A Seminar paper

on

Food Security Through Agricultural Development in Bangladesh: Achievements, Constraints and Strategies

Course Title: Seminar

Course Code: AER 598

Autumn, 2018

SUBMITTED TO:

Course Instructors	Major Professor
1. Dr. Md. Mizanur Rahman Professor, BSMRAU 2. Dr. A. K. M. Aminul Islam Professor, BSMRAU 3. Dr. Md. Sanaullah Biswas Associate Professor, BSMRAU 4. Dr. Shilpi Islam Associate Professor, BSMRAU	Dr. Md. Safiul Islam Afrad Professor Department of Agricultural Extension and Rural Development BSMRAU, Gazipur

SUBMITTED BY:

Mst. Runju Akter

MS Student

Reg. No.: 13-05-2962

Department of Agricultural Extension and Rural Development

BANGABANDHU SHEIKH MUJIBUR RAHMAN AGRICULTURAL UNIVERSITY

SALNA, GAZIPUR 1706

FOOD SECURITY THROUGH AGRICULTURAL DEVELOPMENT IN BANGLADESH: ACHIEVEMENTS, CONSTRAINTS AND STRATEGIES[1]

Mst. Runju Akter[2]

ABSTRACT

The study aims at examining the achievements made so far in agriculture development and its impact on food security Agricultural productivity and food security are the two sides of a coin. Therefore, its maintenance is essential for providing the benefits to humanity, including food security, nutrition and livelihoods. Further, it reveals the key challenges and opportunities for improving the food security recent worldwide food crisis has raised the issue of food security to an urgent basis. Natural disasters like floods, droughts, tornadoes, cyclone etc. have been intensified recently threatening food security of the country more than ever before. Finally a development strategy that might have faster impact on food security has been outlined Thus, strategic actions for food security and climate change adaptation and mitigation have invited some areas of intervention with respect to food grain production and nutrition. Natural disaster prone technology generation, protection of agricultural lands, upholding soil health, mechanized cultivation of lands, sustaining irrigation water market etc. have been emphasized as the strategies to face the challenges of food security.

---

[1] A seminar paper presented at the graduate seminar course on 13 September, 2018.

[2] MS Student, Department of Agricultural Extension and Rural Development, BSMRAU, Gazipur-1706.

CONTENTS

LIST OF TABLES

LIST OF FIGURES

CHAPTER 1

INTRODUCTION

Food, in the hierarchy of needs, is the most basic need for sustenance of life and is the perennial problem issue for healthy and active life of mankind. Food security is not just an economic problem but also a social and political issue in as much as food insecurity is a factor to create political instability in the country. Food security is a basic factor for development of human capital and starter for overall development of the society. Adequate and stable supply of safe food is a constitutional right of the people in Bangladesh. Food security is multi-dimensional having interrelationships with vulnerability indicators; it cannot be captured by any single or specific indicator. It would therefore be important to understand the essential dimensions of food security – Availability of food, Access to food and Utilization of food. The interactions and combinations of these dimensions represent food security together. According to the World Food Summit (1996), "Food Security exists when all people, at all times, have physical, social, and economic access to sufficient, safe and nutritious food, which meets their dietary needs and food preferences for an active and healthy life"**.** According to the Consultative Group on International Agricultural Research (CGIAR), "Food security is a complex issue that involves: not just production, but also access; not just output, but also process; not just technology, but also policy; not just global, but also national; not just national, but also household; not just rural, but also urban; not just amount, but also content"

Agriculture performed relatively well in 2000s.the growth of food & income established 4.3 in 2000s compared to 2.8 over which meat approximately 90% national food requirement 1991-1999 period. The national income grew 6.0% in 2000s. Role of agriculture is the dominant of other agricultural sectors like livestock fisheries etc which showed remarkable Annual Compound Growth Rate (ACGR) of different food items in Bangladesh.

Food security often threatened when domestic production is affected by natural disasters and import of food is affected by food price and bio-fuel production. Damages caused by floods, cyclones, tornados and droughts are becoming more frequent as well as intense. Approximately 40 percent of crop yield will be reduced by 2050 due to climate change variability. A recent World Bank Study revealed the fact that about 4 percent of GDP is eroded by environmental degradation in Bangladesh. Crop production is also restrained by

excessive water or the lack of it. Overall, the crop production is likely to decrease endangering food security (Hussain, 2010).

To let people survive and the economy to function normally, we have to ensure food security. For that the one and only motto should be not to import food grains. Besides, we have to improve market efficiencies, familiarize farmers with the market, ensure easy and timely agriculture loans, restrain smuggling of the subsidized commodities such as oil and fertilizer, and introduce adaptable modern technologies for intensive farming.

The present Government has taken many programs to combat natural disasters in Bangladesh that includes training of personnel from the concerned departments and awareness of general people. However, disaster management program and over all preparedness before any natural disaster occurs can reduce damage and loss due to any natural disaster significantly

Objectives of the Study

The specific objectives of the review paper are as follows:

1. To review the progress made so far in agricultural sector and its consequences on food security in Bangladesh;
2. To highlight key challenges & opportunities for food security in Bangladesh; and
3. To outline strategies that might have faster impact on food security in Bangladesh.

CHAPTER 2

MATERIALS AND METHODS

This seminar paper is exclusively a review paper so that all of the information has been collected from the secondary sources. So, no specific methods of studies are involved to prepare this paper. It has been prepared by comprehensive studies of various articles published in different journals, books, reports, publications, magazines, website etc. with the help of library facilities of Bangabandhu Sheikh Mujibur Rahman Agricultural University (BSMRAU).

CHAPTER 3

RESULTS AND DISCUSSION

Important results and their logical interpretations have been presented in accordance with the objectives of the review paper.

3.1 Achievements

3.1.1 Agriculture the dominant economy for food security in Bangladesh

Agriculture is the dominant economy for food security in Bangladesh. Table-1 indicates that near about 80-90 % commodity produced domestically & rest of the commodities have to import or to manage by other means. If we can utilizes our cultivable land properly, use the modern high yielding & hybrid seed verities and modern production technologies the rest 10-20% yield gap of the above commodities could be minimized.

Table 1. The dominant economy for food security in Bangladesh

Production in food categories	**% commodity produced domestically**	**Percent average**
Grain	89	
Fruits	88	
Vegetables	93	
Meet & eggs	90	80-90
Milk	82	
Sugar	80	
Edible oil	92	
Pulse	81	
Fish	91	

Source: Anonymous, 2007.

The below Table-2 indicates that 1970s-2000s Aus, Aman & Boro production was in increasing trend but wheat production was nil during 1970-1979 period but production increased remarkably from 1980s-2000s which changed millions of peoples food habits from rice to wheat which is a great impact on food security for the country.

Table-2. Annual rice-wheat production

Crops	Years (MMT)			
	1970s	1980s	1990s	2000s
Aus	2.1	2.3	2.5	2.8
Aman	7.2	7.4	8.0	8.2
Boro	9.5	14.5	15.5	18.5
Wheat	0.0	12.5	18	19.5

Source: Anonymous, 2007.

Fruits (major-banana, jack fruit mangoes etc.) yield increased by 0.6% annually in recent years. Side by side trend of minor fruit production increased remarkable (table-3). Food habit is changed by remarkable number of peoples (millions of people). Fruits production diversity by GO's & NGO's can face the sustainable food security in Bangladesh.

Table 3. Recent trends of major and minor fruit production

Fruit categories	Annual Production (TMT)		
	2005	2006	2007
Papaya	30	35	38
Citrus	40	45	50
Guava	25	33	36

Source: Anonymous, 2007.

Agriculture performed relatively well in 2000s. The growth of food and income is estimated 4.3 in the 2000s compared to 2.8 percent over the 1991-1999 period. The acceleration of agricultural growth has continued substantially to improved performance of the over all economy. The national income grew 6.0 percent in the 2000s compared to 5.1 percent during the previous decade (Table-5). The acceleration in the growth of agricultural income was mainly on account of non-agricultural sectors particularly from livestock & fisheries which experienced substantial increase in physical output as well as an increase in relative prices compared to other agricultural produce. The fishery income grews7.8 percent per year in the 2000s (2001-2008) compared to 2.5 percent during the previous decade. The income from

livestock activities continued to grow at a robust rate 7.5 percent up to from 2001 to 2008. Only the forest sub-sector grew at a moderate rate 3.9 percent per year.

Thus agriculture has become much more diversified than last decades even it was at independence. The share of livestock, fisheries and forestry in agricultural incomes was only 20 percent during last decades. Now they contributed nearly 44 percent to agricultural incomes (Table 4).

Table 4. Long-term growths of agricultural sector and economy

Sector	1990s	2000s (2001-2008)
Agriculture Crop	2.8	4.3
Forestry	3.9	3.9
Livestock	5.5	7.5
Fisheries	2.5	7.8
Non-agriculture	6.0	6.5
Gross domestic product (GDP)	5.1	6.0

Source: BER, 2008.

HIES-2005 & BER-2008 estimated (Table 5) that the area under rice has remained stagnant at around 10.40 to 10.90 million ha, rice production (in paddy unit) has increased from 28.8 million tons 1990s to 40.38 million tons in 2001 to 2008. It implies a rate of growth 2.8 percent per year much faster than the growth of population (1.26%).

Table 5. Trend in technological progress and growth in rice production for food security

Indicators	1990s	2000s (2001-2008)
Rice yield(ton/ ha)	2.8	3.92
Rice production(million ton/ ha)	28.8	40.38
Rice production per capita(kg of milled rice)	165	198
Coverage of modern varieties (%)	50	68
Rice harvested area (million ha)	10.40	10.90
Population (million persons)	110.5	132.5

Source: HIES (2005) and BER (2008).

3.1.2 Non-economic indicators

There are indications that Bangladesh has made moderate progress in other dimensions of food security (Table 6). According to the World Bank, the primary school enrolment ratio has improved from 43 to 75 percent, and the infant mortality rate declined from 94 to 43per thousand live births during the 1990-2008 period. The access of the population to safe drinking water has increased from 40 to 84 percent. The most impressive progress has been made in population control. The number of births per woman has declined from 6.1 to 3. The preliminary findings from the 2001 population Census (compared by BER-2008) show a decline in population growth from 2.2 percent in the 19890 to 1.26 percent in the 2008. Household level large scale sample surveys support the findings of improved literacy

Table 6. Progress in non-economic indicators of well-being

Indicators	1990	2000	2008
Infant mortality rate (per 1000)	94	57	43
Under five mortality rate (per 1000)	151	102	98
Maternal mortality rate (per 100,000)	478	440	410
Adult literacy rate (%)	37	53	62.66
Children enrolled primary school (%)	43	70	75
Primary school enrolment rate (%)	60	75	78
Safe drinking water rate (%)	40	84	84
Fertility rate (%)	6.1	3.1	3
Population growth rate (%)	2.2	1.5	1.26

Source: BER, 2008.

and school participation rates, and show that the gender disparity in the school participation rate has almost disappeared for primary level, and has turned in favor of girls at the secondary level. The school participation at both secondary and tertiary level however still remains at a low level.

3.2 Constraints of food security in Bangladesh

3.2.1. Population growth and demand for food security

The major obstacle to food security in Bangladesh is its over-population in relation to natural resources. Fortunately, Bangladesh has started making respectable progress in population control, particularly since the mid-1980s. The population growth has declined from 2.8

percent per annum at independence, to 2.2 percent in the 1980s, to 1.5 percent in the 1990s and 1.26 in 2009. However, we should not be complacent. The population is still growing by two million every year, and may increase by another 30 million over the next 20 years (Table-7).

Table 7. Population growth and demand for food security

Year	Projected population(millions) based on			
	1991 Census	2001 Census for rural & urban		
	Total	Total	Rural	Urban
1990 (actual)	109.8	109.8	88.2	21.6
2000 (actual)	132.4	127.4	97.6	29.8
2010	153.4	143.2	102.3	40.9
2020	172.9	156.8	100.8	56.0

Source: BER, 2008.

It will not be easy to provide food and employment for the additional people and the labor force. As the population has started declining, the proportion of population in the working age group will continue to grow for some time, putting additional challenge for policy makers for generating productive employment.

3.2.2. High irrigation and fertilizer cost

In many parts of Bangladesh in the dry *Rabi* and *Kharif-1* seasons during February to May, the water table can fall below the reach of traditional shallow tube-wells (that are frequently used for irrigation), and thus often irrigation fails. Irrigation is becoming costlier and more uncertain than before due to acute shortages and high prices of electricity and rapidly increasing prices of diesel, by which most shallow tube wells operate. Excessive pumping of ground water is one the main reasons for arsenic contamination problems in Bangladesh. The cost of production of rice per ha is much higher in Bangladesh than India, Thailand and Vietnam (Table 8).

Table 8. Irrigation cost of different countries of South and South- East Asia

Country	Total production cost in cultivation of rice (US$/ha)	Irrigation cost (US$/ha)
Bangladesh	418.87	117.60
India	253.17	32.34
Thailand	223.65	17.94
Vietnam	254.82	17.98

Source: BARC, 2008.

On the other hand rapid increase of Fertilizer price (Table 9) makes the crop production situation more dangerous. The price of fertilizers has gone on a roller coaster ride. Fertilizer shortage is held responsible for the looming food crisis. The recent jump in fertilizers prices are likely to discourage millions of Bangladeshi small farmers to apply required does of fertilizers, especially the essential soil nutrients like phosphate and potash, whose prices have sky rocketed to such a level that their uses are bound to fall.

Table 9. Fertilizer price ($/ton)

Fertilizer	Year		
	2006	2007	2008
Urea	240-290	320-420	650-850(700)
TSP	200-250	400-550	600-1100(1100)
MOP	240-250	300-450	500-700 (700)

Source: BBS (2008) and DAE (2009).

3.2.3. Negative impacts of climate change on Bangladesh agriculture

Bangladesh has a humid, warm, tropical climate. Its climate is influenced primarily by monsoon and partly by pre-monsoon and post-monsoon circulations.

While floods have been endemic to the climate and hydrological systems in South Asia, their increasing magnitude and frequency in recent times is a matter for serious concern. An analysis carried out based on CRED/EMDAT data highlights that flood occupies 35% of all natural disasters in South Asia (Figure 1)

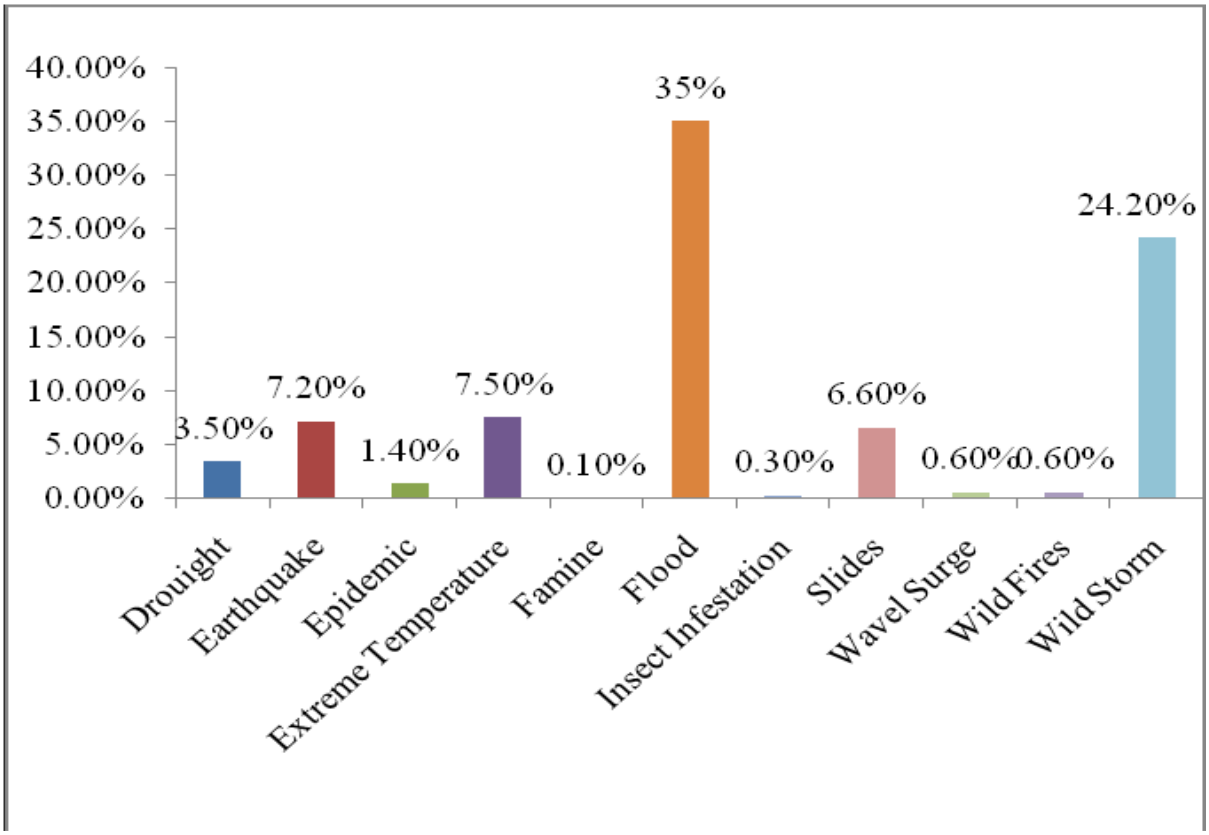

Figure 1.Natural disaster in South Asia (1975-2015).

(Source: Hoyois, 2017)

To be precise, natural disasters in recent years killed 19718 people in South Asia. 58% of them belonged to Bangladesh, followed by India (26%), Pakistan (9%), Afghanistan and Nepal (3% each), and Sri Lanka (1%). Different flood waves contributed largely to these casualties (Figure2).

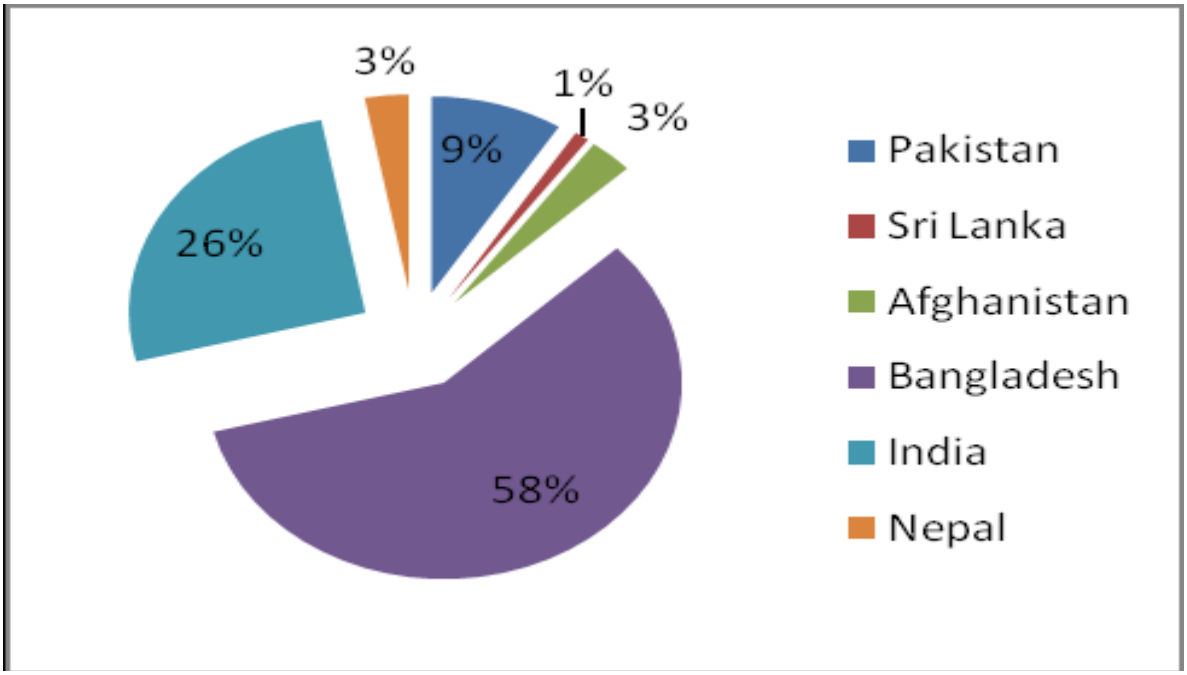

Figure 2.Country-wise numbers of people killed by natural disasters in recent years in South Asia.

(Source: CRED, 2017)

In the following figure-3 it is shown that the crop damage in 2017 flood was highest, it may be due to increase of production in recent year that is compare to 1987 almost 4-5times. In 2017 and 1998 flood crop damage was 6.5 and 4.5 million tons respectively that is highest than any other flood which occur in previous years.

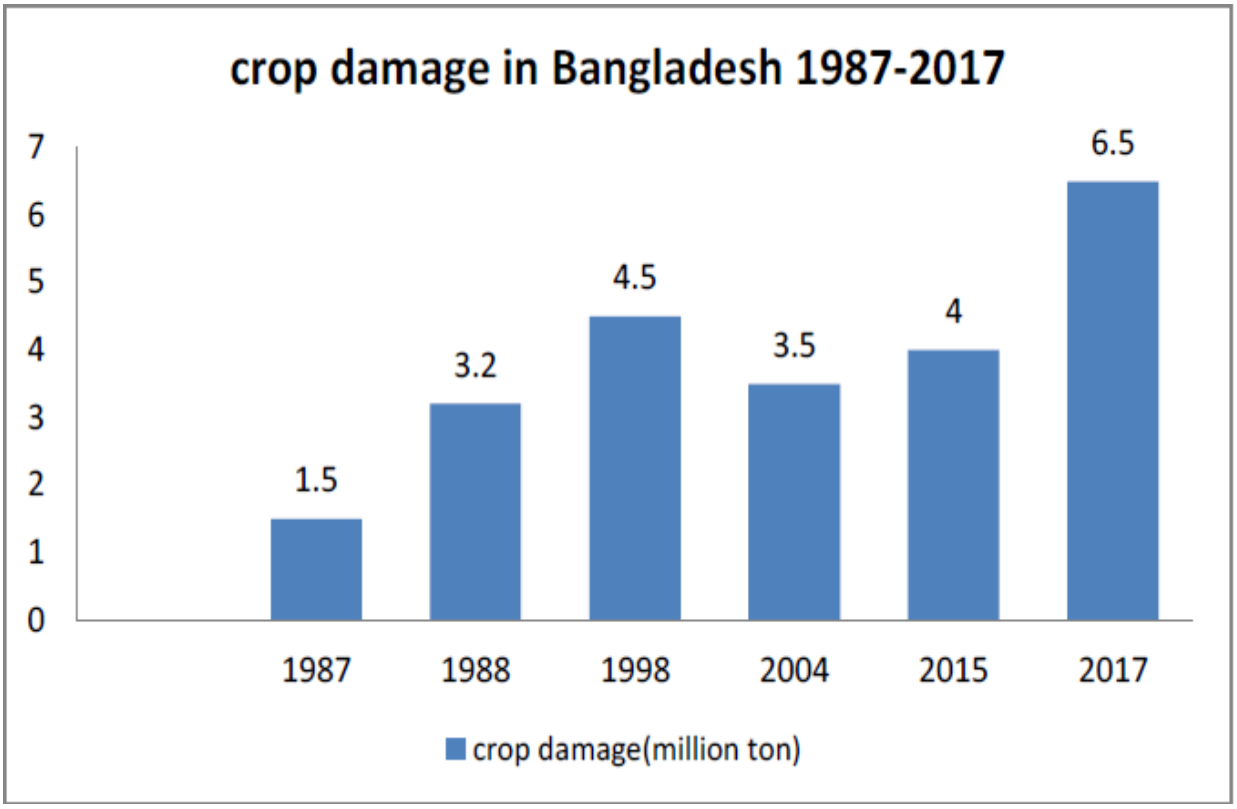

Figure 3. Flood crop damage in Bangladesh (1987-2017).

(Source: DAE, 2018)

In the figure -4 shown that total financial losses due to flood in 1998 was highest. It may be due to coverage of highest total area, damaging of more roads, kalvert, affected more people, more crops damage, economic production decrease etc. In 2017 flood also destroyed due to in this flood total financial losses were 95000 million taka.

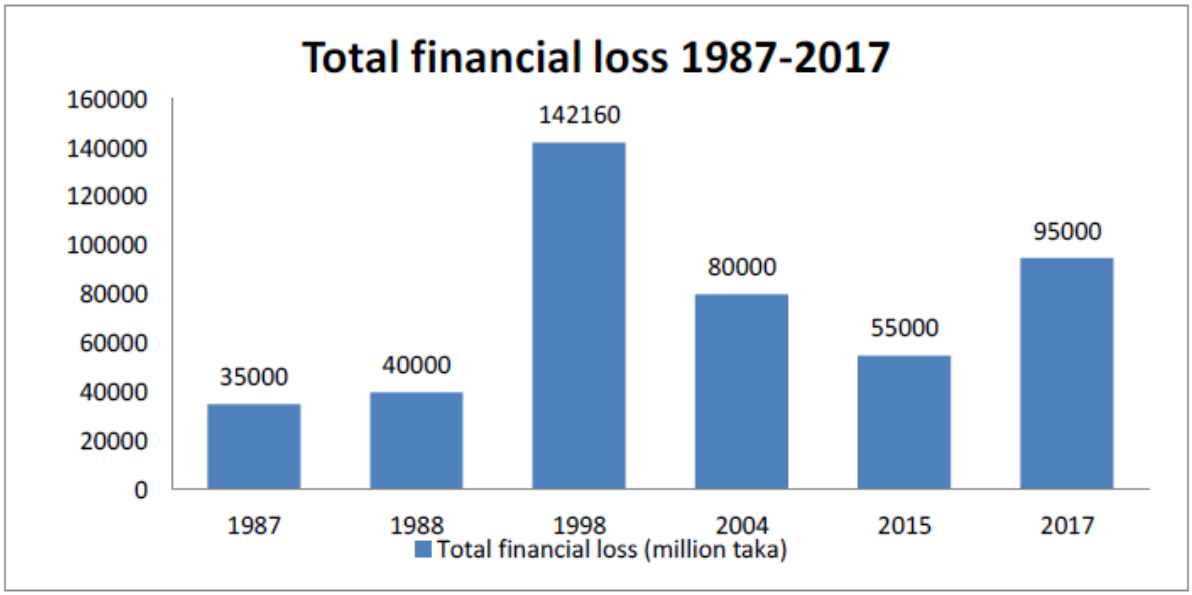

Figure 4.Flood total financial loss in Bangladesh (1987-2017).

(Source: FFWC, 2017)

Drought is a prolonged dry period in natural climate cycle (Table 10). It is a slow-onset phenomenon caused by rainfall deficit combined with other predisposing factors. Drought is the main constraint for causing severe yield reduction. Inhibition of growth under stress condition is the result of inhabitation of cell division, cell elongation or both. The decreased cytokinin and GA and increased abscisic acid content under drought condition suggested that growth reduction under drought condition could be the result of the drought induced changes in membrane permeability and water uptake due to altered endogenous hormone levels.

Table 10. Intensity of drought and yield loss of T. Aman

Intensity of drought	Area of land (ha)	Locations	Average yield (t/ha)	Yield loss due to drought (%)
Very severe	3,42,990	Rajshahi, Nawabgonj (Barind area)	1.7-2.5	70-90%
Severe	7,37,028	Barind area, Gangetic alluvium Western, central and southern regions;	2.0-2.5	50-70%
Moderate	31,54,950	Modhupur tracts, Kustia & Jessore	2.5-3.5	30-50%
Slight	28,67,895	Teesta, Brahmaputra & Gangetic alluvium; Alluvial soils of Meghna & Surma Kushiara rivers	3.0-4.0	10-30%

Source: BARC, 2008.

Total loss in Crop Productions (m.tons/bales/ hectare) due to Natural Calamities (Flood/Excessive rainfall/Flash flood Cyclone/Hailstorm/Storm/Tornado/Tidal bore) in the Year period 2002 to 2007 was remarkable (Table 11) food security become unsecured for sustainable consideration.

Table 11. Total loss in crop productions due to natural calamities (2002 to 2007)

Crops	Total(Unit)
Aus	234400(m. tons)
Aman	114187(m .tons)
Boro	795699(m tons)
Aman seedbed	186270 hectare
Jute	423960 bales
Maize	190(m. tons)
Banana	33339 hectare
Summer Vegetables	57435(m .tons)
Pulse	1684(m .tons)

Source: BBS, 2008.

3.3. Strategies for food security in Bangladesh

World agricultural productivity, especially in poor countries, is the key to global food security and the fight against hunger and poverty. Slow increases in world food production and declining rates of yield growth in main food crops threaten world food security. Land and water constraints, underinvestment in rural infrastructure and agricultural innovation, lack of access to agricultural inputs, and weather disruptions are impairing productivity growth and the needed production response. These factors, combined with sharp increases in food prices in recent years, have added to concerns about the food and nutrition situation of people around the world, especially the poor in developing countries. (Braun, 2008)

3.3.1. Use of agricultural machineries:

Agricultural machinery like reaper, tiller and seeder can play a vital role just before and after a disaster in the vulnerable areas of the country. Reapers are useful to harvest matured field crops like wheat, rice etc. Such a machine can perform 18-20 times and agricultural labor to save time and money. High speed rotary tillers are very useful for rapid land preparation. After a disaster this machine can be used for land preparation in shortest possible time and go for the next crop immediately. Seeders or planters can be used for planting seeds as soon as the land is ready. Depending on the seed size, this machine saves 15-20% seeds over the traditional seeding method. All these agricultural operations are not only time and labor

saving but also very useful for quick and timely operations of land preparation, seeding and harvesting (Table 12).

Table 12. Use of agricultural machineries during disaster management

Agricultural machineries	Use	Perform
Reapers	Harvested matured field crop wheat, rice etc.	18-20 times to save agriculture labor, time & money
Rotary tiller	Rapid land preparation	20-25 times
Seeders or planter	Planting seed	15-20% seed saves over traditional

Source: AIS, 2009.

3.3.2. Food Habit

At present Bangladeshi people take 400 g rice and 175 g vegetables. But Japanese and other developed countries people eat less cereal and more vegetables and fruits. In rabi season only 49% other than rice are harvested which are not the forecasting for balanced diet. So the change of food habit is essential by increasing the other crops & by decreasing the area cultivation of rice(Table 13)

Table 13. Distribution of Rabi harvested area (by season)

Rice	51%
Wheat	13%
Pulse	9%
Edible oil seed	7%
Perennials sugarcane	10%
Other	10%
Total	100%

Source:AIS, 2009

3.3.3. Institutional Management

All agencies specially DAE, NARS institutions, BADC, NGO, fertilizer and seed dealer and other concern authorities should work together to combat disaster. For disaster management, coordination among head quarter and field level worker/officer is necessary. Execution of programmers taken before and after disaster attack should be ensured. Unity is the strength should be the main view in combating disaster.

The first of the eight Millennium Development Goals of the United Nations to be reached before 2015 is to eradicate extreme poverty and hunger. Climate change, environmental issues, poverty, human conflict and population growth are all components of this complex problem. (2010 ESRI International User Conference)

3.3.4. Weed management for food security

Food security requires the supply of an adequate amount of food so as to meet the nutritional needs of all of the people at all time. On an average 37.3% of crop produce is damaged if weed are not controlled in Bangladesh. Now-a-days the scarcity of agricultural labor is a common picture in everywhere. Therefore, herbicides are the best alternatives in crop production(Table 14). By the initiation of GO's & NGO's strategies should be taken to measure the residual effect of herbicides by the laboratory support of Tea Research Institute, BINA, BARRI, DAE etc.so that our soil, water and air environment are not degraded. Good number of herbicides are used in tea, where non-selective herbicides are mainly used but in field crops mainly used selective herbicides of different group are used.

Table 14. Consumption of herbicides

Year	Total amount(mt)	% increase over 2003
2003	963.00	Base year
2004	1093.85	357.39
2005	3463.10	1348.09
2006	2774.94	1060.33
2007	3206.22	1240.67

Source: Anonymous, 2008

3.3.5. Recommended strategies for flood losses areas in Bangladesh

Bangladesh is a disaster-prone area, and the need to know the types of crops and production strategies to overcome losses under these situations. The Ministry of Agriculture prepared some strategies on this issues (Table 15).These issues are combating national disaster which will be used as the strategies for agricultural l development for food security in the disaster-prone area.

Table 15. Flood losses areas in Bangladesh

Types of flood	Proneness to flood(AEZ)	Crop generally damaged	Strategies recommended
Early flood (April-May)	22 and 29	HYV Boro, Aus and Kharif vegetables	Early maturing HYV
Late flood (August-September)	22 and 29	T.Aman both HYV and local Deep water.	Late T.Aman variety, intensification of Rabi crop
Riverine flood (June-September)	8 and 9	T.Aman, Kharif vegetables	Improve useful management practices
Late riverine flood (Early august-October)	8 and 9	T.Aman crop	Late T. Aman, production of potato, maize, mustard, kalai etc.
Hailstorm (March-April)	8 and 9	Winter vegetable, wheat, water melon, potato, guard, long beans etc.	Early cultivation of winter vegetables, local Boro, winter watermelon etc.

Source: BER, 2008.

3.3.6. Reform strategies for food security in Bangladesh

According to (BER-2008) report was made on the strategies of food security also reported Medium Term Macroeconomic Framework (MTMF) for food security through credit facilities named as ‘Reform Strategies’ (Table-16).

Table 16. Strategies for food security in Bangladesh

Name of the major area	Strategies
Medium Term Macroeconomic Framework (MTMF) for poverty alleviation through credit facilities. Food security in Monga Striven Area	Government has taken the policy named as MTMF'Reform Strategies' Government has taken long term CS'Comprehensive Strategies'

Source: BER, 2008.

Which are the reform of Fiscal sector, Monetary policy, Monetary management, Credit policy, Bangladesh Bank & National Commercial Bank, food import & export policy by public & private sector, imposed subsidy through public & private bank for agricultural inputs directly to the farmers within next few years. Food security in Monga Striven area of the greater Rangpur region. Government has taken long term 'Comprehensive Strategies' such as strengthening of research activities in order to produce HYV .BRRI invented BR-33 known as Monga Variety, life cycle 110-115.

3.3.7. Other strategies of food security in Bangladesh.

- Introducing sophisticated technology for rice cultivation
- Concerning profitability rather than subsistence in food grain production
- Emphasizing agricultural diversification
- Promoting fisheries and livestock sector for poverty alleviation and rural development
- Agricultural development through financial assistance
- Disseminating agricultural technology
- Expanding Secondary and Technical Education
- Providing infrastructural development
- Self incompability for hybrid seed production & polyploidy technology should be encouraged for food security in Bangladesh

3.3.8. Private sector & NGO's are involved in changeable strategies for food security

Eleven projects are running on food security by BRDB & seven by BRAC collaboration with government as the next strategic plan. Many GO's and NGO's are financing as macro & micro credits & also taking strategies for nutrition, population control, non-formal primary education, handicraft production & marketing, modern technologies for agriculture & use of hybrid seed, printing press, cold storage, arong, hatchery ,dairy, seed, vegetable, fruits etc. storage, processing & marketing. Also involved in making the strategic plan for negatively affected the livelihoods of landless & marginal farmers by the adverse impacts due to storage of saline water for shrimp cultivation in the coastal regions of the country.

CHAPTER 4

CONCLUSION

Important conclusions have been presented in accordance with the objectives of review paper.

1. Bangladesh is a land of agriculture. In 1990s the agriculture along contributed 30% of GDP. The cropping intensity increased 180-200 with the increasing mouth foods. For sustainable food security the country has to pay keen attention to all of the agriculture dimension to equal & sustainable distribution
2. Attaining food security is the major challenge when global price is high &there are restrictions on exports by major rice exporting countries. Also threatened when domestic production is affected by natural disasters.
3. Disaster forecasting system should be updated, so that people can save their lives, wealth & appropriate strategies for crop management practice should be followed in disaster prone areas through selecting appropriate species/varieties.

REFERENCES

AIS. 2009. Agricultural Information Services, Department of Agricultural Extension, Ministry of Agriculture. 2009.

Anonymous. 2007. Bangladesh NARS-2020, A Vision for Agricultural Research, BARC, Farmgate, Dhaka, Bangladesh.

Anonymous. 2008. Weed and Food Security, Weed Science Society of Bangladesh, 1st National Conference & Seminar, 08 November, 2008.

Anonymous. 2009. Innovations in Food Security and Sustainable Livelihoods, National Workshop and Agricultural Fair, BCFCC, Agargaon, Dhaka, Bangladesh, 25-26 February, 2009.

Barrett, C. B. 2010. Measuring food insecurity. *Science*, 327(5967): 825-828.

BARC. 2008. Fertilizer Recommendation Guide. BARC, Farm Gate, Dhaka.

BARC. 2008. Fertilizer Recommendation Guide. BARC, Farm Gate, Dhaka.

BBS. 2008. Statistical Year Book of Bangladesh, Bangladesh Bureau of Statistic, Ministry of Planning, Dhaka, Bangladesh.

BER. 2008. Bangladesh Economic Review, Economic Advisers Wing, Finance Division, Ministry of Finance, Government of Bangladesh(GOB).

CRED. 2017. Emergency Data (EM-DAT), Centre for Research on the Epidemiology of Disasters, Brussels, Belgium.

DAE.2009. Department of Agricultural Extension, khamarbari, Farmgate, Dhaka.

DAE. 2018. Agricultural Extension Manual. Department of Agricultural Extension, Ministry of Agriculture, Government of the People‟s Republic of Bangladesh, Dhaka.

Dewan, A. M., and Yamaguchi, Y. 2009. Land use and land cover change in Greater Dhaka, Bangladesh: Using remote sensing to promote sustainable urbanization. *Applied Geography*, 29(3): 390-401.

ESRI. 2010. International User Conference on Food Security and Agricultural Productivity.

FFWC. 2017. Annual Flood Report, Flood Forecasting and Warning Centre, Bangladesh Water Develoment Board, Dhaka.

Gregory, P. J., Ingram, J. S., and Brklacich, M. 2005. Climate change and food security. Philosophical Transactions of the Royal Society of London B: *Biological Sciences*, 360(1463): 2139-2148.

HIES. 2005. Household Income and Expenditure Survey 2005. Bangladesh Bureau of Statistics.

Hussain, S. G. 2010. Assessing impacts of climate change on cereal production and food security in Bangladesh. In Climate change and food security in South Asia, Springer, Dordrecht, pp. 459-476

Hoyois, P. 2017.Annual Disaster Statistical Review 2016, Centre for Research on the Epidemiology of Disasters, Brussels, Belgium.

Mondal, M. A. H., Boie, W., and Denich, M. 2010. Future demand scenarios of Bangladesh power sector. *Energy Policy*, 38(11): 7416-7426.

Rivera, W. M., and Sulaiman, V. R. 2009. Extension: object of reform, engine for innovation. *Outlook on agriculture*, 38(3): 267-273.