciding with critical stages of T. Aman rice. Droughts in May and June destroy broadcast Aman, Aus and jute. Inadequate rains in July delay transplantation of Aman in high Barind areas, while droughts in September and October reduce yields of both broadcast and transplanted Aman and delay the sowing of pulses and potatoes. Boro, wheat and other crops grown in the dry season are also periodically affected by drought (Alexander, 1995). Adaptation technology can be defined as "the application of technology in order to reduce the vulnerability, or enhance the resilience, of a natural or human system to the impact of climate change" (UNFCCC, 2005).

These technologies can be classified into “hard” technologies, such as equipment and infrastructure, and “soft” technologies, including management practices and institutional arrangements (Christiansen et al., 2011). In farmlands with no irrigation source, rainwater harvesting through mini ponds as a climate change adaptation technology can provide supplemental irrigation. The practice is suitable to small and medium landowners. Limited family labor is required for the excavation of the mini pond, which farmers prefer to locate on a corner of the field. Many research and study has been taken on drought and irrigation related to crop production. But research on mini pond as a climate change adaptation technology in drought prone area for supplementary irrigation is not yet enough. So the study was taken to investigate the drought situation in the study area, the impact of mini pond as a source of supplementary irrigation and to evaluate the mini pond technique as a climate change adaptation technology.

Materials and methods

The study was conducted to study Minipond as a climate change adaptation technology on agriculture productionat Porsha upazila of Naogoan district.Soil-structure, rainfall-pattern, and temperature are the parameters of the study. The top and sub soil is generally clay to loam and substratum is dominantly clay soil. The mean annual total rainfall varies from 1400 to 1500 mmin the study area. However, the dry season rainfall is only 18-22% of the mean annual rainfall. Annual total evapo-transpiration rate in the study area varies from 1245-1350 mm. The mean annual temperature is around 25 $^{\circ}$C and means minimum and maximum temperature varies from 16-35 $^{\circ}$C. According to the study researcher was taken 50 samples.Primarily, this study covers 100 households. The farmers under the study were selected purposively so that study can be conducted in the villages where mini pond was used as a source of irrigation water.

Solving equation (Filloy and Rojano, 1989) was used for sample size determination considering 8% error. Solvin equation is given below-

$$\mathrm{n} = \frac{N}{1 + N(e)^2}$$

Where,
N = Total number of population (100)
n = Desirable sample size
e = Percent error (8%)

Hence, the total sample size was 50 farmers. Moreover, the socio-economic characteristics of the farmers in these villages also had similarities.

Effectiveness
This criterion measures how well a technology reduces vulnerability or increases resilience. In order to achieve a “more desirable” score on effectiveness, a technology must have some capacity to reduce vulnerability or increase resilience to climate change.

Relative cost

Relative-cost scores are based on cost figures obtained with the “more desirable,” “intermediate,” and “less desirable” scores being assigned according to a numeric scale. The cost scores are not consistent across sectors because the range of costs can differ substantially. All amounts are in US dollars. The scores are compared on the basis of the following scale:

More desirable = less than $10 per unit
Intermediate = $10–$10,000 per unit
Less desirable = more than $10,000 per unit

Co-benefits

This criterion measures other benefits besides reducing vulnerability or increasing resilience the technology may provide, such as increasing ecosystem services or creating jobs. Co-benefit scores are based on number and quality of the co-benefits from the technology.

Co-costs

This criterion measures the negative consequences of using the technology, such as ecosystem destruction or job loss. Co-cost measured by scores based on number and magnitude of the co-costs incurred with the technology.

Barriers to implementation

This criterion measures the difficulties standing in the way of technology implementation, such as the need for infrastructure investment or a specialized set of skills. The barrier scores are measured on based the number of barriers identified for the specific technology.

Feasibility of implementation

This criterion is particularly subject to contextual factors such as internet availability but also reflects such considerations as whether the technology has been adopted elsewhere and is appropriate for different conditions. A technology still in the research phase may receive a “less desirable” score; one that can be easily implemented in a variety of settings, a “more desirable” score.

Scale of implementation

This criterion measures the scale at which the technology is best applied.
Applicable locations and conditions

This criterion considers geophysical factors surrounding the use of the technology.

Potential financing and markets

This criterion considers factors such as the availability of the technology through private markets or an academic institution, or its use by other international organizations. It characterizes funding channels as public or private, and as established or emerging. It also considers the possibility of co-financing or public–private partnerships. Therefore, each technology should be evaluated individually in relation to contextual factors such as local geography, politics, local knowledge, or access to supplies, which might influence the scores in a given situation. The score for each category should be considered in close association with that technology's other attributes

Results and discussion

Chief of the family

It was found that themajority of the respondents (76%) were the family chief himself following son(16%), brother (6%) and wife (2%) in the study area (Fig. 1). So, it presents information aboutthe drought scenarioof different periods, the nature of cropping pattern, condition of annual agricultural production of different crops, state of indigenous knowledge for coping with drought and so many sound information were easily got from them.

Respondents Number based on their union at Porsha Upzilla

The major portion of respondents (60%) were selected from two unions namely Nitpur and Porsha Sadar (Fig. 2). It was done because agricultural activities, affinity of different NGOs, government roles etc. are numerous of these two unions. Equal number of respondents (20%) were selected from the remaining each union of Ganguria and Tetulia (Fig. 2). Overall impacts, adaptation practices were almost same in the four unions. Besides, the inhabitant's social and economical status were tied up in same thread during study period. Therefore, it is assumed that the impacts of drought in nearly same to every union (Ahmed et al., 2010).

Gender of the respondents

Regarding gender issue, participation of female respondents were very low (below 20%) and insignificant in the concerned area due to obstacles ofdifferent social and religious factor (Fig. 3). Therefore, the study got a little information of the female-intensive agricultural activities. However, real scenario of agricultural field, nature of drought, thinking of others people and role of different organizations in this regard, the informations were collected from the large number of male (above 80%) respondents.

Number **of respondents**

Results showed that the highest number (16%) respondents were selected from the village of Sisha, Saraigati and Kalinagar (Table 1). The lower number of respondents was selected from Shovapur (8%), Gopinathpur (8%), Amda (8%) and Shreekrisnopur (4%) villages, which was actually hub of the study area and Comprehensive Disaster Mangement Programmee-II (CDMP-II) took different initiatives to combat against drought with the support of Department of Agricultural Extension (DAE) and United Nations Development Programmee (UNDP). Besides a remarkable portion of respondents selected from Vhabanipur, Srikrishnopur and Sagolpara villages of different unions. So, study area was found and impacts of drought on agriculture producion were covered.

Occupation of the respondents

Among the different respondents, the maximum (64%) were farmer regarding their occupation (Table 2). Whereas, 16% was day labour and the percentage of other occupation viz.transport-sector worker (6%), service holder (6%), small business man (4%) and house hold worker (4%) were minimum (Table 2). Occupational group in this study area posses own land and they were affected substantially due to drought. Others occupational group are also concerned over the negative impact of drought. Apart from that, when any new adaptation techniques are introduced in this area through farmers, others group get opportunity to safeguard against drought. Simillar finding also described by Hossain et al., 2010 and Ahmed et al., 2010. It was known how the economic activity of others group namely Daylabor, Farmer, Household worker, Service holder, Small business man and Transport sector worker.

Family size of the respondents

Size of family was measured on the basis of total numbers of members of a family. The respondents were classified into three categories on the basis of their family size. It was observed that more than 50% of the respondents (52%) possesses medium family (Fig. 4). This statistics indicates that a lion portion of family incomeis incurredto meet up basic needs for members. Results also revealed that a significant number of respondents (27%) have large family and they suffered more to meet up basic needs of their family incumbent. The number of family members of the respondents of the study area ranged from 2 to 8, with an average of 4.53. The average family size of Bangladesh is 5.6 (Anonymous, 2005) while average family size of the study area was lower than the national average.

Educational qualifications of the **respondents**

Analysis of data indicated that 36% respondents had no formal schooling and 50% of them could sign only (Table 3). Among others, 34% had primary level education, 24% had secondary and 6% had higher secondary and above level education.The results showedthat a significant portion of farmers completed the basic level of education. Therefore, they have some understanding of drought, newly invented adaptation techniques for coping with drought. Comparing to national average literacy rate 62% (Shabnam et al., 2017) it was easily visible that the educational situation of respondents in study area was below typical.

Category of respondent regarding farm size

The respondents were classified into three categories according to their farm size (Fig. 5). The average farm size of the respondents was 0.27 ha. The respondents varied greatly in farm size ranging from 0 to 1.0 hectare. It also revealed that about 55% respondents were small farmers followed by 25% in the marginal farm category, 10% belonged to middle farm category and only 2.5% belonged to large farm category. Thus almost all the respondents 83.80 percent had fallen in the possession of small land marginal farm. Therefore, they failed to attain desired agricultural output and always keep on vicious circle of poverty. According to BBS (2002) the distribution of national average are 52.85 percent small farms, 31.65 percent marginal farms and 1.67 percent large farms, which is nearest to the above findings.

Homestead land size of the respondents

Homestead area of the respondents differed remarkably. The most of the respondents (62%) have less than 0.6 acre of homestead land and only 8% have more than 0.8 acre of land. Besides, a significant part (26%) have homestead land in between o.6 to 0.8 acre of land (Fig. 6). The inhabitants of the study area cultivated different types of vegetables and planting fruit-trees regularly in their homestead, which affected severely by drought. Those involved in take care of these homestaed vegetables and fruit-tree are very much familiar with attacking nature of drought.

Pond size of the respondents

It is revealed that pond size of the most respondents (76%) was below 0.005 acre. Beside, pond area 14% of respondents were in the line between 0.05 to 0.10 acre and only 2% had big size of pond (Fig. 7). The water holding capacity of these ponds was poor in nature. Prolonged drought condition as well as irrigation demand are responsible factors for drying water quickly in these pond. Therefore, fish sellingis not an essential component of income portfolio of people's in that area (Islam et al., 2011).

Forest land **of the respondents**

From the results it was found that maximum (about 44%) respondents of study area have no forestland at all. However, a significant part (36%) possesses gardening area less than 0.10acre of land. Besides, 20% have forest land ranged from 0.10 to 0.20 acre of land (Fig. 8). Therefore, it might be concluded that trees grown in the forest is tremendously affected in that study area.

Borga (Lease) land of the respondents

Majority of the respondents (55%) in the study area taken Borga (lease) land below 0.10 acre, 25% were in 0.10-0.20 acre and other 20% respondents were in 0.20-0.30 or ≥0.30 acre in respect of Borga/lease land (Fig. 8). In fact, farmers financial capability is not well off to buy agricultural input to perform agricultural activities properly and they also suffers in the fear of drought effect.

Agricultu**r**al **land of the respondents**

Data depicted that 50% farmers have more than 0.80 acre of cultivable land, 20% have 0.60-0.80 acre and 30% have less than 0.60 acre cultivable land (Fig. 10). Therefore, agricultural land plays significant role in their income portfolio and most of the farmers are very much aware about the probable effect of drought in their field. To mitigate the annual production loss they had to perform forestry, fisheries, live-stock etc. for generating extra money to survive.

Family Income per Month

The respondents were classified into three cetegories according to Islam et al., 2014, which are low, medium and high income groups (Fig. 11). Analysis of data indicated that 46% of the respondents belonged to the monthly income of Tk. 5001 to Tk.10000 followed by 30% in Tk. 10001 to Tk.15000, 20% in below Tk. 5000 and only 4% in more than Tk. 15000 income group (Fig. 11). Results inrespect of family income, an insignificant part (4%) have sufficient income considering their socio-economic status. Different types of climate-induced hazards, lack of adept work force, uncaring to fieldwork, unfamiliar with new techniques of adoption etc. are the rendering factor to higher income. Average monthly family income of the respondents was Tk. 6562, which was lower than national average monthly family income of Tk. 8863 (BBS, 2004). The findings indicated that the socio-economic condition of the study area peoples were poor than a typical social system of Bangladesh.

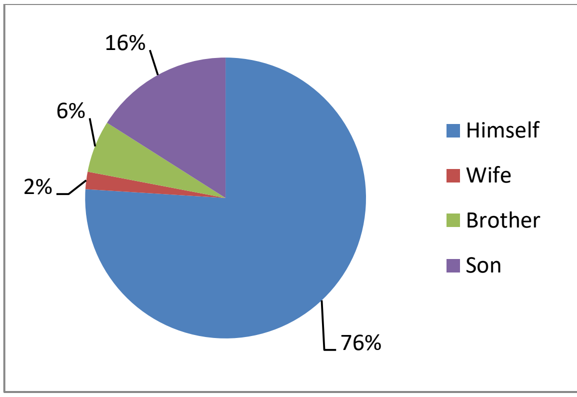

Fig. 1. Distribution of the chief of the family among the respondents

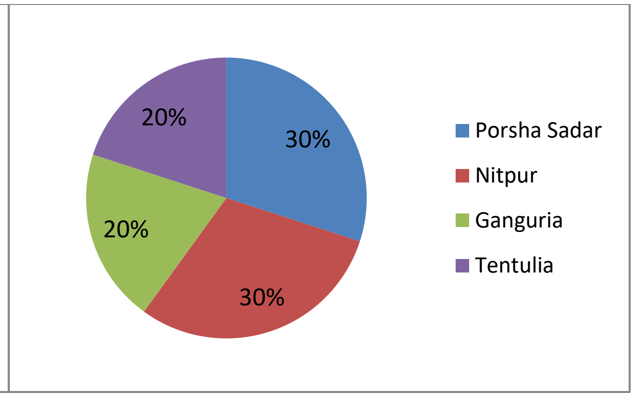

Fig. 2. Distribution of respondents in the four unions of Porsha upazila.

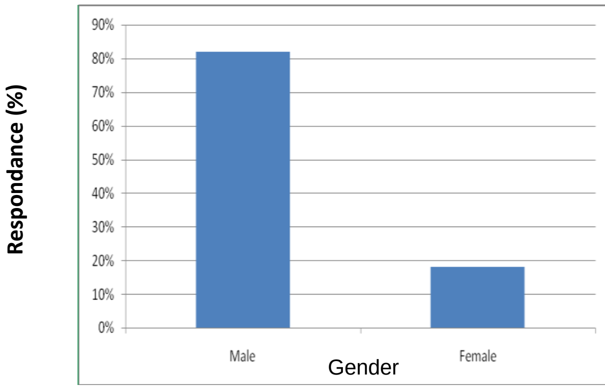

Fig. 3. Gender distribution among the respondents.

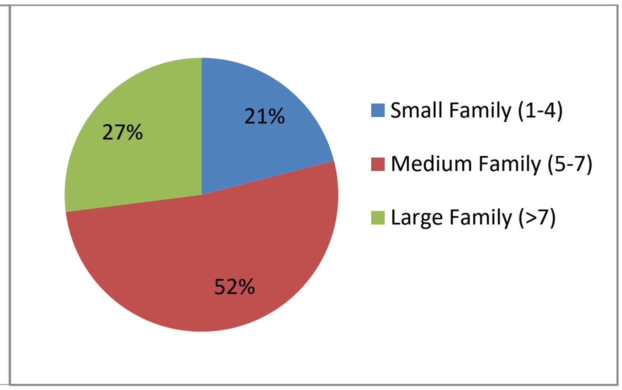

Fig. 4. Distribution of the respondents according to their family size

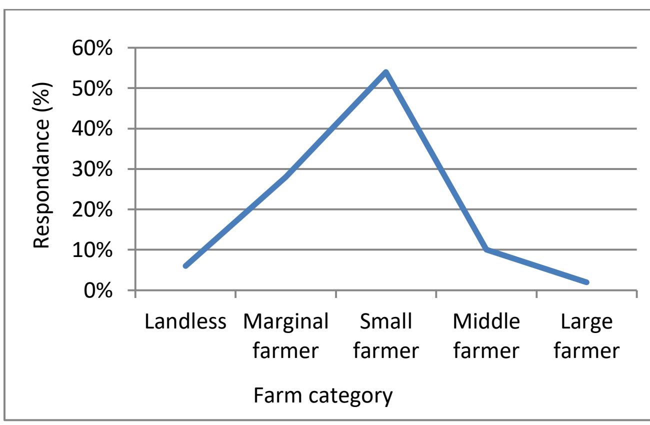

Fig. 5. Distribution of the respondents according to their farm size.

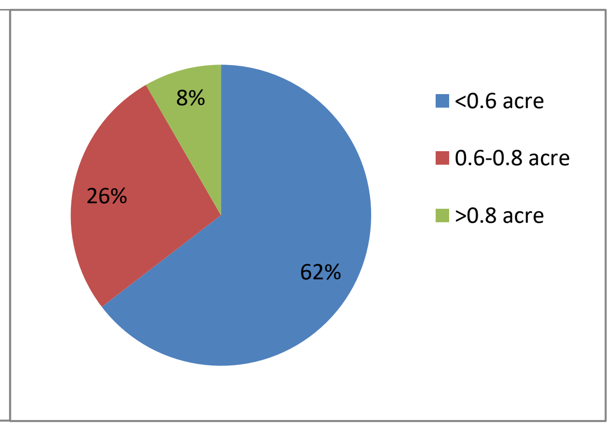

Fig. 6. Homestead land size distribution of the respondents.

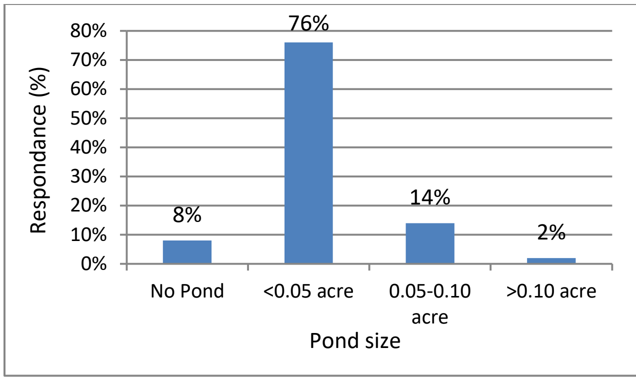

Fig. 7. Distribution of pond size among the respondents in study area.

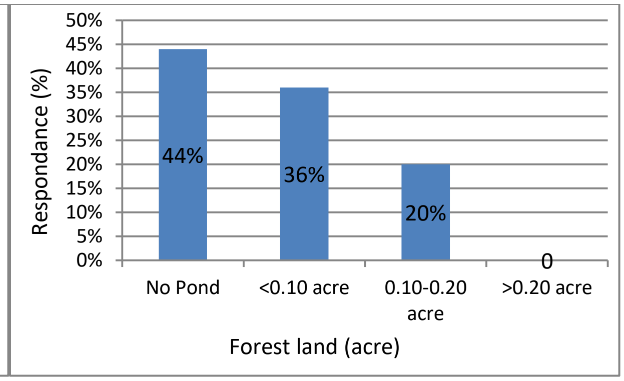

Fig. 8. Forest land distribution among the respondents in study area.

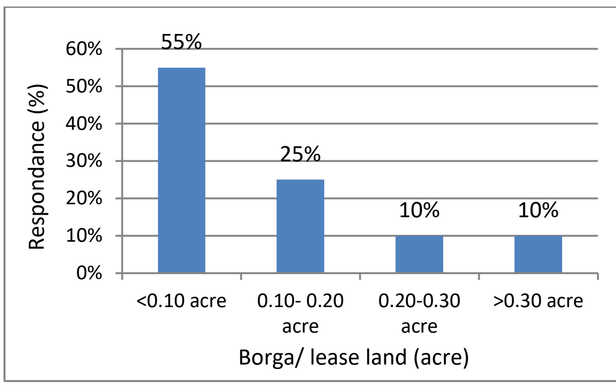

Fig. 9. Borga (Lease) land distribution among the respondents in study area.

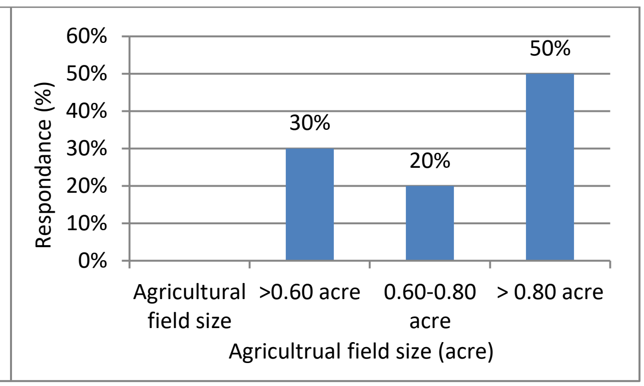

Fig. 10. Agricultural land holding by the respondents in the study area.

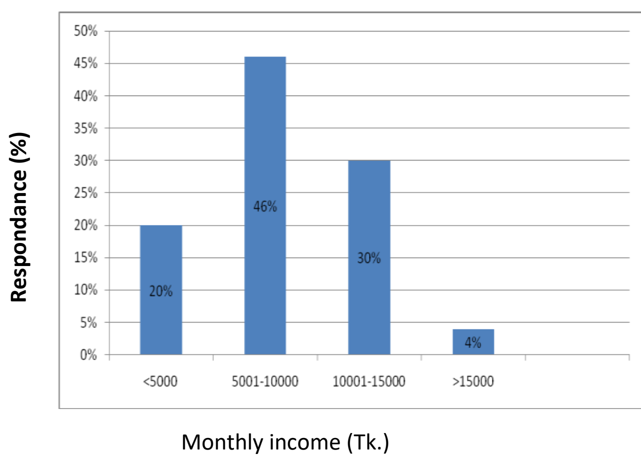

Fig. 11. Distribution of the respondents according to their annual income.

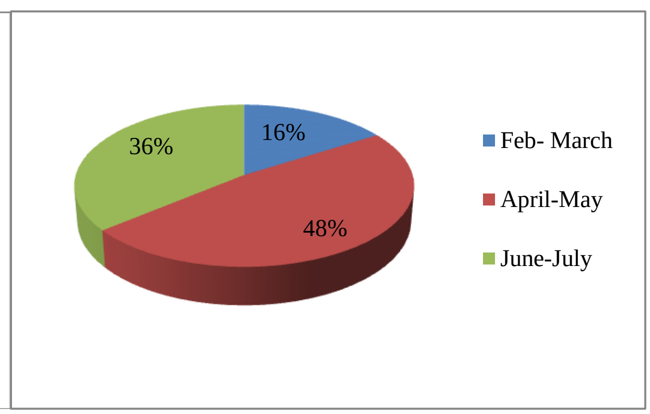

Fig. 12. Present drought-occurring time in the study area.

Drought Impacts on the study area

In the present situation, different type of hazards occured in the study area namely drought, coldwave, thunderstorm, heatwave, insect infestation and tornado are presented inTable 4. All of the respondents (100%) cited that drought is the most terrific type hazard. Cold wave was the second devaststing type according to the 80% respondents opinion. Insect infestation (76%) also became serious hazard due to climate change followed by heatwave (72%) on basis of respondent opinions (Table 4).

Different type of hazards occurred in the past

According to the opinion of the respondents drought was also the predominant type (100 parcent) of hazard in past (Table 5) following coldwave (64 parcent). The ruinous nature of coldwave, thunderstorm heatwaves and tornado were not as much of present time. But, the damaging nature of tornado was more in the past. Some respondents said that, they actually forgot in some of the past-occurring hazards and others told, many times two or more types of hazard worked together and they did not identified clearly.

Present-drought occurring time

Inrespect of present-drought occuring, it was observed thatabout 50% of the respondents (48%) expressed that the intensity of drought persist in April to May. A remarkable part (36%) believed that the intensity of present drought is understandable from June to July. A very insignificant part (16%) thinked that February and March were the suitable time of drought (Fig. 12). Results revealed that in very recent drought was the severe natural hazared in the study area, which affected the agricultural production. Inadequate rains in July delay transplantation of Aman in high Barind areas, while droughts in September and October reduce yields of both broadcast and transplanted Aman and delay the sowing of pulses and potatoes (Islam et al, 2014). Boro, wheat and other crops grown in the dry season are also periodically affected by drought (Alexander, 1995).

Past-drought occurring time

In case of past-drought occuring in the same coverage period, highest respondents (80%)were in favor of the statement of drought persist in April to May. Only 14% of the respondents thinked that February to March were the suitable time of drought and a very insignificant part (6%) seems to intensity of past-drought occurring time was June to July (Fig. 13). For the analyzing of past and present drought-occuring period, it was observed that the nature of persistent of drought has increaesd in a great dimension. A few respondents thinked that drought were not seveire in Februaruy and March. Because on that time, irrigation deamd is coparatively low and a significant portion reamains in fallow.

Table 1. Village wise distribution of respondents in the study area

Name of Village	Number of Respondent	Respondents
Shovapur	4	8%
Gopinathpur	4	8%
Srikrishnopur	2	4%
Sisha	8	16%
Vhabanipur	6	12%
Amda	4	8%
Saraigati	8	16%
Kalinagar	8	16%
Sagolpara	6	12%
Total	50	100%

Table 2. Occupation distribution among the respondents

Occupation	Freq.	%	Valid %	Cumulative %
Day labor	8	16.0	16.0	16.0
Farmer	32	64.0	64.0	80.0
Household worker	2	4.0	4.0	84.0
Service Holder	3	6.0	6.0	90.0
Small Businessman	2	4.0	4.0	94.0
Transport Sector Worker	3	6.0	6.0	100.0
Total	50	100.0	100.0	

Table 3. Educational status of the respondents in the study area

Categories	Number	Percentage
Illiterate	9	18
Only can sign	9	18
Primary level	17	34
Class eight	8	16
SSC	4	8
HSC	2	4
BSc /MS	1	2
Total	50	100

Table 4. Different type of natural hazards occurred at present in the study area

Name of the Hazards	Citation No.	Percentage
Drought	50	100
Coldwave	40	80
Thunderstorm	22	44
Heatwave	36	72
Tornado	08	16
Insect Infestation	38	76

Table **5.** Different type of natural hazards occured at past in the study area

Name of the Hazards	Citation No.	Percentage
Drought	50	100
Coldwave	32	64
Thunderstorm	12	24
Heatwave	28	56
Tornado	22	44
Insect Infestation	18	36

Present duration of drought

In the present condition, most of the respondentds (38%) expressed their opinionthat duration of drought of their locality near about 90 days and a significant portion (34%) said that drought sustain even more than 90 days. Only 10% and 18% of the respondents believed that the present duration of drought were 1-30 days and 1-60 day, respectively (Fig. 14). Due to climate change, irregular distribution of rainfall and erratic behavior of weather is percived to the farming community, which affected directly and accelerated the duration of drought of that area. Alexander (1995) observed that droughts are associated with the late arrival or an early withdrawal of monsoon rains which is similar to the finding.

Past duration of drought

Highest respondents (58%) refered that duration of drought were 1-60 days following 1-30 days (30%). No respondent was found who told drought spell were 90 days and only 12% of the respondents believed that the past duration of drought were 1-90 days (Fig. 15). As a result, the spell of drought increased on an average 30 days from past to present.Inadequate rains in July delay transplantation of Aman in high Barind areas, while droughts in September and October reduce yields of both broadcast and transplanted Aman and delay the sowing of pulses and potatoes. Boro, wheat and other crops grown in the dry season are also periodically affected by drought (Alexander, 1995).

Impact of drought on agriculture in present

Majority of the respondents (30%) refered thatsome crops damaged and a remarkable parts (24%) judged increased irrigation cost and reduce cropping intensity due to drought in their field. Some respondents (12%) stated that fallow land was increased day by day due to drought (Fig. 16). It might be drought directly hampered the growth and development stages of crops resulting crop damaged and increased fallow land. Simillar finding is stated by Shahid, 2008 that recent declines of groundwater levels during the dry season in northwest Bangladesh has posed a major threat in irrigated agriculture system.

Impact of drought on agriculture in past

In the past situation, most of the respondents (36%) stated thattheir cropping intensity is dramatically reduced. Among the respondents 26% belived some crop damaged and 14% believed total crops damaged due to drought (Fig. 17). Therefore, they were failed to attain their desired goal of agricultural output in the past, resulting dropped out one or more crop from the cropping pattern due to drought. From these two standpoints, 4% respondents were ruduced their views in the case of total crops damaged because recently many types of adaptation options already adopted by DAE, UNDP, FAO and NGOs.According to (Hossain et al., 2010) drought is a common problem in irrigated agriculture system.

Impact of drought on the major crops in present

Data presented in Fig. 18 showed that maximum portion of respondents (54%) expressed rice, oil seeds and vegetables were the major crops that affected by drought. From the results it was found more or less similar response regarding effect of drought on other crops in present situation (Fig. 18). It might be the impact of drought that rice, oil seeds and vegetables are the major crops in the study area. Saadat et al., (2009) reported that crop production of Bangladesh is severely affected due to droughts.

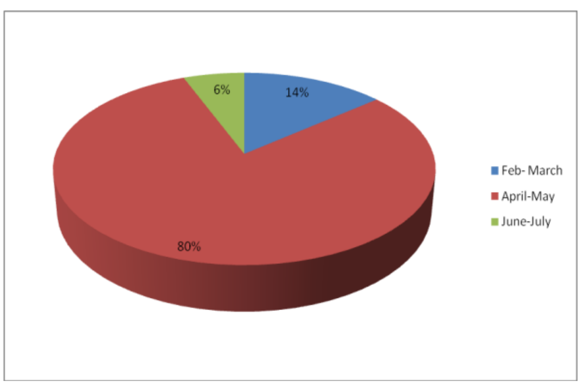

Fig. 13. Past drought-occurring time in the study area.

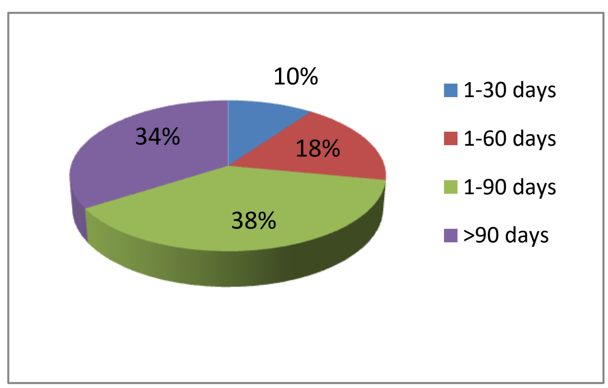

Fig. 14. Present duration of drought in the study area.

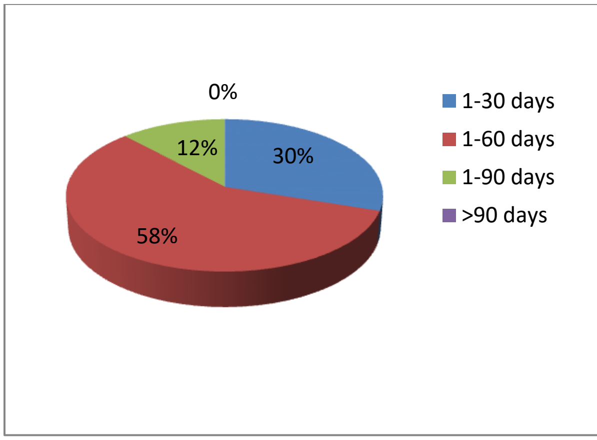

Fig. 15. Past duration of drought in the study area.

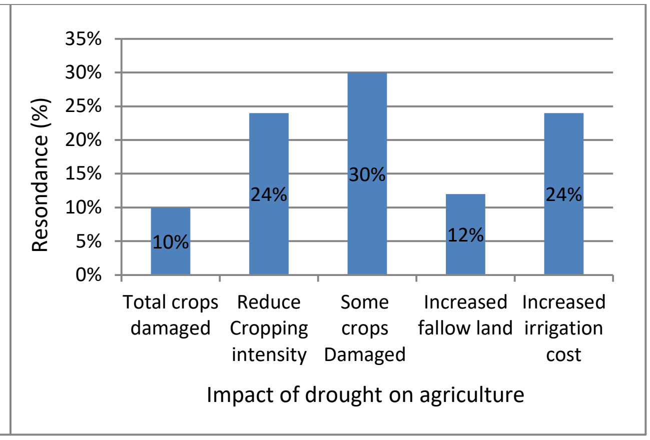

Fig. 16. Impact of drought on agriculture in present in the study area.

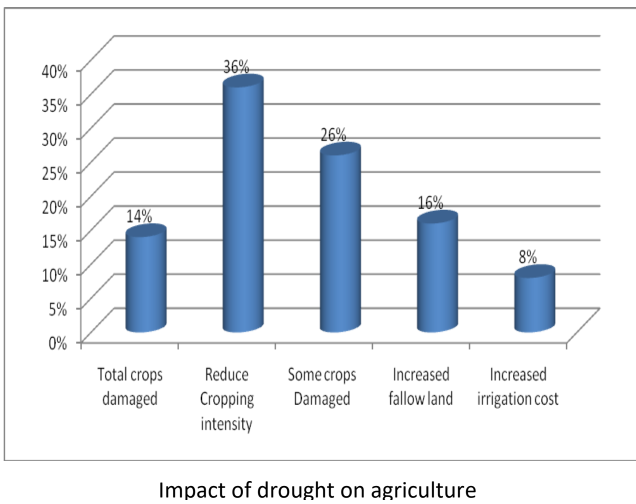

Fig. 17. Impact of drought on agriculture in past in the study area.

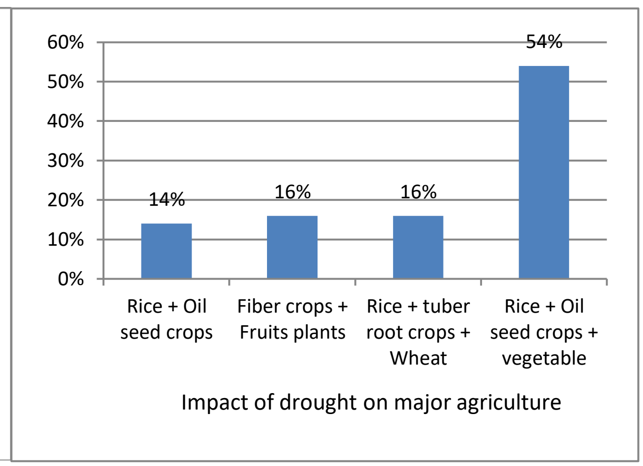

Fig. 18. Impact of drought on the major crops in present in the study area.

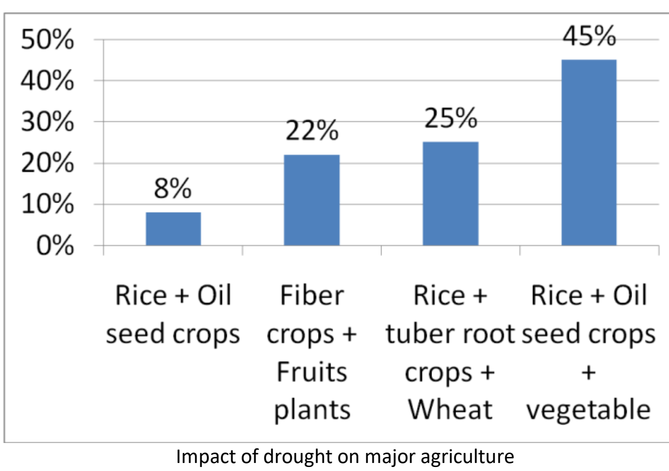

Fig. 19. Impact of drought on the major crops in past in the study area.

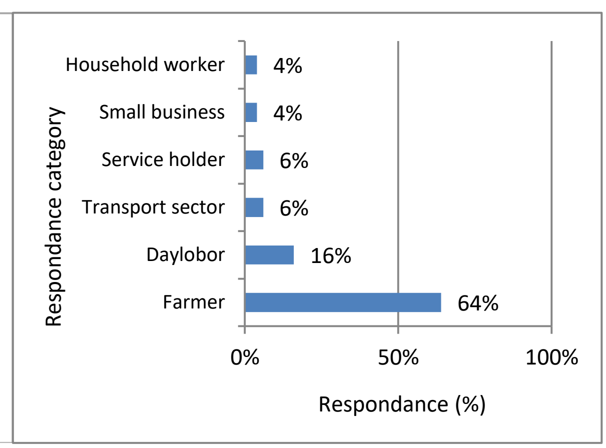

Fig. 20. Idea of respondents on Minipond for using supplementary irrigation in the study area

Impact of drought on the major crops in past

The highest (45%) respondents said that rice, oil seeds and vegetables were affected by drought following rice, tuber root crops and wheat (Fig. 19). In fact, rice is the main item of past and present cropping pattern in the study area that was affected severely by drought in the both time. Therefore, the trend of impact of drought on the major crops in past and present in the study area were more or less similar. Rahman and Biswas (1995) observed that the continued drought in the northwestern districts of Bangladesh led to a shortfall of rice production of 3.5 million tons.

Impact of drought on present cropping pattern

Response of interviewee differed in respect of impact of droughton present cropping pattern showed in Table 6. In present, the majority of respondents (80%) believed that the cropping pattern Wheat-Fallow-T.Aman was highly affected by drought, which was followed by Wheat-T.Aus-T.Aman. It might be due T. Aman rice is the major crop in the study area that grown during drought seasons.

Impact of drought on past cropping pattern

In the past condition, data collected from respondents showed that Fallow-Fallow-T. Aman cropping patterns was the first priority to the 100% respondents, thereafter, 96% respondents expressed their opinion on Fallow-T. Aus-T. Amam cropping pattern affected by drought (Table7). It also might be due T. Aman rice was the major crop in the study area that grown during drought seasons.

Idea on Minipond for supplementary irrigation

Among the respondent's category 64% farmers had an idea on Minipond use as supplimentary irrigation and near about 18% day labour had such type of idea. Other categories viz. transpor sector, service holder, small bussiness man and household worker on had a poor idea on Minipond use as supplimentary irrigation (Fig. 20). The results indicated that farmers know how to mitigate the drought situation by using Minipond for supplimentary irrigation because they are directly related to crop production and they also understood the benefit of Minipond as a irrigation water source.

Knowledge of respondents on adaptation options in drought prone area

The respondents gave their opinion on the different type of adaptation techniques for coping with drought presented in Table 8. Among the different adaptation options, mini pond for supplementary irrigation in boro (winter) rice and pit crop cultivation was the highest (16%) as well as mixed fruit garden (16%). The second options were Jujube (apple kool) plantation at dyke of Mini pond (12%) and dry seed bed (polythene covered) technology of boro (winter) rice: A newly evolved technology in context of changing climate (12%). Kutch (1982) stated that annual rainfall is not the most important factor in water harvesting, especially looking at the technology used to sustain food production in the Negev desert of Israel with an annual rainfall of about 100 mm which is similar to the study. An evaluation finding like FAO also shows similar that the use of small-scale irrigation has a general increase in the availability of food and earning capacity of poor households in developing countries (FAO, 2006).

Relationship between characteristics of the respondents to their income using mini pond as a source of supplementary irrigation

Pearson's Product Moment Coefficient of Correlation (r) was computed in order to explore the relationships between the selected characteristics and Mini pond as a climate change adaptation technology on agricultural production of the study area. The coefficient of correlation (r) was used to test the null hypothesis regarding the relationship between two concerned variables. Co-efficient of correlation 'r' between the selected characteristics of the rural people and their household income condition has been presented in Table 9. However; the interrelationships among the different variables have also been computed by using correlation co-efficient.

From Table 9, it might be stated that family income is highly significant (1% level of significance) with education, category of farmers, homestead land size, pond size, irrigation cost from mini pond and irrigation cost from tube well where non-significant. However, the relationships have been presented in the following sub-sections dealing with one of the characteristics of respondent of study area people.

Table 6. Present cropping patternin the study area affected by drought

Cropping Pattern	Citation No.	Percentage
Wheat-T. Aus-T. Aman	34	68
Whaet-Fallow-T. Aman	40	80
Boro-T. Aus-T. Aman	21	42
Chickpea-Coriander-T. Aman	18	36
Vegetables-Vegetables-T. Aman	17	34

Table7. Past cropping pattern in the study area affected by drought

Cropping Pattern	Citation No.	Percentage
Fallow-Fallow-T. Aman	50	100
Fallow-T. Aus-T. Aman	48	96

Table **8.** Response of rural people to thedifferent types of adaptation options for drought in the study area

Adaptation Option	No. respondents	Percentage
Mini pond for supplementary irrigation in Boro (winter) rice and pit crop cultivation	8	16
Mixed fruit garden: Options for exploiting the threat of drought	8	16
Malta (sweet orange) garden	2	4
Jujube (apple kool) plantation at dyke (embankment) of Mini pond	6	12
Water melon cultivation using sex pheromone by supplementary irrigation	5	10
Drought tolerant boro rice (BRRI dhan28/BINA dhan-7) cultivation	5	10
T. Aman (BRRI dhan49) followed by grass pea/sweet gourd cultivation as relay crop	4	8
Dry seed bed (polythene covered) technology of boro (winter) rice: A newly evolved technology in context of changing climate	6	12
Summer tomato cultivation	2	4
Community based homestead vegetable cultivation	4	8
Total	50	100

Table 9. Correlation co-efficient between selected characteristics of the respondents andfamily income in the study area

Dependent variable	Independent variables	Computed 'r' values with 48 df (n=50)
Family Income	Family size	-0.353*
	Education	0.688**
	Category of farmer	0.388**
	Homestead land size	0.429**
	Pond size	0.668**
	Forest land	0.261NS
	Irrigation Cost from Mini Pond Tk./ha	0.735**
	Irrigation Cost from tube well Tk./ha	0.643**

** Correlation is significant at the 0.01 level
* Correlation is significant at the 0.05 level
NS = Not significant

Conclusion

Drought is the most terrific type hazard and the highest (80%) respondents were in favor of the statement of drought persist in April to May following 30%respondents refered thatsome crops damaged and 36% stated thattheir cropping intensity is dramatically reduced due to drought,54% expressed the major crops that affected by drought and 80% believed that the cropping pattern Wheat-Fallow-T.Aman was highly affected by drought. Majority farmers (64%) had an idea on Minipond use as supplimentary irrigation.All the socio demographic characteristics of the respondent showed significant and positive relationships with their income except forest land. The criteria relative cost, co-benefits, feasibility of implementation were shown more desirable and effective.Thus the establishment of mini ponds on their own or on sharecropped fields is a good option for small and marginal farmers with no or limited access to other ponds to harvest rainwater and provide supplementary (emergency) irrigation to their rice fields, in case urgently needed.

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