



Effect of Climate Change on Livestock Sector: A Case from Taltoli, Barguna

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ABSTRACT

The effect of climate change on livestock is a great deal to talk. This current study sought to investigate the effect of climate change on livestock at the Nishanbaria and Sonakata Union under Taltali sub-districts of Barguna District. To achieve the research objectives, a detail literature review, frequent field visit and household questionnaire survey along with others were conducted. The study was conducted with 100 personnel from 100 households of Nishanbaria and Sonakata Union. This study found that 25 percent respondent's main source of income is livestock rearing and 75 percent respondents are related with livestock rearing besides other source of income. The study reveals that change of climate in this area momentarily continuing and most proportions of Nishanbaria and Sonakata union's livestock rearing are declined when the climatic condition is not comfortable; which leads to respondent's approximate yearly economic loss of 750450 (BDT) that makes them more vulnerable. Using criteria ranking scores 1 to 9, the study shows that the livestock sector is most frequently and negatively affected by 9 types of disastrous conditions: 1) salinity, 2) cyclone, 3) flood, 4) pest attack, 5) heat stress, 6) water logging, 7) storm surge, 8) thunderstorm and 9) river bank erosion. The study found that the respondents are likely facing the challenges caused by climate changes owing to lack of awareness, financial crisis and budget allocation in preparedness of emergency. The study suggests education and training related activities to cope with disasters in case of livestock rearing. Livestock oriented income generating programs should be increased by the government and non-government organization.

Introduction

In recent time, Bangladesh had been experiencing disastrous vulnerability to the issues related to climate change (IPCC, 2001). IPCC forecasted that adverse effect of climate pattern will be continued to worsen the socio-economic condition of Bangladesh. Livestock is an important component of agricultural economy of Bangladesh performing multifarious functions, such as provisions of food, nutrition, income, savings, and foreign currency earning, manure, fuel, transport (MoEF, 2009). The contribution of livestock in GDP of Bangladesh is about 14.21 percent in Agricultural sector (Salim, 2016). The climate change and its effect can result in the outbreak of new diseases and pests that will affect these agriculture, fisheries and livestock (Gaughan *et al.*, 2009). Global temperature has increased from 1.0 to 1.5°C within the last 30 to 50 years and it is under foretell that the global average temperature may be raised up to 4.0°C by this century (IFAD, 2010).

This prediction reflects 20 to 30 percent plant and animal species will be endangered and must face several consequences for insecurity among the developing countries (FAO, 2007). There is no doubt that most of the people live in the countryside engage themselves in livestock farming for their livelihoods with a view to meet the protein demand and income generation. Although, major portion of the coastal area of Bangladesh is not suitable for livestock feeds, fodders, forages and grazing fields and the situation become worst during uncomfortable climatic condition (Ahmed *et al.*, 2012).

There are several effects of uncomfortable climatic condition on livestock sector. The effects of climate change on livestock systems will be spatially and temporally diverse (Rowlinson, 2008). Broad categories of effects include cyclone, salinity, flood, water logging, and storm surge, thunderstorm, heat stress, pest attack etc. in the length of growing seasons for livestock foods grasses and forage crops. Further, altered ranges for pathogens and pests are likely to increase overall disease burdens, and present associated challenges in terms of animal welfare impacts (Moran *et al.*, 2009). Climate change is also affecting livestock bio-diversities, genetics, breeding and livestock rearing (Ahmed *et al.*, 2013). It is possible to distinguish between direct and indirect effects of climate change on livestock rearing. The direct effects on livestock include influences on animal health, welfare, growth and reproduction, while the indirect effects are due to the influence of climate change on the productivity of pastures and forage crops. A more complex indirect effect may result from the effects of climate change on the economic cost of inputs, e.g. feedstock that are imported into these unions systems from Local markets. Both forms of effect can be addressed by a range of adaptations that in turn imply further effects that may be external to the agent undertaking the adaptation (Moran *et al.*, 2009).

Livestock related interventions are found to be a successful strategy for poverty alleviation all over the world and large percentage of rural population depend on livestock rearing to earn their livelihood. Livestock keeping is a livelihood option in rural Bangladesh with landless farmers' together control about 75 percent of country's livestock resources (FAO, 2009). Since the livestock wealth of Bangladesh is mostly distributed among the

marginal people and small landholders, any growth in the sector would be beneficial to the poor people.

The study area is located at coastal portion of Bangladesh and according to the previous studies (Ahmed *et al.*, 2013) it is more vulnerable to disasters conditions. In the study area, livestock is the second largest sector after fisheries to meet the national protein demand (BARC, 2011) and most of the people related to rearing livestock like cow, buffalo, goat, hen, duck, goose, pigeon etc. According to geographic location, the study area is most vulnerable to various disasters like cyclone, storm surge, salinity, flood, bank erosion, water logging, diseases etc. Moreover, the uneven disastrous climatic conditions are negatively affecting the livestock sector of the study area.

The main objective of the study is to figure out the effect of climate change on livestock sector in the coastal area of Bangladesh. Specific objectives are to; (i) identify the major problems in livestock sector due to climate change and its effect; and (ii) address adaptation techniques to protect livestock sector from adverse effect of disastrous climatic condition.

Methodology

According to the title it was mandatory to conduct this research in a climatic hazards prone area where the livestock sector directly and indirectly affected through climate change. After visiting so many places, Nishanbaria and Sonakata Unions of Taltali Upazila of Barguna district was purposively selected as the study area; because these are most climatic hazards prone area of Taltoli Upazila. Most of the people of this area are farmers and they are related with livestock rearing besides their farming activities. Taltali is the coastal most Upazila of Barguna district adjacent to Bay of Bengal. It is bounded by Bwrisher River and Barguna Sadar Upazila in west, Andharmanik River and Kalapara Upazila in east, Bay of Bengal in south and Amtali Upazila in north.

In the present study, both quantitative and qualitative research approaches were used as a source in order to get inclusive view of the compound issues of the risk assessment and adaptation of livestock rearing by the local people in response to climate change. Emphasis was given on the quantitative sources of information, mostly primary and some also from secondary. Qualitative information was entirely gathered from the primary sources. Primary data was collected through field visit, household level questionnaire survey, focus group discussion and key informant interviews and secondary data was collected through review of published and unpublished documents, such as books, journals, articles, thesis, reports, related websites and from respective Union Parishad. Both data are valued carefully while conducting this research for logical and practical approval. In this study, multiple responses of the respondents were considered in some cases to explore the risk in livestock sector and extent of adaptation practice due to climate change.

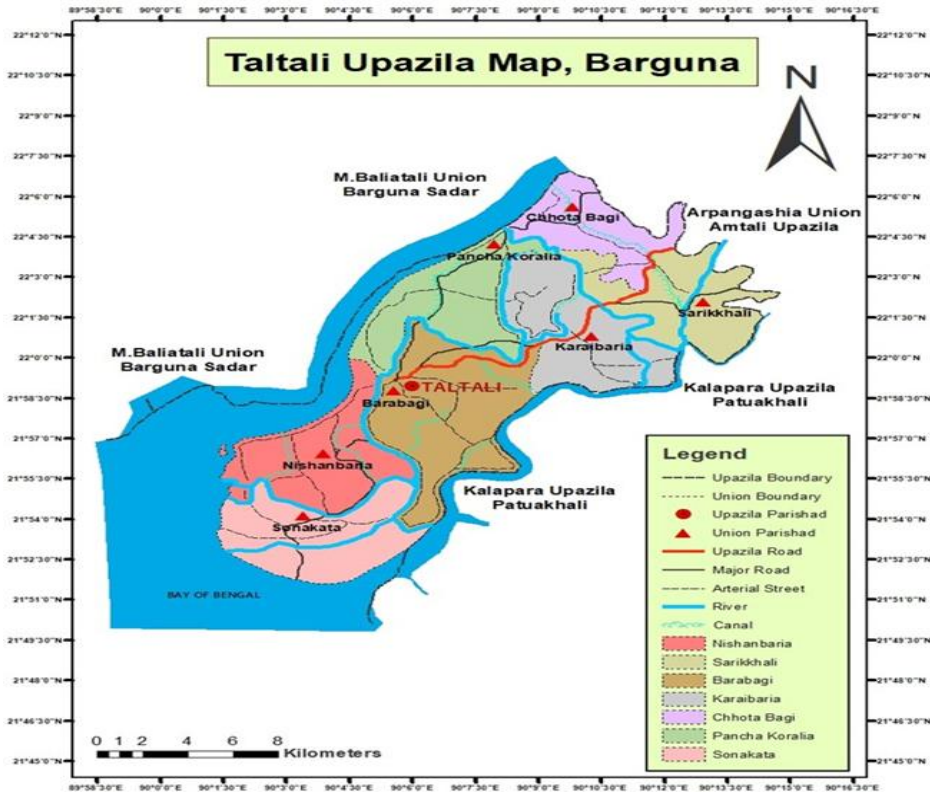


Figure 1 Map of Taltoli Upazila

The quantitative survey approach was used for determining the effect of climate change and adaptive measures taken by the local people. The study was conducted through the following stages:

Stage-1: Frequent field visit was conducted to select the study area.

Stage-2: The Krejcie and Morgan formula was used to determine the accurate sample size from the total number of households of the study area as follows:

Total population, $P=24185$ (BBS, 2011)

Confidence level = 95 percent

Margin of error, $ME= 4$ percent

Chi square at 95 percent level of significance, $X=1.96$

Standard deviation, $SD=0.5$

$$\begin{aligned} \text{Sample size, SS} &= \frac{X^2 \times SD \times (1 - D)}{ME^2} \\ &= \frac{(1.96)^2 \times 0.5 \times (1-0.5)}{(0.04)^2} \\ &= 600.25 \end{aligned}$$

$$\begin{aligned} \text{Then adjusted sample size} &= \frac{SS}{1 + \left[\frac{SS-1}{P} \right]} \\ &= \frac{600.25}{1 + \left[\frac{600.25-1}{24185} \right]} \\ &= 97.62 \sim 98 \end{aligned}$$

As the study is conducted on the basis of household level questionnaire survey, for conservation measures the required sample size is 100.

Stage-3: Questionnaire survey is one of the most important tools for collecting information from population in developing countries. Therefore, 100 personnel from 100 households (sample households) were surveyed purposively through questionnaire survey to find out the research objectives. The surveyed personnel were farmer, fishermen, small trader, government employee etc.

Stage-4: Collected data and information were analyzed and processed through the Microsoft Excel 2010 to make graphical diagrams. Different tables, diagrams and charts have used for processing the relevant collected data.

Results & Discussion

Demographic and socio-economic conditions

For the completion of a successful research, data was collected from the both male and female personnel. Average of the female respondent was 48 percent and the male respondent was 52 percent. Average age of the respondents was 45 years and they have very good experiences of farming and livestock rearing. In the study area mainly five types of income sources of the respondents was found such as agriculture, livestock rearing, businessman, day labor and fishing which is almost similar with the others part of Bangladesh (Ahmed *et al.*, 2013). Among the respondents highest 33 percent of the respondent's source of income is fishing activities, 25 percent is livestock rearing, 20 percent is day labor, 10 percent is agriculture, 7 percent is business and 5 percent of the respondent's source of income is others activities like hawker, boatman etc. Figure 2 represents the income sources of the respondents of the study area. Result shows that livestock rearing is the second highest source of income of the respondents of the study area.

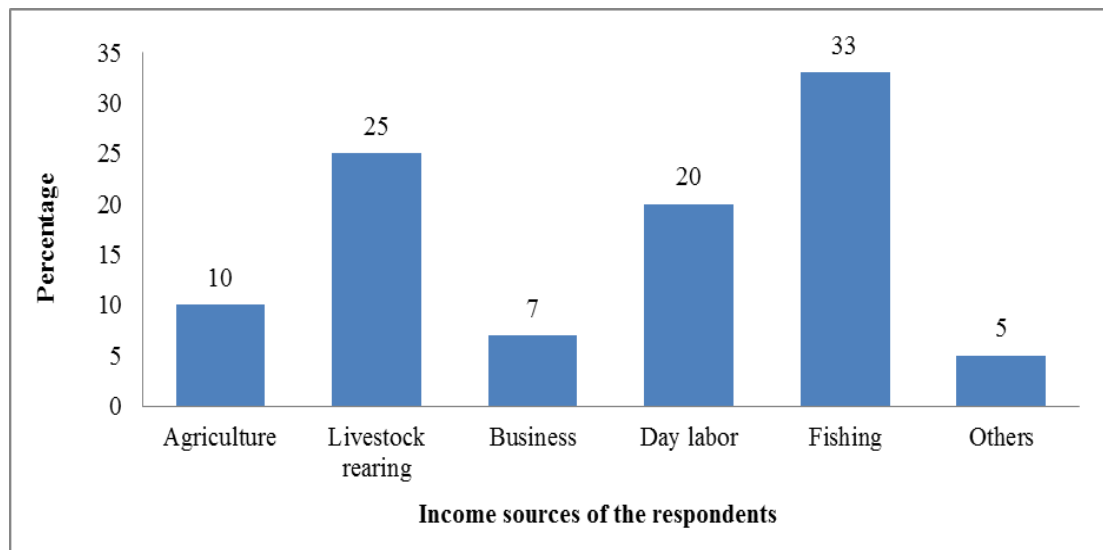


Figure 2 Source of income of the respondents

Figure 3 represents the yearly income of the respondents on the basis of their income sources. It is found from questionnaire survey that, average yearly income of the respondents is 36334 BDT is almost similar to other coastal part of Bangladesh (Ahmed *et al.*, 2013). The highest yearly income is from fishing (55000 BDT) and livestock rearing (45000 BDT) activities.

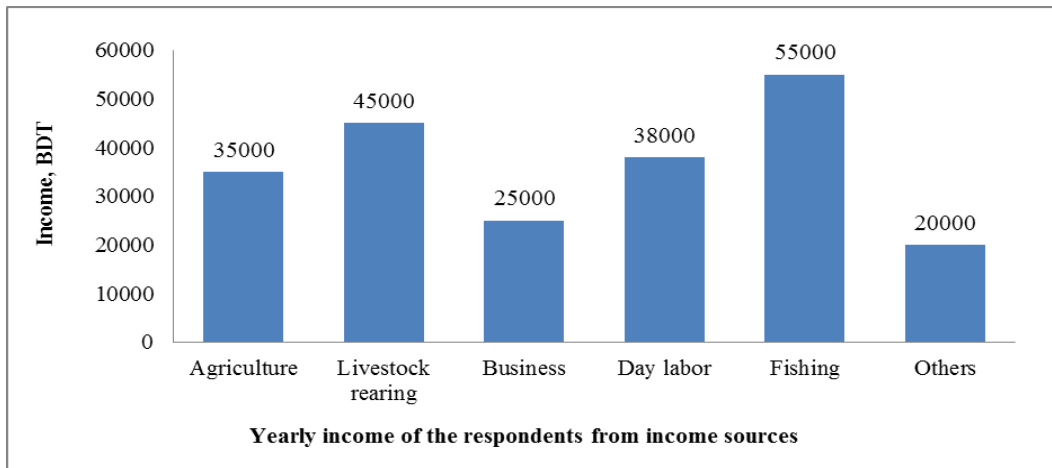


Figure 3 Yearly income of the respondents

Different types of livestock rearing

From questionnaire survey it was found that above 34 percent of the respondents were illiterate and 27 percent had the knowledge of primary level; class 1 to 5. Most of the respondents were farmer and related with rearing livestock as their income generating sources (Salim, 2016). Figure 4 represents different type's livestock that rear by the respondents of the study area. Results show that highest 25 percent of the respondent's rear cow then duck are 19 percent and lowest 12 percent rear buffalo and then goat 8 percent. Most of the respondent said that goats are more vulnerable to uncomfortable climatic condition as cyclone, flood, salinity, storm surge etc. which are almost similar to other coastal parts of Bangladesh (Salim, 2016).

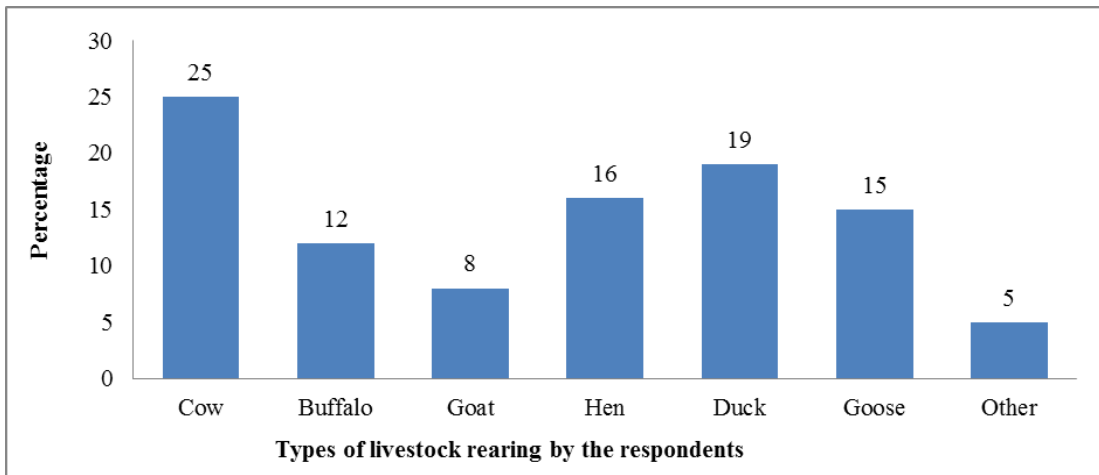


Figure 4 Different types of livestock rearing

Combined livestock rearing

Figure 5 represents the scenario of combined livestock rearing by the respondents. Highest combined rearing livestock occupies 11 percent respondents (CG: cow-goose) and lowest 8 percent (CDGO: cow-duck-goose-others); similar to other parts of Bangladesh (Salim, 2016).

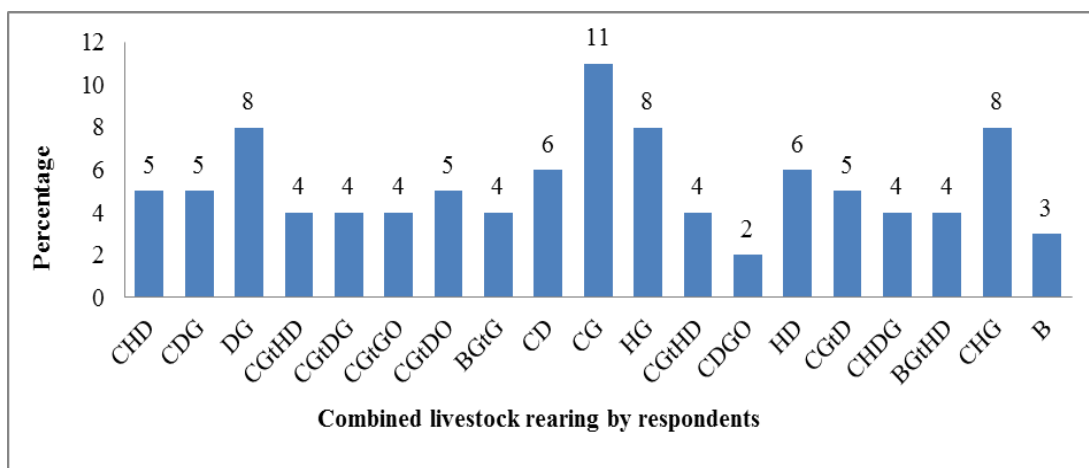


Figure 5 Combined livestock rearing (Code: C=cow, B=buffalo, Gt=goat, S=sheep, Hr=horse, H=hen, D=duck, G=goose, O=others)

Hazard affecting the community people

The study area was in the coastal part of Bangladesh. From the questionnaire survey, it was found that several times various disasters affected the respondent with a sudden and regular interval of time with high frequency and intensity which is about to similar with other coastal part of Bangladesh (Islam, 2016). Table 1 represents the hazards that affected the respondent with ranking order of hazards according to frequency and intensity. According to ranking order results shows that the respondent experiences salinity most and thunderstorm least.

Table 1 Hazard affecting the respondents

Hazard	Intensity	Frequency	Intensity × Frequency	Ranking
Cyclone	5	3	15	2
Salinity	4	4	16	1
Flood	3	3	9	5
River bank erosion	4	3	12	3
Water logging	2	5	10	4
Storm surge	4	2	8	6
Thunderstorm	5	1	5	7

Code: 1=Very low, 2=Low, 3=Medium, 4=High, 5=Very high

Hazard affecting the livestock sector

Table 2 represents the hazard that mostly affected the livestock sector within a ranking score 1 to 9. Results shows, the livestock rearing of the respondents affected by several hazards according to ranking score: 1) salinity, 2) cyclone, 3) flood, 4) pest attack, 5) heat stress, 6) water logging, 7) storm surge, 8) thunderstorm and 9) river bank erosion. This result is about to similar with Bangladesh studies of climate change and its impact (Ahmed *et al.*, 2013 and BC, 2009).

Table 2 Hazard affecting the livestock sector of the respondents

Hazard	Intensity	Frequency	Intensity × Frequency	Ranking
Cyclone	5	3	15	2
Salinity	4	4	16	1
Flood	4	3	12	3
River bank erosion	3	1	3	9
water logging	3	2	6	6
Storm surge	5	1	5	7
Thunderstorm	4	1	4	8
Pest attack	3	3	9	4
Heat	3	3	9	5

Code: 1=Very low, 2=Low, 3=Medium, 4=High, 5=Very high

Effect of climate change on livestock sector

The respondent of the study area experiences several disasters as a result of climate change and its effect goes both on the respondents and adversely affecting their livestock rearing. Uncomfortable climatic condition both directly and indirectly hampered the breeding and production of livestock which lead to loss of food, nutrients and economic losses (Digambar, 2011) is similar to the study area. According to the Department of livestock Service, Taltali Upazila Porishad, Barguna, during the last 5 years (2018-2014) effect of several disasters such as cyclone, flood, salinity, thunderstorm and heat stress are as follows; number of killed: cow (3,400), buffalo (1534), goat (670), hen (22,000), duck (16,767), goose (11,290) and others (3,290). Table 3 represents the last two year (2018-2017) livestock loss of the respondents that acquired from the questionnaire survey.

Effect of cyclone on livestock sector

Livestock rearing of the respondents are adversely affected by high winds or cyclone in the last few years. In coastal area, low frequency cyclone causes very high intensity effect (GoB, 2008). High intensity cyclone causes the death and injured of livestock, source of food and habitation of livestock. In 2007 cyclone Sidr, approximately 90 percent of the community people of the study area lost their livestock during cyclone (GoB, 2008).

Table 3 Effect of disaster in last 2 years (2018-2017) in the study area

Name of livestock	Causes of loss	No of killed	Approximate economic loss (BDT)
Cow	Cyclone, flood, storm surges, thunderstorm, water logging, salinity, heat stress, pest attack	27	5,40,000
Buffalo	Cyclone, flood, storm surges, thunderstorm, salinity, pest attack	13	1,95,000
Goat	Cyclone, flood, storm surges, thunderstorm, water logging, salinity, heat stress, pest attack	15	45,000
Hen	Cyclone, flood, heat stress	375	1,12,500
Duck	Cyclone, flood, storm surges, thunderstorm	417	1,66,800
Goose	Cyclone, flood, storm surges, thunderstorm	273	3,27,600
Others	Cyclone, flood, storm surges, thunderstorm, water logging, salinity, heat stress, pest attack	57	1,14,000

Effect of salinity on livestock sector

Coastal areas are highly affected by salinity problem (Hughes, 2008) which is about to similar to the study area. Saline water from Payra and Bwrisher River flooded the low lying land of the study area. All the year round, salinity effect is highest in the winter and lowest in rainy season. From questionnaire survey it was found that salinity causes the drinking water shortage for the livestock and damages the grass of the land area. It leads to the food shortage for the livestock and ultimately the production goes in decline. Salinity problem causes different types of skin problems for the livestock sector (Hughes, 2008).

Effect of flood on livestock sector

In coastal areas flood causes both direct and indirect effect on livestock sector (Adger *et al.*, 2007). Study area is in the coastal part of Bangladesh and according to respondents opinion on mid-May to mid-October is the flood time in this area. Embankment of this area can't protect the flood water and sometimes high water flow in the Payra River also causes the flood. It causes loss of household livestock and after flood all the feed prices increased and polluted the environment. Flood also causes the loss of livestock habitation and several diseases arise after flood. This leads production, food, nutrient and economic losses of the respondents.

Effect of river bank erosion on livestock sector

River bank erosion has a longer effect on Agriculture and on livestock sector. Due to bank erosion, pasture and grazing land are tremendously reducing (FAO, 2009). This study found that the Payra river site of study area is eroding during rainy season, autumn season and reducing the pasture and grazing land. Some respondents have lost their cattle and housing land due to river bank erosion.

Effect of water logging on livestock sector

Water logging problem in the southern part of coastal region of Bangladesh is serious issues (Rahman, 2008). In rainy season, the study area experiences water logged problem due to lack of sluice gate maintenance and damage of embankment. Due to water logging, several diseases spread and attack the livestock sector and also the community people. Water logging reduces the soil fertility, hampered grass germination, raises soil salinity and its impact goes on livestock (Rahman, 2008).

Effect of heat stress on livestock sector

Cattle are more sensitive to heat than humans and are not acclimated to hot weather is also at greater risk if weather changes rapidly or if the cattle are moved to an environment with greater heat stress (Larson, 2009). The study area is in the coastal part of Bangladesh and vulnerable to heat stress is about to similar other coastal part of Bangladesh. According to respondents opinion high heat causes the farming and pet animals death. On livestock sector high heat stress effects are as follows: it causes environmental changes, destruction of grazing grasses, high incidence of egg spoilage which lead to less milk production, less egg production, increase metabolism and less meat production (Larson, 2009).

Lacking assessment

Multiple questions were considered during lacking assessment survey among the respondents to find out the answer; what causes the effect of losses so high. The respondents identified frequent and high intensity disasters, improper education, shortage of livestock rearing training facilities, financial crisis and communication problem causes devastating effect of climate change on their livestock rearing. Figure 6 represents the lacking assessment of the respondents. The result shows that, majority of the respondents (63 percent) point out the high intensity disasters like cyclone, flood, heat stress, salinity, river bank erosion, thunderstorms as their main lacking because they have no control on it and it can occur at any time, where 6 percent identified improper education on disaster management and livestock rearing. Consequently, 18 percent, 11 percent and 2 percent of respondents addressed lack of livestock rearing training facilities, financial crisis and communication problem. Though government is providing different training on vaccination, technological application, and also

providing financial support on livestock rearing, but it is not sufficient and not reaching to the whole community. Local leaders have influences on selections of beneficiaries.

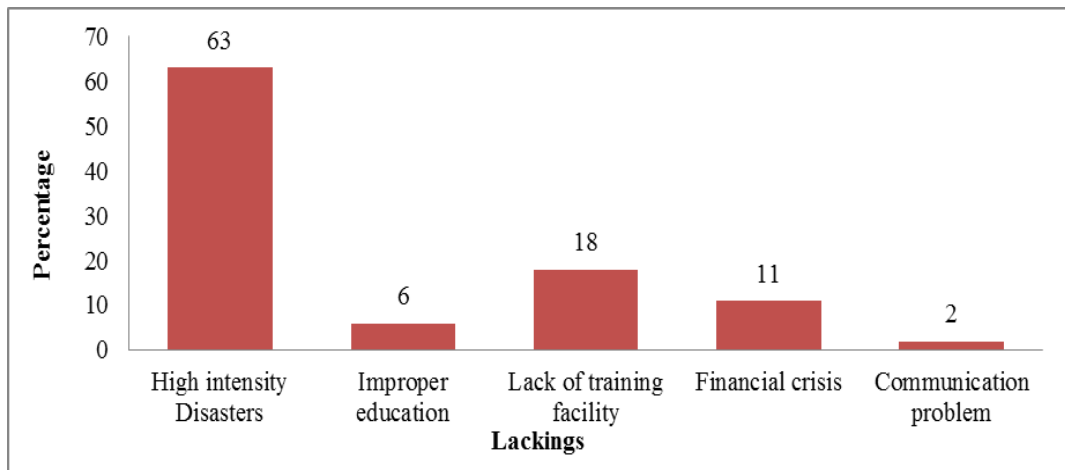


Figure 6 Lacking of the respondents that causes the adverse impact on livestock sector

Adaptation techniques

Various adaptation techniques are derived on the basis of the present study's frequent field visits, questionnaire survey of the respondents and existing knowledge from scientific literature on the present issues. These adaptation techniques or areas are as follows: (i) research relating to livestock sector adaptation can be broken down into practical management options for livestock rearing people; (ii) disaster management educational awareness building programs should be implemented in the community level; (iii) people associated with livestock rearing should give proper training with adaptive livestock rearing activities; (iv) organizer or the authority of Upazila and District livestock department should be more coordinated and communicative with the community people; (v) modification of production and management systems involves diversification of livestock animals and crops, integration of livestock systems with forestry and crop production, and changing the timing and locations of farm operations (IFAD, 2010); (vi) changes in breeding strategies can help animals increase their tolerance to different disasters like heat stress, unfavorable conditions and diseases and improve their reproduction and growth development (Gaughan *et al.*, 2009); (vii) during flood and water logging, alternative flood shelter should be used and alternative concentrative food should be used for animals during drought (Rowlinson, 2008); (viii) indigenous livestock species as example zebu cattle: black bengal goat, aseel and chittagong red hen, khaki camble duck should be reared because they are more adaptive to disastrous condition; (ix) habitation for livestock should be clean and anticipatory (ex-ante) and reactive

(ex-post) responses needs to be taken to prevent livestock diseases (Maluleke and Mokwena, 2017).

Conclusion

In the present time climate changes become a regular phenomenon in coastal area of Bangladesh and it causes several disastrous conditions. Disaster causes death and damages and the livelihood options of affected people and its effect goes on the long run. Livestock rearing is one of the most regular livelihood options of the people in coastal area of Bangladesh. The present study was conducted in Nishanbaria and Sonakata Union under sub-district of Taltoli Upazila of Barguna District; which is one of the coastal parts of Bangladesh. This study found that 25 percent respondent's main source of income is livestock rearing and 75 percent respondents are related with livestock rearing besides other source of income. This result is similar with another study conducted by Salim, 2016. Several times different disasters affected the respondents of the study area which causes the loss of their livestock, food, nutrients and approximate yearly economic loss of 750450 (BDT) that makes them more vulnerable to live well (Ahmed *et al.*, 2013). The study shows that the livestock sector is most frequently and negatively affected by 9 types of disastrous conditions: 1) salinity, 2) cyclone, 3) flood, 4) pest attack, 5) heat stress, 6) water logging, 7) storm surge, 8) thunderstorm and 9) river bank erosion. This result is similar with Bangladesh studies of climate change and its impact (Ahmed *et al.*, 2013 and BC, 2009). Appropriate adaptation techniques and its successful implementation may be the first and foremost way to live with climate change. We cannot stop disasters but we can reduce or minimize the losses from disasters. Based on the findings of the present study, some follow up research can be conducted to identify and design adaptation techniques for the livestock rearing community of the study area. Such research findings might provide effective guideline for the people of the other coastal area of Bangladesh to cope with and resist with the adverse effect of climate change. The relevant government organizations and non-government organizations can assist the people of the coastal area to be more adaptive with climate change effect by providing training facilities.

References

- Adger, W.N., S. Agrawala, M.M.Q. Mirza, C. Conde, K. Brien and J. Pulhin. 2007. *Assessment of adaptation practices, options, constraints and capacity*. Cambridge University Press, Cambridge. UK: 717-743 pp.
- Ahmed, F., G.M. Alam, A.Q. Al-Amin and C.H.B. Hassan. 2013. The Impact of Climate Changes on Livestock Sector: Challenging Experience from Bangladesh. *Asian Journal of Animal and Veterinary Advances*, 8: 29-40.
- Ahmed, F., A.Q. Al-Amin, G.M. Alam and C.H.B. Hassan. 2012. Climate change concern to cattle feed in Bangladesh *Asian Journal of Animal and Veterinary Advances*, 11:1946-1953.
-

- BARC, 2011. Livestock and poultry research and development plan of BLRI-2021. *Bangladesh Agricultural Research Council Newsletter*, 9 (1): 2011-231.
- BBS. 2011. *Bangladesh Population and Housing Census*. Bangladesh Bureau of Statistics, Community Report, Barguna.
- BC. 2009. *Adapting to climate change: the challenge for Bangladesh agriculture and rural areas*. Brussels: Bangladesh Commission.
- Digambar, D.S. 2011. *Impact of climate change on livelihood and biodiversity in rural communities: A case study of Siddhi Ganesh and Nepali community forestry user groups of Sindhupalchok District of Nepal*.
- FAO. 2007. *The state of the world's animal genetic resources for food and agriculture: in brief*, edited by Barbara Rischkowsky and Dafydd Pilling, Rome. Food and Agriculture Organization of the United Nations.
- FAO. 2009. *The state of food and agriculture: Livestock in the balance*. Food and Agriculture Organization of the United Nations, Accessed to: <http://www.fao.org/docrep/012/i0680e/i0680e.pdf>, Accessed on 12 April, 2018.
- Gaughan, J.B., N. Lacetera, S.E. Valtorta, H.H. Khalifa, G.L. Hahn and T.L. Mader. 2009. Adaptive responses of domestic farm animals to climate challenges. *Biometeorology for Adaptation to Climate Variability and Change*, 1: 131-170.
- GoB. 2008. *Cyclone Sidr in Bangladesh damage, loss, and needs assessment for disaster recovery and reconstruction*. Supported by European Commission, Government of the People's Republic of Bangladesh.
- Hughes, G., M. Wilkinson, D. Boothby, J. Clarke, S. Perkins and M. Davies. 2008. *Changes to agricultural management under extreme events - likelihood of effects and opportunities nationally (CHAMELEON) Project Report* to Defra.
- IFAD. 2010. *Livestock and climate change. International Fund for Agricultural Development*. Accessed to: <http://www.ifad.org/lrkm/events/cops/papers/climate.pdf>. Accessed on 02 May, 2018.
- IPCC. 2001. *Climate change: Impacts, adaptation, and vulnerability. Intergovernmental Panel on Climate Change (third assessment report)*. Cambridge University Press, Cambridge: UK.
- Islam, M.T. 2016. Community based risk assessment and adaptation to Change in Crop Sector at Taltali Upazila of Barguna District. *MS Thesis*, Department of Disaster Risk Management, Patuakhali Science and Technology University, Patuakhali.
- Larson, B. 2009. *Recognize the danger heat poses to your herd. Department of Veterinary Medicine*. University of Missouri Extension.
- Maluleke, W. and R.J. Mokwena. 2017. *The effect of climate change on rural livestock farming: case study of Giyani policing area, Republic of South Africa*. 23: 55-62.

- MoEF. 2009. *Climate change adaptation plan of action, 2009. Ministry of Environment and Forest.* Government of the People's Republic of Bangladesh.
- Moran, D., K. Topp, E. Wall and A. Wreford. 2009. *Climate change impacts on the livestock sector.* Sac Commercial Ltd, SAC Research.
- Rahman, A. 2008. Land cover and environmental hazards; satellite remote sensing approach and solutions in Bangladesh.
- Rowlinson, P. 2008. *Adapting livestock production systems to climate change temperate zones.* Proceedings of the Livestock and Global Change Conference, Tunisia.
- Salim, D.H.M. 2016. *Livestock economy at a glance 2015-16.* Department of Livestock Service, LE Section.
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