A Seminar Paper

on

Impact of Natural Disasters on Agriculture and Their Management Strategies in Bangladesh

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Impact of Natural Disasters on Agriculture and Their Management Strategies in Bangladesh[1]

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ABSTRACT

Bangladesh is one of the most disaster-prone countries in the world. Floods, droughts, cyclones, storms, river/coastal erosion, tornadoes, thunderstorms, hailstorms, waterlogging, etc., are common disasters that damage agriculture every year. This paper clarifies the impact of natural disasters on agriculture and highlights the strategic management to reduce the damages and losses. During 2015-2020, disaster-related losses were 1,791,988 million Tk where 28.90% (Tk. 517,961 million) loss occurred in the crop sector. Flood (Tk. 241,842 million), cyclone (Tk. 153,921 million), hailstorm (Tk. 34,155 million) and river/coastal erosion (Tk. 26,765 million) jointly accounted for 88.17% of the total losses in the crop sector and the rest 11.83% were caused by other disasters. In this period, affected areas for paddy, potato, wheat/maize, and jute were 5,431,540 acres, 73,608 acres, 155,136 acres, and 456,127 acres, respectively. For decreasing these losses, the Bangladesh government has taken different steps and management policies. Disaster shelters, disaster forecasting & warning, structural and non-structural construction of dams, dykes etc, can reduce the damage of flood, cyclone, and tornado. Floating farming is one of the greatest achievements in waterlogged area. Structural and non-structural measures were taken for river bank erosion protection. GOs & NGOs also provided relief and some other support to the farmers for continuing agricultural production. But there should be more actions as mentioned in this study to minimize the disasters damages and losses.

Keywords: Disasters, Flood, Cyclone, Crop loss, Hailstorms, Shelters.

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CHAPTER I

INTRODUCTION

Natural disasters are no longer uncommon occurrences. A record number of natural disasters are causing havoc on the world, and their frequency and intensity appear to be increasing. Natural disasters and man-made disasters are the two types of catastrophes. Major natural disasters include earthquakes, volcanic eruptions, floods and tsunamis, landslides, and forest fires. Man-made disasters, on the other hand, include explosions, chemical contamination, transportation accidents and so on (Rasyid *et al.*,2019). Furthermore, climate change which causes drought or inconsistent rainfall, is seen as one of the calamities caused by human activity (Pratiwi *et al.*,2020).

Bangladesh is one of the countries highly vulnerable to natural disasters. Bangladesh's geographical position and physiographic geography bode disaster. Floods, cyclones and tidal surges, tornadoes, earthquakes, and droughts have frequently visited this nation, causing havoc. Furthermore, Bangladesh is a small impoverished country with a large population. Rapid population increase and a sluggish pace of economic growth have pushed a significant portion of the ever-increasing population to dwell in locations too dangerous for human habituation such as newly emerging chars. Thus, a huge number of new towns in coastal regions, char lands, and historic communities near shifting rivers are all constantly threatened by disasters such as cyclones, tidal surges, and riverbank erosion (Hossain, 2011).

Natural disasters strike Bangladesh almost yearly, putting the residents of our community in danger. The effects of disasters vary based on their kind, severity, and people's preparedness (Kusumastuti *et al.*, 2021). Nature is clearly understood by everybody to be beyond human control. However, efficient disaster management can help to reduce the significant loss caused by calamities. As a result, disaster management has gained international recognition as a field.

Disaster management cannot be seen in isolation, preferably as a collection of many management phases in managing this specific challenge. However, there cannot be a perfect system that prevents disaster harm because that would render the disaster ineffective. Disaster management is a systematic process of implementing policies, strategies, and coping capacities of society and communities to decrease the effect of natural hazards and linked environmental and technology disasters (UN/ISDR, 2009). While the rest of the world has recognized the importance of employing appropriate disaster risk management systems, Bangladesh has been implementing various disaster risk management programs for a long time. But as a poor country, it is unable to meet the necessary resources to proactively and reactively meet the

needs of pre and post-disaster needs. The agricultural industry which is entirely dependent on nature, can benefit from disaster management.

It can be stated that agriculture's susceptibility to disasters is increasing day by day, and adequate disaster management policy design and implementation with assessment is critical (Rahman *et al.,* 2017). If the management policies are implemented up to the mark, then Bangladesh will be widely acknowledged as the "Role Model" for disaster and climate risk management across the world.

Previous research has examined the many scenarios of natural disasters that have occurred in the country. Bangladesh's government has also implemented certain plans or strategies to deal with natural calamities. The primary goal of this study is to investigate the impact of natural disasters on Bangladeshi Agriculture and some time-demanding with existing management measures to limit disaster losses to a manageable level.

Objectives of the paper

The specific objectives of this review paper are as follows:

- ✓ To assess the impact of natural disasters on agriculture.
- ✓ To describe the strategic action against the disasters.

CHAPTER II

MATERIALS AND METHOD

This paper is simply a review paper. So, the information in this study is mainly based on the secondary sources. For preparing this paper various articles, published papers, reports, journal papers, and online websites are used.

Formative directions and suggestions were carried out by my Major Professor, Course Instructors and other resource personnel to enrich this paper. After collecting all information and available data it was systematically rearranged and presented in the current form.

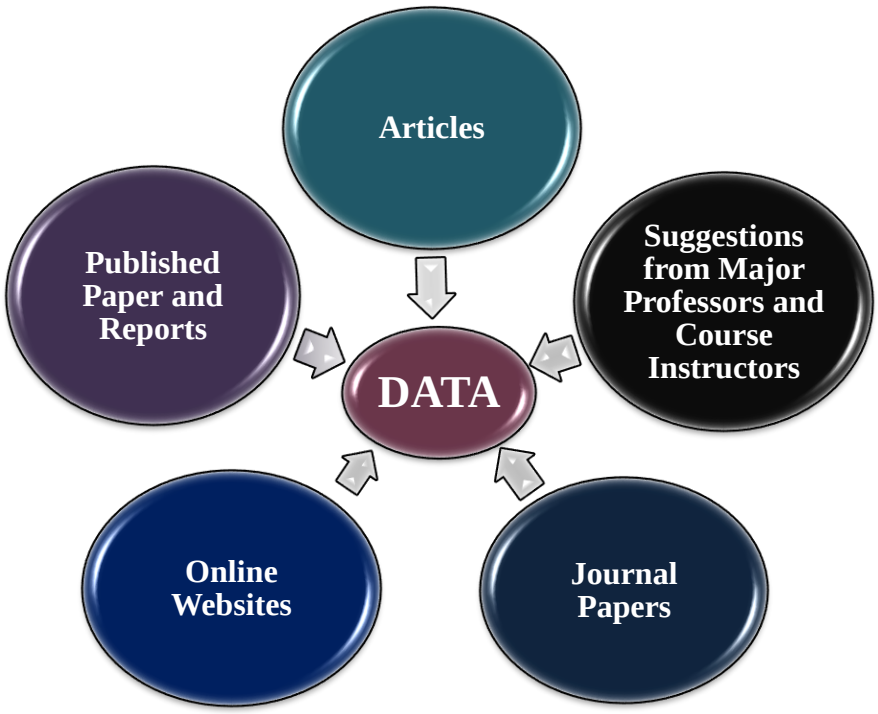


Figure 1. Sources of data and information used to prepare the seminar paper.

CHAPTER III

REVIEW OF FINDINGS

3.1 Overview of Natural Disaster

Natural disasters can have a devastating impact on survivors' livelihoods as well as the number of fatalities. Several significant natural and man-made disasters have recently afflicted both developed and developing countries (Sawada & Takasaki, 2017).

3.1.1 Natural disasters in Bangladesh

Bangladesh is one of the most vulnerable countries to natural disasters due to its geomorphological position. Thus, geographical settings, meteorological features, and hydrological circumstances all contribute to its vulnerability to various geo-disasters and hydro-meteorological hazards. Floods, river/coastal erosions and cyclones are three of the most prevalent natural calamities. Moreover, tidal surges, tornadoes, droughts, water logging etc. are frequent occurrences (Table 1). These disasters often hit, causing millions of losses, extensive property and infrastructure damage (Haque & Jahan, 2015).

Table 1. Damages and losses by type of disasters (2015-2020)

Types of Disaster	Losses (In Million TK.)	Percentage (%)
Drought	27,344.00	1.53
Flood	1,010,882.00	56.41
Water Logging	93,860.00	5.24
Cyclone	255,382.00	14.25
Tornado	15,226.00	0.85
Storm/ Tidal Surge	15,475.00	0.86
Thunderstorm/Lightening	29,195.00	1.63
River/ Coastal Erosion	268,703.00	14.99
Landslide	6,082.00	0.34
Salinity	20,756.00	1.16
Hailstorm	48,945.00	2.73
Others	136.00	0.01
Total	**1,791,988.00**	**100.00**

Source: (BBS, 2022)

3.1.1.1 Flood

Normal floods are considered as a gift for Bangladesh since they provide crucial moisture and fertility to the land by alluvial silt deposition but when the flood is in the extreme condition, it become harmful to the people. There are four types of floods in Bangladesh: river floods, flash floods, rain-fed floods, and tidal surges (Dewan *et al.*, 2003). Bangladesh has been hit by more than 30 floods between 1988 to 2020 (BBS, 2022). Among them some were the most devastated (Table 2).

Table 2. Major floods occurred in Bangladesh (1988-2020)

Year	Location	Damage
1988	Dhaka	Catastrophic flood, inundated about 82,000 sq km
1989	Sylhet, Sirajganj and Moulvibazar	Serious flood; trapped 600,000 people.
1993	28 districts of Bangladesh	Thousands of hectares of crops went underwater.
1998	⅔ of the country	Worst flood; lasted for more than 2 months.
2000	5 South-western districts	Serious flood; 3 million people were homeless.
2004	Almost 50% of total area	30 million were homeless and above 750 died.
2017	31 districts were affected	6.1 million affected, 2800km roads; 123 bridges damaged
2019	21 districts were affected	5 million people affected; more than 70 died, 287513 were displaced. 6655 km roads were damaged.
2020	One third of the country affected	3.3 million people affected; Over 90 people died; 56000 were displaced; 1900 schools were damaged.

Source: (BBS, 2022)

3.1.1.2 Drought

Drought is a big concern in many nations, and the severity of the situation is exacerbated when it comes to maintaining optimal agricultural production in a country such as Bangladesh. Drought has been highlighted as the key issue affecting Bangladesh's expected agricultural productivity over the last few decades (Islam *et al.,* 2019). Bangladesh has faced severe droughts many times (Table 3).

Table 3. Chronological history of droughts in Bangladesh

Year	Historical Description
1973	One of the severest and was responsible for the 1974 famine in northern Bangladesh.
1975	Affected 47% of the country and caused sufferings to about 53% of the total population.
1978-79	One of the severest; reduced 2 million tons rice production; affected 42% cultivated land.
1981	Severe drought adversely affected crop production.
1982	Caused a total loss of rice production amounting to about 53,000 tons.
1989	Most of the rivers in NW Bangladesh dried up and several districts; dust syndrome occurred for a prolonged period due to drying up the topsoil.
1994-95	Caused immense damage to rice and jute. This was most persistent drought in Bangladesh.

Source: (BBS, 2022)

3.1.1.3 Cyclone

Typhoons that develop in the Indian Ocean are referred to as "Cyclones" in English. They often happen from April through May, either in the early summer or the late rainy season. Cyclones are caused by low air pressure over the Bay of Bengal (Hossain & Mullick, 2020). Bangladesh has experienced several major cyclonic storms in last couple of years, resulting damage to crops and property (Table 4).

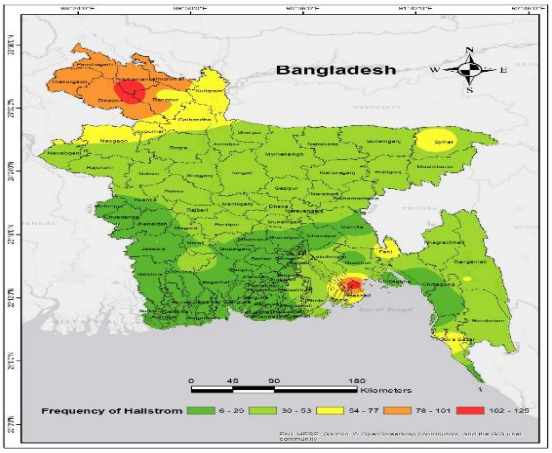
Table 4. Major Cyclonic Storms from 2007 to 2020

Date	Nature of Phenomenon	Landfall Area	Max Wind Speed (km/hr)
15.11.07	Severe Cyclonic Storm with hurricane wind (SIDR)	Khulna-Barishal Coast	223
25.05.09	Cyclonic Storm (AILA)	West Bengal-Khulna Coast near Sea Island	70-90
16.05.13	Cyclonic Storm (MAHASEN)	Noakhali-Chottogram	100
21.05.16	Cyclonic Storm (ROANU)	Barishal-Chottogram Coast near Patenga	128
30.05.17	Severe Cyclonic Storm (MORA)	Chottogram-Cox's Bazar Coast near Kutubdia	146
04.05.19	Very Severe Cyclonic Storm (FANI)	Odisha Coast of India, then moved to Bangladesh	81
10.11.19	Very Severe Cyclonic Storm (BULBUL)	Sagar Island of India, then moved to Bangladesh	91
20.05.20	Severe Cyclonic Storm (AMPHAN)	West Bengal Bangladesh Coast	160

Source: (Bangladesh Environment Statistics, 2020)

3.1.1.4 Hailstorm

A hailstorm is any thunderstorm that produces hail that falls to the ground. Hailstones may cause significant damage and loss to plants, agricultural crops, infrastructure, and outdoor equipment. Strong hailstones can kill animals and people (BDRS, 2021). Rangpur division is the most hailstorm affected area in Bangladesh (Figure 2).



Source: (Raihan *et al.*, 2020)

Figure 2: Hailstorm frequency in Bangladesh

3.1.1.5 Tornadoes and Nor'westers

Tornadoes are one of the natural disasters that strike quickly yet leave a large destructive footage. During the pre-monsoon season, most irregular rainfall or drought conditions occur in various locations. There are also significant seasonal, local storms known as Nor'westers (kalbaishakhi in Bengali). Tornadoes are commonly connected with severe nor'westers and sometimes very devasting (Table 5).

Table 5: Devastating Tornadoes hit Bangladesh

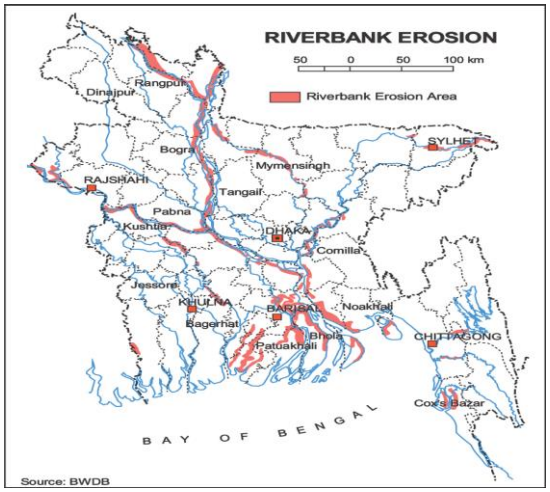
Date of Occurrence	Place of Occurrence	Devastation Area (sq. km.)	Max Wind Speed (Km/hr)	People Killed	Number of Injured
11/04/1974	Bogura	25.9-31.1	242	28	75
01/04/1977	Faridpur	51.8	322	500	6000
26/04/1989	Manikganj	150.2	388-419	526	Innumerable
20/04/1990	Sirajganj	77.7	193	29	2000
07/05/1991	Gazipur	-	298	46	400
18/05/1991	Gouranadi	207.2	251	17	400
08/05/1995	Lowhajang	-	250	34	SH
13/05/1996	Tangail	16 Unions	320-400	570	30000
22/03/2013	Brahmanbaria	20 villages	170	31	500

*SH= Several hundred

Source: (BBS, 2022)

3.1.1.6 River/Costal Erosion

Coastal/river erosion refers to the loss or displacement of land along a coast or river, as well as the long-term removal of sediment and rocks caused by the action of waves, currents, tides, wind-driven water, and other forces. The socioeconomic structure is significantly more devastated by erosion than by any other environmental disaster. Although erosion does not kill, it does lead individuals to become disjointed (BDRS, 2021).

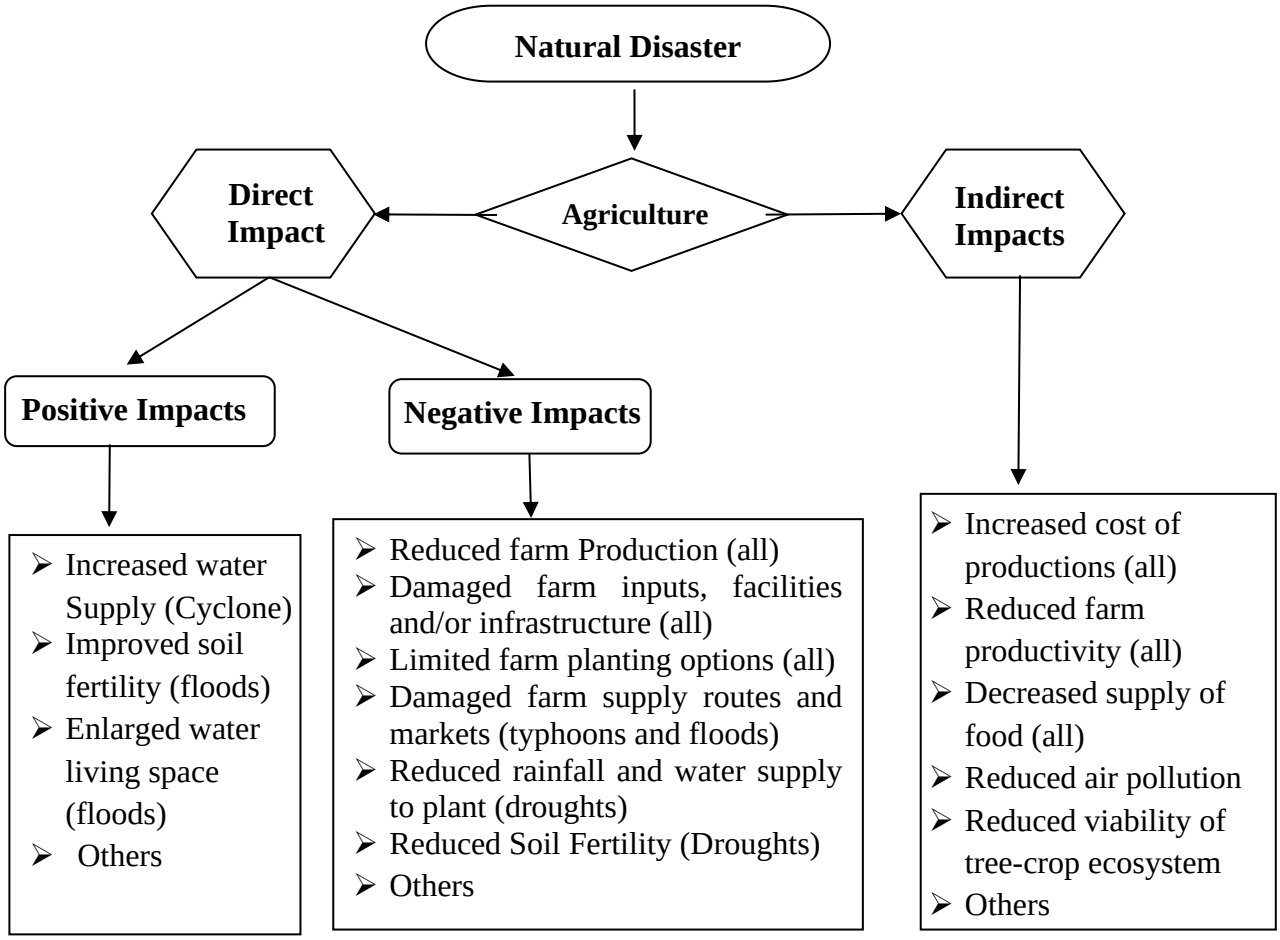


Source: (BWDB, 2017)

Figure 3: Riverbank erosion Map

3.2 Impacts of Natural Disasters on Agriculture

The impacts of natural disasters on Agriculture can be positive or negative. While the impacts are generally negative and do affect human society significantly, there are some positive impacts or benefits that need to be refocused out as well in any discussion on the impacts of Natural Disasters (Figure 4).



Source: (Israel & Briones, 2012)

Figure 4: Framework analysis regarding impacts of Natural Disasters on Agriculture

Natural disasters cause a variety of losses, the destruction of homes, crops, livestock as well as harm to the environment. People's economic, social, and cultural lives are negatively impacted as a result. In the period of 2015-2020 a total of Tk. 1,791,988 million was calculated due to the damage and loss by disasters. Among them, crop sector had a 28.90% loss absorbed alone and the land degradation sector had 52.56 % loss which is directly related to agricultural production (Figure 5).

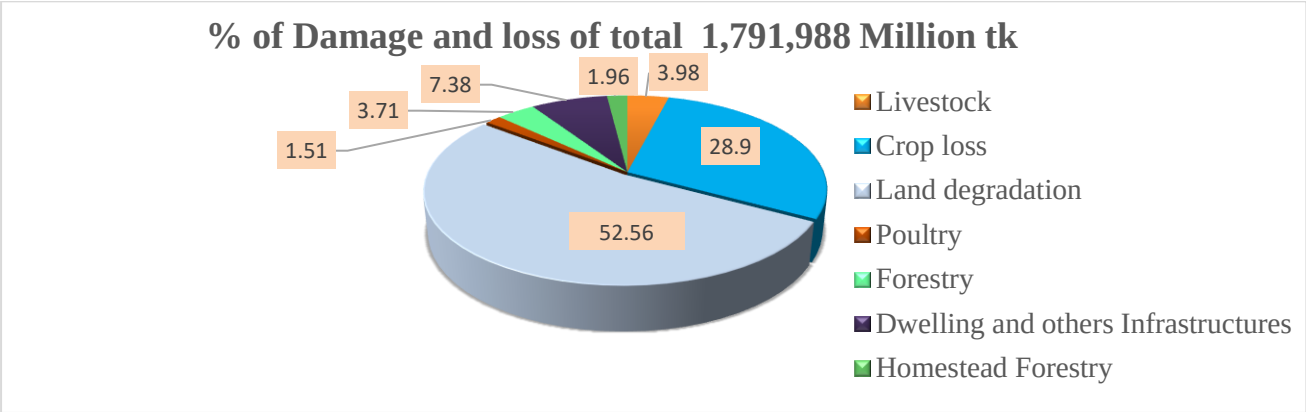


Figure 5: Sector wise % of damage and loss due to disasters Source: (BBS, 2022)

In the period of 2015-20, Total damage and loss was 517,961 million Tk. in crop sector. Flooding alone was responsible for 46.69% (Tk. 241,842 million) while cyclones, hailstorm and river/costal erosion were responsible for 29.72%, 6.59% and 5.17%, respectively (Figure 6). Flood, cyclones, hailstorm and river/coastal erosion combinedly accounted for 88.17% of total damage & losses and others made 11.83% of the damages & losses.

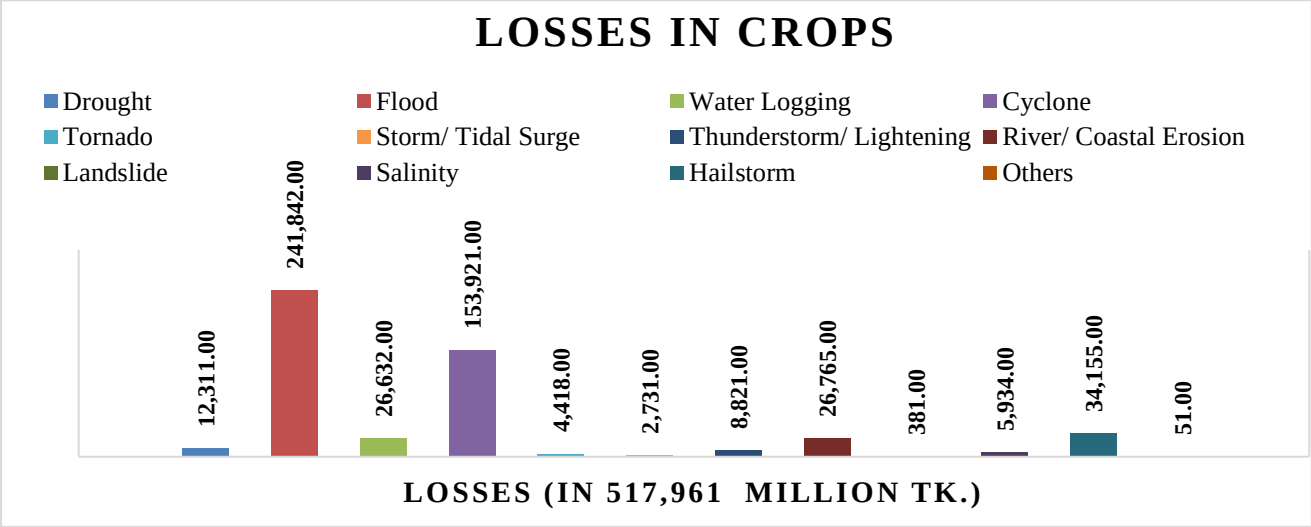
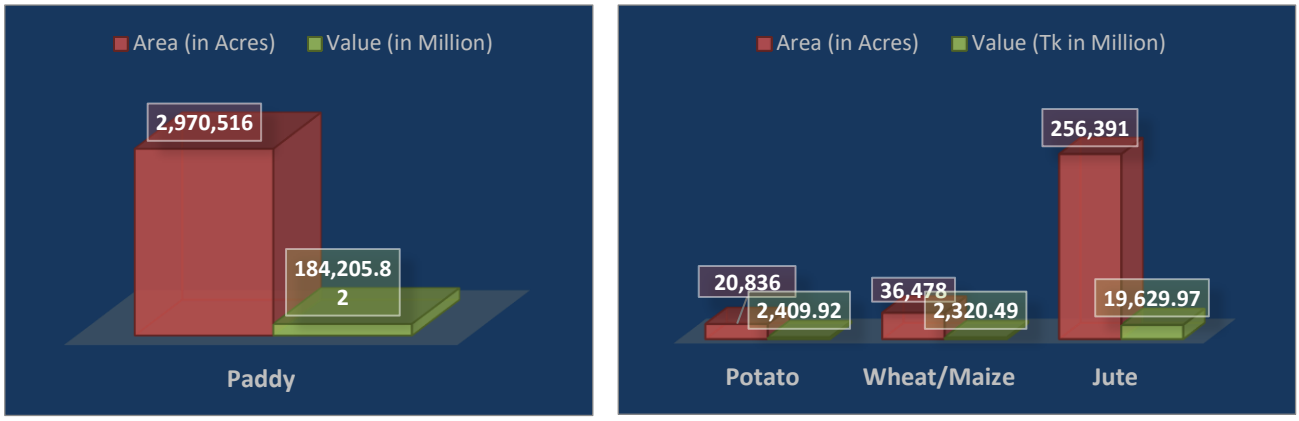


Figure 6: Disaster wise losses in crops. Source: (BDRS, 2021)

3.2.1 Flood impacts

The effects of the floods are noticeable as negative, although it seems hard to believe, the effects of the floods can also be positive. The negative effects of floods are felt especially in areas where local communities have developed or in the case of productive lands. Negative impacts include material losses, economic costs and damage to crops due to soil and subsoil saturation. Floods can also lead to nutrient leaching from soils. On the positive side, floods can result in soil fertilization through the proliferation of freshwater algae that fix nitrogen in flooded areas. (Sîli *et al.*, 2020).

During 2015-2020 season, four major crops and agricultural land were affected badly. Due to the flood, 2,970,516 acres of paddy were affected, resulting in a loss of 184,205.82 million tk. Potato crops on 20,836 acres were affected, causing losses of 2,409.92 million tk. Additionally, the flood affected 36,478 acres of wheat/maize, leading to losses of 2,320.49 million tk. Moreover, 256,391 acres of jute were also affected, resulting in a loss of 19,629.97 million tk (Figure 7).

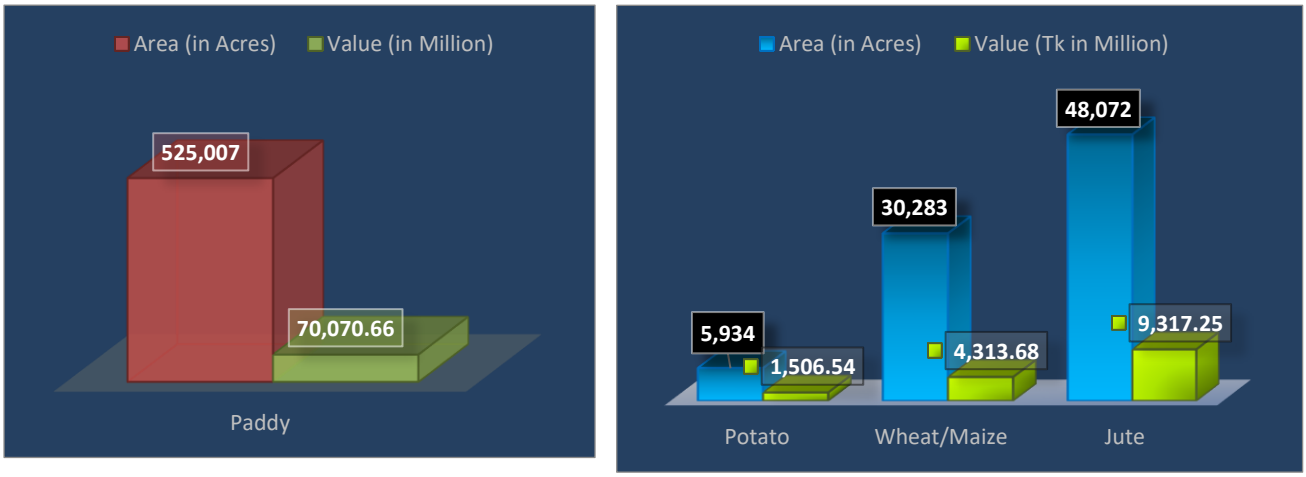


Source: (BDRS, 2021)

Figure 7: Impact of flood on Agricultural crops

3.2.2 Cyclone Impacts

Cyclones have a severe impact on agriculture, particularly on paddy production in coastal areas. In the period of 2015-20 season, 525,007 acres of paddy, 5,934 acres of potato, 30,283 acres of wheat/maize, and 48,072 acres of jute land were affected by cyclones. The losses incurred were 70,070.66 million tk, 1,506.54 million Tk. 4,313.68 million Tk. and 9,317.25 million tk respectively in the previously mentioned crops (Figure 8).

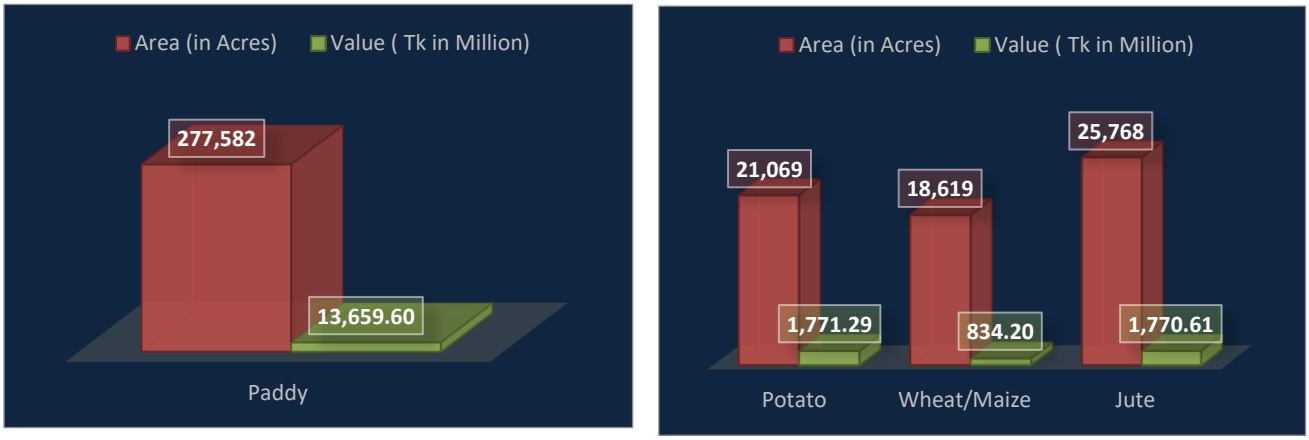


Source: (BDRS, 2021)

Figure 8: Impact of Cyclone on Agricultural Crops

3.2.3 River/Coastal Erosion Impacts

River and coastal erosion have several impacts on Agriculture. During the period of 2015-20, river/coastal erosion caused significant damage to various crops. The major crops affected by erosion were paddy, potato, wheat/maize, and jute. The cropland areas of the previous mentioned crops were 277,582 acres, 21,069 acres, 18,619 acres, and 25,768 acres, respectively. The losses incurred in these crops due to erosion were 13,659.6 million Tk. 1,771.29 million Tk. 834.20 million Tk. and 1,770.61 million Tk., respectively (Figure 9).

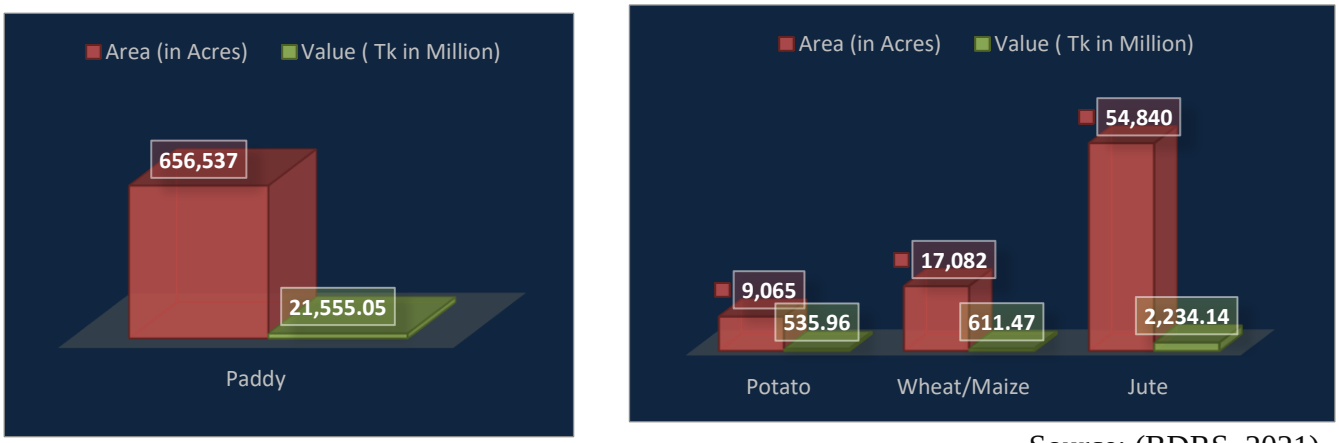


Source: (BDRS, 2021)

Figure 9: Impact of River/Coastal Erosion on Agricultural crops

3.2.4 Hailstorm Impacts

Hailstorms can cause significant damage to crops. Due to hailstorm, paddy, potato, wheat/maize and jute were affected by 656,537 acres, 9,065 acres, 17,082 acres and 54,840 acres of cropland respectively during 2015-20. During this period, losses calculated were 21,555.05 million Tk. for paddy, 535.96 million Tk. for potato, 611.47 million Tk. for wheat/maize and 2,234.14 million Tk. for jute (Figure 10).



Source: (BDRS, 2021)

Figure 10: Impact of Hailstorm on Agricultural crops

3.2.5 Others Disasters Impact

Drought, water logging, thunderstorm, tornado, salinity, tidal/storm surge, and landslide also have several impacts in major crops during the period of 2015-2020 (Table 6).

Table 6. Various types of Disaster impact on major crops

Types of Disaster	Paddy		Potato		Wheat/Maize		Jute	
	Area (in Acers)	Value (in Million)	Area (in Acers)	Value (in Million)	Area (in Acers)	Value (in Million)	Area (in Acers)	Value (in Million)
Drought	241,467	7,718.29	3.344	222.10	13,822	496.57	21,935	1,032.61
Water logging	422,158	16,637.48	6.566	407.97	4,378	146.36	36,014	1,974.74
Thunderstorm	142,039	4,340.85	5.123	205.81	25,390	643.36	7,367	256.41
Tornado	86,045	2,596.01	252	17.18	8,221	308.79	2,373	93.74
Salinity	70,516	3,872.56	417	73.69	100	3.45	1,267	71.19
Tidal Surge	34,145	1,202.43	896	64.93	145	5.31	8	0.40
Landslide	4,885	137.68	105	9.98	579	19.19	0	0.00

Source: (BDRS, 2021)

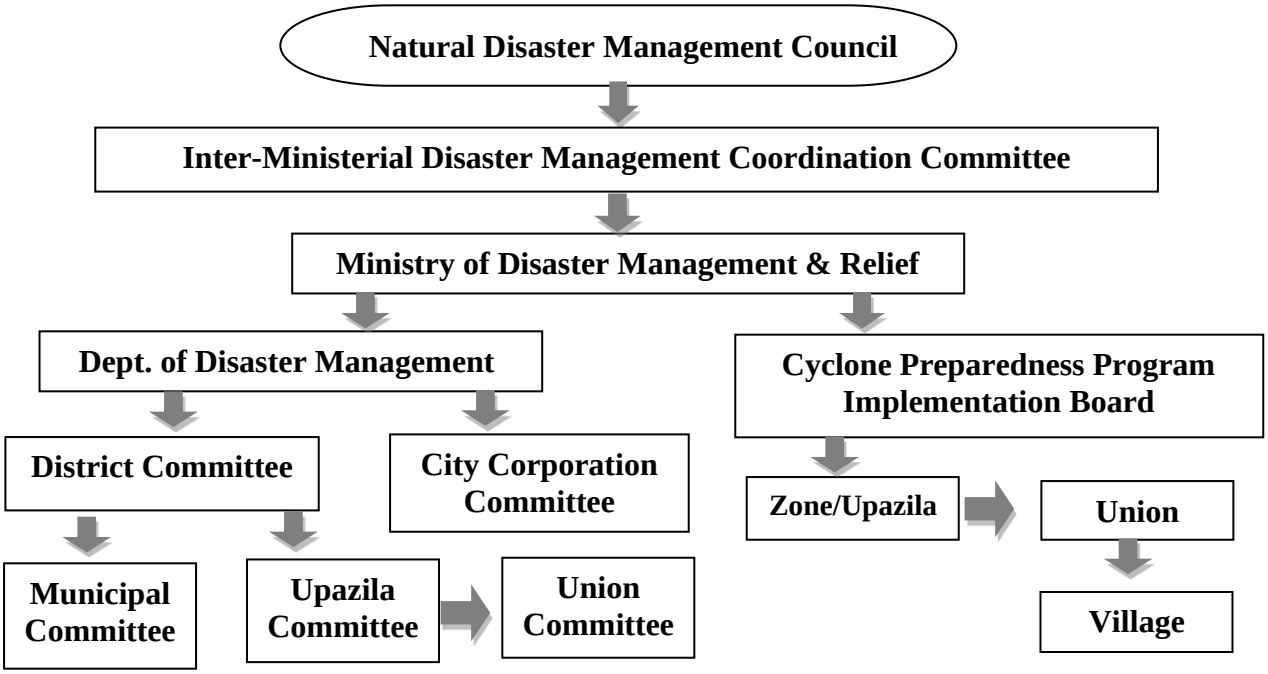
3.3 Disaster management

Disaster management in Bangladesh has evolved through a difficult process. While it was inspired by particular domestic concerns, it also drew inspiration from developments, organizations, and policies outside of Bangladesh (Sabur, 2012). Disaster management literally means using all of the methods and tactics available to prevent and minimize a disaster. The primary goal of disaster management is to mitigate the devastation caused by loss of life and property. Catastrophe management is a broad phrase that encompasses all elements of disaster preparation and response, including both pre and post-disaster operations (Hossain, 2011).

Source: (Salehin *et al.*, 2020)

Figure 11: Disaster management cycle

The process of emergency management is a cycle of four phases for each event (Red colored phases in Figure 11). During the timeframe of NPDM 2016-2020, Bangladesh faced a good number of natural disasters and many localized hazard events with economic losses ranging from 0.8 to 1.1 percent of GDP (NPDM, 2020)



Source: (Baten *et al.*, 2018)

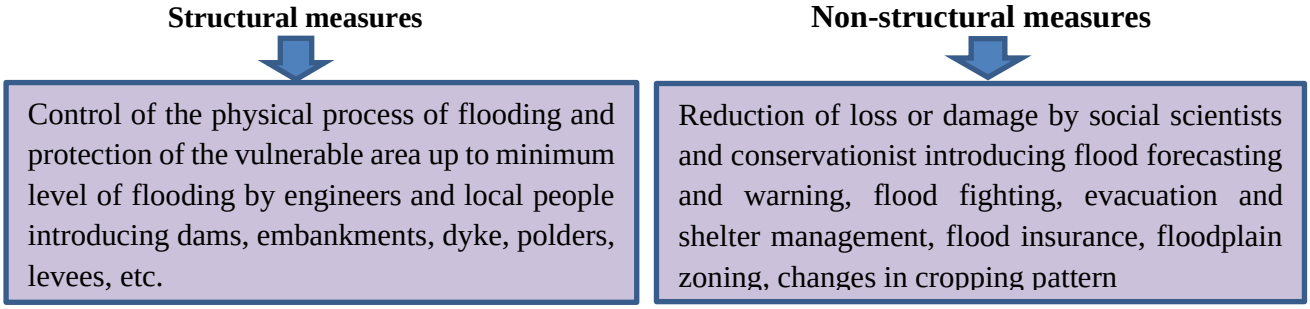
Figure 12: Disaster Management Institutional Framework of Bangladesh

3.3.1 Different Disaster Management Strategies

According to the type and extend of disasters, various types of management tools and plans are used to minimize the number of losses due to the disaster.

3.3.1.1 Flood disaster management strategies

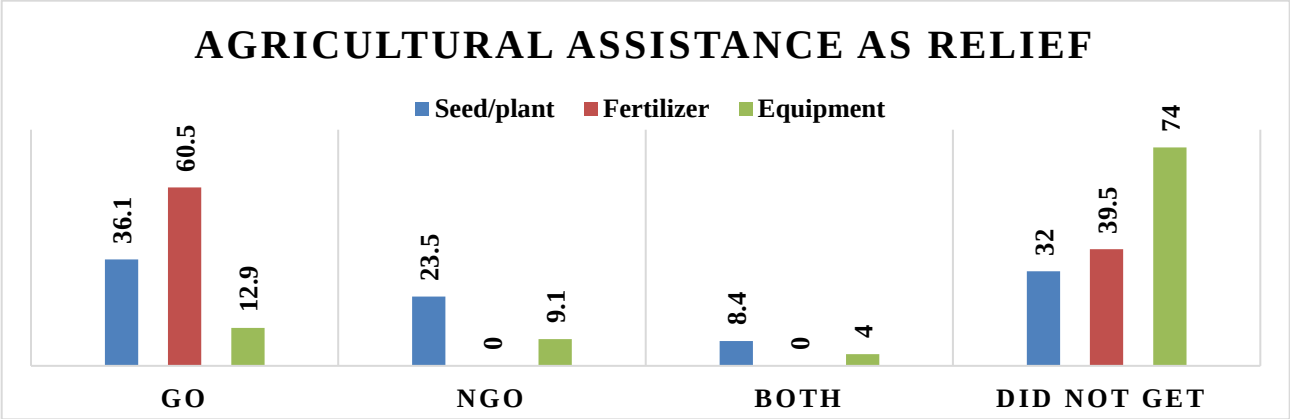
In Bangladesh, floods are the most common disaster. An event like a flood disaster cannot be stopped from happening, but its effects can be minimized if prompt action is made to minimize its severity, frequency, and potential scale. There are two options for flood management measure (Figure 13).



Source: (Baten *et al.*, 2018)

Figure 13: Flood management measures

Government and non-government partnerships are there for providing relief to the farmers to continue their agricultural production (Hossain, 2011). There were 36.1% of respondents received seed from GOs, 23.5% from NGOs, and 8.4% from both GOs and NGOs. Government and non-government organizations tried to provide important equipment and also fertilizer to the farmer (Figure 14).



Source: (Hossain, 2011)

Figure 14: Agricultural assistance as relief from GOs & NGOs (received by % of people)

3.3.1.2 Drought management

Agronomic management practices like manure and composting, seedbed method, ail lifting, tillage and shedding with water harvesting through re-excavation of pond, khari, canal etc. are used by farmers as adaptation practices for drought conditions in some areas in Bangladesh. Some remediation steps suggested to deal with drought conditions are: 1) Storage of rainwater during rainy season and can be use in dry season, 2) River or surface water used for irrigation by canal, 3) Ground water used for a submerged layer, 4) High irrigated crops should be reduced and non-irrigated crop based production system be expanded (Sarker *et al.*, 2011).

3.3.1.3 Cyclone and storm surges management

Table 7: Cyclone Shelters by Districts in Bangladesh.

District	Chandpur	Chattagram	Cox's Bazar	Feni	Laxmipur	Noakhali	Bagerhat	Borguna	Barishal	Bhola	Jalkathi	Patuakhali	Pirojpur	Khulna	Satkhira	**Total**
No. of shelter	80	679	621	76	76	300	163	216	52	677	17	340	70	124	82	**3739**

Source: (BBS, 2022)

Cyclone shelters (Table 7) are constructed as part of pre-disaster preparations during the mitigation stage of disaster management. The structural plan is constructed to withstand gale-force winds and storms. These buildings would be opened to provide safe haven for nearby communities and livestock when storm warnings for cyclones and tidal surges are issued. Once the storm warnings are lifted, the constructions are abandoned. These buildings should only be utilized as momentary cyclone shelters in emergency situations; they should not be used as displaced persons' shelters (Alam *et al.*, 2018).

Coping with tropical storms requires a coordinated effort from various stakeholders (Table 8). It is essential to have effecting coping strategies in place to minimize the risks and ensure a prompt response.

Table 8: Existing coping strategies for tropical storms.

Government	Social	Educational institute	NGO's
➢ Afforestation activities ➢ Dam construction; ➢ Building sluice gates; ➢ Create public awareness; through film, video shows etc. ➢ Create and maintain cyclone shelters.	➢ Encouragement to boost the social benefits of homesteading in forested areas; ➢ Increase the awareness among the community people regarding tools for preparation and reducing impacts of natural disasters.	➢ Educate public children on the effects of natural disasters and existing coping strategies; ➢ Arrange training sessions and seminars regarding the effect of natural disasters and benefits associated with preparedness activities.	➢ Provide training for first aid, search and rescue, and leadership; ➢ Create public educational displays that emphasize disaster preparedness through drama, folk songs, and rallies; ➢ School feeding for awareness build up; ➢ Implement afforestation programs; ➢ Design and construction of cyclone shelters.

Source: (Alam *et al.*, 2018)

3.3.1.4 Salinity management

Farms (Gher) for shrimp farming system is in practice in saline water area. To manage salinity in agriculture, several strategies can be implemented. These include improving irrigation practices by setting up a new water source, using fertilizers to aid crop adaptation to salty environments, elevating the land with the help of government involvement, adopting vertical horticulture with bamboo fence arrangements, and improving current varieties of saline-tolerant plants (Lam *et al.*, 2022).

3.3.1.5 Waterlogging management

Waterlogging is one of the most important impacts during rainy season and it becomes more vulnerable for the urban population. To manage this problem, here recommended several strategies, including the development of a disaster preparedness platform, community-based training programs, and disaster management awareness programs. A technique is in practice in some areas of the most waterlogged conditions where agriculture is must. Floating agriculture is the technique which is in practice in low lying areas of middle and southern districts of Bangladesh (Hossain, 2010).

a) A newly built floating bed. b) A ready bed for planting. c) Red Amaranth.

d) A group of beds. e) Intercultural operations. f) Coriander and Okra.

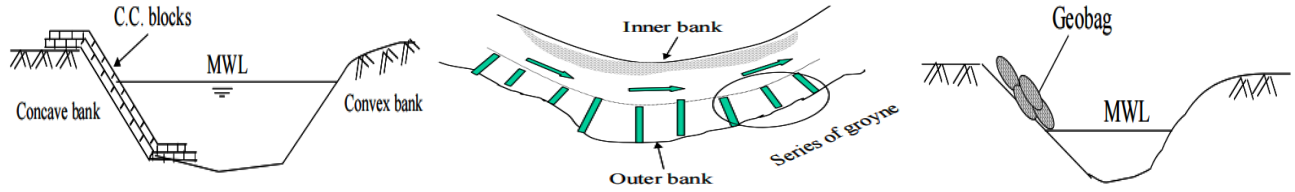
Source: (Hossain, 2014)

Figure 15: Floating Agricultural bed

3.3.1.6 Hailstorm management

Some strategies are applied from the GOs and NGOs to minimize hailstorm losses in agriculture. One of the strategies to detect the forecast situation is by using radar technology which can provide early warning through mass-media. Local government distributes the relief goods to support the affected farmers after the hailstorm. Cropping pattern change are required to adjust in hailstorm prone areas and crop insurance policies should be taken by the farmers to minimize losses (Rahman & Bijoy, 2021).

3.3.1.7 River bank erosion management



a) Hard material protection b) Barrier across the river protection c) Non-structural protection

Source: (Islam, 2011)

Figure 16: River bank erosion management methods

Various methods are available to control bank erosion where structural and non-structural protection measures are most effective. Generally, for the long-term protection structural measures are taken. Hard material protection is suitable for the protection of bank's toes by boulder, stones and C.C blocks (Figure 15-a). In barrier across the river method, erosion is controlled through flow velocity reduction by proper arrangements of the barrier (Figure 15-b). Non-structural measures are taken for the short-term protection (Figure 15-c). Geo bag are dumped on the slope to protect the bank temporally (Islam, 2011).

CHAPTER IV

CONCLUSIONS

- Exposure to natural disasters is a common phenomenon in Bangladesh and its impact on Agriculture is the most. Among all the natural disasters floods, cyclones, hailstorms, river/coastal erosion have more impact on agriculture in Bangladesh. During 2015-2020, a total loss of 517,961 million Tk. was incurred in the crop sector. Flood alone was responsible for 241,842 million Tk. and cyclone, hailstorm, river/coastal erosion costed 29.72%, 6.59%, 5.17% of the total losses respectively.

- Effective disaster management system can ensure saving thousand tons of crops, agricultural lands and properties. Disaster forecasting and warning, management shelters, construction of dams, dykes can reduce the damage of flood, cyclone and tornadoes which are in practice. Some more management practices like storage of rain water to prevent drought stress to plants and floating agricultural bed for waterlogging condition, cropping pattern change to minimize losses of hailstorm should be adopted. Structural and non-structural protection measures have been effective for river bank erosion management. After every disaster the Government and NGO spend a lot of money on relief, recovery and rescue but to make those programs more effective, responsible extension personnel should also come forward to improve safety and social security.

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