

FARMERS' ADAPTATION STRATEGIES TO DROUGHT AND THEIR DETERMINANTS IN BARIND TRACT, BANGLADESH

M.S. Islam^{1*}, M.Z. Hossain² and M.B. Sikder¹

¹Department of Geography and Environment, Shahjalal University of Science and Technology
Sylhet-3114, Bangladesh

²Department of Statistics, Shahjalal University of Science and Technology
Sylhet-3114, Bangladesh

ABSTRACT

Farmers' choice of drought adaptation measures depends on several determinants that include their socioeconomic, demographic, and agricultural characteristics. This study aimed to investigate the presence of dependency or association between the adaptation strategies implemented by farmers' own initiative and their determinants in the Barind Tract of Bangladesh. The study was mainly based on primary data collected through a household level survey using a structured questionnaire covering 400 farming households from an extended area comprising 10 Unions from 03 Districts, viz. Rajshahi, Chapai Nawabganj, and Naogaon in northwest Bangladesh. The chi-square test and Cramer's V test has been applied to measure the association between variables and the strength of the association respectively. The study found that the nature of adaptation strategies implemented by farmers is mainly related to crop production and income generation. Their capability noticeably lacks to facilitate artificial irrigation that made them dependent on government's initiatives. The association between the implemented adaptation measures and selected variables suggests that the farm size, irrigation accessibility, monthly household income, land ownership status, literacy level, and poverty status played significant role in the implementation of adaptation measures. Finally, limitations of currently practiced adaptation strategies and future way forward have been discussed for better drought risk management.

Keywords: Adaptation, Drought, Barind Tract, Determinants

INTRODUCTION

The nature of drought occurring in Bangladesh is mainly agricultural drought. It refers to the scarcity of water required for the plant's growth resulted from a soil moisture deficiency due to precipitation shortage and the difference between actual

* Corresponding Author: mdsaiful91@gmail.com

and potential evapotranspiration (Wilhite, 2000). Almost 15% households in Bangladesh were affected by drought between the year of 2009 and 2014, while one household in every four is affected by drought in Rajshahi Division (BBS, 2015). Farmers are the most direct sufferer from drought as they face difficulties to irrigate their cropland due to scarcity of water resulted from drought (Shahid, 2010). The direct consequence of drought is the loss of crop production that affects the life and livelihood of the concerned people as well as indirectly it affects GDP, local labor market, and economic growth as a whole. For example, Aman¹ Rice accounts about two-third of total annual rice production of 34 million tons (BBS, 2015), from which one-fifth portion is damaged due to inadequate irrigation in a typical year. In 2006, the last severe drought occurred in the country, caused a reduction of Aman Crop production of about 25–30% in the northwest region (Rahman et al., 2008). Overall, in all of the three cropping seasons, namely Kharif-1, Kharif-2, and Rabi of Bangladesh, about 0.40, 0.34, and 0.45 M ha agricultural lands respectively are severely affected by drought in every year (Habiba et al., 2011).

Barind Tract, the largest Pleistocene physiographic unit of the Bengal Basin covering the northwest region of the country, is considered as most drought prone area (Ahmed, 2012; Shahid and Behrawan, 2008; Hasan and Islam, 2013; Shahid, 2008). This region receives less amount of rainfall than that of other parts of the country. Due to complex geologic formation, groundwater is also not available in many parts of the region. As a result, water scarcity creates a soil moisture deficiency that affects crop production. It is not possible to alter climatic or geologic phenomena to control the adversity caused by drought; however, it is possible to lessen the damage of a disaster by undertaking adaptation measures. The farmers in northwest Bangladesh, the most drought affected region of the country, are implementing different types of adaptation measures to reduce the adverse consequences of drought (Habiba et al., 2012; Karim et al., 2017; Hossain et al., 2016; Paul, 1998; Alam, 2015). Adaptation helps farmers to achieve their goals of food, income, and livelihood security in the face of changing climatic and socioeconomic conditions, including climate variability, extreme weather conditions, i.e. drought (Kandlinkar and Risbey, 2000).

The capability of decision making regarding the implementation of adaptation measures by farmers' own initiatives depends on several influential factors called the determinants. The determinants mainly play their role in influencing farmers' decision making regarding the types of adaptation measures they intend to undertake. The previous studies found that the factors that determine the nature of adaptation measures undertaken by farmers vary within social, economic, demographic, and agricultural characteristics of farmers and their households (Hassan and Nhemachena, 2008; Deressa et al., 2009; Ishaya and Abaje, 2008). Knowledge of the

¹Bangladesh has three cropping seasons locally known as Kharif-1 (mid-March – June), Kharif-2 (July – mid-October), and Rabi (mid-October – mid-March). Among them, Rabi season completely depends on irrigation, whereas other two are mainly rain-fed agriculture.

adaptation methods and factors affecting farmers' choices can enhance the policies directed toward tackling the challenges that drought is imposing on agriculture (Deressa et al., 2009). However, there is a lack of studies addressing the determinants of adaptive policy implementation in the case of drought in Barind Tract. Therefore, this study intends to investigate the currently practicing adaptation measures by farmers as well as to examine the influence of different explanatory variables on farmers' decision making regarding the nature of adaptation methods considering various socioeconomic, demographic, and agricultural characteristics.

The findings from this study will help the policy implementers in understanding the types of determinants having more or less influence regarding the capacity building of implementing the adaptation measures. Government and other non-government organizations (NGOs) would be able to improve the farmers' capacity of implementing different types of measures through developing these factors in order to reduce the adverse impacts of drought.

MATERIALS AND METHODS

This study has carried out mainly based on primary data collected through a household-level survey of an extended area. The target group of the survey was farmers who are affected by drought and cultivating different types of crops on their own or rental land as well as undertaken at least one adaptation measure by their own initiative. A structured questionnaire was prepared to collect the data through face-to-face interview of respondents across the study area. The survey was held during February-March, 2017. The data covered socioeconomic and other possible factors that influenced the farmers' decision making regarding the implementation of adaptation strategies.

Sample Size Estimation

Cluster sampling methodology was adopted to select the units of observations (farmers) where the Unions (lowest unit of administrative hierarchy) were considered as clusters. The following recognized formula was applied to determine the sample size:

$$n = \frac{p(1-p)Z^2}{(d)^2} \times Deff \quad (1)$$

Here,

p = Indicator percentage = 50% (proportion of households adopted any sort of measures to cope with drought)

Z = Value of normal variate with 95% confidence interval = 1.96

d = Relative error margin = 0.06

$Deff$ = Design effect = 1.5

The above-mentioned formula yields that at least 400 targeted households are required to cover for the study.

Sampling Technique

The study areas and households for questionnaire survey were selected following several steps. Firstly, according to drought severity ranking prepared by MoDMR (2013), seven Upazilas were selected, which are ranked as ‘very severely’ drought-affected areas. Secondly, total ten Unions were picked up using the Systematic Probability Proportional to Size sampling procedure from those Upazilas (Table 1). Then, two villages were chosen randomly from each of the selected Unions. Finally, twenty farming households were interviewed from each of the villages following UNICEF pencil-spin method (WHO, 2015). Fig 1 shows the map of the study area.

Table 1: Details of study area

District	Upazila	Union
Rajshahi	Godagari	Matikata
	Tanore	Rishikul
		Talanda
ChapaiNawabganj	Nachole	Kasba
	Gomastapur	Radhanagar
		Parail
	Niamatpur	Niamatpur
Naogaon	Porsha	Chhaor
		Tentulia
	Sapahar	Tilna

Analytical Techniques

At first, Pearson’s Chi-Square Test was performed to assess the association between implementation of adaptation measures and their determinants. This test determines the association between categorical variables, *viz.* whether the variables are independent or correlated. It is a non-parametric test consisting of two hypotheses. The null hypothesis states that there is no association between the variables, whereas the alternative hypothesis is in favour of the association. If the calculated p-value of the test is greater than α ($=0.05$), the null hypothesis will be accepted, while the p-value less than/equal to α allows the acceptance of alternative hypothesis. Secondly, Cramer’s V (Cramer, 1946) was calculated to determine the strength of correlations between the variables. The value of the V varies from 0 to 1. The V values closer to zero shows a weak association between the variables, whereas the value closer to 1 indicates a strong association. In addition, frequency distribution was used to

describe the background characteristics of respondents. All of the statistical operations were carried out using SPSS Software.

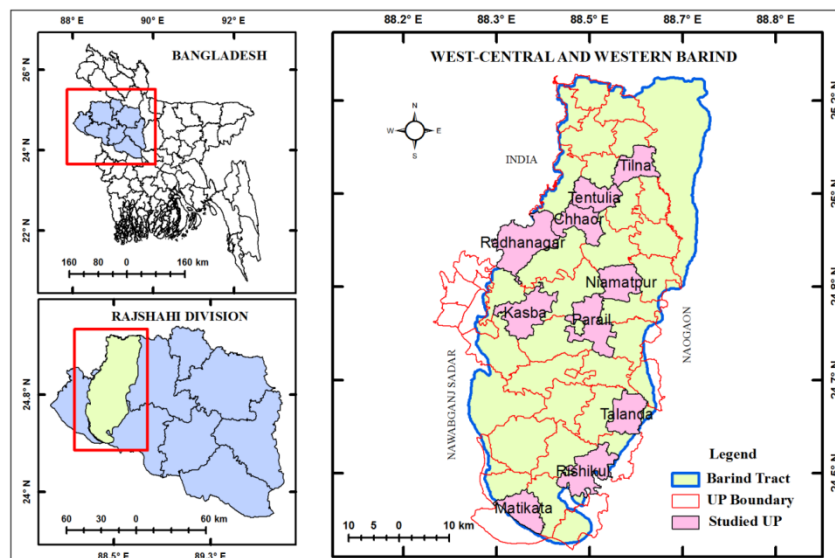


Figure 1. Map of the study area showing selected Unions

RESULTS AND DISCUSSION

Background Characteristics of Farmers

Farmers' background characteristics include demographic, socioeconomic, landholdings, irrigation, and agricultural related variables. This section intends to describe some key figures of background characteristics, whereas details are shown in Appendix Table A. There is a dominance of middle-aged farmers (about 66%) in the study area followed by older aged farmers (about 30%). About two-fifth of farmers had not received any formal education, while almost two-third have received a primary level education. Almost half of the farmers cultivate their crops as tenant farmers followed by quarter of them with own agricultural land. The number of nuclear family accounts almost four times higher than its counterpart—the joint family. Nearly half of the farming households belong to the lower medium income group earning Tk.5000.00 to Tk.10,000.00 on a monthly basis. The poverty status shows that about 36% and 50% households remain below poverty line considering the lower and upper poverty line, respectively, which is higher than previous national level estimations [21.1% and 35.2% based on lower and upper poverty line respectively (BBS, 2010)]. About 80% farmlands have accessibility to irrigation facilitated by the Barind Multipurpose Development Authority (BMDA). Most of the agricultural farms are small in size (1 – 2 acre) followed by very small and moderately large categories that cover ≤ 1 and 3 – 7.5 acre respectively. The study has also found that almost two-third portion of households is partially capable of

purchasing food, whereas a very small portion (about 3.5%) is incapable. Overall, the background characteristics suggest that the surveyed respondents came from a heterogeneous group of farmers representing all classes of society.

Adaptation Measures Undertaken by Farmers

Table 1 shows the adaptation measures undertaken by drought-affected farmers in Barind Tract alongside the percentage of their implementers. Most of the measures are mainly related to agriculture, as this sector is the most vulnerable due to drought. However, some economic related adaptive measures have also been found. More than half of the farmers are using organic fertilizer, which helps soil to retain water and reduces the water loss that ultimately helps crop growing during drought period. Many farmers are preparing 'early seedbed' that allows them to plant seeds immediately after onset of monsoon. This approach saves time and ensures the best use of rainwater during monsoon season. Some farmers have re-excavated the ponds to store rainwater in order to use them for irrigation purpose during dry season, while some are withdrawing groundwater through shallow and deep water-pump. Crop Diversification is another dynamic approach undertaken by farmers that allowed them to cultivate various types of crops instead of rice. They are cultivating potato, wheat, maize, etc. instead of rice as rice consumes more water, which becomes inadequate during drought. The tendency of using limited resources in the most profitable way has been observed among the drought affected farmers as many of them are cultivating more than one crop at a time in the same land by irrigating same amount of water. This 'intercropping/mixed cultivation' approach is highly innovative for ensuring the best use of the water, which becomes a valuable and scarce resource during drought. The popular combinations of intercropping in the Barind region are 'rice + mango', 'wheat + mango', 'rice + papaya', etc. A large number of farmers are adopting a different strategy called 'alternative crop cultivation' in order to cope with water scarcity as well as to draw the maximum profit from farming. In this case, they are cultivating mango in large scale instead of rice. Many of the farmlands in Barind region, especially in Naogaon District, are gradually turning into the mango garden from rice field, because mango cultivation returns more profit than rice consuming less water and labour. The impacts of drought have combined consequences on local and the national level economy. One of the vital consequences is seasonal unemployment that significantly reduces farmers' food security. To mitigate this hardship, many farmers adopted 'alternative economic activities' in parallel with agriculture for earning extra money that enables them to survive during the disaster period. The most common alternative economic activities are petty business, driving, day laborer, etc. Since the precipitation is not adequate, a few well-off farmers are irrigating their farms by withdrawing water from nearby ponds.

Determinants of Adaptation Measures

Implementation of different adaptive measures depends on several factors covering demographic, social, and economic characteristics, which are responsible for farmers' capacity building to cope with drought by undertaking an adaptive strategy. Table 2 shows the factors/determinants, which have been tested to estimate their

correlation with the implementation of different adaptation measures. The significance of the relationship between the variables has been determined based on their corresponding p-values. The findings show that the size of agricultural land has a significant correlation with a highest number of adaptation measures followed by income and irrigation accessibility that influenced the second highest number of adaptation measures. The larger farm size facilitates farmers to implement adaptation measures in easiest way as some adaptation strategies, i.e. crop diversification, alternative crop cultivation, intercropping, etc. requires enough space for implementation. Moreover, farmers with larger land parcel can take the challenge of implementing a new strategy as well as can cope with immediate stress if any strategy does not return expected outcome. As for income, which significantly influences seven measures out of ten, plays the fundamental role to develop the farmers' capability of strategy implementation. They require to purchase and/or rent water pump, seeds, fertilizer, etc. that completely depend on the availability of capital. Without capital, farmers cannot implement adaptive measures independently even though they have satisfied other influencing factors. Most of the adaptation measures are related to agricultural activities that makes farmers dependent on irrigation accessibility. Therefore, according to the findings, availability of irrigation facility strongly determines the farmers' capability of implementing adaptation measures. Another two important determinants are education and ownership status of agricultural land as both of them have significant correlations with exactly six numbers of measures. It is understandable that farmers with formal education can easily access to updated information and can understand training, circulation, instructions, etc. provided by government and NGOs regarding disaster management. Similarly, farmers with own agricultural land can implement adaptive strategies more independently than those of tenant farmers as their decision making ability is not absolute rather controlled by landlords. The other determinants in Table 2, including family type, poverty status, and food affordability have moderate influence over the measures as they significantly correlate with the implementation of four or five measures. It is interesting that farmers' age has a significant association with only two adaptation measures, although it is widely believed that with age comes experience and wisdom; however, in case of drought risk management, the findings imply that the availability of other determinants can overcome the lacking of age-oriented advantages.

Table 3 shows the values of V test that reports the strength of the calculated correlations between the determinants and adaptation measures. The results revealed that most of the correlations are moderately strong as the V values are less than 0.5. However, it is not the function of V test to approve or reject any correlation rather than providing a quantitative concept regarding the degree of the relations. Despite the correlations between the decision-making about the implementation of adaptation measures and their determinants, the overall findings suggest that there are still some scopes for farmers to make the decision independently.

Table 2. Chi-square test statistics between adaptation measures and determinants

Adaptation Measures	% of implementer farmers	<i>P</i> values of Chi-square test								
		Age	Education	Farm Ownership	Family Type	Income	Farm Size	Food Affordability	Irrigation Accessibility	Poverty Status
Organic Fertilizer	55.2	.34	.10	.08	.001*	.68	.002*	.01*	<.001*	.92
Early Seedbed	26.2	.17	.10	.02*	.07	.02*	.07	.01*	.005*	.42
Re-excavation of Pond	5.8	.61	<.001*	<.001*	.03*	<.001*	<.001*	<.001*	<.001*	<.001*
Water Withdrawal using Shallow Pump	4.3	.005*	.33	.36	.31	.12	.29	.11	.02*	.42
Water Withdrawal using Deep Pump	6.8	.60	.003*	.60	.37	.001*	.02*	.41	.40	.44
Crop Diversification	13.6	.01*	.003*	.01*	.001*	<.001*	<.001*	<.001*	.20	<.001*
Mixed Cultivation/Intercropping	32.2	.12	.003*	.01*	.16	.05*	.005*	.10	.009*	.06
Alternative Crop Cultivation	41.6	.12	.05*	<.001*	.57	<.001*	<.001*	<.001*	.006*	<.001*
Alternative Economic Activities	61.7	.13	.62	.48	.08	.12	.002*	.06	.96	.09
Irrigation by Pond Water	7.1	.43	.01*	<.001*	.005*	.001*	<.001*	.06	<.001*	.004*

Note: *Statistically significant considering $\alpha = 0.05$

Table 3. Cramer's V statistics between adaptation measures and determinants

Adaptation Measures	V values of Cramer's V test								
	Age	Education	Farm Ownership	Family Type	Income	Farm Size	Food Affordability	Irrigation Accessibility	Poverty Status
Organic Fertilizer	.073	.164	.110	.167*	.076	.205*	.149*	.182*	.020
Early Seedbed	.094	.163	.134*	.090	.168*	.146	.152*	.140*	.066
Re-excavation of Pond	.050	.349*	.259*	.105*	.305*	.318*	.276*	.215*	.231*
Water Withdrawal through Shallow Pump	.163*	.131	.072	.051	.136	.112	.105	.110*	.066
Water Withdrawal through Deep Pump	.051	.223*	.050	.045	.216*	.167*	.066	.042	.064
Crop Diversification	.150*	.226*	.142*	.166*	.360*	.407*	.224*	.064	.197*
Mixed Cultivation/Intercropping	.103	.225*	.148*	.069	.154*	.194*	.107	.131*	.117*
Alternative Crop Cultivation	.103	.177*	.233*	.028	.279*	.334*	.214*	.139*	.250*
Alternative Economic Activities	.100	.106	.060	.087	.135	.207*	.117	.002	.108*
Irrigation by Pond Water	.065	.204*	.211*	.142*	.222*	.335*	.117	.411*	.165*

Note: *Statistically significant according to their corresponding *P* values ($\leq .05$)

CONCLUSION

The main goal of this study was to investigate the correlations between different types of determinants and farmers' choice of drought adaptation measures. The determinants that has been analyzed here are mainly farmers' social, economic, demographic, and agricultural characteristics. The statistical analyses suggest that each adaptation measure is influenced by at least one or more determinants; similarly, every single determinant showed its influence on at least one or more adaptation methods. In short, the types and nature of adaptation measures implemented by farmers were determined by their demographic, socioeconomic, and agricultural characteristics. Apart from this summary outcome, the study presents some other key findings that need to be considered during future policy formulation. It is also few findings that all of the households have undertaken at least one or more adaptive measure, but the majority of households did not implement the most needed adaptive measures, *viz.* water harvesting. Only a small number of households have implemented surface water harvesting and/or ground water exploitation measure, which is the most effective approach to mitigate irrigation scarcity. This scenario has exposed farmers' limitations to undertake an effective adaptation strategy. According to the findings of V test, it can be interpreted that the determinants definitely have some influence over the decision-making process of the implementation of adaptation strategies, but farmers still hold partial ability to choose an adaptation option independently.

The drought management policy should include the capacity building strategy so that farmers can afford the implementation of appropriate measure by their own initiative without depending on government or NGOs. It is also required to develop and implement an inclusive policy that will guide farmers to select the type of adaptation measure based on their socioeconomic and agricultural characteristics. Since this study has identified the determinants of farmers' capability regarding implementation of adaptation measures, government and other developing partners now can easily categorize the types of measures that can be implemented by any particular household through analyzing their demographic, socioeconomic, and agricultural characteristics, as mentioned in Table 2. This approach might increase the performance of disaster-risk reduction activities significantly.

ACKNOWLEDGEMENT

The NST Fellowship Program of the Government of Bangladesh, awarded to the first author, has supported the study. The authors are grateful to Md. Masum Billah and Mizanur Rahman for their cordial help during household survey.

REFERENCES

- Ahmed, K.M. (2012). Barind tract. In Islam, S. and Jamal, A.A. (ed.). *Banglapedia*. Asiatic Society of Bangladesh, Dhaka.
- Alam, K. (2015). Farmers' adaptation to water scarcity in drought-prone environments: a case study of Rajshahi district, Bangladesh. *Agricultural Water Management*, 148: 196-206.
- BBS. (2010). Household income and expenditure survey 2010. Bangladesh Bureau of Statistics. Statistics Division, Ministry of Planning, GoB, Dhaka.
- BBS. (2015). Bangladesh: Disaster-related Statistics 2015. Bangladesh Bureau of Statistics. Statistics and Information Division, Ministry of Planning, GoB, Dhaka.
- Cramér, H. (1946). *Mathematical Methods of Statistics*. Princeton University Press, Princeton.
- Deressa, T.T., Hassan, R.M., Ringler, C., Alemu, T., and Yesuf, M. (2009). Determinants of farmers' choice of adaptation methods to climate change in the Nile Basin of Ethiopia. *Global Environmental Change*, 19(2): 248-255.
- Habiba, U., Shaw, R., and Takeuchi, Y. (2011). Drought risk reduction through a Socio-economic, Institutional and Physical approach in the northwestern region of Bangladesh. *Environmental Hazards*, 10(2): 121-138.
- Habiba, U., Shaw, R., and Takeuchi, Y. (2012). Farmer's perception and adaptation practices to cope with drought: Perspectives from Northwestern Bangladesh. *International Journal of Disaster Risk Reduction*, 1: 72 – 84.
- Hassan, M.S., and Islam, S.M. (2013). Drought Vulnerability Assessment in the High Barind Tract of Bangladesh Using MODIS NDVI and Land Surface Temperature (LST) Imageries. *International Journal of Science and Research*, 4(2): 55-60.
- Hassan, R., and Nhemachena, C. (2008). Determinants of African farmers' strategies for adapting to climate change: Multinomial choice analysis. *African Journal of Agriculture and Resource Economics*, 2(1): 83-104.
- Hossain, M.N., Chowdhury, S., and Paul, S.K. (2016). Farmer-level adaptation to climate change and agricultural drought: empirical evidences from the Barind region of Bangladesh. *Natural Hazards*, 83(2): 1007-1026
- Ishaya, S., and Abaje, I.B. (2008). Indigenous people's perception of climate change and adaptation strategies in Jema's local government area of Kaduna State, Nigeria. *Journal of Geography and Regional Planning*, 1(18): 138–43.
- Kandlinkar, M., and Risbey, J. (2000). Agricultural impacts of climate change: If adaptation is the answer, what is the question? *Climatic Change*, 45: 529–39.
- Karim, M.R., Ampony, D., Muhammad, N., Noman, M.R.F., and Rahman, M.S. (2017). Factors affecting adopting of local adaptation options to climate change vulnerability. *Journal of Science and Technology*, 15: 1-8.
- MoDMR. (2013). Vulnerability to climate induced drought: scenario and impacts. Comprehensive Disaster Management Programme, GoB, Ministry of Disaster Management and Relief . Dhaka

- Paul, B.K. (1998). Coping mechanisms practiced by drought victims (1994/5) in north Bengal, Bangladesh. *Applied Geography*, 18(4), 355-373.
- Rahman, A.A., Alam, M., Alam, S.S., Uzzaman, M.R., Rashid, M., and Rabbani, G. (2008). Risks, vulnerability and adaptation in Bangladesh. Human Development Report 2007/08, Human Development Report Office Occasional Paper, 2007/13. UNDP, New York.
- Shahid, S. (2008). Spatial and temporal characteristics of droughts in the western part of Bangladesh. *Hydrological Processes*, 22: 2235-2247.
- Shahid, S. (2010). Impact of climate change on irrigation water demand of dry season Boro rice in northwest Bangladesh. *Climate Change*, 3-4: 433-453.
- Shahid, S., and Behrawan, H. (2008). Drought risk assessment in the western part of Bangladesh. *Natural Hazards*, 46: 391-413.
- Wilhite, D.A. (2000). Drought as a natural hazard: concepts and definitions. In Wilhite, D.A. (ed.). *Drought: A Global Assessment*, 1: 3-18, Routledge, London.
- WHO. (2015). Vaccination coverage cluster surveys: Reference manual. World Health Organization. Retrieved January 20, 2019 from https://www.who.int/immunization/monitoring_surveillance/Vaccination_coverage_cluster_survey_with_annexes.pdf

Appendix Table A: Background characteristics of farmers

Category	N	%	Category	N	%
Age category			Education		
Young (≤ 25 Years)	13	3.3	No formal education	167	42.1
Middle-age (26 – 50 Years)	264	66.5	Primary (class 01 to 05)	118	29.7
Old (≥ 51 Years)	120	30.2	Incomplete secondary (class 06 to 09)	67	16.9
Household Size			Secondary	21	5.3
Small (≤ 3)	95	23.9	Higher secondary	17	4.3
Medium (4-6)	293	73.8	Bachelor and/or above	7	1.8
Large (≥ 7)	9	2.3	Farm ownership		
Family type			Owner	101	25.4
Nuclear family	311	78.3	Tenant	190	48.0
Joint family	86	21.7	Owner + Tenant	106	26.7
Housing type			Monthly income		
Thatch and mud-wall	16	4.0	Low (\leq Tk. 5215.92)	143	36.0
Tin roof and mud-wall	359	90.4	Lower medium (Tk. 5215.92 – 10,000)	178	44.8
Tin roof and wall	8	2.0	Medium (Tk. 10,000 – 15,000)	45	11.3
Semi-pucca and pucca	14	3.6	Upper medium (Tk. 15,000 – 20,000)	13	3.3
Land holdings			High (\geq Tk. 20,000)	18	4.5
Absolute landless (≤ 15 decimal)	13	3.3	Poverty status based on lower poverty line		
Functionally landless (15-50 decimal)	105	26.4	Below poverty line	143	36.0
Small (marginal) (50-249 decimal)	149	37.5	Above poverty line	254	64.0
Medium (250-749 decimal)	112	28.2	Poverty status based on upper poverty line		
Large (>749 decimal)	18	4.5	Below poverty line	201	50.6
Source of drinking water			Above poverty line	196	49.4
Tube well (hand operated)	218	54.9	Farm size		
Tube well (motorized)	45	11.3	Very small (≤ 1 acre)	118	29.7
Dug well	45	11.3	Small (1 – 2 acre)	136	34.3

Category	N	%	Category	N	%
Deep tube well installed by BMDA	89	22.3	Medium (2 – 3 acre)	44	11.1
Food affordability			Moderately large (3 – 7.5 acre)	81	20.4
Fully capable	101	25.4	Large (>7.5 acre)	18	4.5
Partially capable	283	71.3	Availability of BMDA irrigation		
Incapable	13	3.3	All year round	259	82.1
Access to BMDA irrigation			Rabi + Kharif-1	35	11.2
Yes	313	78.8	Kharif-1	16	5.1
No	84	21.2	Rabi	3	1.0
			Total (n)	313	100