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Climate change risks and way-forward for Bangladesh livestock sector

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Abstract

The livestock sector in Bangladesh is the backbone of the rural economies in the country as 70% of the farmers depend on it for their livelihoods. It shares around 1.9% of the total gross domestic product (GDP) growing at 3.1%. The livestock population in the country increased from 349 million in 2012-13 to 432 million in 2021-22, i.e., around 24% increase. However, the livestock sector continues to face severe risks due to extreme climatic events such as floods, droughts, tropical cyclones, saltwater intrusion, and sea level rise. To address these risks, the Government of Bangladesh (GoB) along with international institutions, is planning to invest in various initiatives. Since no direct studies were conducted on impact of climate change on livestock health and associated diseases in Bangladesh, a review to explore the linkage between climate change and livestock health is investigated in this article. A few suggestions to combat the impact on the livestock sector are also discussed from the country's perspective. In addition, waste sources from the dairy value chains affecting the environment are identified and listed. Effective waste management strategies for various venues are also discussed in detail. Significant interventions are envisaged to facilitate promoting livestock-related enterprises, smallholder farmers and other stakeholders to progress towards a climate-smart livestock sector.

Keywords: Bangladesh Livestock sector; Climate-smart interventions; Anaerobic digestion; Slaughterhouse; Dairy value chain; Climate change impact; GHG mitigation and adaptation

1 Introduction

Bangladesh is highly vulnerable to climate change and continue to face severe climate risks. It is the seventh [1] most affected country in the world due to extreme climatic events such as floods, droughts, tropical cyclones, saltwater intrusion, and sea level rise. There is a record of 185 climatic events with 0.38 fatalities per 100,000 inhabitants over the past two decades [2]. Bangladesh is a low-elevation country with a very high population density and is highly prone to the risks of climate change. Flooding is reported to be the major cause of climate risks followed by tropical cyclones and droughts [3]. In addition, recurrent heat waves, especially in the Northwest regions cause major droughts. The estimated economic losses from climate disasters per annum is nearly USD 3 billion which is around 1-2% of the country's current GDP. The forecasted annual losses are estimated to be around USD 6-7 billion by 2030 if these climate risks remain unaddressed [4].

Most of the rural households and small farm holders depend on livestock production for their livelihoods. The livestock sector employs around 20% of the population directly and 50% of the population indirectly [5]. As per the Department of Livestock Services (DLS), the country had a total livestock population of 432 million in 2021-22, of which around 312 million are chickens, 63 million ducks, 27 million goats, 25 million cattle, 3.7 million sheep and 1.5 million buffalos. However, due to climate change, the livestock sector faces increased risk and stress through the shortage of feed &

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fodder and the low nutrient value of available feed which affects livestock productivity which in turn impacts the income and livelihood of rural households and small farm holders.

It is to be noted that the GoB has limited investment and capacity in the development of the livestock sector. Owing to these, there is inadequate (i) infrastructure and linkage between crop production and livestock farmers which results in the shortage of feeds supply, (ii) disease-resilient cattle breeds/productive breeding animals (iii) producer/dairy cooperatives to overcome risks (iv) technology for conversion of animal waste into renewable energy and (v) training and capacity building.

In this article, the climate change vulnerabilities & risks faced in the country's livestock sector are discussed. The impacts of climate change on the livestock value chain of Bangladesh are analyzed in detail with more emphasis on the adaptation of climate-smart interventions for waste management of the livestock sector and greenhouse gas (GHG) reduction practices.

1.1 Climate change vulnerability in the livestock sector of Bangladesh

Due to very low elevation, Bangladesh is more prone to flooding and other climate change devastations. The Ganges-Meghna-Brahmaputra River basin is geographically prone to flooding during the monsoon season (June to October). Climate change-driven over-flooding causes severe damage to the agriculture and livestock sector with a considerable reduction in strategic resources. The livestock sector is considered a major part of food security for Bangladesh alongside agriculture and its risks are exaggerated with natural disasters. Migration due to natural calamities is another dimension of the same problem.

'The INFORM Risk Index' places Bangladesh among one of the highest climate change risk-level countries ranking 29th out of 191 nations[2]. Major climate change disaster events in the country include tropical cyclones, flooding (coastal, flash, and riverine), drought, and saline intrusion in coastal areas. Social vulnerability in the country also elevates disaster risks and increases associated financial losses. The socio-economic effects of the disaster events invite joint mitigation/adaptation efforts to overcome these challenges. The natural hazard index of various events in Bangladesh is presented in Figure 1.

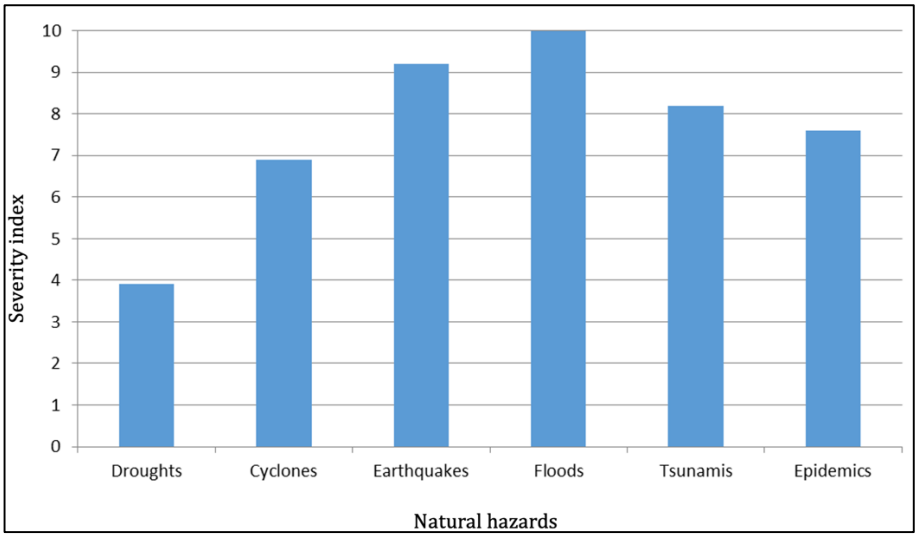

Figure 1 Natural hazard severity index for Bangladesh [6]

The estimated average global mean sea level rise ranges from 0.44 m to 0.74 m [7]. Such sea-level rise poses a severe threat to the habitation of people in the lowlands. The ground level in Bangladesh is also falling due to tectonic movements. Protection measures such as modern dyke does not exist in the country and on the other side, the reduction of mangrove cover is expected to amplify the flooding effects. Further, human activities like groundwater extraction, aquaculture, and sand mining also elevate the risks. The heavier flooding of the inland, accompanied by insufficient sanitary conditions poses a threat to public health through epidemics like cholera and malaria, which also impact the livestock sector [8]. The more frequent extreme weather events like temperature hikes affect the livestock's health causing metabolic disorders, oxidative stress, immune suppression, and heat stress. The direct effects also result in higher disease incidents and deaths. Other related indirect health effects are reproduction, virulence, multiplication and

distribution of parasites, and transmission of infectious pathogens. Growth and management of the crossbreeding livestock industry is also one of the emerging impacts of climate change on re-emerging diseases in Bangladesh [9].

The mangrove ecosystem (Sundarbans) is a bio-hotspot for a wide spectrum of flora and fauna. Sundarbans also provide resources like honey, seafood, wood, etc., sustaining the local communities. Mangrove vegetation acts as a natural barrier against coastal flooding and tsunamis. Salinity intrusion in islands damages the land and water resources affecting agricultural productivity and local livelihood. Coastal Bangladesh is reported to have increased salinity of rivers including the proximities of the Sundarbans. The effect of salinity intrusion affects the fisheries' yield. The Sundarbans faces change in the ecosystem, especially with respect to the numbers of Sundari, Goran, and Gewa trees.

Threat to sustainable livelihood causes migration within the affected districts (approx. 15,000 - 30,000 migrants in a year) [10]. Majority of the country being floodplain puts Bangladesh at the epicenter of the global climate crisis. The Department of Disaster Management under the Ministry of Disaster Management and Relief, requires disaster management and adaptation/vulnerability tools to be kept available till the sub-districts level.

2 Impacts on the livestock value chain

The effects of the livestock value chain in Bangladesh with respect to several factors such as cattle health, animal feed, socio-economic aspects, pollution, manure disposal, and utilization are discussed in detail in this section.

2.1 Animal health

Climatic events such as floods and tropical cyclones increase the exposure of livestock to various diseases. The mortality rate of livestock is high during these events. Similarly, the increasing surface temperature with high humidity, decreases the tolerance of selective breeds to climate risks and affects its fertility. The spread of diseases is more in the case of climate risks such as flood and drought which severely affects the productivity of the livestock/dairy sector [11]. An increase in global temperature, carbon dioxide (CO_2) concentration, precipitation variation, etc., affects the livestock's primary factors like forage, production, reproduction, and health. It also causes major changes in the livestock's ecological, social, individual, and community behavioral patterns [12]. Further, frequent disease inception and high exposures to vector-borne, soil, food, and water-borne diseases cause increased animal mortality rates. Due to these, the income generation of the farmers and their economic situation decreases, affecting their livelihoods severely. It is also to be noted that smallholder farmers are mostly affected due to lack of insurance during severe disaster events. The awareness on livestock vaccination, deworming and insurance is limited among landless livestock farmers. The availability of climate-smart sheds, monitoring and testing tools, need to be increased to prevent spreading of diseases. Facilities like lairage, as shown in Figure 2 at the slaughterhouses, with proper testing and inspecting tools help in ensuring the health of the slaughtering animals.

Figure 2 Lairage at a slaughtering facility

2.2 Animal feed

Loss of grazing land during flooding events and reduced production of fodder during droughts affect the feed requirements of the livestock. The coastal areas are mainly affected by decreased fodder production due to saltwater intrusion. Penetration of modern feed and fodder production elevates the impact on livestock productivity.

2.3 Socio-economic impacts

Financial losses are high during climatic events, especially for smallholder farmers in rural zones. This added to disrupted logistics places the livestock and dairy value chains at high risk. Since most of the rural population depends on livestock rearing, their livelihood is also heavily affected. The socioeconomic growth of vulnerable communities is worsened and serious interventions are needed at the community level. These in turn aggravate the socioeconomic issues including loss of employment, poverty, and migration.

2.4 Pollution/GHG emissions from the livestock sector

The wastes generated from rising livestock markets, energy-intensive processes, and inefficient raw material use affects the sustainability aspects of the livestock value chain. Reported emissions from the livestock sector contribute to global warming making it an important global issue. The increase in the rate of GHG emissions is due to the growing livestock population mainly through manure production. The ammonia emission and nitrogen losses from conventional manure management increase the risks to the local environment. Acidification of the natural environment, eutrophication of the water bodies, and toxicity to humans and livestock are some of the critical effects of ammonia emissions. The water requirement of the livestock sector is also high mainly due to feed and fodder production, rearing activities, slaughterhouses and dairy operations. Conservation of energy and water use with appropriate waste management strategies will reduce the risks associated with their supply and improve judicial use of available resources.

2.5 Manure disposal and utilization

The high density of livestock in Bangladesh consisting of 21 million households rearing livestock out of which 10 million households rearing cattle makes manure management difficult [13]. Around 82% of the total livestock in the country is managed by landless small-scale farmers. The manure is mainly used as cooking fuel and as fertilizer. Manure produced from intensive livestock rearing causes methane emissions, water pollution, and health hazards. Burning dried dung for domestic cooking contributes to air pollution and a high probability for occurrence of respiratory diseases.

Figure 3 Slaughterhouse processing cattle carcass

2.6 Slaughterhouse waste

Large number of formal and informal slaughterhouses meet consumer demand in Bangladesh in an unorganized manner. Large quantities of solid and liquid wastes are generated from slaughtering activities. Slaughterhouses also lack sufficient water supply and drainage facilities. Disposal of generated wastes without proper treatment causes environmental and ecological problems to the neighbouring water bodies. Frequent clogging of drainage systems of the

slaughterhouses is also a major issue. The odour from the slaughterhouse due to untreated waste disposal impacts the social acceptance of slaughtering house operations by the surrounding communities. The process line in a slaughterhouse is shown in Figure 3. Segregation of useful internal organs and blood has economic benefits such as reduced waste disposal expenses and additional income generation from the sale of by-products.

2.7 Tannery waste

The tanning industry, which also comes under the livestock value chain faces considerable challenges due to environmental violations. The tanning industry is a major sector next to the garment industry contributing to 10% of global leather production [14]. The cluster of tanneries in Hazaribagh had caused severe environmental degradation and water pollution of the Buriganga River. The unprocessed wastes from these tanneries remain unchecked and are usually drained into nearby rivers or fields causing severe contamination. Roadside dumping of solid wastes is also predominant. The human health issues of the workers in the tanning industries are a major problem that draws global attention.

2.8 Dairy wastewater

The large water consumption of the dairy industry contributes to massive quantities of dairy wastewater. The growth of the dairy sector demands increased water use and increases the waste generation leading to environmental problems. Activities like crate washing, cleaning in workplace, and silos/bulk milk chillers yield different wastewater streams. The caustic wastewater needs to be properly treated, failure of which leads to difficulties in anaerobic digestion. The dairy industry is energy-intensive mainly due to pasteurization and refrigeration processes. The wastes from the production of dairy products (for example, whey) have imminent commercial value if properly recovered.

3 Key waste management and GHG reduction practices

In this section, waste management aspects, including slaughterhouses as well as dairy waste treatment strategies are discussed. These measures also offer diversification of income generation, improve resource efficiency and in a way contribute to sustainable circular economy development as a way to combat climate change.

3.1 Waste disposal at livestock farms

The livestock waste at the farm level mainly consists of manure, feed/fodder & other agricultural/domestic wastes based on the farm type and location. Manure waste is a major contributor to GHG emissions, primarily the methane. The liquid waste containing pathogens is usually drained into the nearby fields and water bodies pose public health and environmental risks. Appropriate farm-level climate-smart interventions are required to manage and mitigate the pollutants.

Biogas digesters at these farms will address the issue of methane emissions and their utilization will minimize the dependence on fossil fuels. The potential of biogas to replace cooking fuel will help address the smoke/pollution hazard from dried dung. Usage of bio-fertilizer from digesters and other composting/vermicomposting methods increases agricultural productivity.

The collection of manure by small livestock farmers is difficult as most of them are landless. The mixed livestock rearing of small-scale farmers requires capacity development with special emphasis on waste management. Animal wastes yields manures rich in nutrients that can be used for crop/fodder production. Manure management activities at the community level help resolve the operational and maintenance issues ensuring sustainability in the long run. The involvement of youth and women improves social acceptance and local communal benefits.

3.2 Slaughterhouse waste management

Slaughterhouses generate a significant amount of solid and liquid waste streams. Management of slaughterhouse waste solves the problem from installing biogas plants as well as efficient primary effluent treatments. Improper disposal of slaughterhouse waste is a severe environmental concern. Open disposal of slaughterhouse waste is shown in Figure 4. Public health is also compromised through illegal slaughtering practices. A hygienic slaughtering slab with good sanitation facilities help butchers minimize wastes and segregate useful internal organs. The manure and intestines of the animals are the major waste components better to be handled through anaerobic digestion. The blood drained from the slaughtered animal is mostly let out into the drains. It can be used to prepare animal and poultry feed.

Composting is another option for handling solid wastes from slaughtering activities. Bio-slurry from an anaerobic digester could be marketed as fertilizer after dewatering and drying. Rendering of solid wastes and bones yield

commercial products with economic value. Using biogas to meet electricity and thermal needs promotes the smart energy use.

3.3 Dairy wastewater treatment

The dairy industry handles large quantities of water and thereby significant wastewater streams. The disposal of dairy wastewater without proper treatment causes water pollution. Increased Biological Oxygen Demand (BOD) and Chemical Oxygen Demand (COD) in the wastewater favours anaerobic digestion. The effluent treatment facility solves the problem in the case of large dairies. The effluent treatment facility at the dairies usually involves filtration, aeration, settling tanks, and anaerobic digesters. Small and medium milk processors seldom have effluent treatment facilities. The waste management by the sweetmeat producers and other intermediate processors needs to be addressed through environment-friendly activities. The biogas could be used for local thermal and electrical needs. The treated wastewater could also be used locally to minimize the water footprint of the dairies.

Figure 4 Open disposal of slaughterhouse waste

4 Climate-smart interventions

Climate-smart interventions with adaptive farming policies and practices, GHG mitigation initiatives, and socio-economic improvement in livestock management are discussed in this section. The country recognized the impacts of climate change a few decades ago and is committed to implementing various interventions. The key government policies, national adaptation policies, and strategies focussed on mitigating climate change are presented in Table 1.

Table 1 Government policies and strategies

No.	Policy/Strategy	Year
1.	National Adaptation Program of Action	2009
2.	Technology Needs Assessment and Technology Action Plans for Climate Change Adaptation	2012
3.	Nationally Determined Contribution to the Paris Climate Agreement	2016
4.	National Plan for Disaster Management 2016–2020	2017
5.	Bangladesh Delta Plan 2100	2018
6.	National Communications to the UNFCCC	2018
7.	Mujib Climate Prosperity Plan	2021

4.1 Farming practices

Drought-resistant fodder varieties are promoted as an initiative to counter heat waves. Flood adaptive fodder production can be a notable intervention in the livestock sector. The nutritional value of the feeds is another factor the country is focussing on to increase the productivity of livestock. The government encourages testing and monitoring of the feed products to recognize indigenous feed producers. Capacity development and training programs focussing on climate-smart farms and effective management are already being initiated.

Circular economy interventions for shifting from mixed farming to integrated farming practices are highly encouraged. The circular economy promotes poverty alleviation, energy independence, and water efficiency with active mixed farming linkages. Climate resilient sheds are also promoted by the ongoing internationally aided development programs.

4.2 GHG mitigation

The GHG mitigation initiatives in the livestock sector are focussed on waste management, fertilizer abatement, and renewable energy interventions. Integrated livestock manure management policy outlines the emission reduction potential and presents various linkages with other ongoing action plans. Infrastructure Development Company Limited (IDCOL) and the Local Government Engineering Department (LGED) are the notable government entities intervening in the livestock sector waste management requirements.

Clean cooking initiatives are focussed on the reduction of dried cow dung used as household cooking fuel. These interventions aim to improve the health and living conditions of women and children. The climate benefit from reducing the emissions from the combustion of dried manure is an added advantage. Community-scale manure-based biogas systems are promoted by the Rural Development Agency (RDA) providing cooking pipelines, energy, and fertilisers to the local stakeholders.

4.3 Socio-economics

Various adaptation programs are focussed on improving the climate resilience of vulnerable communities in the country. Large number of youth and women are involved in those projects and some are already reaping the benefits from entrepreneurship development initiatives. Co-operatives are also promoted in various livestock-related enterprises mainly in manure management, feed/fodder production, and cold chains. Community-based awareness programs will enable the upliftment of local communities through a special focus on food security, poverty alleviation, energy and water conservation initiatives.

5 Conclusion

Adaptation to climate change events through climate-smart/resilient technologies need to be built on the performance of the previously implemented interventions. Interventions need to be focussed on increased livestock productivity with minimum resources/inputs by the smallholder farms. Encouraging women farmers and provisions for market access will attract social involvement. A key strategy is also to focus on adaptation, sustainability, and climate-smart activities. Initiations like improved early warning systems, capacity development efforts, demonstration of climate-smart technologies, private funding, etc., can help livestock and dairy value chain of Bangladesh to be resilient towards climate change risks.

Compliance with ethical standards

Disclosure of conflict of interest

The authors declare that they have no conflict of interest.

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