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Acronyms and Abbreviations

ANH	Agriculture for Nutrition and Health
APB	Actionable Policy Brief
ARI	Agriculture Research Institute
ARIMA	Autoregressive Integrated Moving Average
BADC	Bangladesh Agricultural Development Corporation
BARC	Bangladesh Agriculture Research Council
BBS	Bangladesh Bureau of Statistics
BCIC	Bangladesh Chemical Industry Corporation
BIHS	Bangladesh Integrated Household Survey
BR	Bangladesh Rice
BRAC	Bangladesh Rural Advancement Committee
BRRI	Bangladesh Rice Research Institute
BWDB	Bangladesh Water Development Board
CARE	Cooperative for American Relief Every Where
CHT	Chittagong Hill Tract
CHTDB	Chittagong Hill Tract Development Board
CIP	Country Investment Plan
CLDDP	Community Livestock and Dairy Development Project
CWU	Consumptive Water Use
DAE	Department of Agricultural Extension
DAP	Diammonium Phosphate
DFAT	Department of Foreign Affairs and Trade
DFID	Department of Foreign Affairs and International Development
DLR	Department of Land Record
DLS	Department of Livestock Services
DoF	Department of Fisheries
DTWs	Deep Tube-wells
FAO	Food and Agriculture Organization of the United Nations
FIAC	Farmers Information and Advice Centre
FMTW	Force Mode Tube-wells
FPMU	Food Planning and Monitoring Unit
FTF	Feed the Future
FY	Financial Year
GCA	Gross cropped Area
GDP	Gross Domestic Production
GED	general Economics Division
GIA	Gross Irrigated Area
GNP	Gross National Product

GoB	Government of Bangladesh
GO-NGO	Government and Non-Government Organization
HDC	Hill District Council
HNPSP	Health, Nutrition and Population Sector Programme
HYV	High Yielding Variety
ICT	Information Communication Technology
IFPRI	International Food Policy Research Institute
IR	International Rice
IRRI	International Research Institute
JICA	Japan International Cooperation Agency
Kcal	Kilo Calorie
LLP	Low Lift Pump
LPL	Lower Poverty Line
MDG	Million Development Goal
MFI	Micro-finance Institutions
Mha	Million Hectare
MMt	Million Metric Ton
MOA	Ministry of Agriculture
MOCHTA	Ministry of Agriculture and Ministry of Chittagong Hill Tracts Affairs
MOF	Ministry of Food
MoP	Murat of Potash
MRA	Microfinance Regulatory Authority
MT	Metric Ton
MV	Modern Variety
NAEP	New Agricultural Extension Policy
NAP	National Agriculture Policy
NARS	National Agricultural Research System
NFP	National Food Policy
NGO	Non-Government Organization
NHP	National Health Policy
N-P-K	Nitrogen-Phosphorous-Potash
NSB	National Seed Board
NSPS	National Social Protection Service
PoA	Plan of Action
PSI	Private Sector Importer
SAAO	Sub-Assistant Agriculture Officer
SFYP	Sixth Five Year Plan
SME	Small and Medium Enterprise
SPARSO	Bangladesh Space Research & Remote Sensing Organization
SRDI	Soil Resource Development Institute
SRR	Seed Replacement Rate
SSP	Single Super Phosphate
STW	Shallow Tube-wells

SWAPNO	Strengthening Women's Ability for Productive New Opportunities
T. Aman	Transplanted Aman
TSP	Triple Super Phosphate
TV	Television
UNDP	United Nations Development Program
UP	Union Parishad
USD	US dollar
YGM	Yield Gap Minimization

Executive Summary

Agriculture is the most important sector of Bangladesh economy due to its role in food security, employment and livelihood. Still more than 70% of the people in Bangladesh are directly or indirectly employed in this sector. The Bangladesh economy is transforming towards commercial agriculture with expansion of service sector. The agriculture of Bangladesh is dominated by crops which accounts about half of total agricultural GDP. Rice dominates Bangladesh agriculture covering more than 80% of the land area. Although food grain production has tripled over the last 40 year period, but productivity of pulses, oilseeds, and fruits have not been increased much.

Agriculture sector is dynamic, changing with demand of people, availability of technology and change of management practices. Thus, it requires regular adjustment with different planning and development programmes. Country has much potential, yet it faces many challenges including vulnerability of climate change. For a long time planning a visionary exercise is needed in order to foster sustainable growth of this important sector. This necessitates a comprehensive Bangladesh Delta Plan (BDP) for development and sustainability of the sector harmonizing with the management of natural resources and addressing the challenges.

The overall objective of the base line study is to support preparation of Bangladesh Delta Plan to ensure long term sustainable production of crops for good security in Bangladesh. The specific objectives of the base study were: (1) To identify gaps in relevant policy and planning documents. (2) To identify challenges and potentials of Bangladesh agriculture and food security. (3) Assessment of current productivity status and to formulate development options for planning exercise. (4) Outline an insight of long term Delta Plan ensuring food and nutrition security; and (5) To develop a common and inclusive knowledge base.

Methodology of the base line study includes: (1) Review of relevant policy and planning documents, Collection of information from BBS, DAE, MOA, MOF, etc. and various on-line resources, etc. (2) Desk review, seminar/workshop, interactive meeting,, consultation with line departments including other stakeholders. (4) Analysis and synthesis. (5) Report preparation and (6) Consultation with relevant ministries. line departments, agencies, focal points experts, including other stakeholders on consensus building on findings of the base line report.

Gaps in relevant policy and planning documents

Much Progress has been made during the last decades in Bangladesh in formulation and adapting agricultural policies to the ever changing needs of modernizing agriculture. The governments in the past have been adapted different sets of policy to cater needs of the government line departments, private sectors and farmers to create an enabling environment for technology dissemination and enhancing agricultural productivity. Bangladesh experienced a continuous process of policy refinement.

Relevant policy and planning documents were reviewed and gaps were identified. The policy and planning documents reviewed were: New Agricultural Policy 2013 (NAP), National Agriculture Policy (NAP 1999), New Agricultural Extension Policy (NAEP,1996), DAE-Strategic Plan, 1999-2002. Agricultural Extension Manual, 1999, Seed policy, 1993, Seed Rules 1998, Fertilizer distribution policy 2009, Plan of Action on National Agriculture Policy (NAP, 2003), Actionable Policy Brief (APB, 2004), National Jute Policy, 2002, Livestock Policy and Action

Plan, 2005, National Fishery Policy, 1998, National Forest Policy 1994, National Land use policy, National Water Policy, 1998, Environment Policy 1992 and Implementation Programme, National Food Policy, 2006 and National Health Policy.

The gaps identified in National Agriculture Policy 2013 are: (1) The policy has addressed cereals and did not address adequately the non-cereals sector like jute, sugarcane, cotton etc. (2) There is absence of a framework to develop effective human resources for commercialized agriculture including unemployed rural youth and women. (3) It is necessary to formulate a strategic plan to encourage export of high value products. Existing land use plan may have to be modified for this purpose to enhance productivity of high value items including fruits, vegetables, medicinal plants, herbs, cut-flowers, foliage etc. and value added processed products. (4) Food safety and quality issues are not adequately covered or emphasized including the traceability of the product.

The public sector policies on seeds were stated in the National Seed Policy 1993, the Seeds (Amendment) Act 1997, the Seed Rules 1998, The Seeds Ordinance 1977 with amendments made in 1997 and 2005, the National Agricultural Policy 1999, the National Food Policy 2006 and National Food Policy Plan of Action 2007. The objectives and strategies for the seed sector are not narrated in these policy documents exactly in the same manner or language though the main thrust or message seems to be similar. It is narrated that the government would facilitate a balanced development of public and private sector roles in the production and distribution of quality seeds. What it actually means and how it would be achieved is not uniformly stated in these documents. Thus private and public sector interpret the intentions of these policies differently, causing some controversy.

The differences between private and public sector perspectives on the seed market are prompted by two factors: (i) lack of accurate data on the size and structure of the seed markets for different crops; and (ii) lack of sufficient clarity on the objectives and strategies of the national seed policy. These issues can be a hindrance to effective participation by private sector.

The fertilizer policy in Bangladesh evolved from adopting public fertilizer distribution system with subsidy to privatization. Existing GOB fertilizer distribution system and regulations often impedes the private dealers from effective operations and does not serve farmers in remote areas. The GoB fertilizer demand assessment is centrally determined and is not based on fertility level of soil, There is a monopoly system of import of urea fertilizer by BCIC. Beside this, BADC and private importers import the required quantity of TSP, MoP and DAP from different countries and sources. Import of fertilizers fully depends on MoA's allotment and permission.

There is no broad focus on the safety and quality of meat, poultry and their products. The Livestock Policy and Action Plan, 2005 fails to address hygienic slaughtering of cattle for safe meat and meat products. The National Fishery Policy, 1998 describes very little on the issue of managing safety and quality of fish for domestic consumption covering Good Aquaculture management. But some activities are in place in respect of export oriented fish and fish products where traceability is established following international requirements.

Strategy of current food production and food security

Ensuring food security for the poor is a fundamental strategic goal of the Government. It involves the physical availability of food at all times and its access to all at affordable prices. The interventions are currently made by

MoA through 19 development projects. Some of the institutional problems and issues are also being addressed by MoA with own resources, and efforts are being made to address the others that will require external funding.

Policy developments & programmes of MoA is underway through implementation of Country Investment Plan (CIP) and needs for further action**.** Under sub-programme 1.1 related to enhancing knowledge generation, CIP (2012/13) includes seven completed, 31 ongoing and seven pipeline projects with total financing at 192.9 million USD or 1.61% of total financed CIP. Of the 181.1 million USD for completed and ongoing projects, 137.2 million USD (76%) was financed by GoB and 43.9 million by DPs. Under sub-programme 1.2, related to improvement of agricultural extension service, there are 11 completed, 24 ongoing and four pipeline projects, amounting to 243.9 million USD. Of the total budget of 202.3 million USD for completed and online projects, 146.7 million USD i.e. 73% are financed by GoB and the rest 27% by DPs. This subprogramme accounts for 2.03% of total CIP budget. Sub-programme 1.3, which mainly focuses on research and extension for climate adaption, includes 11 ongoing and seven pipeline projects worth 366.9 million USD. DPs finance 170.9 million USD or 61% of the total 279.7 million USD of ongoing projects. Further actions are needed on following areas: (1) Improve agricultural extension services, (2) Strengthen management system of research institutes, (3) Focus technological development on efficiency, sustainability and resilience, (4) Improve research infrastructure and strengthen human resource and (5) Promote agricultural research for nutritional development and (6) Expand Farmers Information and Advice Centres.

The World Bank is actively considering assistance in strengthening the agro-technology system; and JICA is reviewing the need for strengthening the Central Extension Resources Development Institute through reorganization and redefining its charter. The process of strengthening the Seed Wing of BADC and revitalizing the Seed Certification Agency is ongoing.

Achieving the MDG targets within the next decade will require Bangladesh to develop and implement more effective strategies by the MoF. Speeding up per capita income growth and pursuing targeted safety net programmes are needed for the expansion of household food intake.
UNDP has designed a project document for a Social Protection Policy Support Programme in partnership with GED, and in coordination with DFID and DFAT. The programme also includes a component of catalytic learning through a pilot delivery intervention called Strengthening Women's Ability for Productive New Opportunities (SWAPNO) that will provide a benchmark for innovative delivering systems, including micro-insurance and climate adaptive social protection.

Land use pattern

Land use pattern of a country reflects its socio-economic stipulation. While land use changes are concerning topics in perspective of socio-economic changes of a country, the pattern of its changes in Bangladesh is to meet the dynamic demand of the society that creates pressure on natural environment. Decade-Wise Land Utilization of Bangladesh has been analyzed. The shifting rate of agricultural land to non-agricultural use is said to be about 1% per year. Availability of agricultural land of Bangladesh is gradually declining. According to BBS statistics annual decline of agricultural land is about 0.38% during 1980 to 2007 (27 years average), 0.75% during 1983 to 1994 (10 years average) and 0.40% during 1993 to 2004(10 years average). It is estimated that 10 percent of farmers in Bangladesh own 50 percent of the land (BBS 2009). About 60 percent of farmers are functionally landless and depend on sharecropping of land owned by the others. Average farm sizes are very

small to support a family adequately. Apart from sharecroppers, approximately 20 percent of farmers are regarded as marginal. The sharecropping has good effect in terms of cultivation and agricultural production; however, it has adverse effect on soil productivity maintenance. Most share croppers do not use proper dose of fertilizer, appropriate crop rotation, or organic manure due to a seasonal or annual contract arrangement and wants to get as much benefit as possible from the land within the contract period.

Soil fertility status

There are thirty agro ecological regions and 88 sub regions which are relevant for land use and assessing agricultural potential. Fertility status of these regions varies. Individual farmers have fragmented the land into small pieces causing wide variation in the management of each and every piece of land. This leads to the large variation in the fertility levels even between adjacent plots. On the basis of origin and properties, the soils of the country are classified into seven tracts as follows: 1. Madhupur, 2. Barind Barind, 3. Gangatic Gangatic, 4.Teesta, Teesta, 5. Brahmaputra, 6. Hills and 7. Coastal Saline. Soil nutrient content of this tract varies widely.

Although Bangladesh is a small country, it has a wide variety of soils. The fertility status of Bangladesh soils is extremely variable. Most of the soils are depleted and in urgent need of replenishment with manures and fertilizer if productivity has to be enhanced. It is estimated that more than 100 kg nutrients per ha year are mining out from the soil system. The fertility status of Bangladesh soils is extremely variable. Most of the soils are depleted and are in urgent need of replenishment with organic matter and fertilizers in order to enhance crop productivity. Balanced fertilization is the key to successful crop production and maintenance of good soil health. It is important to see how close nutrient addition and removal by crops match with each other. According to current statistics, the farmers of Bangladesh use 215 kg nutrients (N: 149 kg, P2O5: 37 kg, K2O: 22 kg and S + Zn + B + others: 7) ha/year from chemical fertilizers, while the estimated removal is around 280 -350 kg/ha. From organic and natural sources about 50-70 kg nutrients are added to the soil system every year.

Bangladesh has virtually no possibility of increasing its cultivable land area. Therefore, food production of this country can be increased through increasing irrigation facilities together with expansion of HYVs and balanced use of fertilizer. Besides, well-timed supply and availability of fertilizer should receive top priority to increase rice production in Bangladesh.

Trend of Fertilizer use

Total requirement of fertilizers like Urea, TSP, SSP, MP, Gypsum and mixed fertilizer for crop production in 20011-12 were 28, 5, 1.25, 1.5 and 3 lakh metric tonnes per year respectively. Among them 60 percent of Urea and 100 percent of mixed fertilizer were produced in the country. There was sharply increasing trend in use of fertilizer during 1981-2008 while TSP and MoP slightly increased. During 1963 to 1979, total fertilizer use increased dramatically with a growth rate of 16.5% per annum. Thereafter, the growth rate of urea declined. During 2004-12 growth rate of TSP and MoP sharply increased due to having government subsidy on these two fertilizers. It is evident that actual uses of all the fertilizers for rice production are below the recommended dose. The gap between the actual and recommended dose also exist for other crops.

Growth of irrigation in Bangladesh

Most of irrigation water is used for rice production with about 86% of the total irrigated area of Bangladesh. Irrigation is considered as a necessary precondition to enhancing agricultural production of Bangladesh. In this

country the earliest approach to irrigation facilities was through constructing large scale multipurpose irrigation, flood control and drainage (FCD) projects during 1960 – 1970. Expansion of minor irrigation through groundwater using DTWs and STWs was the vital component of the GoB's strategy to facilitate irrigation for agricultural development. STWs under private ownership played significant role for irrigation development during 1980s and there had been recorded sharp increase in number of these equipment During Third Five Year Plan (1985-90) continued emphasis on irrigation facilities tremendously increased groundwater irrigation through the use of DTWs, STWs and manually operated HTWs. The agricultural growth in the country has been largely due to expansion of minor irrigation through the use of DTWs, STWs and LLPs. There is positive trend of irrigation growth in Bangladesh from 1982 to 2011.

Demand for irrigation water

The irrigation Consumptive Water Use (CWU) of rice production was 11.8 Bm3 in 2000, has increased by 40% to 16.5 Bm3 in 2010; the latter is estimated using the irrigation CWU per hectare of 265 mm in 2000. A projection has been made on irrigation CWU demand to 2020 and 2030 under two different scenarios: (1) Scenario of area expansion and surplus rice production. Under this scenario the irrigation CWU demand for rice will be 20.9 Bm3 and 24.5 Bm3 in 2020 and 2030, respectively, which are 27% and 48% increases from the 2010 level. (2) Scenario of Self - sufficiency in rice production, improving water productivity with no area expansion. According to this scenario, rice production will have to be 37.2 MMt by 2020 and 40.3 MMt by 2030, respectively. Even with no growth in water productivity (WP), irrigation CWU demand will decrease by 2.6 Bm3 and 6.1 Bm3 by 2020 and 2030, respectively, from the estimates in scenario 1, due to lower production requirement. With 5% growth in WP, irrigation CWU demand will decrease by 2.7 Bm3 and 6.4 Bm3 by 2020 and 2030, respectively; and with 10% growth in WP, irrigation CWU demand will decrease by 2.9 Bm3 and 6.8 Bm 3, respectively. Importantly, the reduced irrigation CWU of rice in scenario 2 can meet most of the irrigation demand of other crops.

The implication of above water demand projection is that given the falling groundwater tables and water quality issues in Bangladesh, it will be extremely difficult to exploit groundwater resources sustainably under scenario 1. Without an increase in WP, it will be difficult to meet even the reduced demand under scenario 2. A few districts have already passed the sustainable thresholds of groundwater use Khulna in the Khulna region, Bogra and Pabna in the Rajshahi region, Barisal, Chittagong, Kishoreganj, Kushtia and Rajshah where irrigation CWU exceeds the usable groundwater recharge.

Supply and demand for seeds

In Bangladesh the national requirement of quality seeds of all crops is estimated to be 9,32,250 metric tons. Against this national requirement, the supply of quality seeds was 1,86,450 metric tons. Seed system through quality seed replacement rate (SRR) against national requirement up to 2011-12 was 20 percent of which an about 80 percent seed is being fulfilled through the informal seed system of farmers' own saved seeds.

Technology generation

Increasing the speed of and sustaining agricultural growth are priorities for increasing food production and reducing poverty. The future challenge of increasing food production could be met through the introduction of modern biotechnology and an increase in investment in agricultural technology generation and transfer. Varietal improvement and improvement of production practices are high priority of NARS research. Technologies developed by the NARS institutes are disseminated to the farmers through the extension

department and NGOs. In meeting the demand for higher food production, thrust should be given to frontier research including genetic engineering, reduction of cultivation costs, strengthening of the technology-transfer linkage, and improvement of postharvest technology.

Cropping intensity and productivity analysis

The average cropping intensity in Bangladesh is over 190% and approaching to 200%. It was found that cropping intensity has increased over the last fifty years by 60 percent. Rice is the staple food of about 156 million people of Bangladesh. It provides nearly 48% of rural employment, about two-third of total calorie supply and about one-half of the total protein intakes of an average person in the country. Rice sector contributes one-half of the agricultural GDP and one-sixth of the national income in Bangladesh. Almost all of the 13 million farm families of the country grow rice. Rice is grown on about 10.5 million hectares which has remained almost stable over the past three decades. About 75% of the total cropped area and over 80% of the total irrigated area is planted to rice. Thus, rice plays a vital role in the livelihood of the people of Bangladesh.

Total rice production in Bangladesh was about 10.59 million tons in the year 1971 when the country's population was only about 70.88 millions. However, the country is now producing about 35.0 million tons to feed her 156 million people. This indicates that the growth of rice production was much faster than the growth of population. This increased rice production has been possible largely due to the adoption of modern rice varieties on around 66% of the rice land which contributes to about 73% of the country's total rice production. Over the last 30 years, Bangladesh has experienced a "green" revolution' in rice production, with a tripling of production from approximately 10 million metric tonns (hereafter tons) in the mid-1970s to almost 30 million tons in 2010/11. It was largely based on the cultivation of high-yielding varieties (HYVs) under irrigation with use of chemical fertilizers.

Yield gaps between the potential yield in BRRI Research Station farm and Actual farmers' yield of different modern rice varieties by season. According to BRRI results of 2006-7 yield gap ranged 18-26%. This means that the farmers' actual yield is 18-26%. lower than the potentially attainable yield. While BRRI results of 2010-11 showed that yield gaps ranged 22 to 32% and with an average of 20%. But if we compare yield gaps estimated using farmer's actual yield from BBS survey and BRRI's technically attainable yields than the yield gap is much higher (30-62%).
Some causes of rice yield gap are decreasing soil productivity, inefficient water and fertilizer use, inadequate supply of quality seeds, imbalanced use of fertilizer, low labour productivity, and higher input price. These factors are restricting realization of full yield potential of HYVs, resulting in lower yield of cereals in the farmers' field compared with much higher yield obtained in the research station

It was found that production declined marginally for rice, but rose sharply for wheat and maize**.** In 2012/13, rice production declined (-0.2%) for the first time since 2005/06. Wheat and maize production grew sharply by 26% and 14%, respectively. Potato production rose by 5%, compared to a 1.8% reduction in the previous year, with the increase in yield (1.6%). Pulse and oilseed production rose faster in 2012/13, respectively by 11% and 5%. Fruit production accelerated, but vegetables exhibited mixed trend over the same period: brinjal and pumpkin maintained the upward trend while beans and lal shak production declined. Agricultural diversification is becoming increasingly important to tackle the rising food trade deficit due to changing consumption habits and for further promoting the diversification of diets, In turn, diversification toward higher value added on-farm activities, such as production of fruits, vegetables, legumes, fishery and livestock products can help accelerate

agricultural income growth and poverty reduction, generate backward and forward linkages and promote growth of agro-based processing and marketing.

Analysis of food security status

Bangladesh has made good progress since 1992 in reducing income poverty based on the national poverty line. The most recent estimates (Household Income Expenditure Survey – HIES, 2010) still 36.5% of the population has absolute poverty and are undernourished who fail to meet minimum level of caloric consumption needs of 2122 KCal/person/day and 17.6% of the total population are hard core poor who are unable to consume 1805 Kcal/person/day. Food security worsens with inter-year shortfall in food grain production caused by climatic variations and natural disaster such as floods, tidal surge and insect and pest attacks. Variations in food intake also exist between regions of the country, between adults and children and between men and women at the household level.

Availability of staple food has been increased largely and Bangladesh has become self-sufficient in rice staple food. The country produced 33.54 million tonnes for its 160 million people in FY 2010-11. Rice production increased by 2.91 times in 36 years, In 1971-72, the average rice yield was 1.05 tonnes per hectare, while in 2005-06 it was 2.52 tonnes. The per capita rice production has increased substantially over the level at independence.

Per capita availability of cereals (rice and wheat) has been found to increase from 374 g/day in 1994-95 to 647 g/day in 2010-11 (Table 6.3). Sharp increase in per capita availability of potato and vegetables is seen in the last four years, while the per capita availability of pulses and oilseeds has remained stagnant or declined. Availability of meat, milk and egg has also increased as shown in Table 4. Per capita fish availability increased from 27 g in 1994-95 to 56 g in 2010-11.

In 2011–12, 36.8 percent of households in the FTF (Government's Feed the Future) zone and 35.3 percent of households in the rural national sample were food energy-deficient who could not afford an adequate diet. Furthermore, 17.5 percent of the households in the FTF zone and 16.5 percent of the households in entire rural Bangladesh were below the lower food energy threshold of 1,805 kcal/person/day and, therefore, remained severely food energy-deficient.

The acceleration in economic and agricultural growth has made a positive impact on the diversity of food intake away from the rice and vegetable based diet in favour of quality food. It may be noted that the per capita consumption of rice and wheat has been declining, while the consumption of vegetables, fruits and fish and meat has been growing.

In terms of minimum energy consumption Rajshahi and Barisal divisions are relatively worse off compared to other divisions (HIES 2005, HFSNA 2009). Malnutrition is also severe in the country. More than 90 percent of rural Bangladeshis are not getting enough vitamins A and iron deficiency— which can cause anaemia and the risk of death in childbirth—is also very high, especially for women of reproductive age (BIHS, 2011-2012).

It was found that that 40.5 percent of the population in the southern region lived below PPP $1.25 per person per day in 2011–12. While 38.2 percent of the population in rural Bangladesh was living below the family

welfare threshold, there are pronounced regional differences in the incidence. The rate varies widely across divisions, ranging from a low of 31.0 percent in Chittagong division to as high as 65.5 percent in Rangpur division. Although Rajshahi division ranks the second highest, the rate in this division is 23.1 percentage points lower than that in Rangpur division. Agricultural wages have increased quite sharply in recent years, enabling the rural poorest to improve their livelihoods significantly.

Bio-physical constraints of some Hot Spots

Coastal region, Haor and CHT have some special type of bio-physical constraints. These regions have been identified as disadvantaged regions in terms of poverty, food insecurity, environmental vulnerability and limited livelihood opportunities. Major Constraints of Coastal region are (1) Extreme environmental events and high vulnerability to climate change. (2) Low agricultural productivity, poor land use and low cropping intensity. (3) Low productivity of Rabi crops and little high value crops cultivation. (4) Predominance of small and landless farmers. (5) Intrusion of saline water, water logging and occasional breaches of embankment. (6) Higher rates of poverty and malnutrition.

The CHT represents 9 percent of the landmass divided in three districts consisting of 25 Upazillas with one percent population of the country. Major constraints of CHT are (1) Natural resource degradation – soil erosion and siltation of water bodies; reduced soil fertility; and biodiversity loss. (2) An under-developed sector for the provision of essential inputs and extension (seed, fertilizer, credit). (3) Scarcity of adaptive research, on-farm trials and demonstrations, leading to low knowledge of CHT-specific conditions and absence of innovative practices. (4) Limited access to markets, and opportunities for agro-processing. (5) Low productivity, and missed opportunities for diversification (and associated benefits to nutrition), due in part to poor access to improved inputs, and/or to new adapted technologies. (6) Poor technical capacity of stakeholders and a lack of technical coordination. (7) Disjointed and/or overlapping programmes, without consistent guiding principles on the part of government and development partners.

Haors are located in the north-eastern region of Bangladesh. It has a total area of 8,000 km2. There are 373 Haor with a gross land area 1.99 million ha, net cultivated land 1.33 million, 16% of total rice land of Bangladesh in Haor area. People in the region are poorer than in any other part, More than 28% are below the Lower Poverty Line. Major Constraints of Haor are; (1) Degradation of natural resources and biodiversity. (2) Natural disasters are the main reason of poverty, lack of availability of basic infrastructure and social amenities, inequity in resources acquisition and poor access to natural resources. (3) Crop damage by flash flood. (4) Declining productivity of crops. (5) Poor Market linkage and value addition

Challenges

The major challenges related to agriculture and food security in Bangladesh are: (1) Curse of poverty, food insecurity and malnutrition. (2) Degradation of natural recourses, (3) Low agricultural productivity and limited modernization and/or diversification, (4) Weak research extension linkage and technology delivery, (5) High post harvest losses, (6) Problems of market linkages and value chains, (7) Scarcity of availability of agriculture labour, (8) Farm mechanization, (10) Food quality and safety problem, (11) Inadequate institutional credit, (12) Inadequate availability of quality seeds to the farmers, (12) Increased environmental shocks and livelihood risk.

Knowledge gaps

Following knowledge gaps have been identified:

- Climate change induced climatic variability and likely impact on availability of water for agricultural production.
- Given the variation between the hydrological regions and expected impact of external drives, the demand needs to be quantified in detail at the level of each region for each of the key sectors
- Availability of mitigation technology and adaptations
- Socio-economic developments, reflected in changing water requirements

Development options/Interventions

Technology development and dissemination

1) *Enhance research and technology generation:* To increase agricultural productivity and diversity in a sustainable manner require research and technology development in support of increased productivity in varied ecosystems is required in the following areas: (i) for crops, varietals development (short maturing Aus and Aman rice, new HYVs, biotechnology) build on respective experiences of private and public sectors; management practices (fertilizer, cropping patterns, cultural practices for char land, hill and coastal areas); and water and soil conservation; (ii) Promote frontier technology development through enhanced investment in R&D for increasing productivity. This will include activities: (i) Develop new varieties, crops, improving food quality, nutrition, etc. (ii) Enhance agricultural productivity through diversification, sustainable management of natural resources (in flood plain and CHT) and inputs. (iii) Promote "agro-ecologically suitable" and "climate-smart" agriculture that are effective to feed the population sustainably in the long term. (iv) Supporting transformation of agriculture by building innovative, action-oriented partnerships with different countries. Promoting innovation and best practice by bringing people together to share experience and expertise.
2) *Improve research-extension-farmer linkages and extension services.* They are required in the areas of technology adoption & community-based learning (farmers skill training, soil health improvement, diversification of agriculture, cultivation of quick growing fruits and vegetables, cropping patterns, farm mechanization) and promotion of sustainable agriculture In order for interventions to be successful, human and infrastructure capacities of DAE, require strengthening.

Improved water resource management and irrigation

1) *Augmentation of surface water for irrigation through development of water reservoir, recharge ground water, reduce use of ground water to avoid hazard of arsenic contamination:* We have identified some key priority investment activities: (i) the development of small scale surface irrigation in the southern part of the country (iii) partially reduce reliance on deep well irrigation in the northern part of the country, reduce costs and mitigate the risk of Arsenic contamination; (iv) rehabilitate dikes and embankments particularly affected by previous cyclones to protect vulnerable households and production base against sea intrusion in the extreme south, (v) improved drainage, saline intrusion control and flood management; and (vi) increasing river water flow towards the south, in particular involving a major river dredging effort.

2) *Use water saving technology for improving efficiency of water and install facilities to reduce distribution losses:* Activities include: (i) reduce water losses in existing schemes through improved water management, development of water saving techniques or rehabilitation of existing schemes.
3) *Reduce impact of saline water intrusion in the South and enhance river water flow:* Activities include: rehabilitation of polders and their management; dredging of rivers; enhanced surface water irrigation; and improved brackish water resource management practices.

Crop diversification

1) Agricultural productivity enhancement through crop diversification, increased cropping intensity, farm mechanization, reducing post-harvest losses, modeling of climate events and

Sustainable supply and use of improved quality of inputs

1) *Enhance availability of quality agricultural inputs:* The proposed priority interventions are: expansion of both seed multiplication and processing farms and preservation facilities of BADC, NARS, DAE, and contract growers; capacity development of public laboratories and SCA for testing quality of inputs; strengthening participation of NGOs and private sector in seed distribution; capacity development of farmers for autonomous production of quality seeds; and establishment of mechanisms to ensure availability and reasonable prices of all quality and environmentally friendly agricultural inputs. Develop public private partnerships through capacity development.
2) *Improve and increase sustainability of soil fertility management:* The proposed interventions are to promote fertilizer use efficiency and balanced use of fertilizer. The main purpose is to strengthen environmentally sound fertility management practices. This will be done through facilitating application of fertilizers on the basis of soil tests, as well as strengthening of soil testing laboratories and promotion of improved soil health management practices.
3) *Facilitate access to credit and other financial services by smallholders and the rural poor:* There is a strong call for collateral-free bank loans at low interest rates for agricultural purposes.

Farm mechanization

Agricultural production and food security in the country is adversely affected owing to the insufficient use of farm power and inappropriate use of farm machinery thereby negatively impacting on environmental sustainability, labour productivity and/or labour scarcity. Some investment priorities are: (i) Increasing the availability of agricultural mechanization technology to the farmer. (ii) Develop and promote agricultural machinery that is resource and energy efficient and conserve natural resources. (iii) Applying appropriate machinery and equipment for agricultural production and (iv) Training and education for farmers for using suitable farm machinery.

Improving market linkages and development of value chains

1) *Improvement of infrastructure:* A number of priority investments have been identified: (i) Construction and adequate maintenance of rural roads to facilitate marketing of products and access to services in particular in remote areas. (ii) Construction or rehabilitation of rural markets including the supply of potable water,

drainage, and storage facilities to improve conditions. (iii) Improvement and rehabilitation of wholesale markets in major cities; (iv) Private storage facilities to reduce losses and increase value added.

2) *Capacity building of value chain actors and market promotion:* A number of **priority investments** have been identified: (i) Capacity building for group marketing at community level in the form of marketing groups, service cooperatives which capacities should be developed and training provided; (ii) Capacity development of farmers and market intermediaries through training in food quality and safety regulations and requirements, good agricultural practices so as to comply with market requirements; (iii) Improved post harvest management, value chain analysis and facilitation (iv) Promote agro-processing. (v) Facilitate coordinated, market-based action, harnessing the productive capacity of agriculture to drive food security, environmental sustainability and economic opportunity.
3) *Establishment of export processing zones:* Harness opportunities to expand market linkages and agribusiness with establishment of export processing zones
4) *Improving Food Safety and Quality for Consumer Health and Nutrition:* Food analytical laboratories at the central and regional level need to be established to facilitate support to food manufacturers, individuals and the enforcement of laws. An effective surveillance on food borne illnesses would be necessary. It is necessary to strengthen capacities of the existing institutions, strengthen consumer protection and build on on-going insufficient food safety activities.

Livelihood improvement and food security

1) Development of programs of alternative income generation and food security, reduce malnutrition of women, children and distressed population.
2) *Development of Community Based Nutrition Activities through Livelihood Approaches:* Home gardening, poultry raising and other community level nutrition-based agricultural activities need to be included as food based nutrition approach This strategy will include linking agriculture and food based nutrition to other nutrition efforts, including health.
3) *Livelihoods improvement of population of char land, haor, coastal region and CHT:* All of these regions are not easily accessible and people are beset with lots of problems and sufferings. A large number of families, due to abject poverty and lack of alternatives, are often forced to relocate to such lands battling precarious weather and adverse living conditions. As the families are often hard to reach through mainstream anti-poverty programmes, it drastically reduces opportunities to promote social and economic development within these communities.

Climate change adaptation

An integrated approach which combines traditional knowledge with innovative strategies need to be adopted to address current vulnerability while building adaptive capacity to face new and dynamic challenges. The process involves four inter-related strategies: promotion of climate-resilient livelihoods strategies, disaster risk reduction strategies, capacity development for local civil society, and advocacy and social mobilization with particular focus on gender. Interventions should include: (i) Program to promote adaptive knowledge and technologies among communities/farmers. (ii) Enabling local preparedness and flood protection works and modeling under extreme climatic events.

Improved Land management

1) Promote Compact Township to reduce substitution of agricultural land for non-agricultural purposes.
2) *Integrated char development and livelihood improvement:* The intervention activities include: (i) Prevent loss of life from natural disasters, (ii) Reduce loss of land, livestock and other assets due to flood and erosion, (iii) Promote sustainable agricultural development, (iv) Widen access to health and educational services, (v) Increase access to land rights for the landless, (vi) Improve access to development inputs and services.
3) *Improvement of land information, land administration and management:* Land ownership record system is insufficient and incomplete in Bangladesh. As a result, it spills out jumbled and spontaneous land development throughout the country. Therefore, , it is important to establish a compatible land administration and management system for establishing a systematic approach for planned land development. Land Information System (LIS) should be accountable and feasible systematic approach for developing an up-to-date land administration and management. The improved LIS shall be related to various quantitative and qualitative aspects of land resource.

1. Introduction

1.1. Background and importance of the sector

Bangladesh has an area of about 50,000 square miles of which about 22.3 million acres (69 percent of total land area) are cultivated land. Agriculture plays a dominant role in the growth and stability of the economy of Bangladesh. More than three quarters of the total population in rural areas derive their livelihood from the agricultural sector. The GDP growth over the last five years consistently remained above 6 percent.

During the recent decade overall GDP of Bangladesh has been considerably shown upward trend. But the growth in agriculture GDP slightly declined with an average of about 3.4% during 1997 to 2013. Agriculture being the engine of growth of the economy, there is no other alternative but to develop agriculture sector for alleviation of poverty by attaining accelerated economic growth. Since provision of food security, improvement of the living standard and generation of employment opportunities of the huge population of the country are directly linked to the development of agriculture, there have been continued efforts by the Government for the overall development of this sector.

Agriculture is the most important sector of Bangladesh economy due to its role in food security, employment and livelihood. Still more than 70% of the people in Bangladesh are directly or indirectly employed in this sector. There is continuous transformation of Bangladesh's economy as measured by changes in the sectoral shares of gross domestic product (GDP). This structural change clearly indicates a rapid movement away from an agriculture-dominated economy. Agriculture's share of GDP declined from 62 percent in 1975 to 19 percent in 2013, but agriculture's share of total employment has not declined as quickly. The declining share of agriculture in GDP should not be construed to reflect a diminishing role of agriculture in the overall growth of the economy or in poverty reduction. Notably, the service sector has expanded at an unusually rapid pace at this stage of economic transformation. Much of the growth in the services sector relates to the marketing and processing of agricultural products resulting from rapid commercialization and diversification in agriculture. The agriculture of Bangladesh is dominated by crops which accounts about half of total agricultural GDP (Table 1.1).

Table 1:1: Contribution of agriculture to GDP (%) at constant prices (Base: 1995-96=100)

Sector/ Sub-Sector	**Year**											
	2001-02	2002-03	2003-04	2004-05	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12	2012-13
Agriculture	23.99	23.47	23.08	22.28	21.85	21.37	20.88	20.49	20.30	20.01	19.41	18.70
A. Crops	13.75	13.43	13.23	12.51	12.28	12	11.7	11.43	11.42	11.32	10.86	10.25
B. Livestock	2.96	2.93	2.91	2.95	2.92	2.88	2.79	2.73	2.65	2.58	2.51	2.45
C. Forestry	1.88	1.86	1.83	1.82	1.79	1.76	1.75	1.75	1.73	1.69	1.66	1.63
D. Fishing	5.4	5.25	5.11	5	4.86	4.73	4.64	4.58	4.49	4.43	4.39	4.37

Source: (1) For the period 2001-2007, Statistical Yearbook of Bangladesh 2007, and (2) beyond 2007, Bangladesh Economic Review 2013(Bengali).

Rice dominates Bangladesh agriculture covering more than 80% of the land area. The production of main staple rice has shown a long term growth trend of 2.8 percent per annum over the period from 1981/82 to 2011/12. During 1997 to 2013, total rice acreage changed little, T. Aman acreage remained almost unchanged, while irrigated Boro acreage substantially increased with the reduction of rain-fed Aus which showed about 6.3 percent annual growth during the same period. Currently, Boro rice accounts for about 60 percent of total food grain production (Figure 1.1 and 1.2).

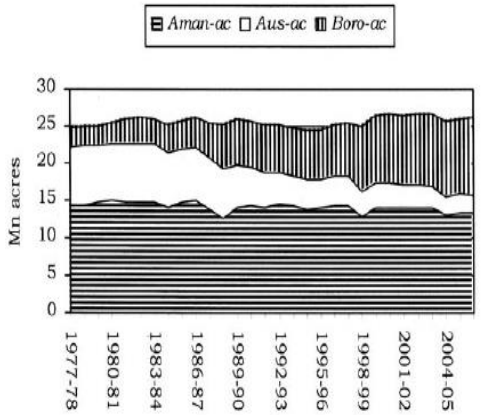

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Figure 1:1: Rice acreage by season

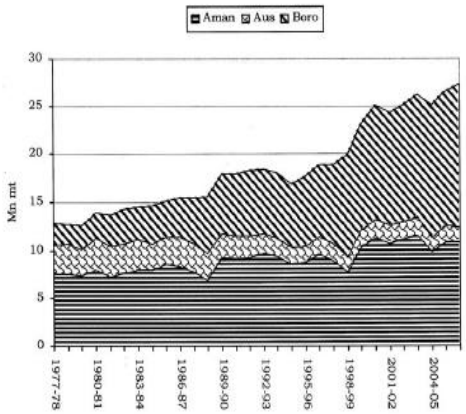


Figure 1:2: Rice output by season

The agriculture of Bangladesh is dominated by crops. Although food grain production has tripled over the last 40 year period, the production of other major food crops, such as pulses, oilseeds, and fruits remains low. The nutritional importance of such produce is therefore of concern. The average Bangladeshi diet contains a very high intake of cereals with too little contents of non-cereal food items. Hence, an average diet is deficient in energy vitamins and minerals.

1.2. Land use pattern

The term land use has been defined differently from various perspectives by different scholars. It has seen as a product of interactions between a society's cultural background, skill and its physical needs in one hand, and the natural potential of land on the other (Ram and Kolakar 1993. Land cover is the observed biophysical cover on the earth's surface. In other words, land use = land cover + land utilization (Di Gregorio and Jansen 1998). Further, land use is the arrangements, activities and inputs that people undertake on a certain land cover type (FAO 2000). According to these definitions land use reflects human activities such as the use of the land like industrial zones, residential zones, and agricultural fields and so on. The above definitions establish a direct link between land and the actions of people in this environment.

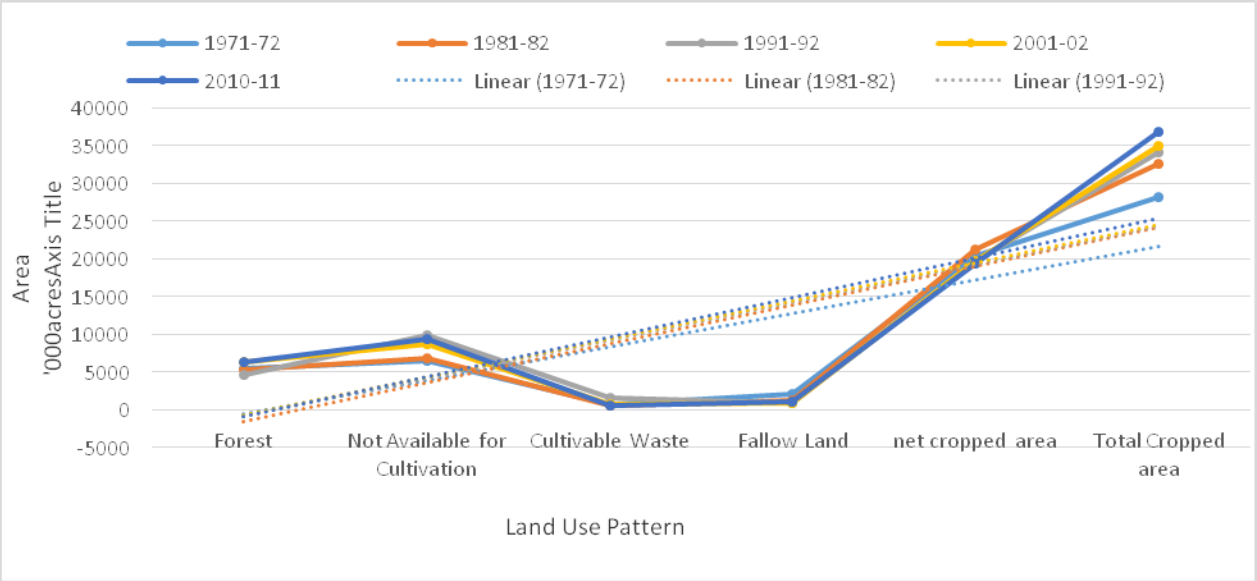


Figure 1:3: Decade-Wise Land Utilization of Bangladesh (1971-2011)

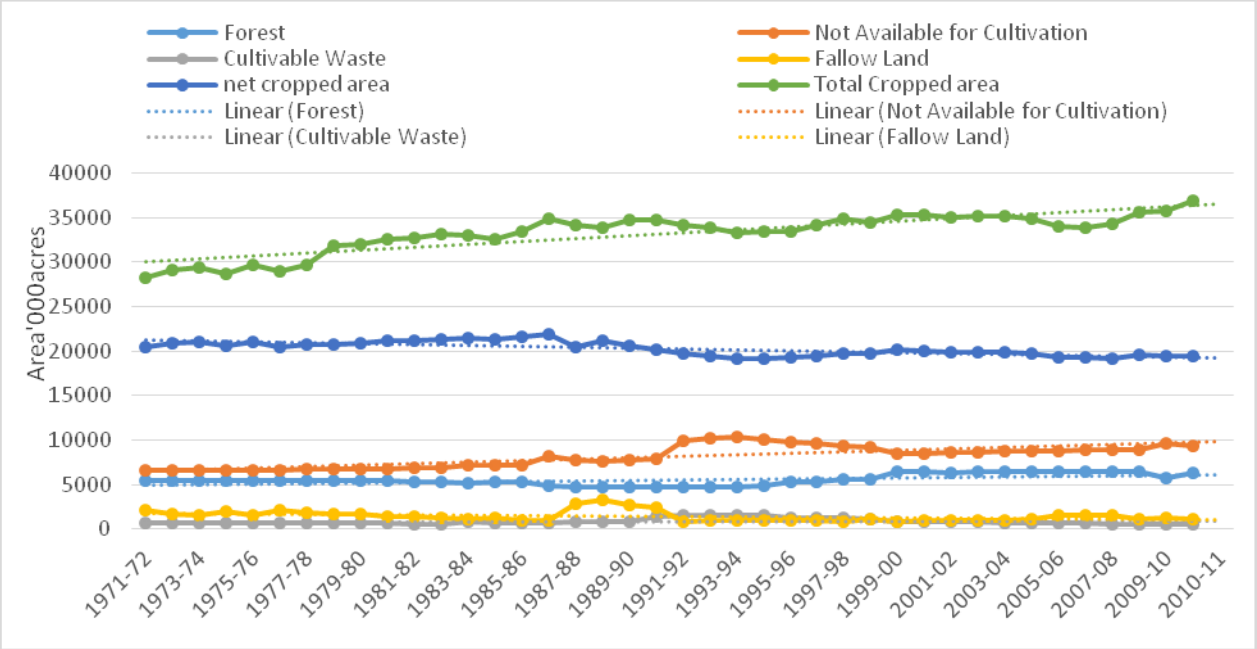


Figure 1:4: Trend of land use pattern of Bangladesh (1971-2011)

Land use pattern of a country reflects its socio-economic stipulation. While land use changes are concerning topics in perspective of socio-economic changes of a country, the pattern of its changes in Bangladesh is to meet the dynamic demand of the society that creates pressure on natural environment.

The shifting rate of agricultural land to non-agricultural use is said to be about 1% per year (South Asian Human Resources Development Report, 2003 by UNDP), which is alarming in respect to the total crop production in Bangladesh (Rahman and Hasan, 2003). This number rate of change however does not seem to

have a sound scientific basis. In fact, if this number were correct, at least one quarter of the country's agricultural land would have been lost since independence.

SRDI estimates land transfer from agriculture to non-agriculture sector using aerial photographs and Land sat imageries and has estimated approximately a 0.13% change per year during the period 1963 to 1983 (Rahman and Hasan, 2003). It is likely that the shifting rate will have been much faster during the 2000s till date, because of faster economic growth and the infrastructure development implied.

But according to BBS decline of agricultural land is about 0.383% annually from 1980-81 to 2006-07 (27 years average), 0.75% annually from 1983-84 to 1993-94 (10 years average) and 0.40% annually from 1993-94 to 2003-04(10 years average).

Despite the agricultural growth has been higher than the rate of population growth (MoA 2004) concerns have been raised whether the land mass of Bangladesh is actually capable of supporting its ever expanding population. It is highly imperative that the twin problem of arable land loss and population growth are addressed simultaneously to ensure increased and sustained production and thereby food security.

Land ownership and Sharecropping: It is estimated that 10 percent of farmers in Bangladesh own 50 percent of the land (BBS, 2009). About 60 percent of farmers are functionally landless and depend on sharecropping of land owned by the others. Average farm sizes are very small to support a family adequately. Apart from sharecroppers, approximately 20 percent of farmers are regarded as marginal and 20 percent are regarded as viable. Country's resource base, notably agricultural land, is stretched to the limit. While population is still growing at a rate of 1.6%, a slower pace than in previous decades, however, is competing for land. Non- farm employment opportunities are creating but not being fast enough to ease pressure on the land. The sharecropping has good effect in terms of cultivation and agricultural production; however, it has adverse effect on soil productivity maintenance. Most share croppers do not use proper dose of fertilizer, appropriate crop rotation, or organic manure due to a seasonal or annual contract arrangement and wants to get as much benefit as possible from the land within the contract period. As a result soil fertility has been declining and ultimately loosing soil productivity.

Agriculture sector is dynamic, changing with demand of people, availability of technology and change of management practices. Thus, it requires regular adjustment with different planning and development programmes. Country has much potential, yet it faces many challenges including vulnerability of climate change. For a long time planning a visionary exercise is needed in order to foster sustainable growth of this important sector. This necessitates a comprehensive Bangladesh Delta Plan (BDP) for development and sustainability of the sector harmonizing with the management of natural resources and addressing the challenges.

1.3. Objectives of the base line study

The overall objective is to ensure long term sustainable production of crops for good security in Bangladesh. The specific objectives of the base study are:

- To identify gaps in relevant policy and planning documents.

- To identify challenges and potentials of Bangladesh agriculture and food security.
- Assessment of current productivity status and to formulate development options for planning exercise.
- Outline an insight of long term Delta Plan ensuring food and nutrition security; and
- To develop a common and inclusive knowledge base

2. Methodology

Methodology includes:

- Review of relevant policy and planning documents - Sixth Five Year Plan, Agriculture Policy, Food Policy, and Departmental Plans, Food safety Guide Lines, Input Management Policy, Irrigation and Land Use Policy, etc.
- Collection of information from BBS, DAE, MOA, MOF, etc. and various on-line resources, etc.
- Desk review, seminar/workshop, interactive meeting,, consultation with line departments including other stakeholders
- Analysis and synthesis
- Report preparation
- Consultation with relevant ministries. line departments, agencies, focal points experts, including other stakeholders on consensus building on findings of the base line report.

3. Review of gaps in relevant policy and planning documents

Much Progress has been made during the last decades in Bangladesh in formulation and adapting agricultural policies to the ever changing needs of modernizing agriculture. The governments in the past have been adapted different sets of policy to cater needs of the government line departments, private sectors and farmers to create an enabling environment for technology dissemination and enhancing agricultural productivity. Bangladesh experienced a continuous process of policy refinement. *A Positive Policy Reform Agenda had been framed and practiced during the green revolution and its post green revolution process* to reap the benefits of more market orientation and open trade, while simultaneously addressing a broader range of domestic policy objectives. It was recognized that the stated objectives of agricultural policies generally fall into two categories. Either they address issues relating to equity and income distribution, or they relate to the correction of market failures and openness of the market economy. Market failures are often believed to be more frequent in agriculture than elsewhere in the economy due to agriculture's many functions as providers of both positive and negative externalities, and public goods.

The positive reform agenda emphasized that issues relating to market failures should be addressed first, and only after that should remaining income issues be tackled. Policies that address market failures also have an impact on farm incomes, sometimes positive and sometimes negative. The optimal level of intervention of each policy instrument should be considered together. For instance, reform of agricultural input markets in Bangladesh in the early 1980s, followed by liberalization of grain trading and the cancellation of several longstanding programmes of public distribution of grains during the late 1980s and early 1990s. The subsequent sections presents our analysis of gaps in relevant policy documents of concerned ministries.

The National Agriculture Policy 2013

The new National Agriculture Policy (NAP) 2013, focuses on: sustainable and profitable agricultural production; development and dissemination of new technologies; increase in productivity, employment and income generation; competitive agriculture through commercialization; adaptation to climate change and sustainability of agricultural system; agricultural marketing to ensure better prices to both farmers and consumers; enhance production quality to meet export standards; opportunities for agro-processing industries; encouraging production of diversified more nutritious crops.

Some threats and challenges identified for the implementation of the policy are: natural hazards; continued deterioration of soil health; continued reduction of arable land and water resources; increased use of agricultural land for non-agricultural purposes; price level and volatility discouraging farmers to engage in crop production; loss of agricultural biodiversity; excessive use of pesticides; environmental degradation; and insufficient budget allocation for agricultural research. The implementation of the agriculture policy should also recognize and cope with the existing weaknesses of the agriculture sector, including an inadequately developed marketing system, excessive post-harvest losses, limited availability of formal credit, and scarcity of technologies, especially for adverse environment. In line with the objectives, constraints and challenges identified, the NAP (2013) defines the following main areas of intervention: research and development; agricultural extension; seed and plant; fertilizer; minor irrigation; agricultural mechanization; agricultural cooperatives; agricultural marketing; women in agriculture; management of natural resources; development of human resources; agricultural labour and non-farm activities.

Fertilizer Policy in Bangladesh

Two kinds of policy goals have affected evolution of fertilizer policies over time in Bangladesh: - (i) Food security growth (export oriented), self sufficiency (output) and (ii) input policies from the political economy point of view. There has been a progressive shift in fertilizer policies in Bangladesh towards privatization, deregulation, and a reduction of subsidies, which began in the mid- 1980s and continued until mid 1990s. This was partially reversed following the severe fertilizer crisis in 1995. During global food price crisis in 2007-08 public sector roles were further strengthened towards market intervention and providing subsidy on fertilizers for achieving self sufficiency and food security. Table 3.1 presented a brief on evolution of fertilizer policy in Bangladesh till the first decade of the 21st century.

Table 3:1: Summary of Transformation Process of Fertilizer Policy/Regulation

Period	Policy, role of public and private sector

Period	Policy, role of public and private sector
Post Green Revolution period (1960-1980s): Heavy subsidization and public sector role	
1960s–1970s	In response to inadequate supply and progress in the spread of fertilizer, the public sector was given complete control over fertilizer procurement and distribution, with the responsibility of procuring fertilizer from both domestic and external sources and distributing it right to the level of the small administrative unit (*thana*) vested solely with the BADC. Under this "old marketing system" (OMS), the distribution of fertilizer was through Thana Sale Centers (TSCs) at subsidized prices. BADC-registered dealers were also allowed to lift fertilizer from TSCs and sell to farmers at regulated prices, for which a commission was paid to them.
1970s–1980s	The OMS was found to have a number of inefficiencies, especially with regard to appointment of dealers, erratic supply, inadequate storage, and skewed incentives for dealers and farmers. Beginning in 1978, efforts were made to improve the system under a series of measures referred to as the "new marketing system" (NMS). Although the overall procurement operations remained a public sector monopoly, significant changes were introduced in the distribution chain, with the aim of improving efficiency and bringing in competitiveness and private participation. BADC withdrew from retail sales and instead concentrated only on maintaining wholesale centers at various strategic points in the country. Restrictions on fertilizer movement across the country and the cumbersome registration process for retailers were eased. Starting in 1983, fertilizer price at the retail level was also decontrolled.
1990s	Although the NMS had enjoyed major success in many aspects, various constraints remained and meeting farmer demand during peak season continued to be a problem. Thus, policy started to shift toward an open market system. By 1989, direct lifting of fertilizer from domestic production centers as well as ports was allowed in response to a urea crisis that occurred despite there being large stocks present. In 1992, the government excluded fertilizers from the list of restricted imports, paving the way for the private sector to import fertilizer. By December 1992, the subsidy on fertilizers was withdrawn completely and import and distribution of fertilizer made open.
Liberalization –reducing public sector roles (1990s-2000s)	
1990s–2000s	Fertilizer crises at various points in time (initially in 1995, followed by more recent setbacks in 2005, 2007, and 2008) resulted in partial restoration of government control over the fertilizer market. In recent years, following the promulgation of a new dealership policy in 2008 and 2009 in the wake of a fertilizer supply crisis and price spikes, the fertilizer distribution system was revamped and some amount of subsidy was also introduced (though the stated aim of the subsidy was more toward balancing the use of various fertilizers to maintain soil health). The fertilizer distribution network is once again composed of appointed/licensed dealers who are limited to selling in a particular designated area, with the objective of ensuring effective fertilizer distribution all across the country. BADC is withdrawn from retail and whole sale markets at Primary Distribution Points (PDP). Licensing process for dealer was simplified and they can buy fertilizers from factory or import. They can sell non- urea fertilizers in their own price.
Post Global Food Price Crisis (Post 2008 to current)	

Period	Policy, role of public and private sector
Post 2008 to current	Government again subsidized the price of fertilizer. The prices of non-urea fertilizers were slashed to almost half per kilogram to help farmers during the *Boro* season. In order to mitigate crisis the government decided to bring the market under its direct control. The control measures were reintroduced on the marketing and distribution of urea in 2010 which again withdrawn in 2011 and non-urea fertilizer prices are now available at a heavily subsidized price.

Seed policy

A key element of production is a reliable supply of quality inputs that farmers can afford to purchase. The seed policy aims at balanced growth of both public and private sector seed production and distribution system. Bangladesh has been successful in switching over, largely, to high-yielding varieties (HYV) for rice production, the source of its impressive agricultural growth. Farmers can now manage 2-3 rice planting seasons per year. This has fueled huge increases in production and in food security.

National Food Policy, 2006

The National Food Policy 2006 (NFP) and the NFP Plan of Action (2008-2015) serve as a basis for identifying and prioritizing the options for investment and interventions for achieving food security in Bangladesh. The NFP provides strategic guidance for addressing the key challenges Bangladesh faces in achieving food security in all its dimensions, including public food supply and management.

The Plan of Action of the NFP (2008-2015) translates the provisions of the NFP into 26 areas of interventions and priority actions, providing a comprehensive framework for identifying investment and priorities for policy actions required to achieve food security. As such it provides a policy agenda, enabling the Government to undertake the right decisions, monitor progress toward the NFP objectives and highlights further policy changes to be undertaken. Food safety and quality control issues are not a major focus of the National Food Policy, although the importance of safe food is stated in Objective 1, but not reflected in the strategies suggested under it. Objective 3 addresses adequate nutrition, and in the Plan of Action (2008-2015) it is missing, Strategy 3.5: Safe, quality food supply briefly addresses food safety and proposes some limited actions. Food production, processing and marketing by the women and disabled does not include food safety and food control issues. Although the policy includes the issues related to food safety and quality, implementation of action oriented activities are absent.

National Health Policy, 2007

The core goal of the National Health Policy (NHP) is to achieve sustainable improvement in health, nutrition, and family welfare status of the people, particularly of the poor and vulnerable groups, including women, children, and elderly people with ultimate aim of their economic and social emancipation and physical and mental well-being. In addition, for the first time the health policy also has put a strong emphasis on nutrition issues (FPMU et al. 2009). The Health, Nutrition and Population Sector Programme (HNPSP) includes facility-based treatment of acute malnutrition in children, iron-foliate supplementation for women, and antenatal care and counseling during pregnancy as well as delivery of basic health and nutrition services. And the National

Policy for Arsenic Mitigation, and the corresponding 2004 Plan of Action was designed to address issues of arsenic poisoning. Food safety issues are not well elaborated in the NHP. The policy document includes only a single paragraph (No. 37) on food safety issues. But practically the implementation of the policy actions narrated in the document is very weak due to insufficient logistic support and shortage of skilled human resources and participation of stakeholders.

National Fisheries Policy, 1998

The policy describes very little on the issue of managing safety and quality of fish for domestic consumption covering Good Aquaculture management. But some activities are in place in respect of export oriented fish and fish products where traceability is established following international requirements.

National Livestock Development Policy, 2007

There is no broad focus on the safety and quality of meat, poultry and their products. The policy fails to address hygienic slaughtering of cattle for safe meat and meat products.

National Policy for Safe Water Supply and Sanitation, 1998

Although arsenic contamination of water is a serious issue in the rural areas, it is not reflected in the policy document. Food safety and quality issues are not at all reflected in the policy.

Perspective Plan 2010-2021

The government embarked on a Perspective Plan covering the period 2010 to 2021. "Achieving food security" and "pursuing environmental friendly development" have been specially mentioned as broad development goals. This would be translated through successive five year plans. Priority attention in planned crop intensification in the coastal zone is particularly emphasized in the document.

Sixth Five Year Plan (2011-2015) - Accelerating Growth and Reducing Poverty

The *Sixth Five Year Plan* (SFYP) is the first of two mid-term indicative plans aiming to "develop strategies, policies and institutions that allow Bangladesh to accelerate growth and reduce poverty" for the implementation of Vision 2021 adopted by the Government to elevate Bangladesh to a middle income country. The SFYP provides a strategy, framework and guidelines for reducing regional disparities, developing human capacity, managing land constraints, using natural resources, increasing agricultural productivity, household income and employment and ensuring food security. "Ensuring food security" has been outlined as a key strategy in the SFYP. In case of food production, climate change adaptation strategy in the agriculture sector is also prioritized. In addition, special emphasis is given to development of agro-processing and non-farm economic activities in the backward regions.

Country Investment Plan (CIP 2011)- A road map towards investment in agriculture

food security and nutrition

The CIP was elaborated through an inclusive, participatory process in response to the L'Aquila Initiative and in line with the 5 Rome Principles. The CIP is a planning, fund mobilization and alignment tool. It was first

approved on 14 June 2010 and revised and released in June 2011. It provides a coherent set of 12 strategic priority investment programmes under three components of food security: access, availability and utilization.

Master Plan for Agricultural Development in the Southern Region of Bangladesh (2012)

This Master Plan was developed by the Ministry of Agriculture with FAO's technical support. It provides a road map for the integrated development of Bangladesh's coastal region focusing on increasing agricultural productivity and sustainable food security.

Sustainable Agricultural Development Strategies for the Chittagong Hill Tracts (2013)

The Sustainable Agricultural Development Strategies were developed in 2013 by FAO under the guidance of Ministry of Agriculture and Ministry of Chittagong Hill Tracts Affairs (MOCHTA). They were motivated by concerns over environmental degradation and food insecurity in the region and define priorities in five areas: i) enhancing productivity, conservation and diversification, ii) more sustainable jum, iii) up scaling technology and sustainable input supply, iv) market/value chain development, v) food security and nutrition.

Table 3:2: Analysis of gap of different policies related to Agriculture and food security

Agricultural Policies	Major goals and policy thrusts	Implementing ministry	Gaps
New Agricultural Policy 2013 (NAP)	Ssustainable and profitable agricultural production; development and dissemination of new technologies; increase in productivity, employment and income generation; competitive agriculture tthrough commercialization; adaptation to climate change and sustainability of agricultural system; agricultural marketing to ensure better prices to both farmers and consumers; enhance production quality to meet export standards; opportunities for agro-processing industries; encouraging production of diversified more nutritious crops.	Ministry of Agriculture	1. The policy has addressed cereals and did not address adequately the non-cereals sector like jute, sugarcane, cotton etc. 2. Absence of a framework to develop effective human resources for commercialized agriculture including unemployed rural youth and women. 3. It is necessary to formulate a strategic plan to encourage export of high/value added products. Existing land use plan may have to be modified for this purpose to enhance productivity of high value items including fruits, vegetables, medicinal plants /herbs, cutflowers/ foliage etc. and value added processed products. 4. Food safety and quality issues are not adequately covered or emphasized including the traceability of the product.

National Agriculture Policy (NAP), 1999	Food security, profitable and sustainable production, land productivity and income gains, IPM, smooth input supplies, fair output prices, improving credit, marketing and agro-based industries, protecting small farmers interest	Ministry of Agriculture	1. Crop diversification, efficiency of irrigation water use, women participation in agriculture were not adequately addressed. 2. Contract Farming as a concept to boost production of high value crops and improve market linkages of the smallholders was not addressed rightly. it was later emphasized in the Export Policy 2003- 2006 since Bangladesh is a land hungry country and large scale farming is not a feasible idea. Land scarcity as well as fragmentation of land holdings perhaps make it a compulsion for the country to look at contract farming with due importance.
New Agricultural Extension Policy (NAEP), 1996	Provision of efficient decentralized & demand led extension services to all types of farmers, training extension workers, strengthening research-extension linkage, and helping environmental protection	Ministry of Agriculture	
DAE-Strategic Plan, 1999-2002	Adoption of Revised Extension Approach, assessment of farmers' information needs, supervision, use of low or no cost extension methods, promotion of food and non-food crops, and mainstream gender and social development issues into extension service delivery.	Ministry of Agriculture	
Agricultural Extension Manual, 1999	Annual crop planning, seasonal extension monitoring, participatory technology development and rural approval partnership, technical audit, attitude and practice surveys.	Ministry of Agriculture	
Seed policy, 1993	Breeding of crop varieties suitable for high-input and high output	Ministry of Agriculture	The public sector policies on seeds are stated in the National Seed Policy 1993, the Seeds

	agriculture, multiplication of quality seeds, balanced development of public and private sector seed enterprises, simplification of seed important for research & commercial purposes, provision of training and technical supports in seed production, processing & storage monitor, control and regulate quality and quantity of seeds.		(Amendment) Act 1997, The Seed Rules 1998, The Seeds Ordinance 1977 with amendments made in 1997 and 2005, the National Agricultural Policy 1999, the National Food Policy 2006 and National Food Policy Plan of Action 2007. The objectives and strategies for the seed sector are not narrated in these policy documents exactly in the same manner or language though the main thrust or message seems to be similar. And that is that the government would facilitate a balanced development of public and private sector roles in the production and distribution of quality seeds. What it actually means and how it would be achieved is not uniformly stated in the various documents mentioned above. Thus private and public sector interpret the intentions of these policies differently, causing some controversy. Related to the supply of inputs are issues of private and public sector coordination. The differences between private and public sector perspectives on the seed market are prompted by two factors: (a) lack of accurate data on the size and structure of the seed markets for different crops; and (b) lack of sufficient clarity on the objectives and strategies of the national seed policy. These issues can be a hindrance to effective participation by private sector and should be addressed
Seed Rules 1998	Delineation of rules and regulations regarding changing functions and of national seed board, registration of seed dealers, seed certification, marking truthful labels, and modalities of seed inspection.	Ministry of Agriculture	
Fertilizer	It governs the key issues of	Ministry of	1. Existing GOB fertilizer

distribution policy 2009	present marketing and distribution system. Under the present system, annual fertilizer demand is assessed by DAE and then MOA fixes the annual target centrally. Urea is imported by BADC only.	Agriculture	distribution system and regulations often impedes the private dealers from effective operations and does not serve farmers in remote areas. 2. The GoB fertilizer demand assessment is centrally determined and is not based on fertility level of soil 3. Monopoly import of urea fertilizer by BCIC. BADC and private importers import the required quantity of TSP, MoP and DAP from different countries and sources. Import of fertilizers fully depends on MOA's allotment and permission.
Plan of Action on National Agriculture Policy (NAP, 2003)	Reviewing NAP and its implementation, setting out strategies and actions, and identifying institution and programme framework	Ministry of Agriculture	
Actionable Policy Brief (APB), 2004	Prioritize immediate medium-term and long-term policy measures with respect to seed, fertilizer, land, irrigation, mechanization, marketing, agricultural research and extension with a view to increasing labour & water productivity, investment in agriculture and improve risk management.	Ministry of Agriculture	
National Jute Policy, 2002	Keeping jute production at a desirable level, stabilizing supply and prices of jute, developing commercially viable jute industries, accelerating privatization of jute industries, and developing multiple uses of jute & jute goods.	Ministry of Jute	
Livestock Policy and Action	Improvement of small scale poultry and dairy farming	Ministry of Fishery and	There is no broad focus on the safety and quality of meat,

Plan, 2005	replicating CLDDP, reform of DLS, enforcement of low and regulations towards animal feeds, vaccines and privatization of veterinary services adoption of breeding policy, and establishment of livestock insurance development fund and livestock credit food.	Livestock	poultry and their products. The policy fails to address hygienic slaughtering of cattle for safe meat and meat products.
National Fishery Policy, 1998	Development of fishery resources, increasing fish production and self employment, meeting demand for animal proteins accelerating fish exports, and improvement of public health.	Ministry of Fishery and Livestock	The policy describes very little on the issue of managing safety and quality of fish for domestic consumption covering Good Aquaculture management. But some activities are in place in respect of export oriented fish and fish products where traceability is established following international requirements.
National Forest Policy 1994	Bringing 20% area under afforestation, enriching bio-diversity, extending assistance to forestry sector development through development of land and water resources, implementation of national and international efforts and agreements relating to global warming, desertification control of wild bird and animal trade, and prevention of illegal occupation of forest lords, felling of trees, encroachment and haunting of wild animals.	Ministry of Environment and Forest, 1994	
National Land use policy	Minimizing loss of cropland, stopping indiscriminate use of land, preparing guidelines for land use for different	Ministry of Land	

	regions, rationalizing land acquisition, and synchronization of land use with natural environment.		
National Water Policy, 1998	Development and management of surface and groundwater in an efficient manner ensuring access of the poor, women and children to water, accelerating development of sustainable public and private water delivery systems, development of a legal and regulatory framework for private sector investment in water development, and capacity building for designing future water resource management plans.		Although arsenic contamination of water is a serious issue in the rural areas, it is not reflected in the policy document. Food safety and quality issues are not at all reflected in the policy.
Environment Policy 1992 and Implementation Programme	Protection of environment, identification and control of pollution, sustainable use of natural resources and participation in all international initiatives to protect environment	Ministry of Forests and Environment	
National Food Policy, 2006	The National Food Policy 2006 (NFP) and the NFP Plan of Action (2008-2015) serve as a basis for identifying and prioritizing the options for investment and interventions for achieving food security in Bangladesh. The NFP provides strategic guidance for addressing the key challenges Bangladesh faces in achieving food security in all its dimensions, including public food supply and management. The Plan of Action of the NFP (2008-2015) translates the provisions of the NFP into 26 areas of interventions and priority actions, providing a comprehensive framework for identifying investment and	Ministry of Rural Development and Cooperatives	1. It covers different aspects of food availability, access and utilizations. It did not rightly address the issue of food quality and safety which is now a burning issue in Bangladesh. Food safety and quality control issues are not a major focus of the National Food Policy, although the importance of safe food is stated in Objective 1, but not reflected in the strategies suggested under it. 2. The Bangladesh Pure Food Ordinance, 1959 and the Bangladesh Pure Food Rules, 1967, regulate food safety in Bangladesh. The Pure Food Ordinance was amended in 2005 and established the National

	priorities for policy actions required to achieve food security.		Food Safety Advisory Council (NFSAC). Current food safety laws and regulations in the country do not cover some of important areas of food safety and that needs to be more science-based and modernized. The laws governing food safety are out-dated, do not cover food from farm to table and is not based on risk analysis with overlapping of legal provisions and responsibilities. 3. No specified coordinated governance design is available in the country. National standards and regulations have not been harmonized with Codex. Food safety issue is dealt not by one body, but around 15 ministries. There is no single authority on food safety.
National Health Policy	The core goal of the National Health Policy is to achieve sustainable improvement in health, nutrition, and family welfare status of the people, particularly of the poor and vulnerable groups, including women, children, and elderly people with ultimate aim of their economic and social emancipation and physical and mental well-being. The National Policy for Arsenic Mitigation, and the corresponding 2004 Plan of Action was designed to address issues of arsenic poisoning . The National Strategy for Infant and Young Child Feeding in Bangladesh is focused on direct interventions targeted to child nutrition.	Ministry of Health	Food safety issues are not well elaborated in the NHP. The policy document includes only a single paragraph (No. 37) on food safety issues. This paragraph includes causes of health problems due to unsafe water and low quality food, emphasizing the need for updating food safety laws, implementation of Pure Food Act, and the possibility of unification of Food and Drug Administration to safeguard the population against health hazards. But practically the implementation of the policy actions narrated in the document is very weak due to insufficient logistic support and shortage of skilled human resources and participation of stakeholders.

3.2. Synthesis of recent strategies of concerned Ministries and line Departments

3.2.1. Strategy of current food production and food security

Ensuring food security for the poor is a fundamental strategic goal of the Government. It involves the physical availability of food at all times and its access to all at affordable prices. Seventy per cent people of Bangladesh live in rural areas and draw their income and employment from agriculture and related activities.

The Ministry of Agriculture (MoA) has prepared a comprehensive agricultural policy in 2004 and started implementing the policy to address the problems of improving land, water and labour productivity by promoting balanced use of fertilizer, small scale mechanization, quality seed production, irrigation interventions in drought-prone areas, crop diversification, and improving water use efficiency and supply of agricultural inputs. These interventions are currently made through 19 development projects. Some of the institutional problems and issues are also being addressed by MOA with own resources, and efforts are being made to address the others that will
require external funding. The World Bank is actively considering assistance in strengthening the agro-technology system; and JICA is reviewing the need for strengthening the Central Extension Resources Development Institute through reorganization and redefining its charter. The process of strengthening the Seed Wing of BADC and revitalizing the Seed Certification Agency is ongoing.

Policy developments &/programmes of MoA underway and needs for further action

Under subprogramme 1.1 related to enhancing knowledge generation, CIP 2014 (2012/13) includes seven completed, 31 ongoing and seven pipeline projects with total financing at 192.9 million USD or 1.61% of total financed CIP. Of the 181.1 million USD for completed and ongoing projects, 137.2 million USD (76%) are financed by GoB and 43.9 million by DPs. Under sub-programme 1.2, related to improvement of agricultural extension service, there are 11 completed, 24 ongoing and four pipeline projects, amounting to 243.9 million USD. Of the total budget of 202.3 million USD for completed and online projects, 146.7 million USD i.e. 73% are financed by GoB and the rest 27% by DPs. This sub-programme accounts for 2.03% of total CIP budget. Sub-programme 1.3, which mainly focuses on research and extension for climate adaption, includes 11 ongoing and seven pipeline projects worth 366.9 million USD. DPs finance 170.9 million USD or 61% of the total 279.7 million USD of ongoing projects.

Enhance research and knowledge generation in a sustainable manner

The Government budget for the research institutes under NARS (including BARC) increased
by 15%, up from 4.5 billion taka in 2012/13 to 5.2 billion taka in 2013/14, although its share in the National Budget remained unchanged at 0.23%, reflected in lower budget allocated to BRRI, but higher for other institutes. The SFYP stressed on avoiding fragmented and duplicated research; focusing research on farming system instead of individual crops; promoting problem solving research in different agro-ecological zones; and building linkage between research and extension.
Research priorities in Bangladesh agriculture published by BARC identified the following thematic areas: varietal development, management practices, diseases and pests, and processing and marketing. For instance, in the case of rice, the research priorities are: development of short duration, salt tolerant, submergence tolerant,

drought tolerant, disease and pest resistant, aromatic, hybrid varieties and varieties with high iron, zinc and vitamin A, integrated crop management, yield gap minimization, intensification and diversification of rice based cropping system under different ecosystems, minimizing post harvest losses, rice milling for high recovery, and diversified use of rice by products.

The National Agriculture Policy 2013 identified different strategies for research and development in the following areas: management system of research institutes, planning and financing of research, research topics and areas, technology transfer, equality in providing services, building information data base, public private partnership and protection of intellectual property right. These are discussed in further detail in the following sections.

Improve agricultural extension services

The DAE is the largest agency providing extension services to farmers with a total of 12,899 extension workers (SAAO) and 2,162 officers. Besides DAE, agricultural universities provide university-based extension training and activities. NGOs like BRAC, CARE Bangladesh, and World Vision as well as some private companies are also providing extension and advisory services. BRAC has 250 agriculturists and 8,903 agriculture extension workers working in 136,320 villages.

Priority issues identified in the NAP 2013 for improving extension services include: assisting farmers through coordinating extension endeavors of public, private sectors and NGOs; solving farmers' problems through building relationship among research institutes, extension department and universities under 'bottom-up' approach; adoption of modern information technologies in agricultural extension activities; encouraging partnership in extension activities between public and private organizations; raising productivity of agricultural crops; ensuring production of quality product; effort to be made to deliver appropriate technologies in hilly, drought-prone, barind, char, *haor /baor* and water logging areas; increasing resilience to natural calamities by adopting short, medium and long run development programme, agricultural rehabilitation programme and crop insurance programme and creating 'agricultural rehabilitation encountering fund'; conservation of environment and natural resources through encouraging development of sustainable and environment friendly technologies, conservation of bio-diversity, adoption of integrated pest and crop management and controlling use of agricultural land for non-agricultural
purposes; creating a coordinated data bank with the existing information on resources, inputs, technologies, production and marketing systems.

The needs for further action in this area include:

Strengthen management system of research institutes: In line with NAP 2013, for scaling up quality of research, the coordination, planning, prioritization, monitoring and evaluation systems of research institutes should be strengthened. Coordination and integration is needed to avoid fragmentation and duplication of research efforts.

Coordinate research by public and private partners: Increased research focus is needed on farming systems or integrated production systems rather than individual commodities. Moreover, in line with NAP 2013, public-private partnership research and research in collaboration with international research organizations should be encouraged.

Focus technological development on efficiency, sustainability and resilience: Research needs to focus on development and improvement of stress tolerant and short duration varieties and farming practices; agricultural machineries and post harvest technologies to enhance handling and marketing especially of high value crops; sustainable and efficient use of land and water resources; crop management in adverse environment and for climate change adaptation.

Develop an information bank: Lots of information obtained through research by different organizations is not openly accessible. So a central data warehouse may be developed under BARC through developing e-network. In line with NAP 2013 a data bank could be created with the existing information on resources, inputs, technologies, production and marketing systems, prices, etc.

Improve research infrastructure and strengthen human resources: The quality of research is constrained by the availability of modern instruments and other infrastructures due to availability of funding in public research organizations. Overall public spending in agricultural research is very low in Bangladesh compared to neighboring country like India. Research funding needs to be up scaled in order to allow the required technological breakthrough.

Promote agricultural research for nutritional development: Agriculture has made remarkable advances, but progress in nutrition is lagging behind. To address this gap, emphasis should be given to carry out nutrition-oriented agricultural research. The starting point for 'Agriculture for Nutrition and Health' (ANH) is that agricultural practices, interventions, and policies can be better adapted and redesigned to maximize health and nutrition benefits and to reduce health risks. In order to achieve this goal, ANH will bring together research and development professionals across the agriculture, nutrition, and health sectors to jointly tackle key challenges and design joint solutions.

Expand Farmers Information and Advice Centres: In line with NAP 2013, all field extension personnel of DAE, DLS, DoF, in collaboration with NGO and private companies need to provide integrated services for all farmers. The Farmers Information and Advice Centre (FIAC) housed in UP complex can work as the reference one stop service centre. For providing agricultural services (crops, fishery and livestock) round the clock, so far 727 "Farmers Information and Advice Centre" have been created under National Agricultural Technology project. For expansion of agricultural technologies so far 13,450 farmers' groups have been formed in 120 upazilas under this project. This centre needs to be expanded throughout the country.

Strengthen agricultural information services through ICT in extension services: In line with NAP 2013, ICT can be used to facilitate farmers' participation and better linking marketing and production system through web and mobile based technologies. Digitized databases and management information systems may be set up at upazila, district and national levels. Mobile based text messages and voice messages may be utilized for early warning on pest and disease outbreak, natural disasters as well as to disseminate critical information. For expansion of ICT, 1,043 computers, 300 laptops and 1,043 printers, 300 multimedia projectors and 450 modems have been supplied in the field offices under DAE For using these instruments, skilled personnel need to be recruited or training needs to be provided to the existing staffs.

Strategies adopted in Sixth Five Year Plan crop sector:

- Sustainable achievement of self-sufficiency in the production of rice.

- Diversification of agricultural crops by adopting a system based on dissemination of information on agro ecological zoning to identify areas suitable for different crops.
- Priority attention in planned crop intensification in the coastal zone, the Sylhet region and the char areas in the northern poverty stricken region.
- Ecologically favorable, months November - February maybe devoted for growing high profit non-rice crops leaving the remaining eight months for growing two rice crops, Aman in particular.
- Motivate farmers to use recommended/balanced doses of chemical fertilizers, extensive production and use of organic fertilizer, and proper utilization of soil guide and soil testing facilities to enhance soil fertility.
- R&D for productivity increase yielding up to 20 per cent higher production of hybrid rice through technological progress, stress tolerant varieties (salt, submergence and drought tolerance for rice as well as heat tolerance for wheat) will be developed.
- Exploring reduction in yield gap for existing technologies and better seeds, efficient management of seed beds and adoption of the System of Rice Intensification (SRI), involving young seedlings, one seedling per hill, larger spacing, alternate wet and dry irrigation, use of compost/farm yard manure and direct seedling.
- Steps will be taken for distribution of khas land to the landless and the marginal farmers easing the rental system, computerized land records and transfer, safeguards against eviction of the bargadars and granting them the right of pre-emption in land transfer.
- ICT for extension will be widely used for regular weather forecasts through TV, community radio and cell phones.
- Services of SPARSO will be extensively used in forecasting.
- Increase of storage capacities by building additional capacities, 50,000 tonnes by 2015 and 1 million tons by 2021 and explored to facilitate safe storage of rice and perishables.
- Production and marketing cooperatives may be formed and concessional credit given to facilitate the growers purchase their own output during the harvest season and release to the market throughout the year; this will reduce the growers' dependence on the middlemen.

Livestock and fisheries

The Ministry of Fisheries and Livestock has also prepared fisheries and livestock policy. The National Livestock Policy is still in a draft form. It is expected to be finalized within this year. The major policies include: (a) promotion of smallholder dairy and poultry development; (b) development of goat, buffalo and duck in high potential areas through special projects; (c) institutional reform of DLS and enactment of laws and regulations for quality control of drugs, vaccines, feeds, chicks and breeding materials; (d) privatization of veterinary services of private
good nature; and (e) explore all alternatives for producing fodder. In addition to routine activities of providing extension services, animal health service, supply of inputs, artificial insemination, and feed analysis, DLS has 9 on-going development programs/projects on production of vaccine, smallholder livestock development, artificial insemination and embryo transfer, breed upgradation, modernization of Central Cattle Breeding Station and Dairy Farm, establishing regional duck breeding farm with hatchery, and training program for small scale dairy.

National Fisheries Policy was formulated in 1998, with the following objectives: (a) enhancing fisheries resources and production; (b) generating self employment for poverty alleviation of fishers; (c) meeting the demand of

animal protein; (d) increase foreign exchange earnings through export of fish and fisheries products; and (e) maintain ecological balance, conserve biodiversity and improve public health. The Ministry is thinking to revisit the policy of 1998. Fisheries Department has developed a strategy and action plan to implement the 1998 fisheries policy, taking into account the likely changes to occur over the next 10 years. The policies are being implemented through a range of revenue and development projects. Revenue projects include extension service to farmers, Fish Act implementation and Jatka protection. As many as 12 development projects supported by different donors are under implementation, covering aquaculture development, Brood Bank establishment, resource development and management, supporting coastal fishing community, fish inspection and quality control and development of Shrimp Seed Certification.

Strategies

- High priority given to closed water fisheries production.
- Increasing fresh water, (rather than brackish water) golda production in coastal areas.
- Potential use of cage culture in flood plains, with individual _ownership.
- Emphasis on supply of inputs and promotion of technical knowledge among the educated youth, in pond and other closed water bodies culture.
- Adoption and implementation of the concept of fishermen cooperatives towards 'Jaal jar jala taar' in government-owned water bodies.

The Ministry of Food: The Ministry has formulated a National Food Security Policy that includes access to and utilization of food, coordination, food policy analysis, short and long-run forecast of domestic and world supply and trade. In order to achieve these objectives, a multi-donor supported project, entitled "National Food Policy Capacity Strengthening Program" had been implemented. The broad objective of the project was to strengthen the capacity of FPMU for performing the new tasks of access to food, its utilization and nutrition, in addition to the current function of monitoring food availability and food assistance. The new functions also include improving inter-ministerial collaboration and coordination, food security related research and policy analysis, strengthening GO-NGO cooperation and encouraging dialogue and research capacity building of the civil society.

Achieving the MDG targets within the next decade will require Bangladesh to develop and implement more effective strategies. Speeding up per capita income growth and pursuing targeted safety net programmes are needed for the expansion of household food intake. A comprehensive programme to address hunger would include interventions in the following
areas:

- Promoting food security by sustaining strong growth of domestic food production and implementing a liberalized regime for food imports
- Designing and implementing interventions to promote food security
- Supporting safety nets for protection against natural disasters
- Promoting change in food habits for increasing nutritional intake of vulnerable
- Promoting improved infant feeding practices, including breast-feeding practices
- Supporting maternal schooling and hygienic practices
- Improving access to safe drinking water, especially by addressing the threat of arsenic contamination of underground water
- Improving access to sanitation

- Improving access to basic health facilities
- Promoting partnership among the Government, private sector and NGOs

Social Protection Policy Support Programme of General Economics Division (GED)

With the aim of supporting NSPS implementation, UNDP has designed a project document for a Social Protection Policy Support Programme in partnership with GED, and in coordination with DFID and DFAT (previously AusAID). Key outputs of this programme include: (i) the development of a better governance for social protection by strengthening coordination, monitoring and evaluation, as well as reporting functions; (ii) stronger research and analysis capacities to build a more effective evidence based policy development, parliamentary engagement and strengthening of social protection systems, by means of electronic payment platforms coordinated with field monitoring and evaluation.

The programme also includes a component of catalytic learning through a pilot delivery intervention called Strengthening Women's Ability for Productive New Opportunities (SWAPNO) that will provide a benchmark for innovative delivering systems, including micro-insurance and climate adaptive social protection. UNDP and the Local Government Division have in partnership planned the SWAPNO project, comprising public works employment of extreme poor women as the entry point, with a state-of-the-art graduation strategy aiming at beneficiaries' sustainable exit from extreme poverty.

4. Agricultural inputs

4.1. Present soil fertility status and fertilizer use

Thirty agro ecological regions and 88 sub regions have been identified by adding successive layers of information on the physical environment which are relevant for land use and assessing agricultural potential. These layers are:

- Physiographic (land forms and parent materials)
- Soils and their characteristics
- Depth and duration of seasonal flooding
- Length of the rained kharif and rabi growing periods
- Length of the pre-kharif period of unreliable rainfall
- Length of the cool winter period and frequency of occurrence of extremely low (below 0.40C) winter temperature.
- Frequency of occurrence of extremely high (> 400C) summer temperature.

Agro ecological regions and sub regions are very broad units. Fertility status of these regions varies considerably. Individual farmers have fragmented the land into small pieces causing wide variation in the management of each and every piece of land. This leads to the large variation in the fertility levels even between adjacent plots.

On the basis of origin and properties, the soils of the country are classified into seven tracts as follows: 1. Madhupur, 2. Barind Barind, 3. Gangatic Gangatic, 4.Teesta, Teesta, 5. Brahmaputra, 6. Hills and 7. Coastal Saline. Soil nutrient content of this tract varies widely. Although Bangladesh is a small country, it has a wide variety of soils. The fertility status of Bangladesh soils is extremely variable. Most of the soils are depleted and in

urgent need of replenishment with manures and fertilizer if productivity has to be enhanced It is estimated that more than 100 kg nutrients per ha year are mining out from the soil system.

Although Bangladesh is a small country, it has wide variety and complexity of soils at short distances due to a diverse nature of physiographic condition, parent materials, lands, and hydrology and drainage conditions. Due to intensive cropping to grow more food, continuous changes are taking place in the soil fertility status due to organic matter depletion, nutrient deficiencies, drainage impedance/water logging followed by degradation of soil physical and chemical properties as well as soil salinity/acidity. The fertility status of Bangladesh soils is extremely variable. Most of the soils are depleted and are in urgent need of replenishment with organic matter and fertilizers in order to enhance crop productivity.

Nitrogen deficiency in soils: All the agricultural soils are critically deficient in soil nitrogen content are major and micro nutrients are also limiting to crop production. But the extent of deficiency varies geographically depending on the extent of land use and nature of parent materials .. The main reasons for such deficiency are due to:

- Less Intense decomposition of organic matter
- Rapid removal of mineralized products under high leaching conditions and crop removal.

Nitrogen being the most important nutrient element in soils plays the most vital role in crop production in Bangladesh. Responses of modern rice to applied nitrogen have been studied extensively throughout the country by a series of fertility trials. The average yield increase due to fertilizer N varies from 30 to 75%. In some cases, without applied N modern rice showed almost complete failure, while application of 100 kg N/ha along with other nutrients resulted in a very successful crop yielding 6-7 t/ha.

Phosphorus deficiency in soils: Phosphorus is the second most important nutrient element limiting successful crop production. It becomes unavailable or fixed in the soils through a variety of ways. In acidic terrace and brown hill soils, phosphorus is largely fixed by iron and aluminum oxides at low pH, while in calcareous soils fixation occurs by calcium-magnesium carbonates. The net result of fixation is a decrease in the immediate availability of native and applied phosphorus.

Potassium deficiency in soils: Potassium is the third major plant nutrient recently identified as deficient in most Bangladesh soils. The previous idea about the sufficiency of potassium in Bangladesh soils might be true for local crop varieties with low yield potentials. One-ton wheat/ha or 2-ton rice/ha can be obtained from soils where K would be a limiting factor continuously without K fertilizers. The crop intensification with high yielding and hybrid varieties has shown widespread deficiency of potassium in Bangladesh soils. It has been recorded that a 5 ton/ha rice crop will remove more than 110 kg K which is to be made available to plants in less than 3 months' time and many of our old and highly weathered soils may not have potential to supply K at this rate.

Sulphur deficiency in soils: Sulphur has been recognized as the fourth major nutrient limiting crop production as early as 1980. In the past very little attention was paid to this nutrient until 1977 when sulphur deficiency in wetland rice was first detected at the Bangladesh Rice Research Institute (BRRI) farm and on nearby farmers' fields. Since then sulphur deficiency in Bangladesh soils is becoming widespread and acute. It has been reported that variable amount of available S in soil ranging from as low as 2µg g-1 soil to as high as 75 mg g-1 is available. The use of high analysis fertilizers such as urea, triple super phosphate, muriate of potash and

diammonium phosphate, cultivation of modern varieties, increasing cropping intensities and limited application of organic manure have all contributed to the intensification of the S deficiency problem in Bangladesh soils. The problem is more severe in wetland rice than in upland crops as anaerobic condition, under which rice is grown, reduces sulphate and makes it unavailable to plants.

Need to promote balanced fertilization: Balanced fertilization is the key to successful crop production and maintenance of good soil health. It is important to see how close nutrient addition and removal by crops match with each other. According to current statistics, the farmers of Bangladesh use 215 kg nutrients (N: 149 kg, P2O5: 37 kg, K2O: 22 kg and S + Zn + B + others: 7) ha/year from chemical fertilizers, while the estimated removal is around 280 -350 kg/ha. From organic and natural sources about 50-70 kg nutrients are added to the soil system every year. One nutrient balance study made by DAE-SFFP (2002) from a typical Boro- Fallow – T. Aman cropping pattern (10 t grain yield) is shown Table 4.1. It is quite evident from the study that severe mining of N and K are going on in the country's soil system. That's why the productivity of the soils is low and decline in crop yields has been recorded in many areas.

Table 4:1: Nutrient depletion due to rice cultivation

Nutrient dynamics	N (kg/ha)	P (kg/ha)	K (kg/ha)
Nutrient uptake cropping pattern	180	27	180
Leaching losses from: Soil Fertilizer	12 17	- -	6 -
Erosion	12	2	12
Gaseous losses: organic	24	-	-
N fertilizer	68		
Total Output	313	29	198
Fertilizer	170	25	75
Organic manure (5t/ha)	20	12	24
Incorporated crop residue	25	3	25
Nonsyymbiotic fixation	10	-	-
Atmospheric fixation	8	1	2
Sedimentation/weathering	-	2	10
Iriigation water	2	6	21
Total Input	235	49	157
Balance	-78	20	-41

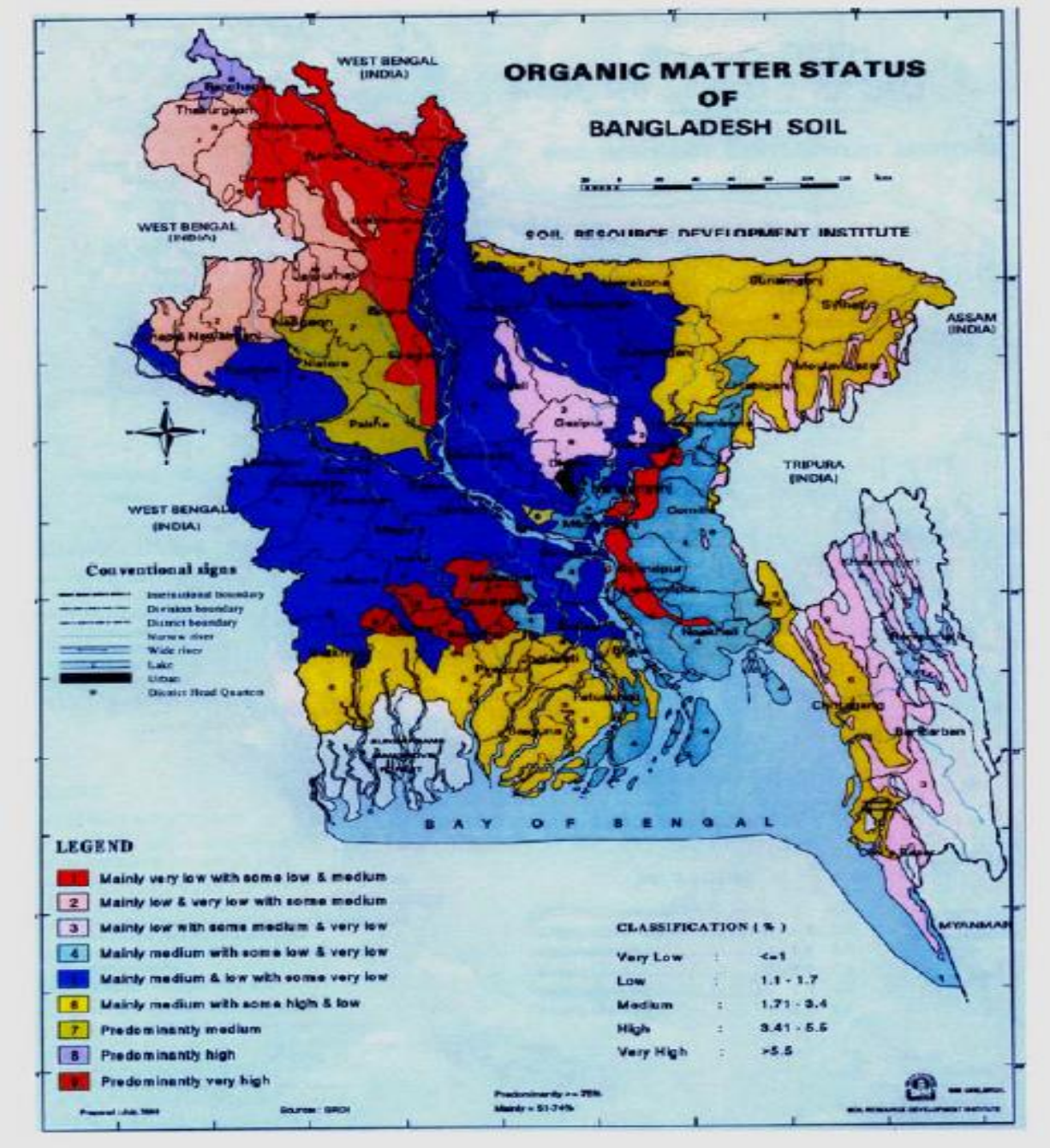


Figure 4:1: Organic Matter Status of Bangladesh Soil

Fertilizer recommendation for single crops and cropping patterns are usually made by following the guidelines clearly stated in "The National Fertilizer Recommendation Guide" which is revised and published from time to time by the Bangladesh Agricultural Research Council in consultation with NARS scientists engaged in soil fertility and fertilizer management research activities. Upazila Soil Use Guide published and updated by SRDI from time to time is also a useful guide for site-specific fertilizer recommendation. Each guide has at least 100-150 site-specific information on soils nutrient status, topography, hydrology, vegetation and drought. Fertilizer recommendations are usually made on the basis of soil fertility classes; yield goals and farmers' management ability. For high yield goal fertilizer recommendation, one should have site-specific information on nutrient

status of soils as well as the crops. If the site-specific information on the soils is not available, moderate yield target may be fixed and the information available about agro ecological region in the guide may be used to find out the fertilizer doses. Research on site-specific N management using leaf color chart in Bangladesh is in progress at the Bangladesh Rice Research Institute.

Box 1: A Case Study on Impact of soil fertility on rice productivity

Impact of soil fertility on rice productivity:

Rahman (2006) examined the influence of selected soil fertility parameters on modern rice productivity utilizing a stochastic production frontier approach on a survey data from 21 villages in three agro-ecological regions of Bangladesh. Detailed crop input-output data were collected from 380 paddy rice farmers. The soil fertility status in each region was determined by analysis of soil organic carbon, available nitrogen, and phosphorus and potassium concentration. Results reveal that in addition to key production inputs, soil fertility also significantly affects the parameters of the production function. Available soil potassium and soil nitrogen significantly increase rice productivity whereas available soil phosphorus has an opposite effect. The soil organic carbon content also has a desirable positive effect but the influence is not significant. The mean technical efficiency of these modern rice farmers is estimated at 73%, implying that 37% [(100-73)/73] of the production can be increased by eliminating technical inefficiency alone. Results indicated that in policy terms technological initiatives should be targeted at measures to identify areas of lower soil fertility so that inherent soil-based productivity restrictions can be minimized. In part this will be facilitated by the transfer of indigenous knowledge from farmers in higher productivity areas, thus increasing rice production. Also, investment in rural infrastructure is suggested to improve technical efficiency.

Soil Salinity: Saline intrusion from sea water in coastal areas, compounded by tidal surges, adversely affects life, property, ecology and agricultural production in those areas. The problem is intensified with global climate change effect and degrading more area with salinity**.** Karim 2009b, mentioning SRDI data showed that over 103,000 ha of lands were saline in 2000, which is about 20% more than the saline area in 1973 (833,000 ha). This indicates that saline area has been increasing in the country over the three decades and will continue in the coming years with sea level rise due to climate change. During the monsoon, about 12% of the total area is under high salinity levels which increase to 29% during dry season. The increased salinity level would limit the cultivation of many crops in coastal areas.

4.2. The Trend of Fertilizer use in Bangladesh Agriculture

Increase in food production and attaining food sufficiency in Bangladesh requires sustainable growth of agricultural sector in order to provide food for her increasing population. Fertilizer is considered to be one of the main inputs for increasing crop yields and farm profit. But balanced fertilization is the key to efficient fertilizer use for sustainable high yields. Bangladesh has virtually no possibility of increasing its cultivable land area. Therefore, food production of this country can be increased through increasing irrigation facilities together with expansion of HYVs and balanced use of fertilizer. Besides, well-timed supply and availability of fertilizer should receive top priority to sustain/increase rice production in Bangladesh.

Ahmed (2004) reported that the use of chemical fertilizer started in the country in 1951 with the import of 2,698 tons of ammonium sulphate, phosphates in 1957 and muriate of potash in 1960. Then, in 1965, the Government launched a 'Grow More Food' campaign and provided fertilizers and low lift pump (LLP) at a highly subsidized rate with pesticide at free of cost to popularize these inputs among the farmers and meet the country's food shortage. Thus, fertilizer consumption began to increase rapidly with the introduction of HYV rice (i.e. IR5 & IR8) and LLP use.

Total requirement of fertilizers like Urea, TSP, SSP, MP, Gypsum and mixed fertilizer for crop production in 20011-12 were 28.0, 5.0, 1.25, 1.5 and 3.0 lakh metric tonnes per year respectively. Among them 60 percent of Urea and 100 percent of mixed fertilizer were produced in the country. Fig 4.2 shows that annual consumption of chemical fertilizer is increasing at constant rate.

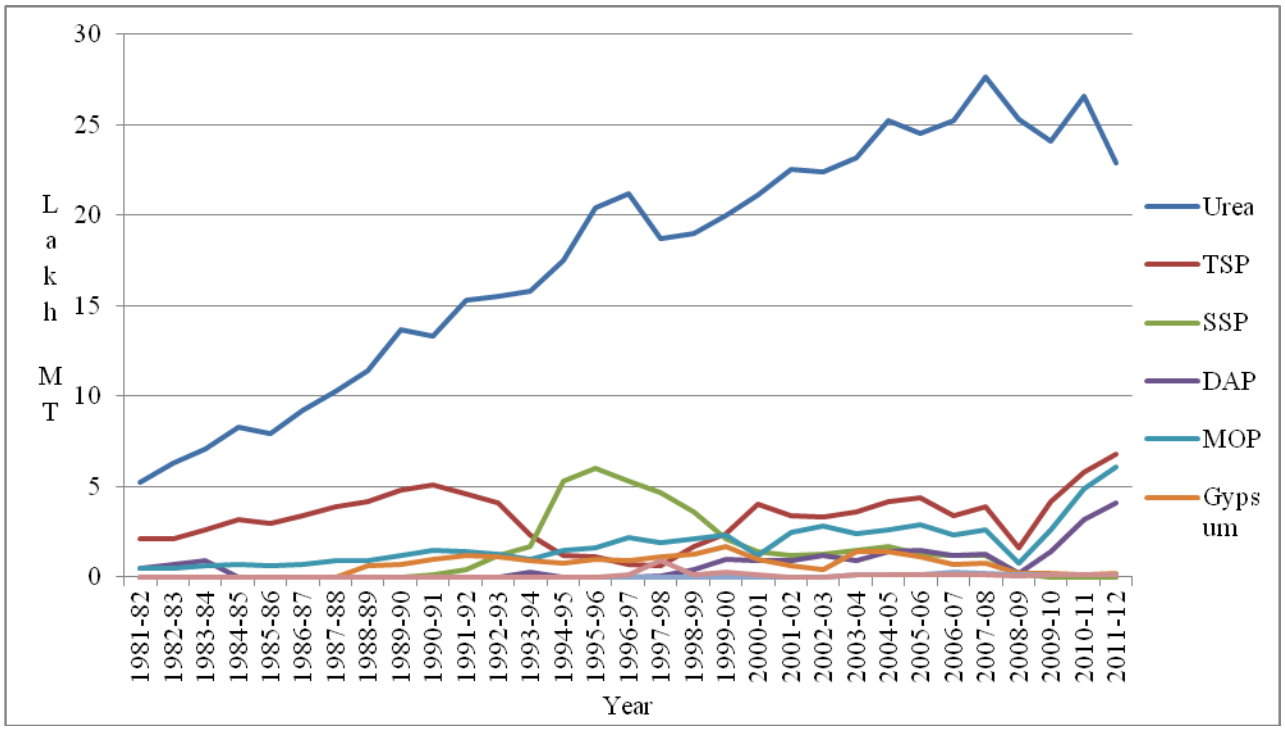


Figure 4:2: Fertilizer use by different types in Bangladesh: 1981-82 to 2011-12

During 1963-1964 to 1970-1979, total fertilizer use increased dramatically with a growth rate 16.5% per annum. Thereafter, the growth rate of urea declined. During 2004-12 growth rate of TSP and MP sharply increased due to government subsidy on these tow fertilizers (Table 4.2).

Table 4:2: Growth rates of fertilizer consumption over time (1984-85 to 2011-12)

Year	Total Consumption	Urea	TSP	MoP
1984/85-2011/12	4.17	4.24	1.80	7.12
1984/85-1989/90	8.05	8.31	5.46	8.97
1990/91-1994/95	3.65	5.57	-74.69	0.59
1995/96-1999/00	1.22	0.92	2.35	1.099

2000/01-2004/05	4.37	3.28	2.84	1.95
2005/06-2011/12	1.35	0.70	3.44	7.54

Source: Bangladesh Economic Review

4.3. Fertilizer Production and Imports

Bangladesh chemical industries corporation (BCIC) is producing Urea, TSP and DAP by about 41%, 10% and 12% of total consumption (Table-4:3), respectively. Rest of the Urea is imported by BCIC. The TSP, DAP & MoP fertilizers are usually being imported by the Bangladesh Agricultural Development Corporation (BADC) and the private sector importers (PSIs). The import requirement of fertilizers has been increasing over time with a declining trend in domestic production.

Table 4:3:Domestic fertilizer production and consumption (2005-06 to 2011-12)

Year	Production in lac MT							
	Urea		TSP		DAP		Total	
	Production	% Consumed from production	Production	% Consumed from production	Production	% Consumed from production	Production	% Consumed from production
2005-06	17.30	70.60	0.56	12.94	0.00	0.01	17.87	58.93
2006-07	18.17	72.25	0.50	14.82	0.80	69.74	19.48	65.58
2007-08	14.75	53.40	0.47	12.02	0.80	61.78	16.02	48.79
2008-09	12.80	50.56	0.24	15.45	0.29	160.00	13.33	49.27
2009-10	10.59	43.94	0.77	18.24	0.33	23.90	11.68	39.38
2010-11	9.09	34.27	0.63	11.24	0.40	12.95	10.12	28.73
2011-12	9.34	41.00	0.65	10.00	0.48	12.00	10.47	31.00

Source: BADC and BCIC

All fertilizers requirements of the country such as Urea, TSP, DAP, and MoP etc are met through domestic production and import. Different key actors are involved in the process of production, import and distribution. They include BCIC, BADC and PSIs. In addition, there are private traders, dealers and sub-dealers involved in the supply chain. BADC and private sector importers (PSIs) import the required quantity of TSP, DAP and MoP from different countries and sources depending on MoA's allotment and permission.

4.4. Fertilizes use in rice production

Rice is the staple food for the people of Bangladesh and will continue to remain so in future. Variations in management practices (irrigation and fertilizer application, crop management practices etc), use of new high yielding varieties (HYV) and modern technologies play vital role for increasing rice production of this country.

Considering total cereal production (32.896 million ton), rice occupies about 95.20 percent (31.32 million tons) and other cereal crops only 4.80 percent (Bangladesh Economic Review, 2010 update). Zaman (1987) reported that 75 percent of total fertilizers are consumed for rice production and the rest of 25 percent for other crops.

Urea, TSP and MP are chemical fertilizers most commonly applied by rice farmers. The amounts of recommended and actual dose of fertilizers for rice production in Bangladesh are given in Table 4.10. Urea (nitrogen) is a major component of proteins, hormones, chlorophyll, vitamins and enzymes, essential for rice. Rice plants require a large amount of nitrogen at the early and mid-tillering stage to maximize the number of panicles (Datta, 1981). The recommended doses of other nutrients are also necessary for potential rice yield. Eliminate any one of these elements, and plants will display abnormalities of growth, deficiency symptoms, or may not reproduce normally.

Table 4:4: Use of fertilizers for Rice production in Bangladesh

Name of Crop (HYV)	Recommended dose (kg/ha)			Actual dose (kg/ha)			Use gap (%)		
	Urea	TSP	MP	Urea	TSP	MP	Urea	TSP	MP
T. Aus	141	101	69	135	28	17	4	72	75
T. Aman	166	101	69	135	30	24	19	70	65
Boro	269	131	121	192	47	37	29	64	69

It is evident from the Table 4.4 that actual use of all the different fertilizers for rice production are below the recommended dose. The gap between the actual and recommended dose would be also true for other crops. The gap is also significant for both TSP and MP fertilizers in Bangladesh. Non availability of fertilizers (availability of both fertilizers are fully depended on import process) and costs have lead to lower use of fertilizers against the recommended dose. But continuing rice production in a sustainable way, one of the important inputs required is the supply of balanced fertilizers consisting of N-P-K. Besides, it is also necessary for keeping soil fertility for a long period. Moreover, balanced fertilizers application is also essential for achieving higher level yield. Thus, there appears to be a large potential for raising fertilizer consumption through adoption of the recommend fertilizer practices by farmers.

4.5. Irrigation

4.5.1. Growth of irrigation in Bangladesh

Bangladesh is a lower riparian country in the flood plains of three great rivers—the Ganges, the Brahmaputra, and the Meghna—and their tributaries and distributaries. Fifty-three rivers drain 1.72 million square kilometers in Bangladesh, Bhutan, China, India, and Nepal. Only 8 percent of the catchment area is in Bangladesh. The country has about 25,000 kilometers of waterway stretching across 4.3 million hectares (MoL 2001), or almost 40 percent of the country's net cultivated area. This also includes wetlands and permanent water bodies that has a major impact on agricultural production and bio-diversity conservation in the country.
Rice (paddy) is the largest irrigation user with about 86% of the total irrigated area. In Bangladesh, irrigation is accomplished by: i) Major irrigation schemes using canal/gravity irrigation by surface water, ii) Minor irrigation schemes using groundwater by Deep Tube-wells (DTWs), Shallow Tube-wells (STWs), Force Mode Tube-wells (FMTWs) and also surface water using Low-Lift Pumps (LLPs). Irrigation is considered as necessary precondition to enhancing agricultural production of Bangladesh.

In this country the earliest approach to irrigation facilities was through constructing large scale multipurpose irrigation, flood control and drainage (FCD) projects during 1960 – 1970. Expansion of minor irrigation through groundwater using DTWs and STWs was the vital component of the GoB's strategy to facilitate irrigation for agricultural development. STWs under private ownership played significant role for irrigation development during 1980s and there had been recorded sharp increase in number of these equipment During Third Five Year Plan (1985-90) continued emphasis on irrigation facilities tremendously increased groundwater irrigation through the use of DTWs, STWs and manually operated HTWs.

The agricultural growth in the country has been largely due to expansion of minor irrigation through the use of DTWs, STWs and LLPs. The trend of irrigation growth in Bangladesh from 1982 to 2011 is shown below in Figure 4:3.

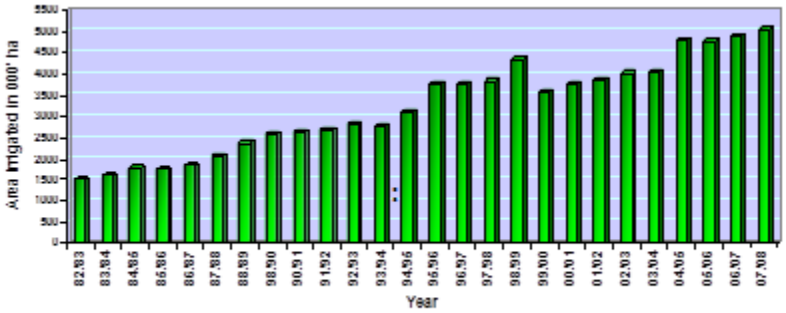


Figure 4:3: Trend in irrigation growth in Bangladesh

4.5.2. Demand for irrigation water

Rice occupies nearly 80% of the gross cropped area (GCA) and gross irrigated area (GIA), and accounted for 93% and 77% of the total increases in Gross Cropped Area (GCA) and GIA, respectively, between 1990 and 2010. Therefore, this analysis only projects the supply of rice and water demand (Upali *et al*, 2014). Among the rice crops:

- *Aus* rice area decreased rapidly and is only 9% of the GCA now;
- *Aman* rice area accounts for the largest portion of GCA (40% in 2010); and
- *Boro* rice expanded rapidly, mainly at the expense of *Aus* rice.

ARIMA models predict the following:

- A further decline in the *Aus* rice area (to 0.7 Mha by 2020 and 0.2 Mha by 2030).
- No significant changes in the *Aman* rice area. It is likely to stabilize between 5.7 to 6.1 Mha

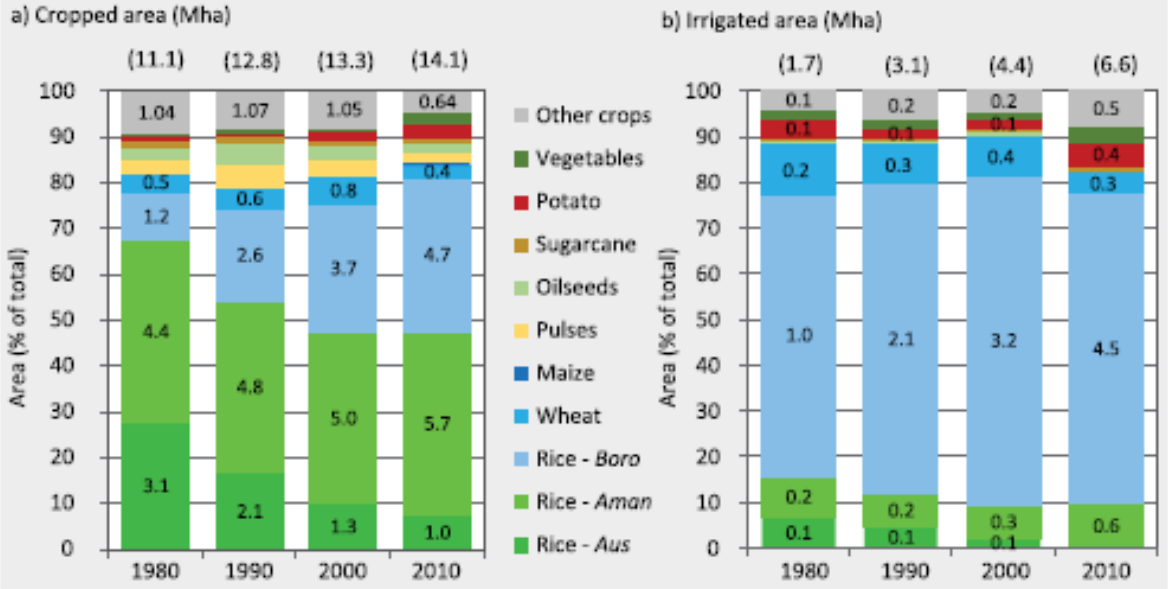


Figure 4:4: a. Cropped area (million ha) and b. irrigated area (million ha)

There will be a further increase in the *Boro* rice area (to 5.7 Mha by 2020 and another 1 Mha by 2030). The predicted increase in the *Boro* rice area will be significantly more than the decline in the *Aus* rice area (Figure 4.4 a). According to the ARIMA forecasts, the total rice area will increase to 12.5 Mha by 2030; an additional 1.1 Mha from the present level and the *Boro* rice area (6.7 Mha) will contribute to almost all of this expansion.

Realistically, the increase in *Boro* rice will not be possible due to the increasing population, urbanization and land constraints. The Bangladesh Rice Research Institute (BRRI) projected that the total rice area will reduce to about 10.3 Mha by 2020 (BRRI 2013). The study carried out by the International Food Policy Research Institute (IFPRI) (Ganesh-Kumar et al. 2012) assumes that the *Boro* rice area can increase up to 6.5 Mha and the total rice area up to 12.6 Mha. While the extent of the projected expansion varies, all studies confirm that the main path to increasing rice production in the future is mainly through yield increases.

The ARIMA models predict:

- Yield of *Aus* rice to increase 2.0% annually between 2010 and 2020; 1.2% annually in the 2020s; and to reach 2.4 t/ha by 2030.
- Yield of *Aman* rice to increase 1.8% and 1.1% annually in the next two decades, respectively, and to reach 2.8 t/ha by 2030;

and

- Yield of *Boro* rice to increase 1.2% and 1.0% annually in the next two decades, respectively, and to reach 4.8 t/ha by 2030. The projections of rice yield above assume that factors that contributed to growth in the past, such as advances in technology and high-yielding rice varieties, will continue to be developed and contribute to yield increases.

This analysis assesses future agricultural water demand under two scenarios of increases in WP: (i) area expansion and surplus rice production and (ii) self-sufficiency in rice production, improving water productivity with no area expansion. Rice production accounted for 93% of the total CWU and 90% of the total irrigation CWU.

The irrigation CWU of rice production, which was 11.8 Bm3 in 2000, has increased by 40% to 16.5 Bm3 in 2010; the latter is estimated using the irrigation CWU per hectare of 265 mm in 2000. This analysis estimates irrigation CWU demand to 2020 and 2030 under two different scenarios:

Scenario 1: Area expansion and surplus rice production: This scenario assumes that the area and yield of rice will increase as projected in the section, *Methodology and Data*. This means that the irrigated area will increase only in *Boro* rice: from 4.5 Mha in 2010 to 5.7 Mha in 2020 and 6.7 Mha in 2030. The irrigation CWU demand for rice will be 20.9 Bm3 and 24.5 Bm3 in 2020 and 2030, which are 27% and 48% increases from the 2010 level, respectively.

Scenario 2: Self - sufficiency in rice production, improving water productivity with no area expansion: According to this scenario, rice production will have to be 37.2 MMt by 2020 and 40.3 MMt by 2030, respectively, these estimates are 5% more than the projected consumption demand; and the additional 5% replenishes stocks. The assumption of self-sufficiency requires 3 MMt less production than in the "Business as Usual" scenario. This scenario analyzes irrigation CWU under different WP growth scenarios of 0%, 5% and 10%. These are potentially feasible, since increases in WP are possible in both *Boro* and *Aman* rice. If the saving in production that is made from self-sufficiency is from *Boro* rice then the following will be true:

- Even with no growth in WP, irrigation CWU demand will decrease by 2.6 Bm3 and 6.1 Bm3 by 2020 and 2030, respectively, from the estimates in scenario 1, due to lower production requirement;
- With 5% growth in WP, irrigation CWU demand will decrease by 2.7 Bm3 and 6.4 Bm by 2020 and 2030, respectively; and
- With 10% growth in WP, irrigation CWU demand will decrease by 2.9 Bm3 and 6.8 Bm 3 , respectively.

Importantly, the reduced irrigation CWU of rice in scenario 2 can meet most of the irrigation demand of other crops. The other three major irrigated crops are wheat, vegetables and potatoes: (a) the additional demand for these crops would be 0.7 MMt, 11.1 MMt and 4.0 MMt, respectively; (b) the water productivity of these crops is 1.29 kg/m3, 1.96 kg/m3 and 3.98 kg/m2, respectively; and (c) the additional CWU demand (crop demand/water productivity) of these crops is 0.5 Bm3, 1.5 Bm3 and 5.7 Bm3, respectively. Since irrigation contributes to 19%, 74% and 62% of the total CWU, the total additional irrigation CWU of these three crops is 4.9 Bm3, which is less than the reduction in CWU of rice in scenario 2. Indeed, demand management taking into consideration food demand and production can substantially reduce the irrigation demand. However, there are still water supply constraints that need to be addressed.

Groundwater is the source for more than 75% of the irrigated area (BBS 2011). Thus, groundwater would have contributed to about 13 Bm3 of irrigation CWU in 2010. A large part of this CWU is from natural recharge, and the balance is from return flows of surface water irrigation. If the current share of groundwater irrigation was to

continue, this would require at least 14-16 Bm3 by 2020 and 14-19 Bm3 by 2030. Besides this, domestic and industrial water demand will also increase. Therefore, a pertinent question is whether there are adequate renewable groundwater resources to meet the increasing demand.

Given the falling groundwater tables and water quality issues in Bangladesh, it will be extremely difficult to exploit groundwater resources sustainably under scenario 1. Without an increase in WP, it will be difficult to meet even the reduced demand under scenario 2. A few districts have already passed the sustainable thresholds of groundwater use Khulna in the Khulna region, Bogra and Pabna in the Rajshahi region, Barisal, Chittagong, Kishoreganj, Kushtia and Rajshah where irrigation CWU exceeds the usable groundwater recharge.

Table 4:5: Irrigation CWU demand under different scenarios of WP growth

Time	Season	Area (Mha)		CWU (Bm^3)		Total production	Water productivity	Savings of irrigation CWU (Bm^3) by only meeting the rice demand[1]		
		Total	Irrigated	Total	Irrigation	(MMt)	(Kg/m^3)	WP growth scenarios[2] 0%	5%	10%
2010	*Aus*	1.1	0.0	4.8	0.0	1.9	0.40	-	-	-
	Aman	5.6	0.6	30.7	0.0	12.5	0.41	-	-	-
	Boro	4.7	4.5	27.5	16.5	18.3	0.67	-	-	-
	Total	11.4	5.1	63.0	16.5	32.8	0.52	-	-	-
2020	*Aus*	0.7	0.0	3.2	0.0	1.5	0.47	-	-	-
	Aman	5.7	0.0	30.8	0.0	14.1	0.46	-	-	-
	Boro	5.7	5.7	33.9	20.9	24.6	0.73	2.60	2.74	2.89
	Total	12.1	5.7	67.9	20.9	40.2	0.59	-	-	-
2030	*Aus*	0.2	0.0	1.1	0.0	0.6	0.53	-	-	-
	Aman	5.7	0.0	30.8	0.0	15.9	0.52	-	-	-
	Boro	6.7	6.7	39.9	24.5	32.1	0.81	6.08	6.40	6.76
	Total	12.6	6.7	71.7	24.5	48.6	0.68	-	-	-

Sources: The area and total production data for 2010 are from the Bangladesh Bureau of Statistics; Water productivity and CWU for 2010, and projections for 2020 and 2030 are authors' estimates.

Notes: [1] Rice demand in 2010, 2020 and 2030 are 30.2 MMt, 37.2 MMt and 40.3 MMt, respectively.

[2] WP growth scenarios are only assumed for *Boro* rice.

4.6. Supply and demand for seeds

National seed system is mixed with three intercepting circles representing the main components (Figure-4.5). This diagram provides a conceptual overview of national system so that the relationship of the various sectors can be better understood. National Seed Systems vary greatly between countries. Some countries have quite strong national seed systems with well developed agricultural research, national seed services and private sector seed companies. Others countries have quite weak national seed systems with the community based seed system providing most of the seed used by farmers. In Bangladesh the National Agricultural Research (NARS) Institutes), Agricultural Universities, International Research Institutes and some private seed companies act as the source of modern varieties. The formal seed system (commercially oriented seed supply) involves both public and private sector seed enterprises, producing foundation and certified seeds. In the informal system the farmers produce, save and exchange seeds.

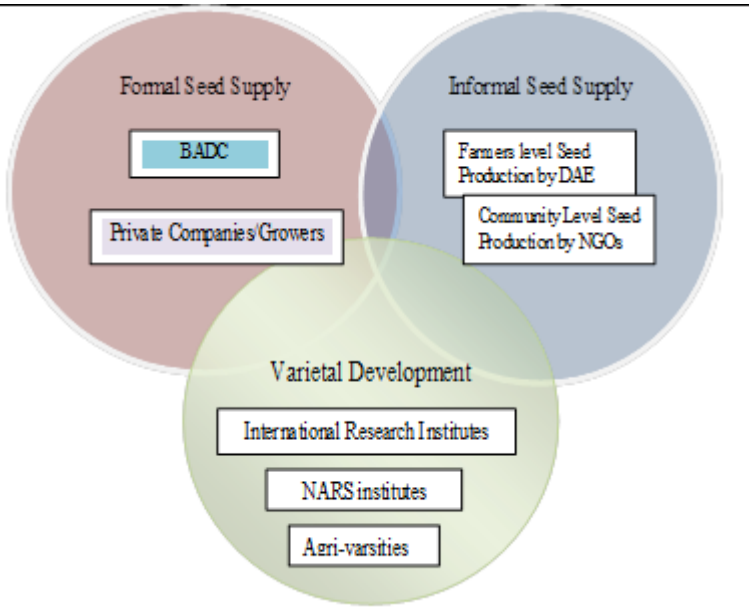


Figure 4:5: National seed system in Bangladesh

The first formal and organized seed system was introduced in Bangladesh with the establishment of the public sector agricultural inputs supply and service providing organization-the then East Pakistan Agricultural Development Corporation (EPADC) in 1961-62, later it was renamed as Bangladesh Agricultural Development Corporation (BADC) after the independence of Bangladesh in 1971. The BADC started its journey with the production of a meager quantity of 13.8 tons of quality seeds. During 2011-12 it has increased its capacity to the extent that it could supplied a large quantity of 1,44,200 tons of quality seeds of HYVs/MVs/Hybrids of four notified crops (rice, wheat, jute, and seed potato), and eight non-notified crops (maize, barley, kaon, cheena, pulses, oilseeds, spices, and vegetable seeds) .

In Bangladesh the national requirement of quality seeds of all crops is estimated to be 9,32,250 metric tons (Seed Wing, Ministry of Agriculture 2005-06). Against this national requirement, the supply of quality seeds was 1,86,450 metric tons (Seed Wing, Ministry of Agriculture 2011-12). Seed system through quality seed replacement rate (SRR) against national requirement up to 2011-12 was 20 percent of which an about 80 percent seed is being fulfilled through the informal seed system of farmers' own saved seeds.

During 2011-2012, the seed replacement rate (SRR) of the quality rice seed of HYVs/MVs/Hybrids has increased to about 43 percent from 25% in 2005-2006,.The contribution of BADC alone is significant i.e 39% against 10 percent in 2005-2006. This has made large achievement on country's rice production to over 33.5 million tons in 2010-2011, and 33.9 million tons in 2011-12.

5. Technology generation and productivity of agriculture

5.1. Technology generation

The government of Bangladesh has given priority to the agricultural sector to boost agricultural production. Increasing the speed of and sustaining agricultural growth are priorities for increasing food production and reducing poverty. The future challenge of increasing food production could be met through the introduction of modern biotechnology and an increase in investment in agricultural technology generation and transfer. Table 5.1 presents information on technology generation and innovations in Bangladesh agriculture during 2004-14 and Table 5.2 presents information on number of cultivars registered for notified crops, 2000–14.

Varietal improvement and improvement of production practices are high priority of NARS research for rice, wheat, sugarcane, oil seeds, pulses, vegetables, fruits, fisheries and livestock. Also improvement of water resource for agricultural use, post-harvest management, farm mechanization high priority of NARS research. NARS of Bangladesh has 12 ARIs, which are coordinated by BARC under MoA. The ARIs are mainly involved in doing agricultural research on crops, fisheries, livestock, and forestry. Technologies developed by the NARS institutes are disseminated to the farmers through the extension department and NGOs. In meeting the demand for higher food production, thrust should be given to frontier research including genetic engineering, reduction of cultivation costs, strengthening of the technology-transfer linkage, and improvement of postharvest technology.

Table 5:1: Technology generation and innovations in Bangladesh agriculture during 2004-14

Product type	**Examples of innovations**
Inputs	
Seed	Rice cultivars, hybrid rice, hybrid maize, Cultivars for potatoes, vegetables, and other crops
Fertilizer	Biofertilizer from coconut dust, earthworm compost, and green manure
Pesticide	Pheromones, parasitoids, and phostoxin
Machinery	Corn shellers, rippers, threshers, straw-bundle cutting machines, and seeders
Large-scale production	
Crop-based	Cultivars for gladiolas, strawberries, longum, grapes, guava, jujube, and durian
Processing	
Crop-based	Rubber rollers, color sorters, and graders for rice processing; and solvent extraction for oil seeds and rice bran

Table 5:2: Number of cultivars registered for notified crops, 2000–14

Species, type of seed	Cultivars submitted by private companies or NGOs	Cultivars submitted by public agencies	Total
Rice			
Hybrid	76	5	81
Variety	0	13	13
Wheat	0	6	6
Maize	44	8	52
Jute	0	3	3
Potatoes	0	11	11
Sugarcane	0	8	8

For all non-notified crops, such as maize and vegetables, private companies have introduced hundreds of cultivars, but there is no centralized record of what has been introduced. For example, the Seed Certification Agency registered 52 maize cultivars during 2000–08, of which private organizations submitted 44.

5.2. Cropping intensity

The average cropping intensity in Bangladesh is over 190% (BBS 2008b) and approaching to 200%. Cropping intensity in Bangladesh is limited by several factors. The primary factor is the flooding season, when land is constrained from cropping due to inundation. However, the duration of the rice season emerges as the primary malleable factor in increasing cropping intensity. A significant portion of the land cultivated under rice stands fallow later in the dry season, with possibilities for non-rice cultivation given access to minor irrigation. No quantitative data seems to exist for the production limits through increased cropping intensity; this would be a complex exercise that would need to take account of local conditions. A study by Chowdhury *et al.* (1994) stated that cropping intensity has increased over the last fifty years by 60 percent. Between the mid-1970s and mid-1990s cropping intensity increased by 20 percent. Investment in irrigation appears to be the most important cause of increasing intensity of cropping with diversified high value crops. However, the influence of declining holding sizes with many short duration crops is also important in increasing cropping intensity. Continuous cultivation of flood free lands has deteriorated the land productivity. Appropriate crop rotation with legumes or deep rotted crop with fellow period may help to improve the soil health. Improvement of crop husbandry with proper extension program may improve the soil fertility situation.

5.3. Present status of rice production and its potentiality

Rice is the staple food of about 156 million people of Bangladesh. It provides nearly 48% of rural employment, about two-third of total calorie supply and about one-half of the total protein intakes of an average person in the country. Rice sector contributes one-half of the agricultural GDP and one-sixth of the national income in Bangladesh. Almost all of the 13 million farm families of the country grow rice. Rice is grown on about 10.5 million hectares which has remained almost stable over the past three decades. About 75% of the total cropped

area and over 80% of the total irrigated area is planted to rice. Thus, rice plays a vital role in the livelihood of the people of Bangladesh.

Total rice production in Bangladesh was about 10.59 million tons in the year 1971 when the country's population was only about 70.88 millions. However, the country is now producing about 35.0 million tons to feed her 156 million people. This indicates that the growth of rice production was much faster than the growth of population. This increased rice production has been possible largely due to the adoption of modern rice varieties on around 66% of the rice land which contributes to about 73% of the country's total rice production. However, there is no reason to be complacent. The population of Bangladesh is still growing by two million every year and may increase by another 30 million over the next 20 years. Thus, Bangladesh will require about 27.26 million tons of rice for the year 2020. During this time total rice area will also shrink to 10.28 million hectares. Rice yield therefore, needs to be increased from the present 2.74 to 3.74 t/ha.

5.3.1. Rice productivity

Rice is grown in all over Bangladesh. Figure 5.1 presents top 10 rice producing districts in terms of highest contribution to country's total rice production. In this regard Comilla stood first followed by Patuakhali and Bhola.

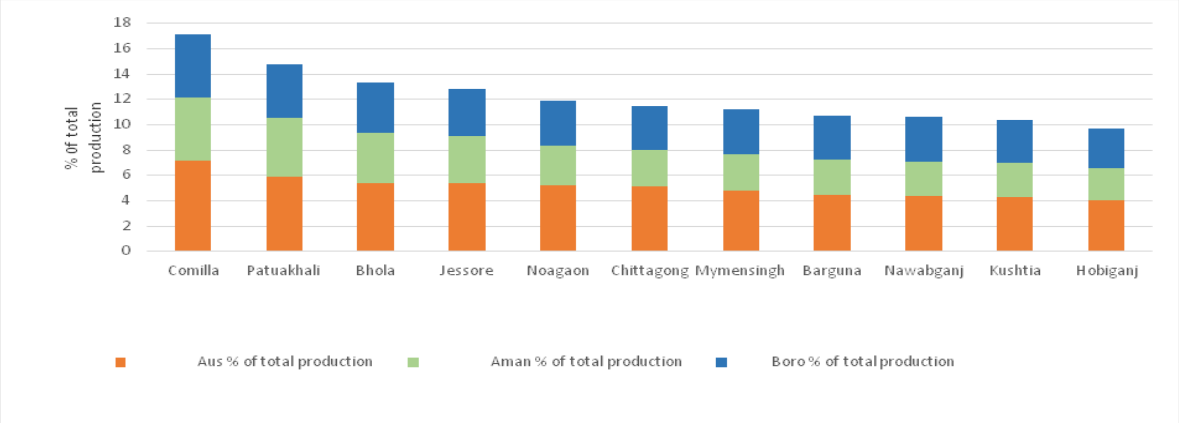


Figure 5:1: Top eleven rice producing districts of Bangladesh

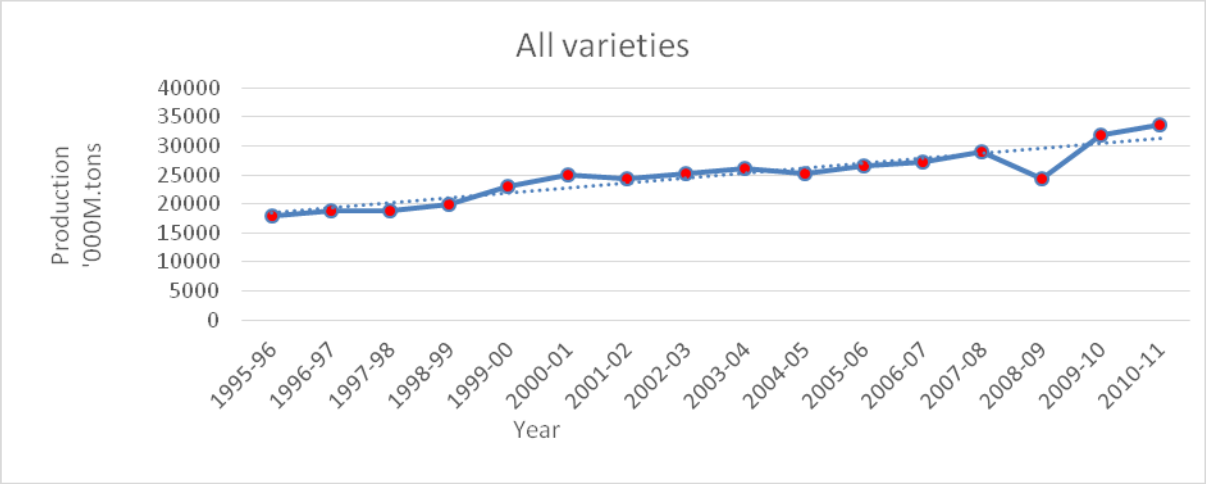


Figure 5:2: Trends of rice production during 1995-2011

Figure 5.2 illustrates the trends of rice production over the past three and a half decades. Over the last 30 years, Bangladesh has experienced a "green" revolution' in rice production, with a tripling of production from approximately 10 million metric tonns (hereafter tons) in the mid-1970s to almost 30 million tons in 2010/11. It was largely based on the cultivation of high-yielding varieties (HYVs) under irrigation with use of chemical fertilizers This 'Green Revolution' has enabled Bangladesh to increase food availability to meet the demands of a rapidly growing population. Fig 5.3 presents trends in rice production in Bangladesh by season. It is found that during 1970-2010 growth in Aus rice production was almost stagnant while both Boro and Aman Rice production had increasing trends. The main rice producing season is Boro and Aman (Figure 5.3)

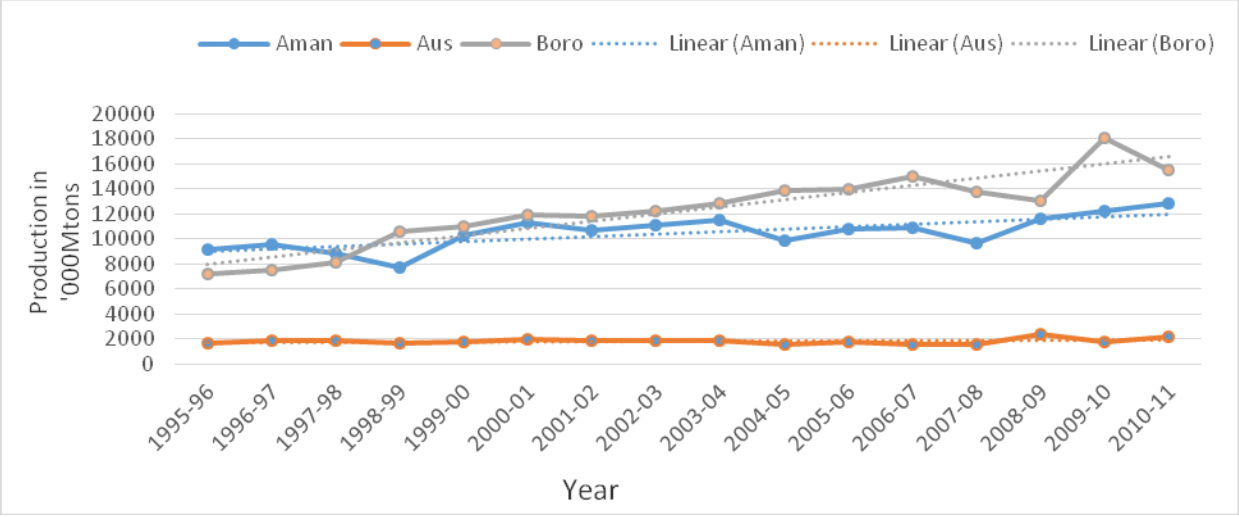


Figure 5:3: Trends of rice production by variety during 1995-2011

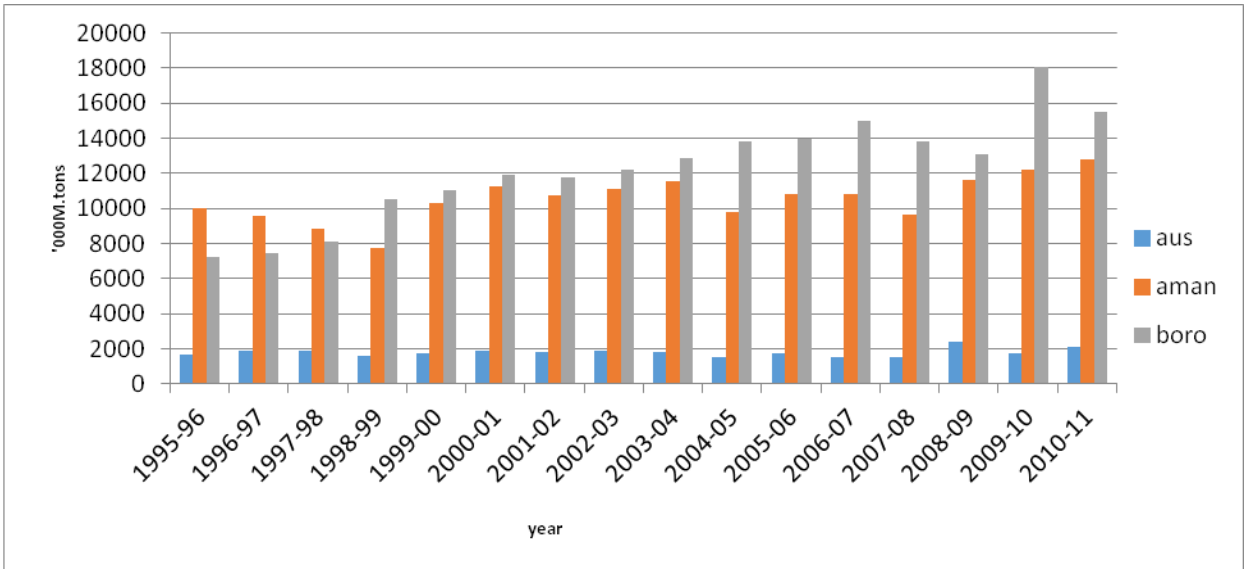


Figure 5:4: Production of rice by season

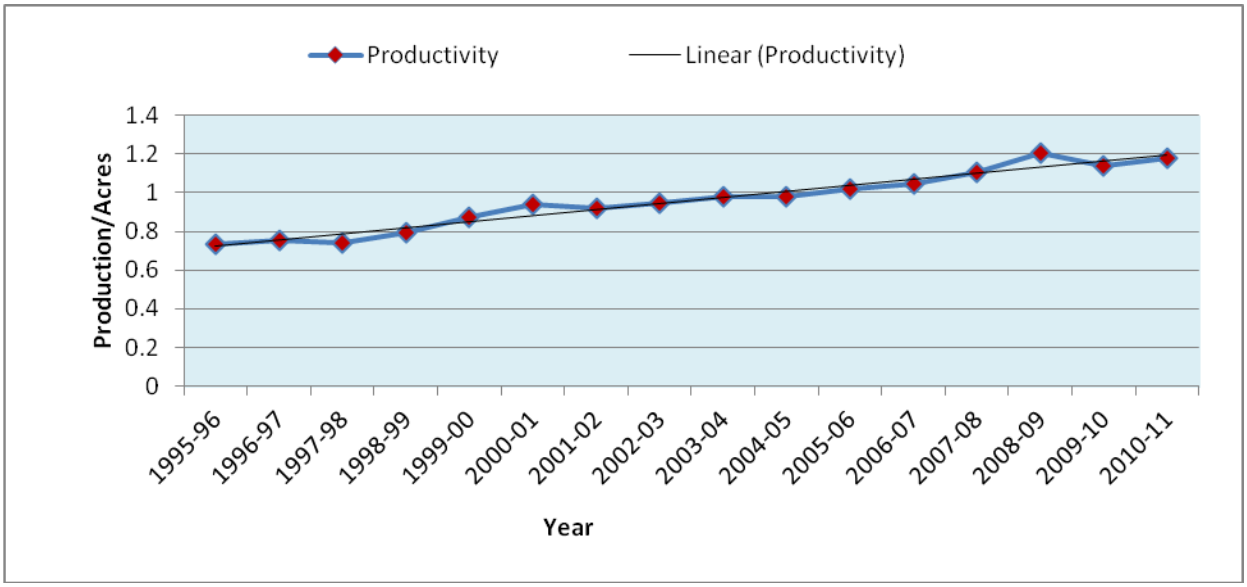


Figure 5:5: Productivity of all varieties of rice

5.3.2. The potentiality of new rice varieties in Bangladesh

Since 1973, BRRI in partnership with IRRI has been engaged in adaptive research for evaluating elite lines under the IRRI managed International Network for Genetic Evaluation of Rice (INGER) and released varieties that suited Bangladesh agro-ecological conditions under the brand name BR and later Brridhan. Many of the elite lines that came to Bangladesh were suited for the boro and aus seasons. The most popular of them are BR1, BR3, BR14, BR14, and more recently BRRI dhan 28 and BRRI dhan 29. Yield gap between the potential farm yield in BRRI farm and Actual farm yield of different modern rice varieties are shown in Table 5.3.

Table 5:3: Maximum Possible Rice output considering new modern rice varieties in 20011-12 in Bangladesh

Season	No. of Rice Varieties	On-station Potential Farm Yield (t/ha)	BRRI on-farm Yield (t/ha)	Yield Gap (t/ha)
T. Aman	22 BRRI rice varieties	5.03	3.45	1.58
Boro	16 BRRI rice varieties	5.59	4.35	1.24
Aus	Average 15 BRRI rice varieties	5.1	3.51	1.59
Average of all variety		5.22	3.74	1.48

Data source: Household survey of BRRI in 9 regions of Bangladesh, Annual report of BRRI 2010-11 and 2011-12.

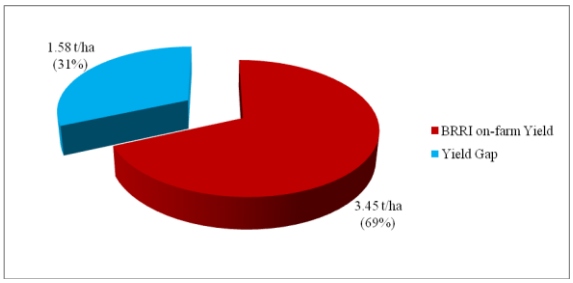


Figure 5:6: Yield Gap of Modern T. Aman Rice

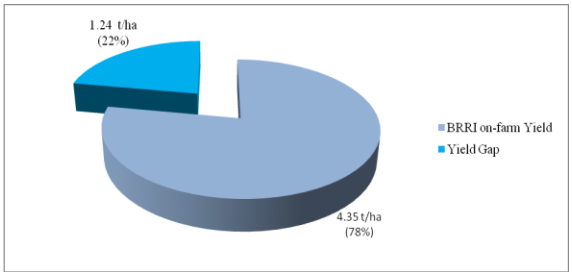


Figure 5:7: Yield Gap of modern Boro Rice in 2010-11

in 2010-11

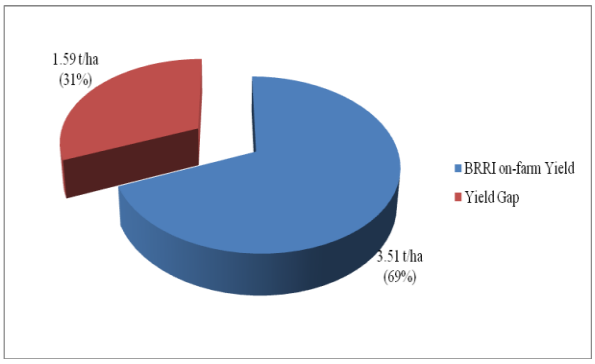


Figure 5:8: Yield Gap of Modern Aus Rice in 2010-11

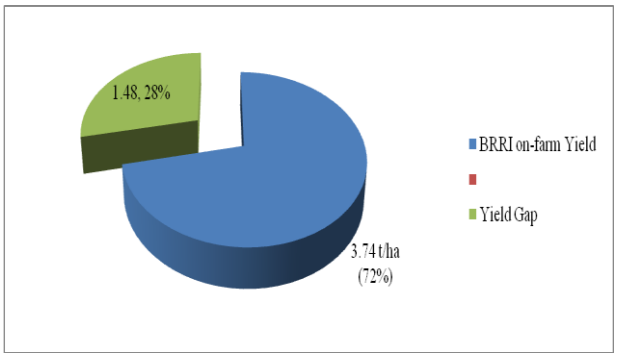


Figure 5:9: Yield Gap of all Modern Rice Varieties in 2010-11

5.3.3. Potentials of enhancing rice productions

For increasing rice production in the country following interventions could be considered:

- Bridging the yield gap
- Scaling up of good farmer's management practices (GFMP) under favourable Agro-Ecological Zones (AEZ)
- Greater thrust of agricultural intensification in the southern and Sylhet regions.
- Replacement of local varieties by modern varieties in T. aman season where possible.

- Limited increase in modern variety Boro area.
- Replacement of the present varieties by superior inbred, hybrid and super high yielding varieties.
- Increment of irrigation areas in both Boro and T. Aman season.
- Application of superior management technologies.
- The use of quality seeds.
- Mechanization of rice cultivation particularly minimization of post-harvest losses.

Bridging the yield gap

Since 1973, BRRI in partnership with IRRI has been engaged in adaptive research for evaluating elite lines under the IRRI managed International Network for Genetic Evaluation of Rice (INGER) and released varieties that suited Bangladesh agro-ecological conditions under the brand name BR and later Brridhan. Many of the elite lines that came to Bangladesh were suited for the boro and aus seasons. The most popular of them are BR1, BR3, BR14, BR14, and more recently BRRI dhan 28 and BRRI dhan 29, BRRI dhan 58.

We have used 4 data sets for analysis of yield gaps of modern rice varieties. We have analyzed yield gaps by growing seasons- Aus, Aman and Boro. We have used one data set of BRRI based on a field survey during 2006-7 and another data set based on a survey in 2010-11. We have used also BBS and DAE data sets.
Yield gaps between the potential yield in BRRI Research Station farm and Actual farmers' yield of different modern rice varieties by season are presented in Table 3.1 and also in figures 3.5 to 3.8. Less yield gap was observed for Modern Boro rice. Comparing results of different data sets it was found that BRRI survey results indicated less yield gaps compared to BBS and DAE results. According to BRRI results of 2006-7 yield gap ranged 18-26%. This means that the farmers' actual yield is 18-26%. lower than the potentially attainable yield. While BRRI results of 2010-11 showed that yield gaps ranged 22 to 32% and with an average of 20%. But if we compare yield gaps estimated using farmer's actual yield from BBS survey and BRRI's technically attainable yields than the yield gap is much higher (30-62%). Results of Karim (2009) based on DAE and BBS data also indicated that higher yield gaps exist (Table 3.1).

Causes of yield gaps: Some of the persisting problems of increasing crop production, particularly cereal production using the available HYVs are decreasing soil productivity, inefficient water and fertilizer use, inadequate supply of quality seeds, imbalanced use of fertilizer, low labour productivity, and higher input price. These factors are restricting realization of full yield potential of HYVs, resulting in lower yield of cereals in the farmers' field compared with much higher yield obtained in the research station. The major concern is how to reduce this yield gap by improving soil, water and labour productivity, optimizing fertilizer use and reducing input price. Declining land resources and competing demand for limited land is a major concern for future agriculture. New technological breakthrough, appropriate development interventions and a robust land use policy will be needed to address the problems.

Agricultural land in Bangladesh is shrinking fast. The option left for increasing productivity is through minimizing yield gap. The average yield of rice was taken from BBS data base and the attainable yield by the farmers was computed from a large number of research and demonstrations, on farm trials and farming system sites, farmers participatory and pilot demonstration (Table 5.4). Only attainable but sustainable yield is considered as the maximum yield ceiling by farmers

Table 5:4: Attainable yield of rice and yield of good Farmers' management practices (GFMP)

Rice	Average Yield (ton/ha)		
	National	Attainable	GFMP
Aus Rice			
Local	1.14		
HYV	1.96	3	2.5
Aman Rice			
Broadcast	0.93		
Local	1.24		
HYV	2.27	4	3.65
Boro Rice			
Local	1.79		
HYV	3.9	5.5	4.5
Total			

It is considered that 30% and 60% of yield gap may be reduced by 2021. Table 2.7 provides the projected production of rice. There is some opportunity of increasing HYV coverage during the Aman season. This will add some increased production of HYV in Aus and Aman areas by replacing local varieties. It is reasonable to consider 20% and 15% increase, respectively in HYV of Aus and Aman seasons. It is enhanced production over the production by bridging the yield gap situation. There could be 37.6 million ton of rice production by the year 2021 from the existing rice area (Table 5.5).

Table 5:5: Projection of rice production in 2021 based on 60% and 30% yield gap minimization (YGM)

Rice	**Project of milled rice production 2007-2021 (000 mt)**			
	2020		**2021**	
	30% YGM	**60% YGM**	**30% YGM**	**60% YGM**
Aus Rice				
Local	408	408	408	408
HYV	1262	1425	1275	1450
Aman Rice				
Broadcast	287	287	287	287
Local	1660	1660	1660	1660
HYV	9359	10998	9485	11251
Boro Rice				
Local	226	226	226	226
HYV	19482	21479	19631	21783
Total	**32683**	**36483**	**32972**	**37064**

5.3.4. Productivity of other crops and agricultural diversification

It was found that production declined marginally for rice, but rose sharply for wheat and maize**.** In 2012/13, rice production declined (-0.2%) for the first time since 2005/06. Wheat and maize production grew sharply by 26%

and 14%, respectively, during the same period, mainly due to favourable weather condition and timely supply of seeds and fertilizers by GoB and private companies. Moreover, higher prices before planting encouraged farmers to bring more land under these crops. Potato production rose by 5%, compared to a 1.8% reduction in the previous year, with the increase in yield (1.6%) accounting for about one third to the observed growth. As a result, potato prices deepened at harvest time, causing protests by the growers, then the prices rose as a result of increasing export and stocking in cold storages (see Box 1). Pulse and oilseed production rose faster in 2012/13, respectively by 11% and 5%, compared to 5% and 3% in the previous year. Fruit production accelerated, but vegetables exhibited mixed trend over the same period: brinjal and pumpkin maintained the upward trend while beans and lal shak production declined. Table 5.6 depicts the production growth rates of selected crops pre- and post- PoA. Growth of rice, wheat, pulses, brinjal and edible oilseeds accelerated after the start of implementation of the PoA, which coincided with the post food price crisis period, while it decelerated for other crops. Wheat, pulses and brinjal production growth rebounded from declining trends. Agricultural diversification is becoming increasingly important to tackle the rising food trade deficit due to changing consumption habits and for further promoting the diversification of diets, especially in rural areas, where production and consumption patterns tend to be more closely linked. IFPRI studies show that agricultural diversification is positively correlated with household and child dietary diversification, and that it is promoted through access to irrigation, credit, input subsidy, extension services and women's empowerment. In turn, diversification toward higher value added on-farm activities, such as production of fruits, vegetables, legumes, fishery and livestock products can help accelerate agricultural income growth and poverty reduction, generate backward and forward linkages and promote growth of agro-based processing and marketing. A more diversified production requires a more diversified set of inputs, public and private services and infrastructures. A number of programmes have been undertaken to promote diversification through appropriate technologies. While these need to continue, greater emphasis is required to adapt public interventions and to promote the engagement of private actors, for example in providing diversified extension services for the different.

After the food price crisis crop diversification had been hampered by the increasing use of land to produce rice and other key staples such as wheat and oilseeds, whose areas – beside the one occupied by pulses-rebounded from their previous negative trends. Maize, spices, potato, and vegetables continued expanding, albeit at a slower pace in the same period. Sugarcane and fruit area declined. It is particularly noticeable that the rice area in total cropped area dropped year-on-year in 2012/13, giving space for the increase in share of all other crops, but jute and fruits.90 Indeed, it provides a first sign of a renewed focus on diversification. A similar trend is observed in terms of overall agricultural diversification, which seems to have improved, in the last fiscal year, as the share of rice on total agricultural value year-on-year fell by 0.8% with rising shares of fishery and livestock sectors by 0.7% and 0.2%, respectively, in 2012/13.

Crop sub-sector growth has been highly unstable varying from 5.23% in 2005-06 to 4.82% (estimated) in 2010-11(Bangladesh Economic Review, 2011). This shows that it is possible to enhance growth of crop agriculture with appropriate use of production inputs under favourable climatic conditions. On the other hand, growth instability in certain years indicates that crop agriculture is highly vulnerable to natural disasters and unpredictable climate behaviour. Growth of crop agriculture also depends on input availability, input quality and input-out price.

6. Analysis of current food security status

Food security exists when all people, at all times, have access to sufficient, safe and nutritious food to maintain healthy and productive lives. The key elements of food security are: a) availability of enough food from domestic production and/or imports to meet the demand, b) access of the food to all people at all times through enough incomes and affordable prices, c) proper hygiene and sanitary practices and safe water for utilisation of food to have optimum impact on health and nutrition, and d) a regulatory framework in place and its proper implementation for controlling contamination to ensure food safety.

Bangladesh has made good progress since 1992 in reducing income poverty based on the national poverty line. The country was able to lower the overall incidence of poverty from 58.8 percent in 1991-92 to about 48.9 percent in 2000, with an annual rate of decrease of 1.8% per year. It further declined to 40% in 2005 with a decreasing rate of 3.9% per annum (Fig. 6.1). In spite of the advancement, about 57.7 million people are poor with one-third caught in hard-core or extreme poverty. Bangladesh past efforts towards improving food security have resulted in a 5% point decrease in the proportion of undernourished between 1990-1992 and 2002-2004 down to 30%. However, mainly due to population growth, the number of undernourished actually increased from 39.3 million to 44 million (POA, 2008-15). The most recent estimates (Household Income Expenditure Survey– HIES, 2010) still 36.5% of the population has absolute poverty and are undernourished who fail to meet minimum level of caloric consumption needs of 2122 KCal/person/day and 17.6% of the total population are hard core poor who are unable to consume 1805 Kcal/person/day.

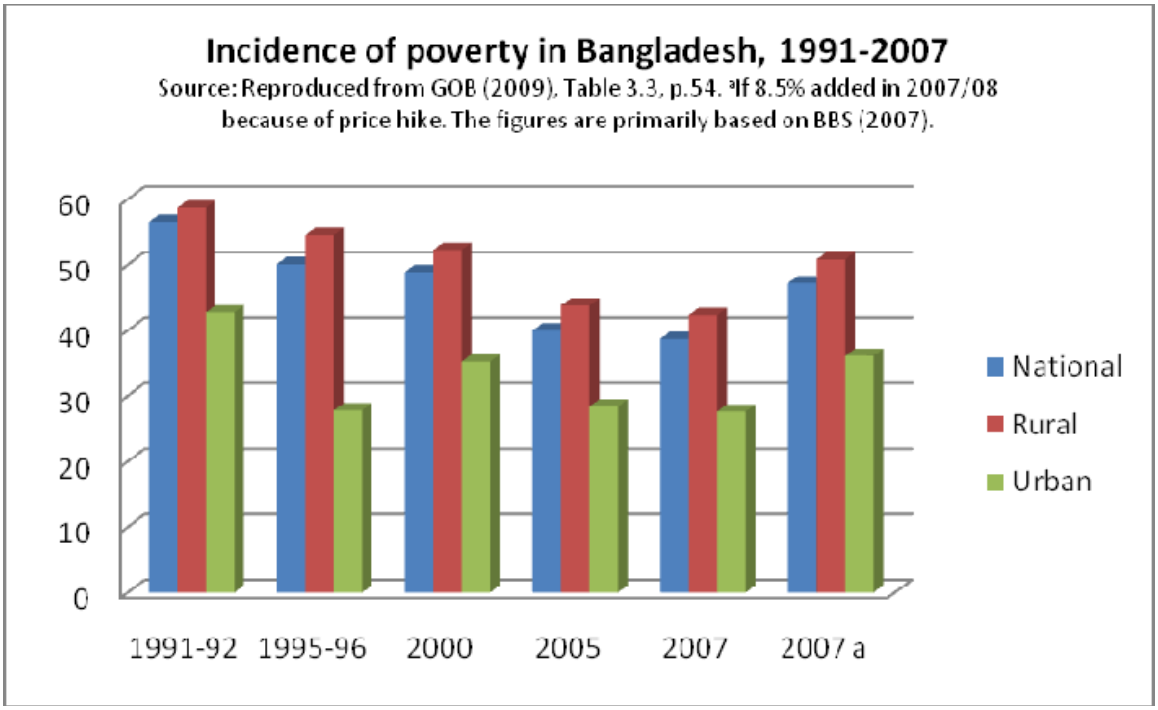


Figure 6:1: Incidence of poverty in Bangladesh

Food security worsens with inter-year shortfall in food grain production caused by climatic variations and natural disaster such as floods, tidal surge and insect and pest attacks. Variations in food intake also exist between regions of the country, between adults and children and between men and women at the household level.

6.1. Availability of food

In view of repeated experience of severe hunger and famine, food security in Bangladesh has long been synonymous with achieving self-sufficiency in rice, the dominant staple food. The Bangladesh economy has made remarkable progress in rice, tripling production from 11 million tonnes in 1971 to 33 million in 2012. In the fiscal year (FY) 1974-75, when the population of Bangladesh was only 79.9 million, the total rice production was 11.1 million tonnes and the cultivated rice area was 10.32 million hectare. The country produced 33.54 million tonnes for its 160 million people in FY 2010-11. Rice production increased by 2.91 times in 36 years, In 1971-72, the average rice yield was 1.05 tonnes per hectare, while in 2005-06 it was 2.52 tonnes.

The per capita rice production has increased substantially over the level at independence. The growth of production was achieved by fast adoption by farmers of higher yielding crop varieties developed by scientists, supported by rapid expansion of irrigation infrastructure through private investment in tube wells.

Rice production continues to increase, but wheat production is showing a declining trend in recent years. Wheat production decreased from 1.6 million tons in 2001-02 to 0.97 million tons in 2010-11. Similarly, pulses and oilseed production steadily declined mainly because of the loss of areas under these crops to Boro rice and other remunerative winter crops. Production of vegetables and fruits has increased, but at a slow pace from 1.59 million tons and 1.47 million tons in 2001-02 to 11.19 million tons and 3.56 million tons in 2010-11 respectively. Spectacular success has been achieved in the production of potato. It has made a quantum jump from 2.90 million tons in 2001-02 to 8.30 million tons in 2010-1 (Table 6.1). Production of non-cereals such as pulses, oilseeds, vegetables and fruits, which are the chief sources of protein, mineral and vitamin, still remains far below the actual requirements, making it difficult to provide balanced diet for all. The production of oilseeds has picked up in recent years due to favourable prices, some progress in the development of higher yielding varieties, and identification of favourable agro-ecological niche. The dependence of Bangladesh on the world market for the availability of pulses, edible oil and sugar and milk has been growing, along with wheat.

Table 6:1 : Domestic production (gross) trend of food grains, potato, pulses, oilseeds, vegetables and fruits (2001-02 to 2010-11) (Million MT)

Year	Food grain		Potato	Pulses	Oilseeds	Vegetables	Fruits
	Rice	Wheat					
2001-02	24.30	1.61	2.90	0.35	0.39	1.59	1.47
2010-11	33.54	0.97	8.30	0.72	0.84	11.19	3.56

Around 90 per cent of the rural population of Bangladesh is directly involved in agriculture and around 43.6 per cent of the total labour force is engaged in agricultural activities. For increasing food production and attaining food sufficiency a sustainable growth of the agricultural sector is required.

Bangladesh used to receive substantial amount of wheat, the secondary staple food as food aid from developed countries. Commercial import of wheat has however increased despite growth in domestic production till the 1990s, mainly due to the discontinuation of food aid and stagnation of domestic production after a rapid growth in the 1980s. The import has recently exceeded three million tonnes. It appears that even if Bangladesh achieves self-sufficiency in rice production or becomes a rice exporting country, the import of wheat will continue.

Bangladesh has rich biological resource base for fish production. In terms of nutrition, fish occupies a significant position in the dietary habits of the people. The growth in fish production was sluggish in the 1970s, it picked up in the 1980s, and was very rapid (7 percent per year) in recent years due to the expansion of pond aquaculture. Entrepreneurs have started converting low-lying lands into fish ponds and engaging in highly productive and profitable pond aquaculture. The prices of cultured fish such as tilapia, koi, and pangash have declined compared to other fish, and have been within the reach of low income consumers.

Fish production increased from 1.89 million tons in 2001-02 to 2.89 million tons in 2010-11 (Table 6.2). Meat, milk and egg production has also increased significantly over the last ten years But the shortage is still present. Growth potential is high in livestock sub-sector. According to partial figures from the Bangladesh Economic Review, 2011 the livestock growth rate in 2010-11 was 3.54% and 5.44% for fisheries sub-sector. Bangladesh Economic Review 2011 also reports steady growth of livestock compared to crops, fisheries and forestry.

Table 6:2: Fish, meat, milk and egg production trend (1994-2005)

Year	Fish (Million MT)	Meat (Million MT)	Milk (Million MT)	Egg (Million piece)
2001-02	1.89	0.78	1.78	4424
2010-11	2.89	2.95	1.98	6078

Per capita availability

Per capita availability of cereals (rice and wheat) has been found to increase from 374 g/day in 1994-95 to 647 g/day in 2010-11 (Table 6.3). Sharp increase in per capita availability of potato and vegetables is seen in the last four years, while the per capita availability of pulses and oilseeds has remained stagnant or declined. Availability of meat, milk and egg has also increased as shown in Table 4. Per capita fish availability increased from 27 g in 1994-95 to 56 g in 2010-11.

Table 6:3: Production and availability of major food items (1994-2011)

Food Items	Production (million tons)			Availability (gm/capita/day)		
	1994-95	2004-05	2010-11	1994-95	2004-05	2010-11
Cereals	18.08	26.13	35.0	374	464	647
Potato	1.50	5.95	8.30	32	108	153
Pulses	0.53	0.31	0.72	11	10	13
Oilseed	0.48	0.56	0.84	10	10	15
Vegetable	1.21	6.50	11.19	21	108	207
Fruits	1.41	4.60	3.56	24	68	65

Fish	1.17	2.10	2.89	27	41	53
Meat	0.48	1.06	1.90	11	21	35
Milk	1.52	2.14	2.95	35	42	54.60
Egg (Million)	2400	5623	6078	19	41	41

6.2. Access to food

In a market economy, the access to food depends on four elements: a) production-based element that depends on ownership of land, b) trade-based entitlement that depends on market prices of food, c) labour-based entitlement that depends on the employment and wages, and d) transfer-based entitlement that includes gifts, remittances from relatives, and relief and subsidies obtained from the government. The ability of the household and the people to access food is the outcome of the complex operation and interactions of all these elements.

In Bangladesh, 70 percent of the people live in rural areas where agriculture is the major occupation. Almost 60 percent of the rural households are engaged in farming. The farming household can access their food from self-production and/or trading the surplus with other foods available in the local market. But the landownership is unequally distributed, and so is the access to food from self-production. Almost 30 percent of the households do not own any land and another 30 percent own only up to half an acre. Such tiny landownership is insufficient to meet the food needs of four to five-member households, whatever advanced technology the farmer use. A tenancy market is in operation, which provides access to land to landless and marginal landowners for farming. A large proportion of marginal farmers go the market to access food as their own production (after payment of rent and interest for loans) is inadequate to meet the household needs.

An analysis of the BIHS data (2011-12) has been carried out to estimate the percentages of households that could not afford to acquire 2,122 kcal/person/day and 1,805 kcal/person/day. The results are illustrated in Figure 6.2. In 2011–12, 36.8 percent of households in the FTF (Government's Feed the Future) zone and 35.3 percent of households in the rural national sample were food energy-deficient who could not afford an adequate diet. Furthermore, 17.5 percent of the households in the FTF zone and 16.5 percent of the households in entire rural Bangladesh were below the lower food energy threshold of 1,805 kcal/person/day and, therefore, remained severely food energy-deficient.

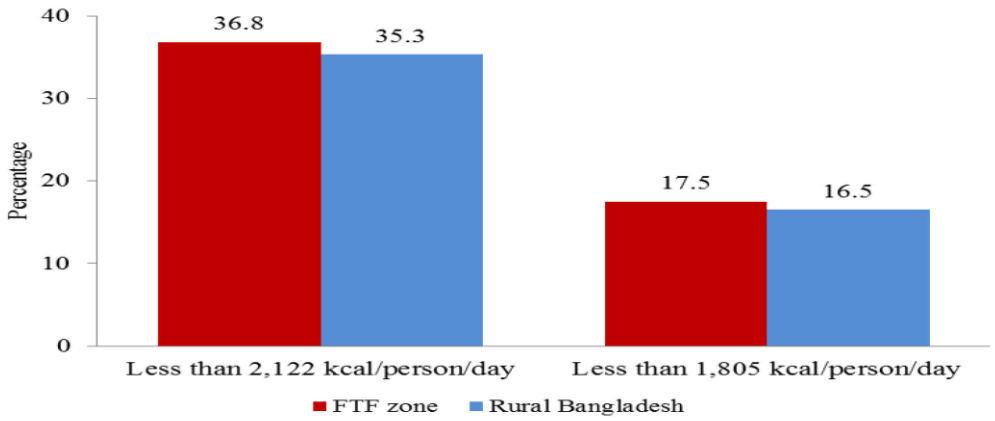


Figure 6:2: Percentage of households below food energy thresholds

The dominant determinant of access to food is obviously the level and the growth of income. In Bangladesh, the per capita income remained almost stagnant till the end of 1980s due to slow growth of GNP and high population growth. The income growth per year has accelerated since 1990, reaching 6.5 percent in recent years. Bangladesh has also achieved remarkable progress in population control. But, the income is highly unequally distributed and the disparity has been growing. As a result nearly one-fourth of the people still live below the poverty line, with inadequate income to access food from the market.

An indicator often used to assess the capacity of the poor to access food from the market is the level and trend in real wages. This indicator shows that since the mid-1990s there has been a favourable trend in the income of the households who depend on selling labour in the market, such as agricultural wage labourers, transport operators and construction workers. The Land Reform in 1984 stipulated a minimum wage equivalent to 3.5 kg of rice at the prevalent market price. The rice equivalent wage had increased from about three kg in 1990 to nearly 8 kg in 2011. The only low group who have not been able to increase their real income are industrial labourers, particularly the unskilled workers in the garment industry and the fixed wage earners in the public sector.

The hike in food prices after the food crisis in 2007 has had a negative impact on the real wages and access to food. Sharp increase in food grain prices significantly lowers the real income of poor households who spend over half of their income on staple food. At the same time the instability in producer prices increases risks and uncertainty, and discourages the subsistence farmer to invest in agriculture. The volatility in food prices remains an issue for achieving seasonal and temporal stability in food security.

Safety net programmes: Bangladesh is often at the mercy of natural calamities such as floods, droughts and cyclones. Riverine Bangladesh also witnesses frequent land erosion causing thousands of people to lose their land every year. Despite the gains achieved by Bangladesh in augmenting availability of staple food, a safety net programme is essential to insulate the poverty stricken population from chronic as well as temporary food insecurity that results from external shocks. A number of food safety net programmes are in operation in Bangladesh, each with its own specific objectives and target population. These include test relief, Vulnerable Group Feeding, Vulnerable Group Development, Food for Work, Employment Guarantee Scheme, etc. A number

of social protection programmes such as vulnerable group feeding, allowance for destitute women, and old age pensions have also been introduced to support food security of the extremely needy people.

The present government has given high priority to the safety nets for ensuring food security. Currently nearly 2.2 percent of the GDP are allocated for safety nets and social protection. The evaluation of the programmes however revealed several limitations; a) large overheads due to operation of a large number of small programmes by different ministries often with the same objectives, b) improper targeting of beneficiary households, and c) leakages in implementation.

6.3. Utilisation of food and nutrition security

The acceleration in economic and agricultural growth has made a positive impact on the diversity of food intake away from the rice and vegetable based diet in favour of quality food. The change in per capita consumption of different items in the food basket for the rural and urban people, as estimated by the Household Income and expenditure surveys (HIES) of the BBS, are reported in Table 7.4. It may be noted that the per capita consumption of rice and wheat has been declining, while the consumption of vegetables, fruits and fish and meat has been growing. For rural areas the consumption of rice has declined from the height of 175 kg per person per year in 2000 to 161 kg in 2010, a decline of about 1.4 kg per year. For urban areas, the consumption of rice and wheat together has declined from 155 kg per person per year in 2000 to 140 kg in 2010, a decline 1.5 kg per year. During 2000 to 2010, the consumption of meat has increased by one-third for rural areas and by 40% in urban areas.

Table 6:4: Consumption of different food items (gm/person/day)

Food item	Normal for balanced nutrition	Rural area				Urban area			
		1984	2000	2005	2010	1984	2000	2005	2010
Rice	500	421	479	477	442	351	377	389	143
Wheat	100	65	24	12	38	79	17	28	51
Vegetable	225	140	196	218	221	179	196	228	241
Pulses	30	26	15	13	13	22	19	19	17
Fruits	50	17	26	33	43	21	27	33	50
Fish	45	29	38	40	46	39	41	50	60
Meat & egg	34	10	15	18	20	22	31	31	42
Milk	50	22	29	31	32	34	33	37	39
Total	934	741	899	986	1005	761	841	999	983

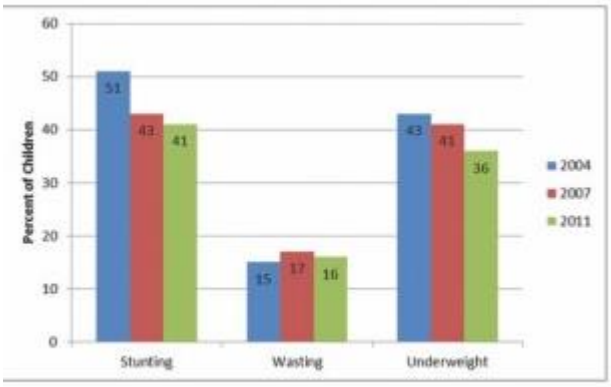
Source: Household Expenditure Survey report of various years, Bangladesh National Nutrition Council for minimum food intake requirement

However, the level of consumption of other food items, hardly meets the requirement for balance diet as specified by the National Nutrition Council and FAO. The numbers in Table 1 shows the average level of

consumption has reached the adequacy level for rice and vegetable, and about to be reached for fruits and fish, but serious deficiency persists for quality food such as pulses, oil, and livestock products.

The average numbers also masks serious inequality in the distribution of consumption across the income scale. While the richer sections of the society are being able to gradually reduce their cereal intake and diversify their diet, the poor still have an unmet demand for rice. For all the other food items, consumption for all income groups have increased, marginally for the bottom 40 percent but substantially for the top 20 percent. A recent IFPRI study shows that nearly 20 percent of the population is still calorie deficient and the gender disparity in calorie intake still persists. The 2011 report of the Food Security and Nutrition Surveillance project implemented by the Helen Keller International (HKI) and BRAC University shows that a quarter of the households has go without a meal a day or to reduce the intake of food a number of days during a month.

Bangladesh has made significant progress in reducing under-nutrition for the children (Figure 6.3). The prevalence on underweight children for their age declined from 60 percent in 1990 to 36 percent in 2011, and is on track for achieving the target set by the Millennium Development Goals (MDGs). However, progress in reducing stunting, the indicator of chronic malnutrition, shows a less encouraging picture. The level is still about 41 percent, much higher than countries in sub-Saharan Africa. Over 2007 to 2011, the stunting declined by only two per cent points. Stunting affects the cognitive ability and the immunity of the children from diseases. The prevalence of wasting, an indicator of current nutritional status, remains at an alarming level of 15 to 17 percent, with very little improvement over time.



Source: Bangladesh Demographic and Health Surveys 2011

Figure 6:3: Under-nutrition in under 6 children in Bangladesh, 2004-7

Low birth weight among Bangladeshi infants is among the highest in the world, ranging between 20 and 22 percent. The nutritional status of women shows a better trend. The proportion of women with chronic energy deficiency has declined from 52 percent in 1997 to 25 percent in 2011. But the prevalence of obesity among women is also emerging as a public health issue. The hidden hunger, the insufficiency of vitamin A, iron and zinc in the diet that causes major diseases such diarrhoea and anaemia and poor eye sight is still a major health issue.

Despite tremendous accomplishments in the past, in 2009 nearly half of the Under-5 children were underweight (nearly 8.0 million children). Given the current trend it is unlikely that Bangladesh will reach the MDG (Millennium Development Goals) target of reducing prevalence of the underweight in children by 2015. Based on data from 1990 to 2009, the number of underweight reduced at the annual rate of 1.0 per cent. To reach MDG target, the number of the underweight has to reduce at the annual rate of 2.0 per cent from 2009 and onwards.

The underweight rates were more pronounced in rural areas compared to urban areas (BDHS 2007 & HFSNA 2009). By 2005, 40 per cent of the population (60 million) were not obtaining the minimum level of dietary energy of 2122 Kcal. In terms of minimum energy consumption Rajshahi and Barisal divisions are relatively worse off compared to other divisions (HIES 2005, HFSNA 2009). Malnutrition is also severe in the country. More than 90 percent of rural Bangladeshis are not getting enough vitamins A and iron deficiency— which can cause anaemia and the risk of death in childbirth—is also very high, especially for women of reproductive age (BIHS, 2011-2012).

6.4. Analysis of food security by region

Poverty and food insecurity are interlinked. The most startling consequence of widespread poverty in Bangladesh is that about one-fifth of the country's 160 million people cannot afford an adequate diet. The poor do not have sufficient purchasing power to secure their access to food, even when food is available in local markets. Chronically underfed and highly vulnerable, this segment of the population remains largely without assets (other than its own labor power) to cushion lean-season hunger or the crushing blows of illness, flooding, and other calamities. The poor are highly vulnerable to shocks (such as natural disasters or crop failures) that cause sudden losses of real income and, hence, transitory food insecurity. Sudden increases in food prices, such as the surge in 2007–08 and again in 2010–11 also result in transitory food insecurity, particularly for low-income households, by reducing their real income. Family coping strategies (such as the consumption of less food, the withdrawal of children from schools, and the distress sale of productive assets) often aggravate the risks of destitution.

The economic setting presented in this section is the fundamental basis for access to food at the household level. Various factors that can affect a household's access to food in terms of its purchasing capacity are analyzed from the Bangladesh Integrated Household Survey (BIHS) data.

The figure 6.4 shows that 40.5 percent of the population in the Feed the Future (FTF) zone lived below PPP $1.25 per person per day in 2011–12. While 38.2 percent of the population in rural Bangladesh was living below the family welfare threshold, there are pronounced regional differences in the incidence. The rate varies widely across divisions, ranging from a low of 31.0 percent in Chittagong division to as high as 65.5 percent in Rangpur division. Although Rajshahi division ranks the second highest, the rate in this division is 23.1 percentage points lower than that in Rangpur division.

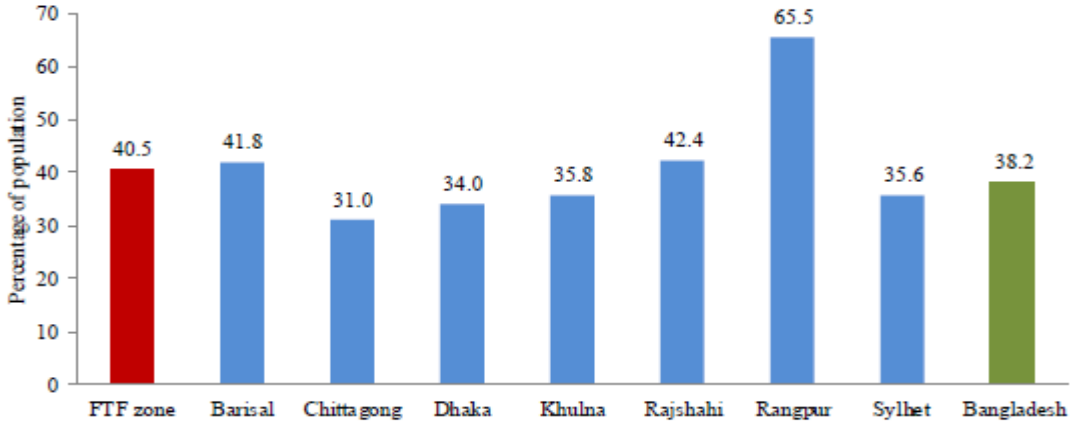


Figure 6:4: Percentage of people living on less than PPP $1.25/day

Figure 6.5 provides the estimates of consumption expenditures per person per month. At the national rural level, average monthly per capita expenditure was Tk 2,692 at 2011–12 current prices, which was only 1.2 percent higher than the estimate for the FTF sample of households at Tk 2,660 per person per month.

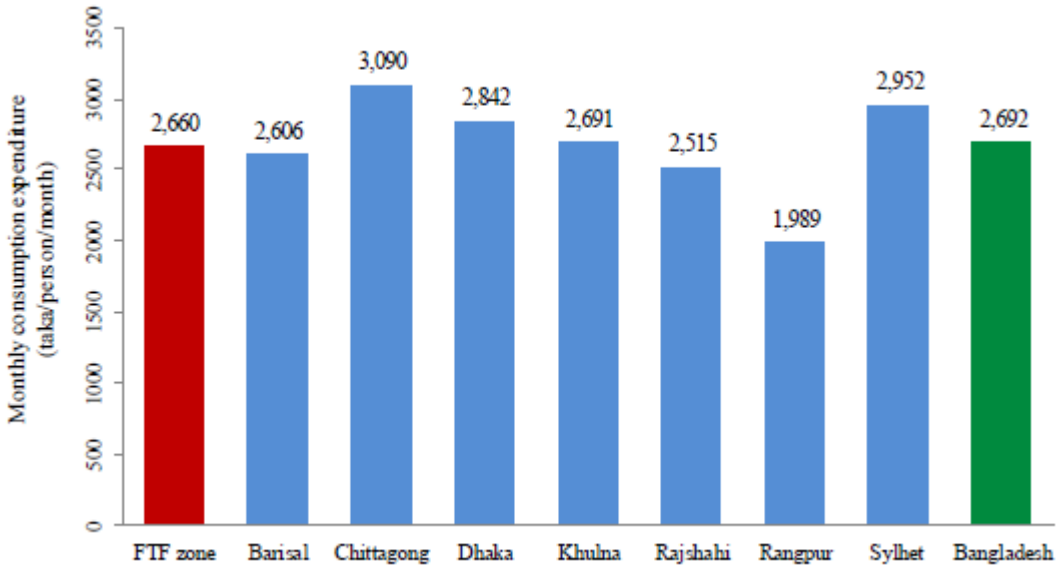


Figure 6:5: Monthly per capita consumption expenditures

The highest average monthly per capita expenditure was Tk 3,090 in Chittagong division, followed by Tk 2,952 in Sylhet division. The lowest average monthly per capita expenditure was Tk 1,989 in Rangpur division, which was about 26 percent lower than the national rural average.

Tables 6.5 and 7.6 present the patterns of income distribution in the FTF zone and in entire rural Bangladesh, respectively. The figures in Table 5.1 indicate that while the richest 10 percent of the population in the FTF zone earned 22.7 percent of all income, the poorest 10 percent earned only 4.3 percent of the total income. The distribution of income at the national rural level shows a similar pattern: the poorest 10 percent of the

population earned 4.2 percent of total income in rural Bangladesh, while the richest 10 percent earned 23.2 percent of all income (Table 6.5).

Table 6:5: Distribution of per capita income: Feed the Future zone

Per capita expenditure group	Average per capita expenditure	Share of total expenditure in each group
(taka/month)	(percent)	
1 (poorest)	1,019	1.91
2	1,275	2.39
3	1,411	2.65
4	1,536	2.88
5	1,650	3.10
6	1,747	3.28
7	1,863	3.50
8	1,975	3.71
9	2,096	3.93
10	2,212	4.15
11	2,349	4.41
12	2,484	4.66
13	2,641	4.96
14	2,834	5.32
15	3,049	5.72
16	3,303	6.20
17	3,626	6.81
18	4,123	7.74
19	4,805	9.02
20 (richest)	7,283	13.67
All households	2,660	100.00

Table 6:6: Distribution of per capita income: Rural Bangladesh

Per capita expenditure group	Average per capita expenditure	Share of total expenditure in each group
(taka/month)	(percent)	
1 (poorest)	1,015	1.85
2	1,275	2.32
3	1,440	2.62
4	1,566	2.85
5	1,671	3.04

6	1,781	3.24
7	1,893	3.45
8	2,016	3.67
9	2,140	3.89
10	2,268	4.12
11	2,412	4.39
12	2,566	4.66
13	2,734	4.97
14	2,916	5.32
15	3,137	5.70
16	3,386	6.16
17	3,749	6.82
18	4,263	7.75
19	5,062	9.20
20 (richest)	7,675	13.96
All households	2,692	100.00

The most widely used summary measure of inequality is the Gini coefficient. The estimated Gini coefficients for income distribution are 0.284 for the FTF zone and 0.307 for overall rural Bangladesh (Figure 6.6). The inequality in income distribution is highest in Sylhet division (0.319) and lowest in Rangpur division (0.273).

Comparisons among estimates presented in Figures 6.4, 6.5, and 6.6 indicate that the incidence of poverty (termed as the family welfare indicator) and inequality in income distribution are negatively correlated across regions, whereas there is a positive relationship between average income and income inequality.

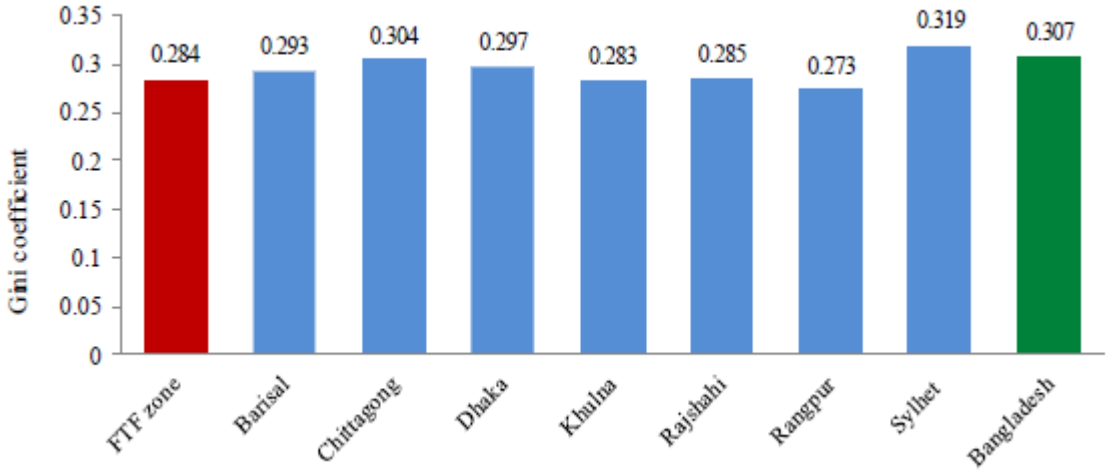


Figure 6:6: Gini coefficients for income inequality, by region

The **labor force participation rate** for all household members age 15 and above is about 73 percent both in the FTF zone and in entire rural Bangladesh. However, there are considerable differences in labor force participation rates in terms of males and females. In the FTF zone, the overall labor force participation rate for males is 86 percent, while for females, it is 61 percent. The rates are 87 percent for males and 60 percent for females in rural Bangladesh as a whole. The labor force participation rate is the highest for the poorest income group, the rate declines as household income increases, and this relationship is more pronounced for males (Tables 5.9 and 5.10).

Rural Bangladesh is predominantly an agrarian society with low rates of employment in the nonfarm sector. Farming is by far the main source of employment, with 71 percent of the total labor force in the FTF zone and 66 percent in entire rural Bangladesh engaged in farming. Wage labor (agricultural and nonagricultural) is negatively correlated with household income—12 percent of the labor force in the FTF zone and at the national rural level belong to the lowest income quintile, and only 1.5 percent and 1 percent of the labor force in the FTF zone and in rural Bangladesh, respectively, are in the highest income quintile. In contrast, business and trade and salaried work are positively correlated with income.

Agricultural Wage: The level of agricultural wage has a large bearing on the incidence of poverty and food insecurity. Agricultural wages have increased quite sharply in recent years, enabling the rural poorest to improve their livelihoods significantly (Zhang et al. 2013).

Figure 6.7 shows the pattern of daily agricultural wages in the FTF zone and across divisions in rural Bangladesh. Wages represent average wage received by a worker in seven days prior to the survey date. The wages were estimated by adding cash wages to the value of in-kind (usually food) wage, if any. The average daily wage was Tk 220.3 for males and Tk 199.9 for females in the FTF zone. The daily wage rate at the national rural level for males (Tk 222.5) was 16.0 percent higher than the rate for females (Tk 191.8). The gender gap in wage rates was biggest in Barisal division—the male wage was 31.4 percent higher than the female wage, and smallest in Rangpur division—the male wage was only 3.8 percent higher than the female wage. The agricultural wages for both males and females were the highest in Chittagong division. The lowest wage for males was recorded in Rangpur division, and for females in Rajshahi division.

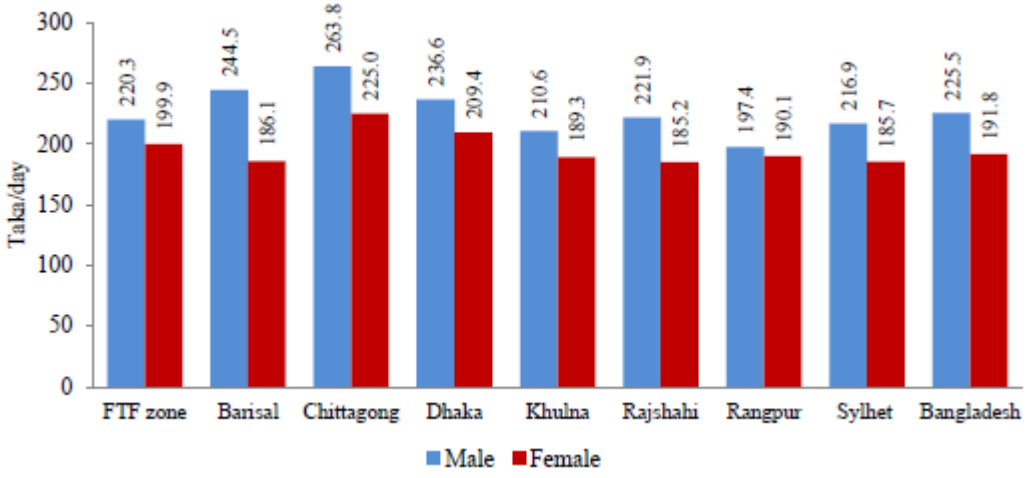


Figure 6:7: Average daily wage rates of agricultural labourers, by region

Figure 6.8 shows the amount of rice (in kilograms) that could be purchased by one day's wage for males and females across regions. The BIHS data suggest that on average, a rural household with 4.7 members consumes 2.33 kilograms of rice per day (average daily per capita rice consumption is 495.5 grams). The average daily agricultural wage for a male worker in rural Bangladesh during the survey could buy 7.6 kilograms of rice, which is 3.3 times higher than the rice consumption of an average rural household.

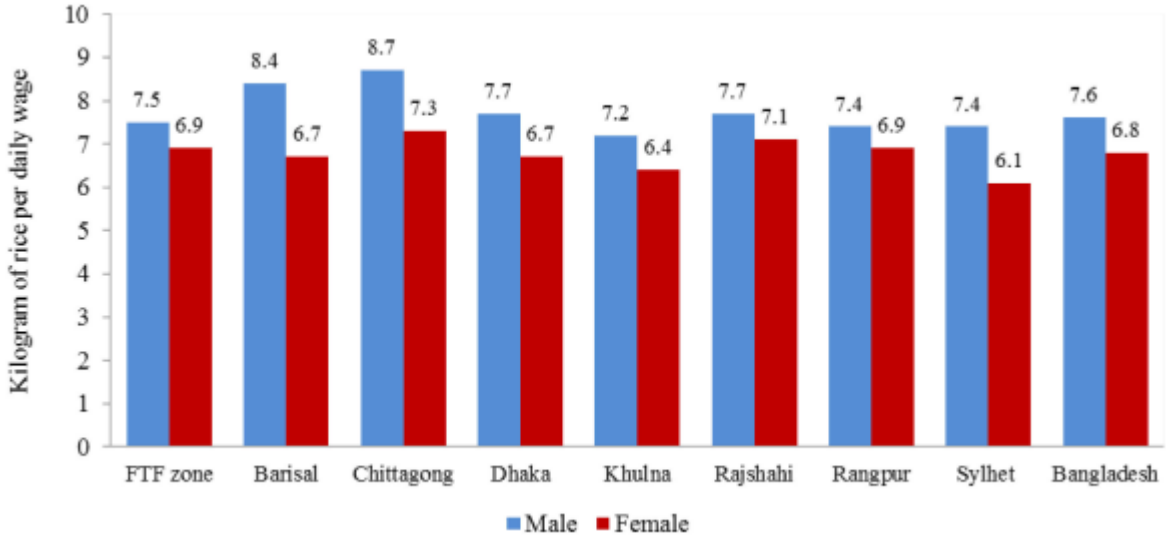


Figure 6:8: Kilograms of rice that could be bought by daily agricultural wage, by region

6.5. Food security implications in the long term planning

Around 90 per cent of the rural population of Bangladesh is directly involved in agriculture and around 43.6 per cent of the total labour force is engaged in agricultural activities. For increasing food production and attaining food sufficiency a sustainable growth of the agricultural sector is required. However, it would be a great challenge to attain food security while maintaining sustainable agriculture practices. Moreover, decreasing arable agricultural land, together with still increasing population and changing climatic conditions, make this challenge more acute.

The recent global food price inflation illustrates the critical importance of ensuring food security for a large poor country like Bangladesh. Past progress in rice production suggests that Bangladesh has the capacity to achieve food security efficiently through domestic production. Indeed, with proper incentives, there is scope for food exports also.

The emphasis on productivity improvements will be particularly helpful in reconciling food security objectives with farmer incentives. In case of food production, climate change adaptation strategy in the agriculture sector needs to be prioritised to tackle the global food insecurity susceptibility due to climate change.

7. Development impediments in the agro-ecologically depressed regions

7.1. Coastal region

Coastal region, Haor and CHT have some special type of bio-physical constraints. These regions have been identified as disadvantaged regions in terms of poverty, food insecurity, environmental vulnerability and limited livelihood opportunities. Table 7.1 presents salient features of coastal zone of Bangladesh.

Table 7:1: Salient features of coastal zone of Bangladesh

Coastal Zone: Salient features*	
Area	47,201 Sq km (32% of country total)
Number of districts	19 (in parts or in full) 12 in exposed coastal zone that meets the coast;
Number of upazilas	147 (48 in exposed coastal zone)
Population (S-SW)	36.8 million (2001); 41.3 million (2010); 60.8 million (2050)
Main AEZ regions	13 (GTF): Satkhira, Khulna, Bagerhat, Barisal, Pirojpur, Jhalakati; Patuakhali, Barguna; 18 (YMEF): Bhola, Lakshmipur, Noakhali, Feni, part of Barisal; (AEZ region 23 (CCP) – Chittagong, Cox's Bazar – is excluded; but additionally Gopalganj, Kushtia, Jessore and other adjacent areas are considered as relevant and interlinked)
Embankments	5017 km

In the southern region, 15 percent of total cultivable land is either fallow and/or not under productive use. Major physical factors responsible for land being not used intensively are soil salinity, water salinity, subsidence and water logging.

Polders are major interventions in the southern region with protective structures that provide benefits to the production systems and livelihoods. The polders of the southern region are edge-old and facing following problems:

- *Siltation:* Due to empoldering, natural inundation outside the polders has been obstructed by embankments resulting in higher elevation of land outside the polder and no siltation inside.
- *Drainage:* Because of siltation of outfall channels, channels within polders have significantly lost drainage capability resulting in water logging. The problem has been compounded by siltation of internal drainage channels.

- *Water logging:* Because of land accretion, particularly in the Meghna estuary, many rivers and *khals* (drainage canals) have been silted up. Onrush of upstream flow and prolonged rainfall often cause water logging. This problem has been aggravated by empoldering.
- *Salinity:* Though soil salinity declines in the long run because of empoldering, problem recurs because of erosion and embankment failure (breaches or overtopping by storm surge).
- *Land use conflict:* Shrimp farmers bring saline water inside the polder by cutting embankment or using LLP. This affects salinity balance inside the polder and causes damage to crops in surrounding fields. Competing land use often results in confrontation and violence and thereby affects the social fabric. Polders have not been designed for the multi-functional land use and the BWDB has no mechanism how to deal with land use conflicts.

Vulnerability of polders

- Many polders are in dilapidated conditions in terms of breach and slip in the embankment, erosion, neglect in repair works, drainage congestion because of siltation and encroachment of canals and, above all, location in the risk zone.
- Water control structures in many places are damaged or non-functional.
- BWDB has categorized that out of 158 polders 51 are "most vulnerable" and another 55 polders as "medium vulnerable". To cope with vulnerability, it is necessary to rehabilitate damaged infrastructures of the polders

Major Constraints of Coastal region

- Extreme environmental events and high vulnerability to climate change
- Low agricultural productivity, poor land use and low cropping intensity
- Low productivity of Rabi crops and little high value crops cultivation
- Predominance of small and landless farmers
- Intrusion of saline water, water logging and occasional breaches of embankment
- Higher rates of poverty and malnutrition

7.2. Chittagong Hill Tract (CHT)

The CHT represents 9 percent of the landmass divided in three districts consisting of 25 Upazillas with one percent population of the country. According to the Population and Housing Census 2011, the CHT region has a total area of 13,295 km^2, 342,390 households and about 1.7 million people. Population density per km^2 is lower in the CHT (120) compared to Bangladesh (1015). CHT is the home of a large number of small ethnic communities.

Land has been a common access resource for local communities. They operate on land for agricultural purposes with customary rights obtained through an ages-old traditional system. Majority of farms are of small size, less than one hectare each. Only seven percent of holdings are 'large' (being three hectares or above). Small farms are more concentrated in Khagrachhari district, while medium and large farms are more prevalent in Bandarban and Rangamati.

The extent of poverty is high in the CHT. About half of the population or more are poor. The income per household member in the CHT is about two thirds the income of rural Bangladesh and the percentage of main income earners that rely on manual labour, 43%, is almost twice as high as rural Bangladesh.

Land and Water are the two critical resources for sustaining agriculture productivity. In the CHT lands are at different elevations, Rangamati and Khagracchari are relatively low-lying. Land in Bandarban covers a wide range of elevation. Elevation is a key factor in determining crop suitability and seasonality based on agro-ecological considerations. Because of the predominance of hilly terrains with steep slopes, most of the land is not suitable for 'plough agriculture'.

Large number of Watersheds exist in the region. The main source of surface water is rainfall and accumulated waters in streams, *chharas*, and lakes. Khagrachhari district has been delineated into 119 watersheds. Rangamati has 273 watersheds, while Bandarban has 267 watersheds. Total length of *chharas* connected to the rivers and spreading over the CHT region is more than 7,200 km. These *chharas* are steep and so they cannot hold water for long. About 862 km of *khals* connected to *chharas* and rivers flow during the wet season.

Most of the rivers, *chharas* and *khals* dry up in the winter due to deforestation, non scientific crop cultivation in the upland areas causing soil erosion and consequent siltation of the rivers, *chharas* and *khals*. The *Kaptai Lake* is also endangered due to siltation problem. The deforestation in all three districts is taking place at a very fast rate. Dense forest coverage has reduced by 61% in the last five years and the rate is also high for medium dense forests. In total 659 watersheds have been delineated in the CHT, 119 in Khagrachhari district , 273 in Rangamati district and 267 in Bandarban district. Very limited surface water level stations are available in the CHT.

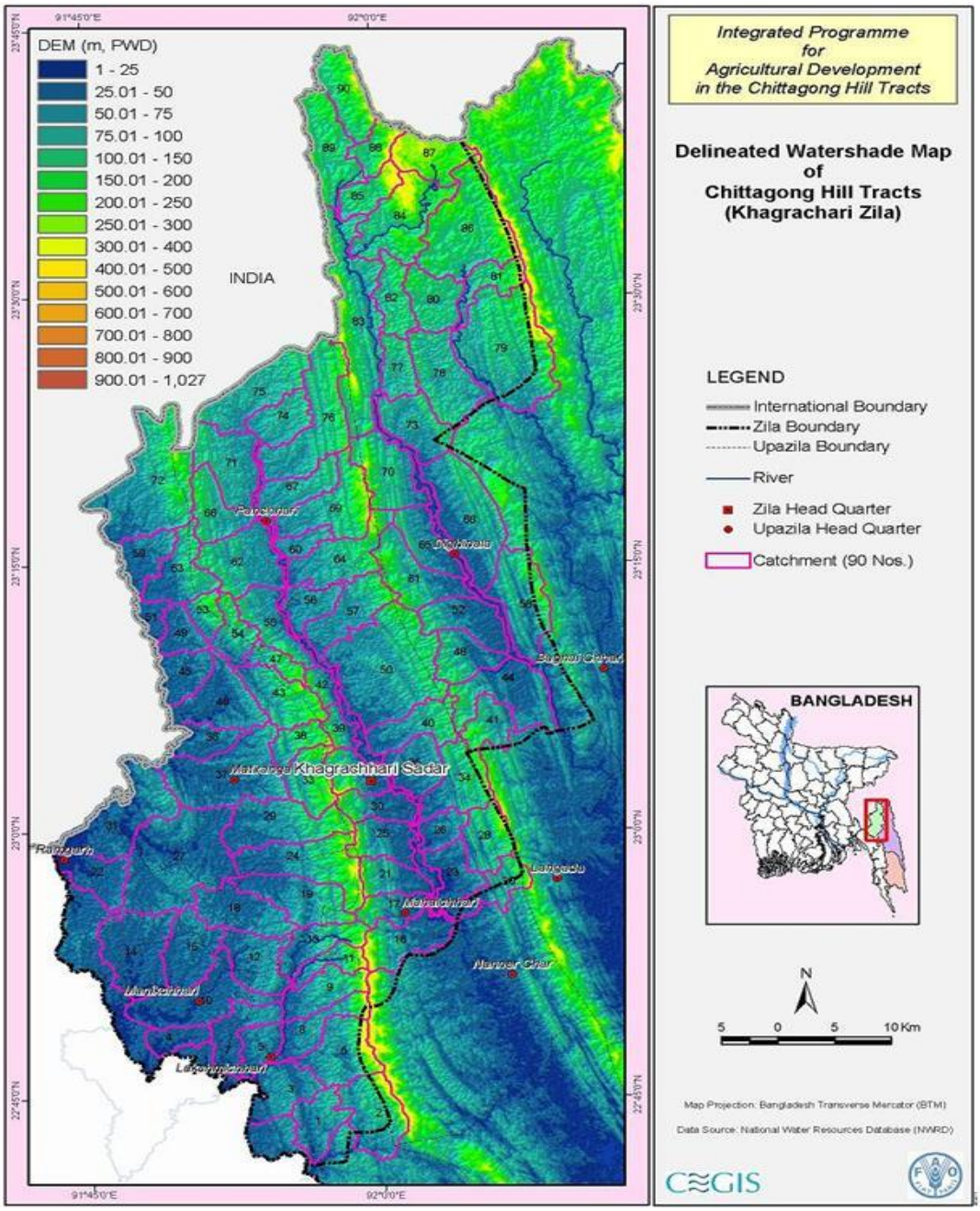


Figure 7:1: Watershed of CHT

Major Livelihoods Practices are farming, fishing, livestock rearing and trading. Less than one-fifth of the total valley land area (270,812 ha) is currently under irrigation. Rice is the main crop grown in this land area. Some HYV rice varieties are grown in the floodplains. Besides rice, maize, mustard, chili, winter vegetables and potato are also grown. Jum is a prominent indigenous farming practice and 6.5% of the farmers depend on jum farming system. The number of *jum* farmers was 7,832 in 1880; it is now estimated at 22,413, although numbers have

fallen recently. An average *jum* cycle was 12-15 years to allow sufficient regeneration of natural resources during the interval. In 1961, after the construction of the *Kaptai Dam*, the *jum* cycle was shortened to 3-5 years. At present the average is 2-3 years.

Main crops grown in the *jum* are rice, maize, millet, sesame, cucumber, pumpkin, ash gourd, melon, chili cowpea, turmeric, flowers and medicinal herbs. Sugarcane, cotton and tobacco are important cash crops in the CHT. However, cotton cultivation has declined in comparison to the past. Sugarcane cultivation has slowly increased because of market demand and the advent of HYV species of chewing variety. Tobacco cultivation is increasing and has made inroads in some of the remote areas.

Commercial fruit gardens are mainly concentrated on banana, papaya, lemon, pineapple, mango, orange, cashew nut and jackfruit But a number of other fruit crops are grown in scattered areas. Farmers hardly follow recommendations on plant spacing, proper application of different fertilizers and other cultural practices. As a result, yields are relatively low and much of the potential remains unexploited.

Major constraints of CHT

- Natural resource degradation – soil erosion and siltation of water bodies; reduced soil fertility; and biodiversity loss
- An under-developed sector for the provision of essential inputs and extension (seed, fertilizer, credit)
- Scarcity of adaptive research, on-farm trials and demonstrations, leading to low knowledge of CHT-specific conditions and absence of innovative practices.
- Limited access to markets, and opportunities for agro-processing
- Low productivity, and missed opportunities for diversification (and associated benefits to nutrition), due in part to poor access to improved inputs, and/or to new adapted technologies
- Poor technical capacity of stakeholders and a lack of technical coordination
- Disjointed and/or overlapping programmes, without consistent guiding principles on the part of government and development partners.

Strategies for development of agriculture and livelihoods of CHT (prepared by MoA and FAO in 2013)

Enhancing productivity

Improved access to low lift pumps (LLP) for irrigation and the utilization of surface water should be the subject of a major investment programme, as it is in other areas of the country (cf Country Investment Plan for Agriculture, Food Security and Nutrition, Ministry of Food, 2010).

A centre under the CHT Regional Council should be established for both in situ and ex-situ conservation of genetic resources – this will require at least 100 ha of land with necessary laboratory and other physical facilities.

More sustainable adapted and improved jum practices

Adopting such measures on a large scale will require local strategies, a major awareness raising campaign, and targeted skills development programmes such as specialist farmer field schools

Up-scaling of technology and sustainable input supply

A programme of local adaptive research is needed, to build better bridges between research and local initiatives such as farmers field schools, supported by a network of extension staff, locally-based scientists and farmer field school facilitators. Programes and incentives are needed to develop the agro-inputs sector.

Marketing and value chain development

HDC, LGED, DAM and AIS need to promote development of market infrastructure (market sheds, storage infrastructure, sanitary facilities, etc) construction of link roads, improvement of transportation and market information systems. SME and household based agro-processing need to be promoted by CHTDB, HDC and BSCIC and line departments.

7.3. Haor region

Haors are located in the north-eastern region of Bangladesh. It has a total area of 8,000 km2. There are 373 Haor with a gross land area 1.99 million ha, net cultivated land 1.33 million, 16% of total rice land of Bangladesh in Haor area. Total population of Haor is 20 million, rich ecosystems and bio-diversity. People in the region are poorer than in any other part, More than 28% are below the Lower Poverty Line (LPL).

Major Constraints of Haor

- Degradation of natural resources and biodiversity
- Natural disasters are the main reason of poverty, lack of availability of basic infrastructure and social amenities, inequity in resources acquisition and poor access to natural resources.
- Crop damage by flash flood
- Declining productivity of crops
- Poor Market linkage and value addition

8. Challenges

The following section outlines the major challenges related to agriculture and food security in Bangladesh.

8.1. Curse of poverty, food insecurity and malnutrition

Despite its transformation from a country of chronic food shortages to one of food self-sufficiency, Bangladesh still faces food-security challenges. Almost 40 percent of people in rural Bangladesh live on less than $1.25 per day and 60 percent of that income is spent on food. In rural Bangladesh, 66 percent of the labor force makes their living in farming, and the vast majority of the farmers (81 percent) farm less than one and a half acres (Bangladesh Integrated Household Survey (2011-12)

Bangladesh has a population of approximately 165 million and is growing at a rate of 1.6%. The Bangladesh economy faces much pressure to feed increased numbers of people. Despite poverty reduction over the last two decades, absolute rates are still high. About 58 million people, or 40% of total population, are still poor, with one-third caught in hard-core or extreme poverty. Regional and gender-based differences are also a grave concern, as are time-bound vulnerabilities caused by fluctuations in weather throughout the year. Certain social constituencies also tend to suffer more from poverty, malnutrition and food insecurity, including women, children, elderly, the disabled and remote rural dwellers.

Indeed, the average Bangladeshi diet is very poor as regards to diversity and quality of nutritional intake. Fruits, vegetables, dairy, protein and other important sources of nutrients are often lacking.

8.2. Degradation of natural recourses

The growing population places stress on limited natural resources, decreasing agricultural lands and a waning supply of natural resources. Cropped land is declining at the rate of about 1% per year. On average, Bangladesh is losing good quality agricultural land by approximately 80,000 ha annually due to urbanization, building of new infrastructure such as roads and implementation of other development projects. In addition, degradation is due to soil erosion, river erosion, soil fertility decline, depletion of soil organic matter, water logging, soil salinity, pan formation, acidification and deforestation.

Water erosion accounts for about 40 percent of land degradation due to washing away of topsoil and depositing sand on the croplands from upstream. Riverbank erosion and siltation are chronic concerns for Bangladesh. About 1,200 kilometers of riverbank are eroding and more than 5000 kilometers river banks face erosion-related problems in the country. The major rivers such as the Jamuna, Ganges and Padma consume several thousand hectares of floodplain making thousands of people landless and homeless every year. During the last three decades the Jamuna, Ganges and Padma rivers have consumed about 180,000 ha. (BWDB 2009). This amount excludes the annual erosion along the other major rivers and also in the Meghna estuary where the amount of erosion is very high. From the 1970s to early the 1990s, the extent of mean annual erosion was about 3,300 hectares along both banks of the Jamuna River only. The Flood Action Plan, Bangladesh predicts a net erosion loss in the Brahmaputra-Jamuna basin of 34,120 hectares of “mainland” acreage for the period 1992-2011, an area similar to what had eroded in the 12 years previous to that time (MPO 1987). Similar rates

of net loss in land due to erosion are expected in the other three main rivers. The river bank erosion is expected to increase further with the rise of water flow in the rivers due to global temperature rise and increased ice melting in the Himalayas. Given the geo-morphological development of the rivers and the prevailing socio-economic context of Bangladesh, it would not be feasible to protect the riverbank erosion fully. Non-structural measures, such as prediction of erosion when and where applicable and educating people how to mitigate could be alternatives to minimize the suffering of the people.

In the last three decades, for instance, 170,000 ha area of agriculture land has been affected by increased salinity. Soil fertility decline is occurring in Bangladesh due to imbalanced use of fertilizer, intensification of crop cultivation without appropriate techniques for sustainable natural resources management, and the advance of mono-culture rice without rotation. C cultivation practices in CHT have lead to top soil loss.

The major rivers passing through Bangladesh deposit sediment on the flood plains, gradually changing their topography and creating the phenomenon of *Charlands,* which tend to have lower agricultural productivity due to soil quality, and are subject to further erosion and frequent flood damage. Linked to the high levels of siltation affect irrigation and drainage systems; water logging can also be a severe problem. Over exploitation of groundwater has also led to arsenic contamination of tube wells and groundwater sources. Within 59 districts of the country where about 1.44 million tube wells have been affected and people are exposed to arsenic toxicity.1

Forest area amounts to about 11% of the total land area, but barely half of that is actual tree covered. High degradation of forested land is occurring in Bangladesh, largely due to population encroachment and crop/horticultural farming; illegal logging practices are also to blame (particularly in the CHT). In addition, the output of forests in Bangladesh is one of the lowest in the world. Productivity is low due poor management practices, low initial survival, incompatible species composition, low soil efficiency, etc. Better management practices, even at community level, are necessary in this regard.

Inland and coastal capture fisheries are thought to be suffering environmental degradation and species depletion, although a thorough stock assessment is overdue. In some cases practices in aquaculture, such as wild fry collecting, have had a major impact on fish stocks

8.3. Low agricultural productivity and limited modernization and/or diversification

The agriculture sector in Bangladesh is characterized by a fragmentation of farm structure: 80% of farmers are marginal and small (0.02 to 1.0 ha of land). Decreasing farm sizes, inefficient use of limited water resources, degradation of soil quality and failure to adopt known modern technologies and practices are behind the phenomenon of low productivity. Indeed, there is a wide gap between farm yields and experimental stations. This is true across all sub-sectors. The yield gaps even in the favourable agri-ecological regions often exceed 40% of the farmer's achievable yields with good practices.

1 FAO, UNICEF, WB & WHO, *Towards an Arsenic-Safe Environment in Bangladesh* (Dhaka, Bangladesh, March 2010), http://www.unicef.org/bangladesh/Towards_an_arsenic_safe_environ_report_22Mar2010.pdf.

8.4. Weak research extension linkage and technology delivery

While many improvements in management practices are theoretically possible, the National Mainstream Extension Approach of DAE, DLS and DOF does not have the capacity to cope with the emerging challenges in each sector on the scale needed. Equally, research scientists are only slowly adjusting the research agenda to meet the needs of farmers and producers. Despite a long history of Farmer Field Schools in the country there is a very limited amountof "action" or "adaptive" research being practiced

8.5. High post harvest losses

There is large post harvest loss around 20% (Table 8:1) in rice and 30% in vegetables and fruits. There is also a substantial scope to increase agricultural production by reducing post-harvest losses, by increasing the shelf life of perishable commodities and by adding value through agro-processing of agricultural commodities into finished or semi-finished products, packaging in appropriate containers, proper storage and exports. The food processing industry in Bangladesh is growing. The policy, institutional and infrastructure barriers to agribusiness, agro-processing and supply chain need to be removed in order to provide a "big push" to agriculture and rural development. The production and processing of these products is also labour intensive and, therefore, is likely to have a significant favorable impact for generating additional employment in the rural areas.

Table 8:1: Post harvest losses of major corps in Bangladesh

Sl. No.	Food crops	Production (million tons)	Loss (%)	Total losses (million tons)	Cost/kg	Total loss (Million Tk.)
1.	Rice	29.75	12	3.57	8.00	28,560.00
2.	Wheat	0.77	13	0.10	8.00	8,000.00
3.	Maize	0.78	13	0.05	5.00	475.00
4.	Pulses	0.56	15	0.08	25.00	2,075.00
5.	Oil seeds	0.55	15	0.082	20.00	1,640.00
6.	Spices	1.46	15	0.22	10.00	2,200.00
7.	Vegetables	8.75	30	2.62	4.00	10,492.00
8.	Fruits	7.88	25	1.97	9.00	17,721.00
9.	Potato	5.37	20	1.07	8.00	8,592.00
10.	Sweet potato	0.72	20	0.15	3.00	435.00
11.	Sugarcane	3.51	20	0.70	2.00	1,404.00
	Total	600.94		106.63	-	81,594.00

Source: NMTPF, 2010.

8.6. Problems of market linkages and value chains

The lack of organized markets for selling farm produce is a significant problem for Bangladesh. The salient features of agricultural product markets are poor infrastructure, with lack of storage and processing facilities, poor roads and communication system, unfair practices of middlemen, etc. The marginal and small farmers are often facing problem of marketing their products and are not getting fair price due to existence of trade syndicates. Additionally, in some localities such as coastal areas and CHT, the limitations of infrastructure make access to markets difficult. The rate of post-harvest loss is quite high in such cases, estimated country-wide at around 20% in rice and 30% in vegetables and fruits.

Furthermore, agri-business and agro-processing activities are extremely restricted, which severely impedes the country's post-production potential. Value addition and supply chain investments including processing,

packaging, storage and transportation at the local and national levels are a priority. In addition, efforts need to be made to ensure that products abide by certain quality criteria. Several issues including policy environment, such as product standardization, food safety, sanitary and phyto-sanitary measures need greater investment to increase the quality of produce and potentially the volume of exports.

In Bangladesh, small, medium, and even large farmers are vulnerable to the exercise and influence of market power by rural traders, wholesalers, retailers, and processors. These petty traders are poorly rewarded for their efforts and the risks they take in an environment of inadequate quality control, gross returns as well as increasing product wastage. Formation of farmers' groups is one possible way to create better market linkages and ensure fairer competition in prices and curb exploitation of middlemen.

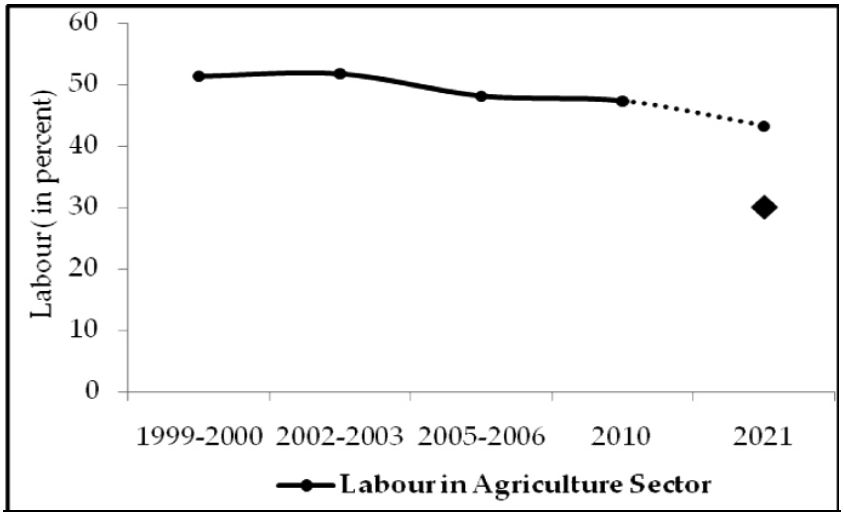
8.7. Scarcity of availability of agriculture labour

The share of agricultural sector in informal economic activity in Bangladesh however, is very high (Sixth Five Year Plan, 2011) the contribution of labour in agricultural sector is decreasing over the years (Figure 6.2). The rate of labour in agricultural sector increased between 1999-2000 and 2002-2003 with a rate of 0.4 percent but till then it has decreased.

Household panel data collected from 62 villages showed that adult male participation in agriculture has sharply declined from 83% in 1988 to 56% in 2000, a decrease by 27%; this has however, increased to some extent to a level of 65% in 2008. Participation of women in agriculture on the other hand remained almost the same in 1988 and 2000 (59% and 58% respectively); but compared to 2000, in 2008 women participation has increased by about 8%. Findings indicated that decrease in agricultural activities by adult male was due to less involvement in crop cultivation in recent years. About 79% adult males were engaged in crop cultivation in 1988 which has dropped to only about 42% in the year 2000; however, there had been some increase in male participation in crop cultivation in 2008 (53%).

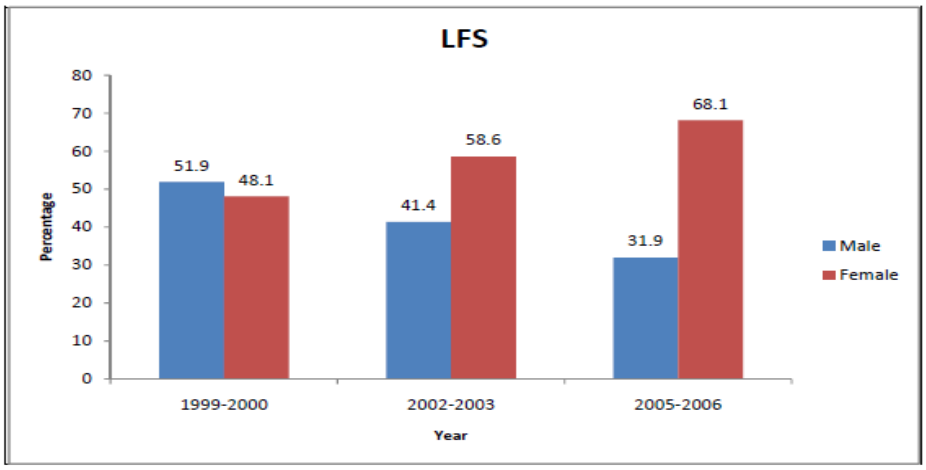
This transformation of agricultural labour is found due to productive and well paid job situation mainly in the organized manufacturing and services sector. As a result scarcity of agricultural labour during peak season is increasing. The government made a commitment to reduce the rate of labour in agricultural sector to 30 percent by 2021. Based upon historical track record, the labour in agriculture has decreased to 47.3 percent in 2010 with an annual rate of 0.78 percent from 51.3 percent in 1999-2000. If this trend of decrease continues, the contribution of labour in agriculture might slide down to 39.55 percent by 2021, which is higher by 9.55 percent than that of the target of the present government.

In Bangladesh, being a traditional Muslim society, women's participation in economic activities in general and in agriculture in particular has remained low. But recent labor force surveys conducted by the Bureau of Statistics show rapidly increasing participation of women in economic activities. The progress is attributed to poverty, empowerment of women by NGOs, and migration of male members from agriculture to non-farm occupation. With the absence of male members, women's role is changing from unpaid family worker to farm managers.



Source: Labour Force Survey (1999-2000, 2002-2003, 2005-2006 and 2010), Bangladesh Bureau of Statistics (2002, 2004, 2008 and 2011a)

Figure 8:1: Employed labour in agriculture sector



Source: Labor Force Survey (LFS) 1999-2000, 2002-2003 and 2005-2006.

Figure 8:2: Percentage of adult male and female participation in Bangladesh agriculture overtime

8.8. Farm mechanization

Modernization in Bangladesh agricultural sector is going on with the increased use of power tillers, irrigation equipments, threshers, drum seeders, maize shellers, rice milling machine, improved storage, cool-chain and transportation, etc. Farm machinery, such as, weeders, threshers, winnowers, centrifugal pumps etc. are developed and manufactured locally with locally available materials. Manually operated weeders and sprayers are used widely. A few hundred pedal and power operated winnowers are also being used in the country (Roy and Singh, 2008). It was found that farm mechanization promoted commercial farming and helped in reducing post harvest losses. Post harvest loss in agriculture amounts over 4000 million US$ a year. Proper grading, packing, pre-cooling, refrigerated storage and transportation can reduce these losses and maintain the quality. Mechanization in the country is associated with some inherent drawbacks like, fragmented lands, poor buying

capacity of farmers, lack of quality machines for farm operation, inadequate knowledge of the users about machines and insufficient awareness building activities. For the modernization of the agricultural sector, support is needed on skill development of researchers, capacity building of manufacturers, formulation of agricultural mechanization policies, support to the formation of farmers groups, review and rationalization of current tariff rates and expand credit facilities for farm mechanization.

8.9. Food quality and safety problem

Bangladesh faces significant problems with food contamination through poor handling practices, and deliberate adulteration for purpose of fraud (extension of shelf life, passing off cheaper ingredients as expensive ones, etc). Not only does this impact the health of the population, but it also affects the exportability of Bangladeshi agricultural produce. The challenge is how to create a satisfactory food control system backed by inspections and improved practices among food producers and handlers, as well as building awareness of consumers.

8.10. Inadequate institutional credit

While demand for credit is increasing with the advent of new technologies and high value crops, the supply side has remained less vibrant. Volume of institutional credit is conspicuously low and the proportion of the public sector in the total volume of institutional credit is even smaller. According to data of Bangladesh Bank, around 25 percent total disbursement of rural credit is delivered by the public sector. The remaining 75% has been delivered by micro-finance institutions (MFI) including NGOs and the *Grameen Bank*. However, the demand for credit is much more than what is met by non-institutional sources.

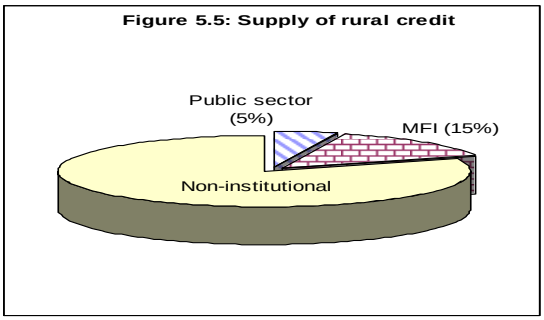


Figure 8:3: Supply of rural credit in the Southern region

In a case study conducted under the preparation of the Master Plan for agricultural development of the Southern region it is roughly estimated that around 80 percent of the volume of credit comes from various non-institutional sources largely dominated by *mohajans* and *dadanders*. They charge interest on loan at exorbitant rates, generally 10 percent per month. Loan conditionality of *dadanders* is quite stringent, as they lend money with the guarantee of repayment in the form of products whose price is fixed unilaterally by them in advance. Advance sale of labor in crop fields in exchange of loan (cash or rice) is also common.

Specialized banks, like the *Krishi Bank*, are a major source of agricultural credit. Two-thirds of the credit from public sector agencies is from specialized banks (Planning Commission, 2011). As of July 2010, there were 527 NGOs registered by the Microfinance Regulatory Authority (MRA). The *Grameen Bank*, however, operates as a quasi-NGO specialized bank outside the orbit of the MRA. They usually cover the landless and poor women who are categorized as "non-farm" households (defined as those who own less than 0.05 acre of land). Average amount of microcredit from MFI sources has been Tk 7,144 (Planning Commission, 2011). Amount of credit received per person would be higher as people borrow from multiple sources.

Despite fast growing microfinance sector and its better recovery performance, there has hardly been any attempt by public sector institutions, particularly specialized banks, to reform their mode of operation and make them user-friendly. Besides few government projects with credit component, public sector credit agencies are characterized by the following phenomena.

- Access to credit is impeded by procedural complexities, such as, provision of collateral, filling up forms and delay in approval.
- Farmers often find it difficult to understand procedures.
- Hidden and real costs of credit are high in terms of travel, time and obscure payments that discourage farmers to go to the banks for credit.
- Poor farmers do not receive satisfactory clientele service from banks.
- Women are excluded from the banking service as they can hardly offer any collateral (land).

As total demand for credit far outweighs its supply, private moneylenders dominate the credit market. Poor farmers have little choice.

8.11. Inadequate availability of quality seeds to the farmers

The first and foremost challenge in the seed sector of Bangladesh is how to make available sufficient quantity of quality seeds to the farmers. The NSB has estimated national requirement of quality seeds to be 932,250 tons for the year 2011-12. The seed replacement rate of quality seed against national requirement was 12.61% in 2005-2006 which has increased to 20% (average of quality seed replacement rate of all agricultural crops) in 2011-2012 against forecasted target of 22%). For improving total crop production, seed replacement rate must be enhanced and the private sector has a major role to play in this endeavour.

8.12. Increased environmental shocks and livelihood risk

The prevailing high incidence of poverty and population density makes Bangladesh extremely vulnerable to climate change and natural disasters (flooding, tropical cyclones and storm surges). Indeed, in the Climate Change Vulnerability Index 2011, Bangladesh is rated 'extreme.' It is the sixth most cyclone-prone country in the world, and first flood prone country in terms of human exposure (annually, 30 to 50% of the country is flooded). Climate change and variability have already been creating adverse impact on livelihoods, particularly those who are living in the coastal areas and in the arid and semi-arid regions of the country. Poorer constituencies are even more vulnerable to climate-induced emergencies, in particular women and children. In addition to affecting lives and livelihoods directly, it also puts a strain on agricultural production and limits investments due to preoccupation with high risk. The most vulnerable regions in Bangladesh are 14 coastal districts in the south and 6 districts of haor basins areas in the north east.

9. Knowledge gaps

Following knowledge gaps have been identified:

- Climate change induced climatic variability and likely impact on availability of water for agricultural production.
- Given the variation between the hydrological regions and expected impact of external drives, the demand needs to be quantified in detail at the level of each region for each of the key sectors
- Availability of mitigation technology and adaptations
- Socio-economic developments, reflected in changing water requirements

10. Development options/Interventions

Following interventions are suggested for inclusion in the Bangladesh Delta Plan for development of agriculture and food security:

Technology development and dissemination

1) *Enhance research and technology generation:* To increase agricultural productivity and diversity in a sustainable manner require research and technology development in support of increased productivity in varied ecosystems is required in the following areas: (i) for crops, varietals development (short maturing Aus and Aman rice, new HYVs, biotechnology) build on respective experiences of private and public sectors; management practices (fertilizer, cropping patterns, cultural practices for char land, hill and coastal areas); and water and soil conservation; (ii) Promote frontier technology development through enhanced investment in R&D for increasing productivity. This will include activities: (i) Develop new varieties, crops, improving food quality, nutrition, etc. (ii) Enhance agricultural productivity through diversification, sustainable management of natural resources (in flood plain and CHT) and inputs. (iii) Promote "agro-ecologically suitable" and "climate-smart" agriculture that are effective to feed the population sustainably in the long term. (iv) Supporting transformation of agriculture by building innovative, action-oriented partnerships with different countries. Promoting innovation and best practice by bringing people together to share experience and expertise.
2) *Improve research-extension-farmer linkages and extension services:* Interventions should be based on existing programmes (such as the National Agricultural Technology Project) and aim to put in practice the agricultural extension policy. They are required in the areas of technology adoption & community-based learning (farmers skill training, soil health improvement, diversification of agriculture, cultivation of quick growing fruits and vegetables, cropping patterns, farm mechanization) and promotion of sustainable agriculture (including implementation of the Southern delta master plan).. In order for interventions to be successful, human and infrastructure capacities of DAE, require strengthening.

Improved water resource management and irrigation

1) *Augmentation of surface water for irrigation through development of water reservoir, recharge ground water, reduce use of ground water to avoid hazard of arsenic contamination:* We have identified some key priority investment activities: (i) the development of small scale surface irrigation in the southern part of the country requiring new infrastructure and capacity building possibly building on the

projects implemented by the Ministry of Local Governments; (iii) partially reduce reliance on deep well irrigation in the northern part of the country, reduce costs and mitigate the risk of Arsenic contamination; (iv) rehabilitate dikes and embankments particularly affected by previous cyclones to protect vulnerable households and production base against sea intrusion in the extreme south, (v) improved drainage, saline intrusion control and flood management; and (vi) increasing river water flow towards the south, in particular involving a major river dredging effort.

2) *Use water saving technology for improving efficiency of water and install facilities to reduce distribution losses:* Activities include: (i) reduce water losses in existing schemes through improved water management (capacity building of water management cooperatives), development of water saving techniques or rehabilitation of existing schemes.
3) *Reduce impact of saline water intrusion in the South and enhance river water flow:* The focused activities that emerged from the consultations are: rehabilitation of polders and their management; dredging of rivers; enhanced surface water irrigation; and improved brackish water resource management practices.

Crop diversification

1) Agricultural productivity enhancement through crop diversification, increased cropping intensity, farm mechanization, reducing post-harvest losses, modeling of climate events and

Sustainable supply and use of improved quality of inputs

1) *Enhance availability of quality agricultural inputs:* The proposed priority interventions are: expansion of both seed multiplication and processing farms and preservation facilities of BADC, NARS, DAE, and contract growers; capacity development of public laboratories and SCA for testing quality of inputs; strengthening participation of NGOs and private sector in seed distribution as the role of private sector in the provision of quality seeds and other inputs has increased over past years; capacity development of farmers for autonomous production of quality seeds; and establishment of mechanisms to ensure availability and reasonable prices of all quality and environmentally friendly agricultural inputs (i.e. seeds, planting materials, fertilizers, pesticides). Develop public private partnerships through capacity development. Public private partnerships are needed in order to strengthen capacities for the production of agricultural inputs, laboratories and the establishment of marketing networks in the country.

2) *Improve and increase sustainability of soil fertility management:* Restoring soil fertility is an important issue for the Bangladesh government**.** The proposed interventions are to promote fertilizer use efficiency and balanced use of fertilizer. The main purpose is to strengthen environmentally sound fertility management practices. This will be done through facilitating application of fertilizers on the basis of soil tests, as well as strengthening of soil testing laboratories and promotion of improved soil health management practices. Additionally, awareness of Upazilla Nirdeshika (land and soil use guide) for location specific prescription of fertilizers by the grass root level extension workers should be strengthened.

3) *Facilitate access to credit and other financial services by smallholders and the rural poor:* There is a strong call for collateral-free bank loans/credit at low interest rates for crops, livestock and fishery production for smallholders and the rural poor. The need to create specialized financial institutions for these sectors was also iterated.

Farm mechanization

Agricultural production and food security in the country is adversely affected owing to the insufficient use of farm power and inappropriate use of farm machinery thereby negatively impacting on environmental sustainability, labour productivity and/or labour scarcity. It is important of moving toward sustainable agricultural practices, by increasing access to environmentally sound agricultural machinery that contributes to the enhancement of rural livelihoods and reduces pressure on natural recourses that are the lifeblood for producing food. Some investment priorities are: (i) Increasing the availability of agricultural mechanization technology to the farmer. (ii) Develop and promote agricultural machinery that is resource and energy efficient and conserve natural resources. (iii) Applying appropriate machinery and equipment for agricultural production and (iv) Training and education for farmers for using suitable farm machinery.

Improving market linkages and development of value chains

1) *Improvement of infrastructure:* A number of **priority investments** have been identified that could form the programme, including (i) Construction and adequate maintenance of rural roads to facilitate marketing of products and access to services in particular in remote areas. (ii) Construction or rehabilitation of rural markets including the supply of potable water, drainage, and storage facilities to improve conditions. (iii) Improvement and rehabilitation of wholesale markets in major cities; (iv) Private storage facilities to reduce losses and increase value added.

2) *Capacity building of value chain actors and market promotion:* A number of **priority investments** have been identified that could form the programme, including (i) Capacity building for group marketing at community level in the form of marketing groups, service cooperatives which capacities should be developed and training provided; (ii) Capacity development of farmers and market intermediaries through training in food quality and safety regulations and requirements, good agricultural practices so as to comply with market requirements; (iii) Improved post harvest management, value chain analysis and facilitation (iv) Promote agro-processing. (v) Facilitate coordinated, market-based action, harnessing the productive capacity of agriculture to drive food security, environmental sustainability and economic opportunity.

3) *Establishment of export processing zones:* Harness opportunities to expand market linkages and agribusiness with establishment of export processing zones.
4) *Improving Food Safety and Quality for Consumer Health and Nutrition:* Food analytical laboratories at the central and regional level need to be established to facilitate support to food manufacturers, individuals and the enforcement of laws. There is no reliable surveillance data on food borne illnesses, impeding the understanding of the extent of disease burden and health and nutritional implications. An effective surveillance on food borne illnesses would therefore be necessary. It is strengthen

capacities of the existing institutions, strengthen consumer protection and build on on-going insufficient food safety activities.

Livelihood improvement and food security

1) Development of programs of alternative income generation and food security, reduce malnutrition of women, children and distressed population.
2) *Development of Community Based Nutrition Activities through Livelihood Approaches:* Home gardening, poultry raising and other community level nutrition-based agricultural activities need to be included as food based nutrition approach and also complemented by integrated horticultural development, fish ponds, behaviour change communication or any other activities on demand. This strategy will include linking agriculture and food based nutrition to other nutrition efforts, including health. The proposed programme under the Delta Plan would aim to restore a process to assist the rural communities, based on their local conditions and priorities, to undertake these activities through a livelihood approach aimed to build local capacities and provide technical and financial support where required.
3) *Livelihoods improvement of population of char land, haor, coastal region and CHT:* All of those *chars* regions are not easily accessible and people are beset with lots of problems and sufferings. Despite appalling conditions, a large number of families, due to abject poverty and lack of alternatives, are often forced to relocate to such lands battling precarious weather and adverse living conditions. As the families are often hard to reach through mainstream anti-poverty programmes, it drastically reduces opportunities to promote social and economic development within these communities. In consequence, to achieve the millennium development goals (MDGs) and accelerated economic growth and nationwide poverty reduction policies of the Government are hindered.

Climate change adaptation

Bangladesh, due to its geo-physical position and socio-economic context, is highly prone to regular natural hazards and the impacts of climate change. Riverine *char* lands, coastal region and haor areas are considered as hotspots for climatic hazards. An integrated approach which combines traditional knowledge with innovative strategies need to be adopted to address current vulnerability while building adaptive capacity to face new and dynamic challenges. The process involves four inter-related strategies: promotion of climate-resilient livelihoods strategies, disaster risk reduction strategies, capacity development for local civil society, and advocacy and social mobilization with particular focus on gender. Interventions should include: (i) Program to promote adaptive knowledge and technologies among communities/farmers. (ii) Enabling local preparedness and flood protection works and modeling under extreme climatic events.

Improved Land management

1) Promote Compact Township to reduce substitution of agricultural land for non-agricultural purposes.
2) *Integrated char development and livelihood improvement:* The intervention activities included: (i) Prevent loss of life from natural disasters, (ii) Reduce loss of land, livestock and other assets due to flood and erosion, (iii) Promote sustainable agricultural development, (iv) Widen access to health and educational services, (v) Increase access to land rights for the landless, (vi) Improve access to development inputs and services.

3) *Improvement of land information, land administration and management:* Bangladesh has a very high population density. Scarce land and the rapid increase of population of the country are creating high pressure over land-man ratio. Land ownership record system is insufficient and incomplete in Bangladesh. As a result, it spills out jumbled and spontaneous land development throughout the country. Therefore, , it is important to establish a compatible land administration and management system for establishing a systematic approach for planned land development. Land Information System (LIS) should be accountable and feasible systematic approach for developing an up-to-date land administration and management. The improved LIS shall be related to various quantitative and qualitative aspects of land resource. Holding different cartographic information, the improved LIS shall facilitate capturing, retrieval, and querying of information and provides tools to perform different analyses.

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