FINAL DRAFT

Agricultural Research Vision 2030 and Beyond

RESEARCH PRIORITIES IN BANGLADESH AGRICULTURE

Bangladesh Agricultural Research Council

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Research Priorities in Bangladesh Agriculture

Editors
Sk. Ghulam Hussain
Anwar Iqbal

Bangladesh Agricultural Research Council

Preface

The importance of agriculture in Bangladesh needs no elaboration. It plays a pivotal role in national economy, food security and labor force employment. Enhanced productivity in a sustainable manner under all sub-sectors of agriculture is a crying need of the nation to cater the growing demand of the increasing population. Although, there has been a commendable success in agricultural R&D, particularly in rice and vegetable over the last three decades, yet there is a growing concern among the scientists and policy planners about how to meet the demand of the increasing population in future when our natural resource base (land, soil & water) is shrinking and degrading. The situation becomes graver with climate change. This is really a formidable challenge for the nation. A break through in agricultural R&D can only ease the situation. Concerted efforts for effective research and development with policy support would be the key instruments for increasing productivity and production to cope with future demand. In this context, identification and prioritization of the researchable areas/issues under all sub-sectors of agriculture is an essential prerequisite for best utilization of the available national resources. However, in order to harness the potential benefits, the research and development efforts must be supported with adequate financial and technically qualified and dedicated human resources.

Under the above stated backdrops, Bangladesh Agricultural Research Council (BARC) being an apex body of the National Agricultural Research System (NARS) has taken up a task to prepare a Vision Document on Agriculture for 2030 and beyond. Identification of researchable issues under different sub-sectors of agriculture and their priority ranking as high, medium and low is the 1st step in undertaking R & D projects in agriculture. Priority setting, an essential part of research planning process would be an integral part of this vision document. To accomplish this task, 12 national experts were engaged to prepare background papers under 12 different sub-sectors of agriculture where priority setting in agricultural research would be an essential component. Background papers prepared by the national experts with priority ranking in agricultural research were presented before the senior scientists of NARS institutes as well as senior extension officials for discussion and feedback. Local level problems as identified by CIG members and incorporated in the Upazila Extension Micro plans were also considered in priority setting process. Basically, problem oriented scoring and value judgment approaches were followed in this exercise. Key parameters considered in this priority setting exercise were: severity of the problem, extent of the problem, magnitude of economic loss due to this problem, chance of solution of the problem, size of beneficiary farmers, time to be required to solve the problem and cost required for the solution.

Our goal is to bring a break through in agricultural R&D for enhanced productivity in all sub-sectors of agriculture. With that end in view, a list of priority researchable areas/issues under all sub-sectors of agriculture has been prepared after a series of consultative meetings/workshops with relevant stakeholders, including farmers for the next 20 years and beyond.

I am very much hopeful that this priority list prepared by the competent professionals of the country through an exhaustive exercise for all the sub-sector of agriculture would serve as an effective guide for undertaking core research by NARS institutes as well as research under Sponsored Public Goods Research of NATP & Competitive Grants Programme of Krishi Gobeshona Foundation.

Dr. Wais Kabir
Executive Chairman
Bangladesh Agricultural Research Council

Acknowledgement

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Last but by no means least, with deep sense of gratitude I sincerely thank the Committee Members for their contributions made during the preparation of this document.

Sk. Ghulam Hussain
Convener,
Committee for Finalization of Priority Research

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Abbreviations and Acronyms

AI	:	Artificial Insemination
ARI	:	Agricultural Research Institute
AWD	:	Alternate Wetting and Drying
BADC	:	Bangladesh Agricultural Development Corporation
BARC	:	Bangladesh Agricultural Research Council
BAU	:	Bangladesh Agricultural University
BBS	:	Bangladesh Bureau of Statistics
BEI	:	binaryethylenemine
BFRI	:	Bangladesh Forest Research Institute
BGM	:	Botrytis gray mold
BIDS	:	Bangladesh Institute Development Studies
BLB	:	Bacterial Leaf Blight
BLS	:	Bacterial Leaf Streak
BNF		Biological Nitrogen Fixation
BPH	:	Brown Plant Hopper
BPLB	:	Bipolaris Leaf Blight
BSTI	:	Bangladesh Standard Testing Institute
BWDB	:	Bangladesh Water Development Board
CGIAR	:	Consultative Group on International Agricultural Research
CGP	:	Competitive Grants Program
CIG	:	Common Interest Group
CIMMYT	:	International Maize and Wheat Improvement Center
CNG	:	Compressed Natural Gas
DAE	:	Department of Agriculture Extension
DANIDA	:	Danish International Development of Agency
DFID	:	Department for International Development
DLS	:	Department of Livestock Services
DoF	:	Department of Fisheries
DSR	:	Direct Seeded Rice
DSS	:	Decision Support System
DTW	:	Deep Tubewell
ELISA	:	Enzyme-Linked Immunosorbent Assay
EPB	:	Export Promotion Bureau
ES	:	Expert System
FAO	:	Food and Agriculture Organization of the United Nations
FD	:	Forest Department
FMD	:	Foot & Mouth Disease
FYM	:	Farm Yard Manure
GDP	:	Gross Domestic Product
GM	:	Green Manure
GM/GMO	:	Genetically Modified Organism
GoB	:	Government of Bangladesh
GPS	:	Global Positioning System
HACCP	:	Hazard Analysis Critical Control Point
Hortex	:	Horticultural Export Development Foundation
HYV	:	High Yielding Varieties
IBU	:	Interactive Bottom-Up
ICM	:	Integrated Crop Management
ICRISAT	:	International Crops Research Institute for the Semi-Arid Tropics
ICT	:	Information and Communication Technology
IGA	:	Income-Generating Activity
INFS	:	Institute of Nutrition and Food Science
IPCC	:	Intergovernmental Panel on Climate Change
IPHN	:	Institute of Public Health Nutrition
IPM	:	Integrated Pest Management
IRR	:	Internal Rate of Return
IYR	:	International Year of Rice

Abbreviations and Acronyms *contd*..

JAF	:	Jute and Allied Fibre
KGF	:	Krishi Gobeshona Foundation
LR	:	Leaf Rust
MDG	:	Millennium Development Goal
MIS	:	Management Information System
NARC	:	National Agricultural Research Centre
NARS	:	National Agricultural Research System
NCCD	:	Non-communicable Diseases
NCFR	:	Non-Conventional Feed Resources
NGO	:	Non-Government Organization
NPV	:	Net Present value
OIE	:	World organization for animal health
OM	:	Organic Matter
P&E	:	Planning and Evaluation
PCR	:	Polymerase Chain Reaction
PCU	:	Project Coordination Unit
PIU	:	Project Implementation Unit
PM	:	Poultry Manure
POs	:	Private Organizations
PPR	:	Peste Des Petits Ruminants
PRA	:	Participatory Rural Appraisal
PRS	:	Poverty Reduction Strategy
PTD	:	Participatory Technology Development
QPM	:	Quality Planting Material
RCT	:	Resource Conserving Technology
RDA	:	Recommended Dietary Allowance
RFLP	:	Restriction Fragment Length Polymorphism
RT-PCR	:	Real-time polymerase chain reaction
SLR	:	Sea Level Rise
SPGR	:	Sponsored Public Goods Research
STW	:	Shallow Tubewell
TB	:	Tuberculosis
ToR	:	Terms of Reference
TPS	:	True Potato Seed
UNDP	:	United Nations Development Programme
YMV	:	Yellow Mosaic Virus

1. Introduction

Bangladesh is one the most densely populated countries of the world. The country has a land area of 148.4 million hectares (Mha), population of over 144.2 million with a density of about 1000 persons per km^2, which is one of the highest in the world. The economy of Bangladesh is based on agriculture, industry and services. The agriculture sector contributes a major share in the GDP, which is about 20.6% and employs about 48.10% of the working force. Services sector is also an important sector in the economy of the country; about 49.67% of the GDP is generated through this sector and the rest by industry sector (29.73%) (both the sectors engage 37.35% and 14.55% of the work force respectively (BBS, 2009). Again, among the sub-sectoral contributions of agricultural GDP (Figure 1) is dominated by crops (56.07%), followed by fisheries (22.18%) and Livestock (13.25%) and the rest by forest and related services (8.50%) (BBS, 2010).

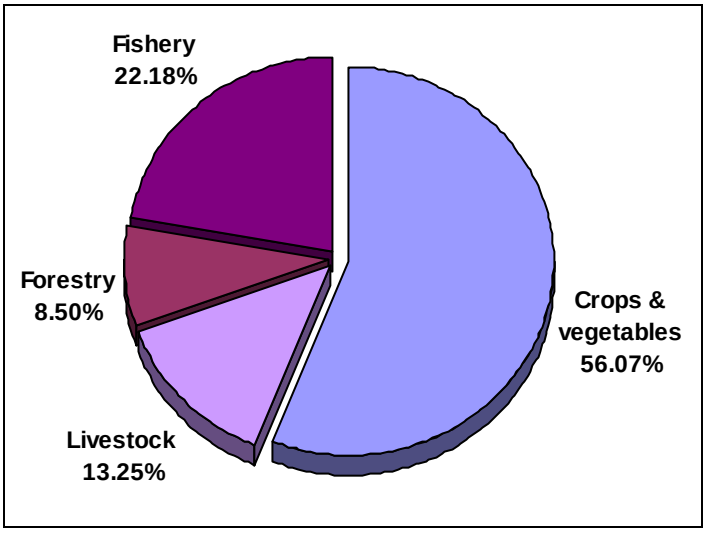

Figure 1. Sub-sectoral Contributions to Agricultural GDP

1.1. Major Challenges in Agriculture

The country has to face a number of challenges for achieving sustainable food security. The major ones are:

- High Population Growth
- Declining and Degrading Land resources
- Decreasing Water Resources
- Increasing Natural Hazards
- Climate Change Vulnerability
- Wide Yield Gap
- Imperfect Market

1.1.1. High Population Growth

Rapid population increase is one of the major problems of Bangladesh. The population growth rate is about 1.26 %, which translates into about two million additional new

mouths every year need to be fed. The estimated population stands at 144.2 million in 2008-09 (BBS, 2010). The projected population for the 2015, 2020 and 2030 would be 156.70, 166.90, 195.53 million respectively and to feed them the estimated food, especially rice and wheat, requirements would be 25.943, 27.632 and 32.377 million tonnes (MoA, 2007). Number of Civilian Labour Force is 47.4 million of which 36.1 million is male and 11.3 million Female. Sectoral Contributions to GDP and Employment of Labour Force is presented in Figure 2.

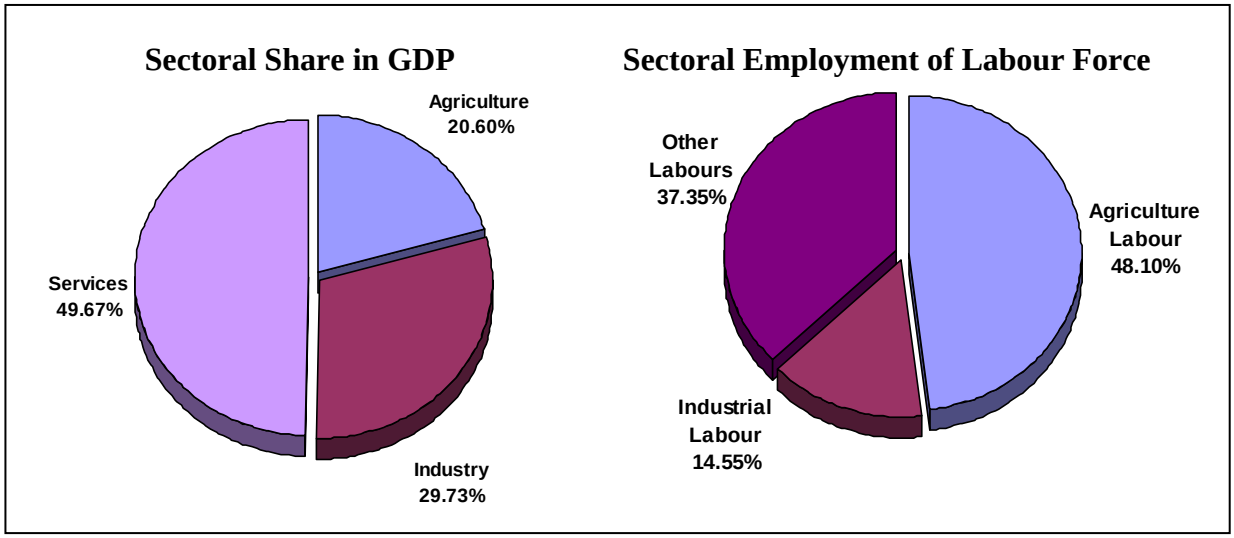

Figure 2. Sectoral Contributions to GDP and Employment of Labour Force

1.1.2. Declining and Degrading Land Resources

Bangladesh has a total area of 148.4 million ha (Mha), 67% of which is arable. The effective land area of the country is roughly 13.39 Mha, about 0.98 Mha is occupied by rivers and 2.14 Mha are under forest cover (BBS, 2008). The country is predominantly flat with almost 80% of the land area occupied by floodplains and piedmont plains, about 8% by slightly uplifted fault blocks (terrace) and about 12% by hills. In one hand, during the last three decades the population has grown rapidly, which has put intense pressure on the scarce land resource to produce more food for its vast population and infrastructure development. About 1% of the cultivable land is going out of agricultural use annually. The land-man ratio is decreasing at an alarming rate; the current estimated per capita arable land stands at 0.05 ha only. On the other hand, intensified agricultural land use accompanied with increased use of modern crop varieties has contributed to deterioration of soil health (Jahir et al, 2010). The agricultural land use statistic is presented in Table 1.

There are many different processes of land degradation/land quality change due to improper anthropogenic interventions. In Bangladesh, active land degradation processes are water erosion and loss of fertility due to physico-chemical or biological degradation of soils. Water erosion is the widespread and affecting about quarter of the agricultural land. The areas of low soil fertility comprise about 60% of the total cultivable land of the country. This is due to nutrient mining, the balance between input and uptake of plant nutrients is negative in most cases. In one hand, deficiencies of major nutrients like N, P, K and S are widespread. On the other hand, deficiencies of micronutrients like Zn, B, Mg and Mo have been reported in many areas. Most of the

Bangladesh soils suffer from organic matter depletion and contain less 1 to 1.7%. Present average organic matter level of the 50% soil is only 1.0%.

Table 1. Agricultural Land use statistics of Bangladesh

Total area	14.845 million hectare
Forest	2.599 million hectare
Cultivable land	8.44 million hectare
Cultivable waste	0.268 million hectare
Current fellow	0.469 million hectare
Cropping intensity	175.97%
Single cropped area	2.851 million hectare
Double cropped area	3.984 million hectare
Triple cropped area	0.974 million hectare
Net cropped area	7.809 million hectare
Total cropped area	13.742 million hectare

Source: BBS, 2010

1.1.3. Decreasing Water Resources

The hydrological cycle of Bangladesh is influenced very much by the presence of the Himalayas in the north and the Bay of Bengal in the south. The major watersheds important for the country are the Brahmaputra and the Ganges. About 93% of water that flows through the country comes from trans-boundary sources. Annual river flow from other countries is 1105.6 km3 and annual internal renewable 105.0 km3, while annual withdrawal is only around 15.0 km3. The sectoral withdrawal is dominated by agriculture (86%) followed by domestic (12%) and industry (2%).

Water is an essential component of sustainable agriculture. For rainfed or irrigated crop cultivation, livestock production, fisheries, and forestry development an adequate supply of good quality water is essential. In Bangladesh, about 90 percent of the rainfall occurs in the monsoon from June to September. Due to scanty rainfall in other months, areas having low soil moisture content and physical soil constraints to tillage, crop diversification are hampered considerably (Karim et al., 1986). Proper irrigation plays a vital role in crop production in the country and will be of more importance in the future, when the scarcity of fresh or irrigable water is feared to increase. Soils vary conspicuously with respect to moisture holding capacities, infiltration rates, and other related properties (Karim et al., 1990). Therefore, more emphasis should be given to rainfed and low water consuming agriculture. Most of the present large scale gravity irrigation systems are operating at much below the planned capacity, mainly because of poor operation and maintenance. The cost of irrigation has also increased substantially with rapid deterioration of existing facilities. The future development of surface water would require a large public investment.

According to irrigation potential there is still scope for expanding 28 percent of irrigated area. At present groundwater contributes to 77% of total irrigated area in Bangladesh (BBS, 2008). The groundwater irrigation increased with the expansion of High Yielding Variety (HYV) rice cultivation. About 80% of groundwater was used for crop production of which Boro paddy alone consumes 73% of total irrigation (Rahman and Ahmed, 2008). Hence, Boro rice production is increasing at about one percent annually and contributes to 55% of the total rice production (BBS, 2007).

The irrigation water use efficiency in STW and DTW command areas is below 60%. The water productivity is equally low at about 0.3 kg grain per cubic meter of water; on the other hand, the cost of pump irrigation has been estimated at about Tk. 3,500 per hectare per season at present. It is projected to further increase with increasing cost of operation and maintenance including the cost of diesel, since a vast majority of pumps (90%) is operated by diesel. Diesel supply and high price problems do occur during peak irrigation season. Adequate supply of diesel at reasonable prices is essential to support irrigated agriculture.

Reduced water availability, climate change and intensive agricultural practices through changing crops and cropping patterns result increased demand for water in Bangladesh. Agricultural Water Management is considered one of the important areas of research today. Water saving technology and water management, storing and processing are equally demanding areas.

Arsenic in groundwater is a major health and environmental concern in Bangladesh. A large-scale contamination of groundwater with arsenic has been detected in about two-thirds of the geographic area of Bangladesh. It has been identified that, arsenic laden pyrites are the source minerals of arsenic that are being drawn up to the surface with the extraction of groundwater. Water samples from over one-half of the hand tube-wells of about 54 districts showed concentrations of arsenic exceeding the national acceptable limit of 0.05 mg/1.

In Bangladesh, groundwater tables are generally at shallow depth. Recharge conditions are favourable in 80 per cent of the alluvial basin due to heavy monsoon rains and prolonged inundation. The high permeability of the aquifers and the quality of water contained by the systems are good, with the exception of brackish and saline groundwater in the coastal zone. Groundwater irrigation accounted for 69 percent of the total minor irrigation command area in 1994 (MOA/FAO, 1995). In most parts of Bangladesh, these shallow aquifers are hydraulically connected to surface water sources.

1.1.4. Increasing Natural Hazards

Frequent natural hazards are common and their severity is increasing in Bangladesh.

Floods: Different types of flood occur in Bangladesh. About 1.32 Mha and 5.05 Mha of the net cropped area (NCA) is severely and moderately floodprone. In 1998, over 65% of the country's land area was inundated for a period of over 60 days. Crop loss was enormous, besides loss in man and materials.

Droughts: Rainfed transplanted aman paddy, which contributes nearly 40% of the total rice production. The crop is affected by drought resulting loss of more than 45% of the achievable yield. During dry and pre-monsoon season, wheat, potato, broadcast paddy also suffers yield loss. About 2.32 Mha and 1.2 Mha of NCA are severely affected by drought during monsoon and dry rabi season respectively.

Salinity and coastal tidal surges: Over 30% (2.85 Mha) of the NCA is on the coast of which 1.02 Mha is affected by different degrees of salinity. Agricultural land use is poor because of tillage problem; and crop diversification is a problem because of the lack of suitable salt tolerant crop cultivars. Crop yield very often suffers to a great extent due to salinity.

Loss of land and soil resources: Land areas in the floodplains and newly accreted 'char lands` are subject to moderate to severe erosion due to mainly river erosion and storm

surges. Further loss of topsoil in the hill (1.74 mha) slopes due to faulty management is of serious environmental concern. Lack of appropriate watershed management practices has resulted in deterioration of cultivable soil through siltation.

Cyclones and storm surges: Because of the funnel shape and geographic location of Bangladesh, severe cyclone and tidal surges are common in the 710 km long coastal belt causing severe damage to life and property. Tidal surge of 29 April 1991, caused death of 1,25,000 people and damage of several thousand hectares of crop and other properties occurred.

Global warming and sea level rise: As projected by the Intergovernmental Panel of Climate Change (IPCC), sea-level rise will inundate 16% of the total area, displacing 10% of the population and causing loss of 2 million tons of crop harvest by the year 2050 in Bangladesh. Global warming will inhibit cyclones and storm surges in higher frequency and volume also. The increasing salinity will almost destroy the mangrove forests of the Sunderbans in the south west of Bangladesh (Mahtab and Karim, 1992).

Desertification: Vast Northwest region of the country falls in the minimum rainfall zone of the country (average 1200-1400mm); experiences high summer temperature (>40°C)-also cool temperature during winter (4° to 8°C). Since drought effect is highest in the northwest, vegetation suffers much. Further to this, diversion of the Ganges river water adds to further complicate the situation. These results in low discharge/even disruption in groundwater supply during various times of the year. Some sort of aridity situation prevails in the northwest causing loss in flora and fauna of that region. Satellite imagery indicates a definite denudation of vegetative cover, which resembles to an arid zone during March-April.

Air and Water Pollution: Air and water pollution does not respect boundaries, and affects ecosystems and agriculture. Because of the transboundry characteristics of air and water pollution, global as well as regional planning to combat pollution is essential. Air and water pollution in the megacities of the topical Asia is a major concern of today. The emission of GHG within the country and in the region is affecting the life and production system of agriculture in the country. Though the emission of GHG in Bangladesh and many countries of the region is low, but the region is blamed much for the emission of CH4 from the rice fields through wet land culture. Since industrial emission of CO_2 is very low in the region, much could be done to abate CH_4 emission from rice field through appropriate management.

Arsenic in groundwater is a major health and environmental concern in Bangladesh. A large-scale contamination of groundwater with arsenic has been detected in about two-thirds of the geographic area of Bangladesh. It has been identified that, arsenic laden pyrites are the source minerals of arsenic that are being drawn up to the surface with the extraction of groundwater. Water samples from over one-half of the hand tube-wells of about 54 districts showed concentrations of arsenic exceeding the national acceptable limit of 0.05 mg/1.

1.1.5. Wide Yield Gap

Yield gap (the difference between national average yields and research station yields) can be reduced by transforming present crop varieties into varieties that have stronger resistances to diseases and pests and are better able to withstand abiotic hazards. The yield gap is large not only for rice but for all other food crops as well as in the fisheries and livestock sectors. To narrow the yield gap, scientists must develop varieties with

stronger tolerances or resistances to the biotic and abiotic production hazards that farmers face. Determination of the management variables that are responsible low yields at farm level is very important. On the other hand, research-extension-farmer linkage should be strengthened in order to better disseminate the new technology.

1.1.6. Climate Change Vulnerability

Climate change is no longer a hype, it is a reality and it is announcing its presence through increasingly erratic behaviour. The Fourth Assessment Report of the IPCC (2007) considers agriculture and water are likely to be most susceptible sectors to climate change-induced impacts in Asia. Agriculture is one of the most vulnerable systems to be affected by climate change in the south Asian region. Agricultural productivity in this region is likely to suffer severe losses because of high temperature, severe drought, flood conditions, and soil degradation. According to the Intergovernmental Panel on Climate Change (IPCC), Bangladesh will be one of the worst victims of climate change. Sea level will be increased due to rise in temperature and the frequency of cyclone-storms will also be increased. As a result, food security will be in jeopardy and different types of natural calamities will put lives at risk. On top of these, high population density will make the problem more serious.

The people of Bangladesh have been adapting to the risks of floods, droughts and cyclones for centuries. Heavy reliance of rural people on agriculture and natural resources increases their vulnerability to climate change. Therefore, supporting rural and urban communities to strengthen their resilience and adaptation to climate change will remain a high priority in coming decades. Disaster management, climate change and other related issues in agriculture are cross-cutting in nature. All the sub-sectors of agriculture are vulnerable to natural hazards, shocks and stresses. Although, all the sub-sectors might not be impacted equally, but it is likely that some would be more susceptible.

1.1.7. Imperfect Market

Faster growth in urbanization and concentration of higher income groups in the urban areas, the demand for improved marketing services is rising. The costs of such services are higher particularly in case of perishable products like fruits, vegetables, fish, milk, meat, eggs etc. as they need careful packaging and cooling vans for safe transportation. The costs of wholesaling and retailing of these perishable products are thus, higher. Actually farmers' shares to urban consumers' prices often go below 40%. The shares decline further in the off-seasons due to extra costs of specialized storage and other needed post-harvest services. Farmers are therefore, deprived of due shares in their prices. Their shares could however, be raised if the farming community could be directly involved in the distribution of farm products to consumers. Seasonal nature of farm productions is encouraging the growth of food processing industries in Bangladesh, especially noticeable in fruits and bakery industries. Some of the processed products are allegedly adulterated.

Further, with respect to the prevalence of market competition, there are allegations of syndications among the traders and thus, the farmers are deprived of fair prices of their produces. Existing market information services there are of little use. Actually poor bargaining power on the part of growers is the main bottleneck there; although no such specific study has been undertaken in this regard.

The challenges mentioned above are not all, but the major ones. Some are anthropogenic and some are natural. Some of them can be coped through scientific research and some can be adapted innovative ideas. For achieving sustainable food security these have to be addressed to overcome their negative impact. Therefore, there is no alternative of demand-driven research in these arenas.

1.2. Why Priority Setting is Necessary?

Recent global as well as country level developments and trends are making agricultural research more challenging. On the one hand, in the developing countries population growth, urbanization and rising incomes will create an increasing and shifting demand for food. Demand for high value cereals, fruits, vegetables, animal products and processed foods are likely to increase significantly. On the other hand, globalization of the economies, price hikes of agricultural commodities, and increase in climate related vulnerabilities, etc. are also shifting the research agenda (Li Pun and Koala, 1993).

When resources like investment, infrastructure and human resources are insufficient getting priorities right is one way to improve the effectiveness of public-sector agricultural research. But informed priority setting is not a necessary and sufficient condition for effective public-sector agricultural research that is often constrained by lack of incentives, low and seasonally unavailable operating budgets, obsolete research infrastructure, and inadequate human capital (Eicher 2001). These constraints are more or less common in the developing and under-developed countries.

Eliminating these constraints requires long-term attention and so does the generation of a routine and cost-effective process for priority setting. Bryson (1988) outlined four broad areas, which present barriers to effective strategic planning, which seem directly reflected in the challenges we find in setting program priorities. The four barriers are:

a) **The Human Problem** – difficulty in focusing the attention of key people on key issues, decisions, conflicts, and policies. The challenge is to establish the imperative of organization priority setting, asking people to set aside specific interests until the broader framework is developed.

b) **The Process Problem** – managing information and ideas throughout the priority setting process. A key challenge is to develop support for the product throughout the process.

c) **The Structural Problem** – management of part/whole relationships. For us, the challenge is to arrive at Association-wide priorities that reflect consistent interpretation of mission and goals. We have done fairly well setting priorities within program areas but across programs

d) **The Institutional Problem** – translating priorities into action this entails assuring follow through on changes reflected in the new priorities.

1.3. Priority Setting Processes in Practice

As there are changing demands on agricultural research and growing scarcity of research resources, research priorities must be consistent with the clients needs, scientific potential, national priorities and should be framed in a broader policy context. There are no simple, transparent methods for priority setting. Research priorities are set

across commodities, regions, disciplines, technology types, research problems and also at different levels –national, institute, research program, project, etc.

Priority Setting is doing “First Things First” in a cost effective manner. It is not static but dynamic. Li Pun and Koala (1993) reported that priority setting is usually done through expert consultation meetings. Based on opinions of participants, a steering committee usually proposes an annual or biannual research agenda. A general framework is established based on the problems to be solved and proposed options. This guides to annual or biannual reviews of priorities. Priorities in general respond to biological constraints, although low-input technologies or adaptability to small farm situations is often mentioned. However, even in those cases, socioeconomic analyses are often missing.

National and international research institutes and NGOs have a growing interest in structured and more transparent methods of priority setting. In practice, they increasingly face similar problems in priority setting. Aside from selecting and applying appropriate methods, they have to ensure that various stakeholders are well represented. This is crucial for the results and implementation of identified priorities (Manicad, 1997).

There are two major approaches in priority setting procedures - top-down and bottom-up. Officials dominate the top-down approach and experts oriented towards achieving government goals and based on technical information provided by the research leaders and scientists. In case of the bottom-up approach basically farmers together with scientists is involved in the priority setting of problems and solutions. Farmers' needs, knowledge and priorities are solicited to formulate research agendas and identify research priorities.

In other methods such as ***Participatory Technology Development (PTD)***, farmer participation goes beyond diagnosis and priority setting. PTD includes farmer-led experiments, development and evaluation. Although bottom-up approaches originate from NGOs, the methodologies are now increasingly adapted by some NARCs and IARCs. Manicad (1997) briefly described two examples of PTD as:

Participatory Rural Appraisal (PRA) is a compilation of semi-structured activities carried out by interdisciplinary teams in partnership with communities and their local leaders. Although PRA deals with general community development, it could be specifically designed for agriculture research. Farmers can improve problem diagnosis and orient research to local issues and circumstances. PRA's visual approaches and the cross-checking with interdisciplinary teams and community members can be an effective tool for implementing participatory research and development.

The Interactive Bottom-Up (IBU) approach's main strength is the involvement of different actors (scientists, farmers, governments, NGOs, donor) to a series of dialogues to assess problems and prioritize solutions for small-scale farmers regarding biotechnological innovations. Enhancing dialogue amongst different institutions is still relatively pioneering work. The IBU approach utilizes interdisciplinary perspectives to technology assessment and development, and assesses the comparative advantage of biotechnology over other existing technologies. However, both the approaches can suffer from imbalance in representation.

The main aims of priority setting exercises, be it formal or informal, are defining research agenda, guiding allocation of resources to improve quality and efficiency of

research. However, there are some supply driven and demand driven approaches followed in the CGIAR Institutes. The approaches are as follows:

Precedence considers the level of funding in the previous year as a basis for the following years allocation of resources. While the congruence method, ranks alternative research themes or areas on the basis of a single measure. In case of scoring approach ranks alternative research programs, themes, or project according to multiple criteria. In one hand, the benefit-cost model uses efficiency as the main criteria for ranking alternative research themes (generation and adoption of technologies, annual benefits and costs, NPV, IRR). On the other hand, the economic surplus model considers enhancement of benefit-cost; price responses to increased productivity induced by investment in research and technical change.

Bangladesh Agricultural Research Council (BARC) is the apex body of the National Agricultural Research System (NARS). As the apex organization the mandated objectives and functions of the Council are to plan, execute, coordinate, monitor, and evaluate agricultural research keeping national needs in view. Besides these, prioritizing agricultural research vis-à-vis National Agriculture Policy guidelines is a prime task of BARC. The Council is entrusted with the preparation the Vision Document and the National Agricultural Research Plan at certain interval based on the national priorities. These documents serves as a guide for planning of research and undertaking action plan to implement those by the NARS; comprising 11 institutions including BARC. Based on these, the agricultural research institutions (ARI) draw up their Master Plan and execute research activities accordingly.

Research priority setting in agriculture is a dynamic process. This is required to adjust with the contextual and temporal changes and to undertake demand-driven research to address the need of the technology users. Priority setting in agricultural research has been done earlier by BARC, but this is for the first time, besides different stakeholders the views at grass-root level were taken into consideration in priority setting endeavor. A hybrid approach was followed in this priority setting efforts rather than following one of the six aforesaid methods. The detailed procedure has been described in the methodology section of this document.

Several group meetings were held to review the research priorities at ARIs and universities. All Extension agencies e.g., DAE, DOF, and DLS and also Hortex Foundation were requested to provide information on identified field level problems. Four regional workshops provided valuable inputs on regional issues. All these were taken into account in setting research priorities. Synthesis and finalization was done at a national workshop.

To provide guidance and research direction to the ARIs and for funding of research, BARC needs to perform this mandated job based on analysis of the problems faced by the farming community. The Government of Bangladesh and development partners also need a set of priority issues in order to assist in research pursuits. Moreover, public and private sectors follow BARC's Agricultural research priorities. Currently, Project Implementation Unit (PIU) of BARC under The National Agricultural Technology Project (NATP) Phase-I and the Krishi Gobeshona Foundation (KGF) respectively; are using BARC's research priorities for funding of activities under Sponsored Public Goods Research (SPGR) and applied/adaptive research under Competitive Grants Program (CGP).

In each of the regional workshops participants were asked to breakout into Thematic Groups according to their preference/choice and discipline/expertise. Thematic Groups varied with the region because of the agroecological settings and predominance of type of agricultural practices. The outcomes of the regional workshops were rationalized and presented at the National Workshop held during 01-02 June 2010 at BARC, Dhaka. Through these processes, a vast wealth of information was accumulated, which needed further synthesis and refinement to enable the research planners to undertake research through core program of the ARIs and to execute grant program under SPGR and CGP.

Finally, for the purpose, the Dr. Wais Kabir, Executive Chairman of BARC formed a Committee vide Memo:ARC/P&E/RP/2009 dated 21-06-2010 with the following members and Terms of Reference:

Committee for finalization of Priority Research Areas:

1.	Dr. Sk. Ghulam Hussain Member Director (Planning & Evaluation), BARC	Convener
2.	Dr. N. I. Bhuiya Director (Research Management), KGF	Member
3.	Dr. Md. Matiur Rahman National Coordinator (Research), PCU	Member
4.	Dr. Khabir Ahmed National Coordinator (Fisheries), PCU	Member
5.	Dr. Muhammad Salehuddin Khan National Coordinator (Livestock), PCU	Member
6.	Mr. M. Anwar Iqbal Monitoring & Evaluation Expert, PIU-BARC	Member
7.	Dr. Md. Abdur Razzaque Senior Programme Officer (Research Management), KGF	Member Secretary

Terms of Reference:

a. Review and synthesis of the (i) information gathered on "Research Priority in Agriculture" and contained in the 12 Sub-sectoral study reports (ii) recommendation of the regional workshops on research priority (iii) research need obtained from the upazila extension plans, Hortex, DoF, CIG farmers and others and (iv) feedback from the National workshop on Research Priority.
b. Based on the above, formulate the "Research Priority" in all the Sub-Sectors of agriculture by thematic areas and finally transform the indicated research into researchable topic with duration and priority ranking.
c. In doing so, the team may consider and incorporate if found some important and urgent research agenda missing in the earlier exercise.
d. The team, if needed may take the assistance of the Member-Secretaries of the Sub-Sectoral groups.
e. The final report to the completed and submitted to the undersigned by 08 July 2010.

Efforts were made to categorize all the researchable areas/issues under each thematic area into sub-clusters. In case of commodity the thematic areas were basically Production, Protection, Processing and Marketing, Food/Feed and nutrition, etc. While in case of non-commodity related issues, the sub-clusters varied and were in line with the goal of food security, sustainable use of natural resources, and disaster management

etc. Priority setting was done considering the nature of research like basic, strategic, applied and adaptive. The duration for each type of research was categorized as, short, medium and long. The document is organized under the following sub-sectors:

1. The Crops Sub-Sector included major cereals like rice, wheat, and maize; minor cereals are barley and millets. Under the non-cereal crops- fibre crops, oilseeds, pulses, roots and tubers, sugarcane, spices, vegetables, fruits, and flowers and ornamentals were considered.
2. Sub-Sector: Livestock included cattle, small ruminants, and poultry.
3. Sub-Sector: Fisheries considered riverine, marine and brackish water fisheries and both open water and capture for inland fisheries.
4. The Sub-Sector: Natural Resource dealt with land and soil resources, water resources for agriculture and forestry.
5. Sub-Sector: Human Nutrition included matters related to food availability and consumption, post harvest losses, and agro-processing technology, food quality, safety and human nutrition
6. Sub-Sector: Agricultural Economics incorporated matters relating to policy and planning, production and farm productivity and supply chain and marketing.
7. Sub-Sector: Agricultural Mechanization considered pre- and post harvest mechanization
8. Sub-Sector: ICT and Disaster Management in Agriculture dealt with the use of ICT in the field of agriculture and management of disasters in agriculture

This document assessed the demand driven research needs in the agriculture sector and identification and targeting of new research areas, identifies emerging research issues, and provides a guideline for the public as well as private sector R&D in agriculture. It is believed that this effort would be useful in strengthening the agriculture of the country at large.

2. Methodology

Priority setting exercise for agricultural research was taken up as one of the tasks towards developing the 'Vision-2030 and beyond' document; which the BARC has conceived in the recent time. As a way towards that, detailed sub-sectoral studies were planned and executed embracing the priority exercise. To accomplish the task, BARC formed and engaged 12 Sub-sectoral Working Groups with specific Terms of Reference (ToR) presented in Annex-1, each group led by an eminent scientists/professor (Annex-2) as the Group Leader. Beside others, the Member-Secretaries drawn from different technical divisions of BARC specifically assisted them. The groups were provided with specific guidelines (Annex-3) for their work. Each group was assigned for detailed sub-sectoral study and to report on the problems, opportunities and constraints in their respective areas. To assist in performing the task, the Group Leaders were provided with several relevant documents on policy, Government/Development partners' technical reports, Master Plan & Annual of ARIs, Website addresses of various agencies etc. for consultation and review. Further, BARC communicated with all the Extension agencies and requested them to provide information on field problems. On receipt of the diagnostic information from the DAE, DoF, DLS and Hortex those were also made available to the Group Leaders. The Group leaders arranged several consultation meetings with the professionals of their respective areas at the ARIs, Universities and other relevant agencies and collected their opinions and required information.

Four Regional Consultation Workshops on Agricultural Research Priority Setting were organized by BARC; out of which, two were organized in association with KGF. Participants from different stakeholders attended these workshops. On average, 55% of the participants were from different extension agencies, 25% from research, 10% farmers and the rest 10% from NGOs and POs and other organizations. Besides, most of the leaders and members of the Working Groups were present at the workshops.

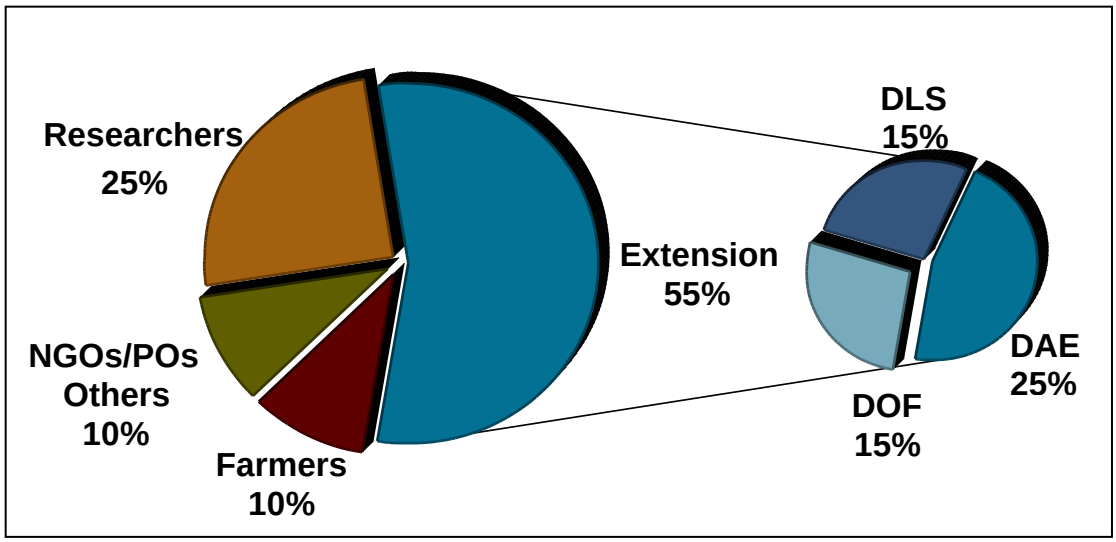

Figure 3. Stakeholders' participation by profession

The activities of the breakout groups were divided based on regional context, reality and the local expectations (Table 1). The recommendations of the workshop were also made available to the Group Leaders for consideration.

Table 2. Four Regional Stakeholders Consultation Workshops on Agricultural Research Priority Setting

Region	Venue	Date	Sponsor(s)	Thematic Groups
Rajshahi	Rural Development Agency, Bogra	29 December 2009	Jointly organized by BARC and KGF	– Plain Land Agriculture – Terrace Agriculture – Livestock – Fisheries
Chittagong	Regional Public Administration Training Centre, Chittagong	11 January 2010	Jointly organized by BARC and KGF	– Plain Land Agriculture – Coastal Agriculture – Hill Agriculture – Fisheries: Marine and Freshwater – Livestock
Khulna	BRAC Centre, Barisal	27 January 2010	Organized by BARC	– Plain Land Agriculture and Coastal Non-Saline Agriculture – Coastal Saline Agriculture – Livestock – Fisheries Brackish
Dhaka	Bangladesh Institute of Nuclear Agriculture, Mymensingh	17 February 2010	Organized by BARC	– Plain Land Agriculture – Forest, Hill and Terrace Agriculture – Haor and Depressed Land Agriculture – Livestock – Fisheries

After preparation of the draft sub-sectoral reports, the Group Leaders presented the draft report in forums of their respective discipline organized by BARC. The feedbacks obtained were incorporated in the updated/revised reports. Final draft reports were presented by the Group Leaders in the workshop of the Head of the agencies of research and extension and policy planners arranged by BARC. The inputs obtained were taken into account by the Group Leaders to prepare the almost final form of the reports which were then presented by the Group Leaders in the larger forum of the participants, in the broader breakout groups of the National Workshop on Research Priority organized by BARC. The suggestions, comments and opinion of the learned participants were evaluated and used in the finalization of the priorities in the sub-sectoral reports. By the process, updated researchable problems were identified and furnished in the Sub-sectoral reports. Twelve Sub-sectoral reports were placed in the public domain at the website: www.barc.gov.bd. To review, compile, synthesize and formulate the "Research Priority" in all the Sub-Sectors of agriculture by thematic areas and finally transform the indicated problem into researchable issues/topic with duration and priority ranking, a Committee was formed by the Executive Chairman, BARC (Annex-4). The output of the committee as per ToR is furnished in this report. Figure 2 summarizes the Processes Involved in Research Priority Setting.

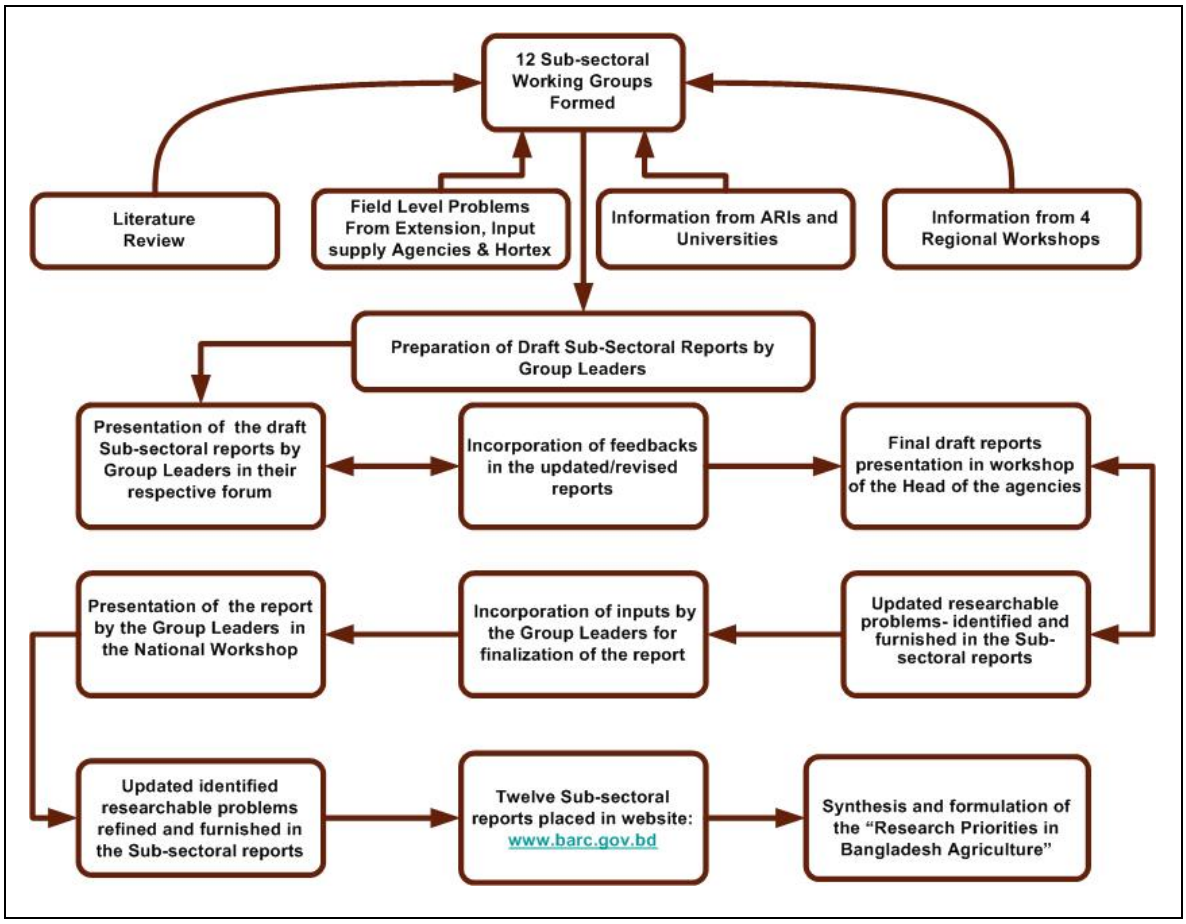

Figure 4. Schematic representation of the Processes Involved in Research Priority Setting

3. Use of Terms in this document

3.1. Types of research

3.1.1. **Basic/Fundamental Research** (also known as pure research) is carried out to generate new knowledge, increase understanding of fundamental knowledge, concept and basic scientific principles. The end result of such research may not have direct or immediate commercial benefits, but may lead to major technological advancement. By nature, this type of research is of longer duration.

Example: Study on the genetics of plant and animal, physiology, biochemistry, and ecology, done primarily to advance frontiers of knowledge. There is no direct agricultural target, although long-term potential for enabling major practical advances may be foreseen- Genome sequencing of jute.

3.1.2. **Strategic Research** is mission-oriented with sharp focus on tangible outputs that could be achieved in short to medium time-span. It involves the application of established scientific knowledge and methods to broad economic or social objectives. This type of research is meant for upstream research in the strategic areas of national and long-term importance with opportunities for exploring development of cutting edge technologies and frontier sciences. Further, strategic research is to address areas of critical gap, cross-cutting over more than one area, inter-agency and interdisciplinary.

Example: The incorporation of salt resistant genes into rice plants or the exploration of effects of nutritional factors on reproduction of animal.

3.1.3. **Applied Research** is the application of the principles derived from basic/strategic research to address and is carried out to generate useful and transferable technologies. The outcomes of strategic research are used to design and produce prototype materials and methods that are suitable for testing and introduction under practical conditions. This type of research is always of short to medium term. This kind of research is conducted for client driven purpose.

Examples would be the propagation of new animal and plant varieties, and the design of improved corn sheller or Urea Super Granule applicator for paddy cultivation.

3.1.4. **Adaptive Research** is the replication of applied research under varied conditions for evaluation of its applicability at on-farm level. Adaptive research can generate feedback information for the use of the applied researchers to modify or further refine the technology. This type of research is particularly effective in evaluating and selecting new varieties and multiplying seed, enabling large numbers of farmers to access a new variety at low cost etc. Adaptive research is normally for a short period of time

Example: Evaluation of a new variety of salt-tolerant rice in the saline coastal region.

3.2. Research Duration

In discussing research and research management the terms short, medium and long are often used. This document aims to set out how research managers/planners view timescale and purpose with regard to different research agenda.

For example:

- *Research undertaken at the present is done on the basis of producing knowledge/technology that will be of immediate value i.e. to assist production of quality rice seed and develop strategies for quick dissemination - this is short-term research.*
- *To develop knowledge/technology of value in the production and dissemination of the heat tolerant wheat in 2012 the research could be categorized as medium term.*
- *Long term research will frequently involve ideas that are not clearly defined as issues yet!*

IWRM-Net (2007) stated that present research needs are identified based on the understanding of the present situation from an analysis of the existing gaps. As for future research needs the key is to be able to speculate what would be the researchable issues in the future and to express them today. So the future research needs are non intuitive scientific questions that will become apparent in the long run.

The following matrix summarizes the Timescale based classification of Types of research.

Timescale	**Research duration**	**Types of research**	**Who defines**
Short term	< 3 years	Applied/Adaptive	Questions well defined by farmers and field level extension workers
Medium term	3- 5 years	Strategic	Questions broadly defined by farmers and field level extension workers and research institutes
Long term	5+ years	Basic/Fundamental Research	Strategic research managers, prudent scientists/experts

3.3. Priority Ranking

3.3.1. **High:** High-Priority Researchable Areas/Issues are those crucial matters which need to be addressed in the immediate future. The extent of the problems in respect of severity and number of people involved. These high priority topics include: emerging issues in different sub-sectors of agriculture like changes in the climate, food safety and food security, and the transformation and commercialization of agriculture.

3.3.2. **Medium:** Medium-priority issues and research subjects are those which would potentially be critical in the near future. This category includes: the impact of global warming on different sub-sectors of agriculture, the rising demand for specialty agriculture, etc.

3.3.3. **Low:** Low-Priority Researchable Areas/Issues are those wide-ranging issues and research subjects that do not pose immediate threat food safety and food security or would be beneficial in the long run.

4. Prioritization of Researchable Areas/Issues under different sub-sectors of Agriculture

4.1. Sub-Sector: Crops

4.1.1. Sub Sub-Sector: Cereals

4.1.1.1. Rice *(Oryza sativa* L.*)*

Rice, a cereal crop plays a vital role in global food security and acts as a main source of nutrition for the millions of resource poor farm families living in Asia and Africa. Rice is grown in all the countries of the world except Antarctica. It is the staple food for most of the Asian countries. Over 90% of the world's rice is produced and consumed in Asia. Of the 26 major rice producing countries that account for 96% of the global production, 16 are located in Asia. Rice will continue to be the major source of livelihood for the majority of Asian farmers and agricultural landless households of this region. Bangladesh stands fourth position in both rice area and production among the 16 Asian rice producing countries. The Food and Agricultural Organization of the United Nation declared 2004 as the International Year of Rice (IYR) with a slogan "Rice is life". The vision of the IYR is to improve food security, alleviate poverty and preserve the environment for the billions of people for whom Rice is life. To emphasis the importance of rice further, the Assistant General of FAO also made a statement that "A more sustainable increase in rice production leads to less hunger, less malnutrition, less poverty and better life".

Food security has been and will remain a major concern for Bangladesh. Rice is the main food for her people and will continue to remain so in the future. It grows in all the three crop growing seasons of a year and occupies about 77% of the total cropped area of about 13.9 million hectares. At presents rice alone constitutes about 95% of the total food grains produced and consumed annually in the country. It provides about 75% of the calorie and 55% of the protein in the average daily diet of the people. Moreover, rice alone contributes about 10% to GDP and the enterprise of rice production, processing and trade employs about 65% of the total labor forces of the nation. It ensures political stability of the country and provides a sense of food security of the people.

The greatest challenge agricultural scientists, extensionists and planners face to-day in country is to provide the teeming millions with the most basic need of life that is food, means rice. Achieving self-sufficiency in rice production and sustaining this in the face of an ever-growing population pressure continues to be the major goal of agricultural planning, research and extension in our country. Bhuiyan (2002), based on an optimistic scenario estimated that clean rice requirement of 28.4 million tonnes for a projected population of 169 million by the year 2025. Although, there has been a great success in rice production over the last three and a half decades, yet there is a growing concern among the scientists and policy planners about how to feed the increasing population in future when the natural resource base (land and water) is shrinking and degrading.

Under the above scenarios, concerted efforts for effective rice research and development with policy support would be the key instruments for increased rice production to meet future demand. In this connection, identification and prioritization of the researchable areas/issues related to rice production is an essential prerequisite for best utilization of the available national resources. However, in order to harness the

potential benefits, the rice research and development efforts must be supported with adequate financial and technically qualified and dedicated human resources.

Towards that goal, a list of priority researchable areas/issues in rice has been prepared after a series of consultative meetings/workshops with relevant stakeholders for the next 20 years and beyond. Under the following Thematic Areas, researchable areas/issues for rice with priority ranking have been presented in Table 3.

Thematic Areas

a) Rice Production -Varietal Improvement
b) Rice Production - Management Practices
c) Rice Protection – Diseases and Pests
d) Rice Processing and Marketing (Value Addition and supply chain development)

Table 3. Priority Researchable Areas/Issues for Rice *(Oryza sativa* L.*)*

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of Research	Research Duration
1. Rice Production - Varietal Improvement	1.1. Short duration rice varieties (10-14 days shorter than the existing popular ones for all crop growing seasons)	High	Basic/Applied	Long
	1.2. Hybrid rice varieties (shorter duration with 20% higher yield than the existing best varieties) for Boro and T. Aman Seasons	High	Basic/Applied	Long
	1.3. Super high yielding rice varieties (30% higher yield than the existing varieties) for Boro and T. Aman Seasons	High	Basic/Applied	Long
	1.4. Salt tolerant (10-12 dS/m) varieties for Boro and Aus seasons under tidal saline environment of the coastal region	High	Basic/Applied	Long
	1.5. Submergence tolerant (10 -14 days) rice varieties for non-saline tidal coastal wetland/ /flash food/moderate stagnant conditions	High	Basic/Applied	Long
	1.6. Drought tolerant/aerobic rice varieties for Aus and T. Aman seasons	High	Basic/Applied	Long
	1.7. Resistant rice varieties to major disease and insect pests like BLB, BLS and BPH etc.	High	Basic/Applied	Long
	1.8. Fine grain aromatic rice varieties with higher yield for Boro and T. Aman seasons.	Medium	Basic/Applied	Long
	1.9. Rice varieties with high Fe, Zn and vitamin A content for Boro and T. Aman seasons	Medium	Basic/Applied	Long
	1.10. Collection, evaluation, characterization and conservation of germplasm/genetic materials	High	Basic	Long
	1.11. Molecular characterization of promising breeding lines & varieties	Medium	Basic	Long
	1.12. Identification of races and biotypes of major disease and insect pest of rice; mapping of R-genes and genes pyramiding	High	Basic	Long

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of Research	Research Duration
2. Rice Production - Management Practices	2.1. Integrated crop management (ICM) practices for higher rice productivity in different rice ecosystems	High	Applied/Adaptive	Short- Medium
	2.2. More productive rice – based cropping system with best management practices for different rice ecosystems	High	Applied/Adaptive	Short- Medium
	2.3. Yield gap minimization in rice and rice based cropping system using management practices through participatory on - farm research	High	Applied/Adaptive	Short- Medium
	2.4. Intensification and diversification of rice- based cropping system under different rice ecosystems.	High	Applied/Adaptive	Short- Medium
	2.5. Management practices for DSR (direct seeded rice)- Dry/Wet	High	Applied/Adaptive	Short- Medium
	2.6. Quality rice seed production and strategies for quick dissemination	High	Adaptive	Short-Medium
3. Rice Protection	3.1. Appropriate management practice for major diseases, insects and weeds in rice and rice based cropping system to minimize yield loss	High	Applied/Adaptive	Short- Medium
	3.2. IPM in rice and rice based cropping system	High	Applied/Adaptive	Short- Medium
	3.3. Minimization of post harvest and storage loss in rice	High	Applied/Adaptive	Short- Medium
4. Rice Processing and Marketing (Value Addition and supply chain development)	4.1. Rice milling for higher recovery	High	Applied/Adaptive	Short- Medium
	4.2. Diversified utilization of rice byproducts (bran, husk, straw)	Medium	Applied/Adaptive	Short- Medium

Note:- Title of the Project Proposal will be given by the Proponent/Researcher from a Specific Priority Researchable Areas /Issue listed against a Specific Thematic Area.

4.1.1.2. **Wheat** *(Triticum aestivum L.)*

Wheat (Triticum aestivum L.) was a nontraditional crop in Bangladesh up to early seventies. This country has become a wheat growing country by mid-eighties through a massive wheat production programme that initiated in 1975-76. Wheat has a very good industrial and commercial value due to its easy utilization and marketing and about 50 items of food products are prepared from wheat. The consumption rate of wheat is increasing at the rate of 3% per year. So, to meet up the demand Bangladesh needs to import at least 2.0 million tonnes of wheat grain every year.

Wheat requires less water and can be grown with 1-3 light irrigation and in some case it can be grown in residual soil moisture. Wheat cultivation needs very little or almost no pesticides. Presently, wheat is grown on 0.40 million hectares that occupies 2.94% of the total cropped area and 3.47 % of total cereal area. Currently, Bangladesh is producing 0.96 million tonnes of wheat (30%) against the national demand of 3.0 million tonnes. About 85% of wheat is grown after harvesting of T. Aman rice and 60% of which is planted late.

Among the biotic stresses diseases are important such as Bipolaris Leaf Blight (BPLB), Leaf rust, Black point, Head Blight. No serious insect pest affect wheat yield as yet except sporadic infestation of wireworm, stem borer and rodents.

It appears from the statistics that during 1970-71 to 1980-81, wheat jumped from 0.126 million hectares to 0.591 million hectares and production increased from 0.11 million tonnes to 1.07 million tonnes. A change in the dietary habit of the consumer also enhanced wheat production. The initial momentum, however, could not be sustained for long. The annual growth rate of wheat area slowed to 1.1% during 1981-82 to 1993-94 and production remained virtually stagnant during this period. Many wheat farmers of the seventies switched to Boro rice because of stable and higher yield, high return and for food security. As a result wheat cultivation reduced gradually. In the mid-nineties there was again a new momentum in wheat production. Both the area and production reached its highest peak in 1998-99. During this growing season, wheat was grown on 0.85 million hectares with a record production of 1.9 million tonnes, which was almost double the production of 1980-81. The national average yield also continued to increase and rose to 2.3 tonnes per hectare in 1998-99; after that both area and production has started to decrease. The predominant variety Kanchan became highly susceptible to leaf blight diseases during this period which is one of the main reasons for the decreasing area and production of wheat. During 2005-06, the production reduced to almost half of 1998-99. The disease Bipolaris Leaf Blight (BpLB) was relatively higher because of less cooler winter in the said years. However, with the development of several heat tolerant and disease resistant varieties the production became stabilized.

From the above mentioned facts and figures it is revealed that global climate change will affect wheat production unless necessary measures are well taken. Among the biotic factors, new races of diseases may become more virulent. Intensity of abiotic stresses like high temperature, drought, salinity, etc. will be enhanced affecting the productivity of wheat in future. Availability of land will also be reduced due to urbanization. Due to climate change in future there will be scarcity of water during wheat growing season and crops will be exposed to more frequent drought. To keep pace with future demand of wheat, vertical expansion through improving wheat productivity is more feasible than horizontal expansion.

The scope of expanding wheat in traditional area is very limited. However, a vast area (about 0.8 million hectares) remains fallow in winter in southern and Sylhet regions. Moreover, in

the Barind area of Rajshahi region every year about 70,000 hectares land remains fallow due to moisture stress during winter. In future, availability of water for irrigation will be severely reduced due to global climate change and depletion of groundwater. So in this region Boro rice should be replaced by wheat and short duration Aman rice should be introduced in this area for so that planting of wheat is not delayed. Wheat could be introduced in part of the areas with limited/light irrigation or with residual soil moisture. In that case, high yielding disease resistant varieties well adapted to the stress situations like heat, drought, salinity, etc. will be required in future.

Therefore, the following points may be considered to sustain and increase wheat production in Bangladesh and research priorities should be targeted broadly covering the following aspects.

Water table is going down every year; annual precipitation is also reducing due to global climate change. So, water is going to be scarce commodity in future. Wheat may become the alternative source of cereal in place of Boro as wheat requires much less water than rice.

Since, there is very high crop competition in traditional wheat area; wheat can be expanded in barind area of Rajshahi, southern belt and greater Sylhet district, where abundant land remains fallow in the winter.

Collaborative research works with CIMMYT in special fields like breeding varieties for salinity, drought, heat, etc. should be strengthened. Participatory adaptive research in farmers' field should be strengthened for up scaling of technologies and reduce yield gap. Under the following Thematic Areas, researchable areas/issues for wheat with priority ranking have been presented in Table 4.

Thematic Areas

a) Wheat Production- Varietal Improvement
b) Wheat Production - Management Practices
c) Wheat Protection – Diseases and Pests

Table 4. Priority Researchable Areas/Issues for Wheat

Thematic Areas	Researchable Areas/Issues	Priority Ranking	Types of research	Research Duration
1. Wheat Production-Varietal Improvement	1.1. Collection, evaluation & conservation of germplasm/ genetic materials	Medium	Basic	Long
	1.2. High yielding disease resistant (LR, BPLB, BP) variety development	High	Basic/Applied	Long
	1.3. Early maturing and heat tolerant variety development	High	Basic/Applied	Long
	1.4. Abiotic stress tolerant variety development (against drought, salinity)	Medium	Basic/Applied	Long
	1.5. Molecular Characterization of varieties	Medium	Basic/Applied	Medium
	1.6. Quality seed production	High		
2. Wheat Production - Management Practices	2.1. Yield gap minimization of wheat-through farmer's participatory research.	High	Adaptive	Short
	2.2. Resource Conserving Technologies (RCT) to maintain soil moisture and fertility	Medium	Applied	Medium
	2.3. Introduction of wheat in potential areas	High	Adaptive & applied	Medium
	2.4. Refine improved management package for high yield goal through farmer's participatory research on regional basis	High	Applied	Short
	2.5. Water resource management and promotion of water saving technology, especially in the drought prone areas like Barind Tract by replacing Boro rice by wheat.	High	Adaptive	Medium
	2.6. Wheat Residue management for soil improvement	Medium	Adaptive	Medium

Thematic Areas	Researchable Areas/Issues	Priority Ranking	Types of research	Research Duration
3. Wheat Protection – Diseases and Pests	3.1. Survey and monitoring of new diseases and new races, especially Ug-99	High	Basic	
	3.2. Identify pathogenic races using molecular techniques	High	Basic & Applied	
	3.3. Cultural, chemical and integrated control of major diseases	High	Applied	
	3.4. Regular field monitoring the status of insect pest	Medium	Basic & Applied	

4.1.1.3. Maize *(Zea mays* L.*)*

Maize is the third most important cereal after wheat and rice and plays a significant role in human and livestock nutrition worldwide. About 75% of maize is fed to animals, thus, indirect consumption is greater than direct consumption. Although 68% of the global maize area is in the developing world, but its contribution is 46% to the total global production. The average yield of maize in the developed world is 8 t/ha and that of developing world is around 3 t/ha (FAO Website).

Maize in Bangladesh is becoming an important crop in the rice based cropping system. Currently about 1.0 million tonnes of maize is produced in the country on around 0.15 million hectares of land. The area, production and yield steadily increased since the introduction of hybrid maize in 1993 by the private sector. These are due to favorable growing conditions (no serious constraints) during the main maize growing season (October - March), use of hybrid seeds and improved cultivation practices. Maize productivity in the country (5.5 t/ha) is the highest in Asia. It is mostly fed to poultry, fish and animals as well as consumed to some extent by people mixing with wheat flour, and popcorn in Bangladesh. The annual demand now is about 1.8 million tons of which about 50% is imported and in 2030 the estimated demand will be 3.0 million tonnes. Maize is grown almost throughout the country. But major concentrations are in the northwest part, Jessore, Dhaka (Savar) and Comilla regions.

Maize is a versatile crop, every part of which is utilized. Grain is used as feed and food, green leaves and stalks are used as fodder for cattle, after threshing the rachis, husks and dried stalks are used as fuel which is becoming a scarce commodity in Bangladesh.

Bangladesh is a densely populated country and its cultivable land is shrinking but food demand (rice and wheat) is increasing every year. Therefore, production of more food from unit area is needed and among the cereals only maize has got the highest yielding potential. The country has unique opportunity to increase maize production. Because firstly, it is already familiar crop for its high yield potential, secondly about 100% area is covered with hybrids and thirdly it may be cultivated in both the seasons and fourthly no serious diseases and pest problems (through 28 diseases and 15 insect pests have been recorded so far). Now steps should be taken to change the food habit of people as has been done during early seventies for wheat.

Effort should be made to expand its cultivation in southern belt; greater Sylhet region etc. where lands remain fallow after harvest of Aman rice. Planting technologies (dibbling) and subsequent cultural method should be developed for these areas to harvest a moderate yield. The scope of horizontal expansion of maize in rabi season is limited due to heavy crop competition. Therefore, effort should also be made to increase maize cultivation in early kharif season (early February planting) after harvest of early rabi crops like potato, vegetables, mustard, lentils etc. especially in the northern districts. To withstand lodging due to high wind short-stature maize should be developed.

So research should be directed to address these issues. Under the following thematic areas, researchable areas/issues for maize and for barley and millets with priority ranking have been presented in Table 5 and Table 6, respectively.

Thematic Areas

d) Maize Production - Varietal Improvement
e) Maize Production - Management Practices
f) Maize Protection – Diseases and Pests
g) For minor cereals Production and Processing

Table 5. Priority Researchable Areas/Issues for Maize

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
1. Maize Production - Varietal Improvement	1.1. Development of disease resistant hybrids (QPM) for human consumption and poultry Industry	High	Applied	Long
	1.2. Development of abiotic stress tolerant hybrids (water logging, salinity) for kharif season	Medium	Applied	Long
	1.3. Development of short-stature maize to withstand lodging due to high wind	High	Adaptive	Long
	1.4. Development of Mg, B, Mo, Zn efficient inbred and hybrids	Medium	Applied	Long
	1.5. Development of pop corn and sweet corn hybrids	Medium	Applied	Long
	1.6. Hybrid seed production & preservation	Medium	Applied	Short
	1.7. Molecular characterization of varieties and inbreds	Medium	Basic	Long
2. Maize Production - Management Practices	2.1. Develop maize based cropping pattern to sustain and improve soil fertility	High	Applied	Medium
	2.2. Introduction of maize after T. Aman rice in new areas, especially in the southern Bangladesh	High	Adaptive	Medium
	2.3. Develop and refine improved management packages for high yield goal on regional basis	High	Adaptive	Medium
	2.4. Determination of optimum planting time for maximum seed setting of inbreds and F1s	High	Applied	Medium
	2.5. Seed quality research, seed health, vigour, seed abnormality etc. in storage.	High	Basic	Medium
3. Maize Protection – Disease and Insect pests	3.1. Surveillance of diseases and insect pests and new races of disease pathogens	High	Basic	Long

	3.2. Cultural, chemical and integrated control of major disease and insect pests, if any	High	Applied	Short-Medium
	3.3. Molecular characterization of disease pathogens	Medium	Basic	Long
	3.4. Screening for QPM with high carotene and minerals for human consumption	Medium	Basic	

Minor Cereal Crops

Table 6. Priority Researchable Areas/Issues for Barley (*Hordeum valgare*) and Millets (*Sorghum bicolor*)

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
1. Production	1.1. Adaptive trail of Barley in southern region (saline region)	Medium	Adaptive	Medium
	1.2. Adaptive trail of Foxtail millets varieties in traditional and potential areas	Medium	Adaptive	Medium
	1.3. Introduction of sorghum hybrids (ICRISAT) in drought prone areas, char areas and potential areas	Medium	Adaptive	Medium
	1.4. Local germplasm of all kinds of millets be collected and conserved	High	Basic	Medium
	1.5. More germplasm should be collected for those crops from home and abroad for development of new varieties	Medium	Applied	Long
2. Processing	2.1. Up scaling of processing of barley with farmer's participation	Medium	Adaptive	Medium
	2.2. Food/preparation using barley and sorghum and assess their quality	High	Adaptive	Short

4.2. Sub Sub-Sector: Non-Cereal Crops

4.2.1. Fibre Crops: Jute *(Corchorus sp.)*

Jute is an industrial cash crop grown in Bangladesh. On an average it contributes about 4.21% of country's total export earnings (Economic Trends, January 2009. Bangladesh Bank). In Bangladesh two species of jute are cultivated in two ecosystems- *Corchorus capsularis* in lowland which can withstand waterlogged condition and *Corchorus olitorius* under upland condition. Presently, jute is grown on about 0.50 million hectares which is 2.6% of the total net cropped area. Out of this *C. capsularis* occupies 20% and C. olitorius occupies 80% area and their productions are 0.96 million bales and 4.37 million bales respectively (Jute, Kenaf, Sisal, Abaca, Coir and Allied Fibres Statistics, FAO, 2008). The area of kenaf *(Hibiscus cannabinus L.)* and mesta *(Hibiscus sabdariffa L.)* cultivation of the country is about 15.0 thousand hectares and are primarily used like jute fibre.

From the statistics of the last 37 years it is observed that the area has continuously declined from 690 thousand hectares to 463.5 thousand hectares during these decades. Production has also declined from 5,106 thousand bales to 4,943 thousand bales and jute is being pushed to the marginal land due to expansion of food crop cultivation. However, yield per hectare has increased from 8.19 to 10.64 bales over the period. This has happened due to dissemination of modern technologies including high yielding varieties of jute at farmer's level. But the average yield obtained from varietal demonstration during the last few years at farmer's field is 16.50 bales. Mean yield per hectares of the modern varieties of jute at research station with optimum management is 22.20 bales, which is almost double of the national average. Lower yield of jute at farmer's field, is due to various biotic, abiotic and social constraints.

Among the biotic stresses diseases such as stem rot, anthracnose, die-back and leaf mosaic and insect pests such as hairy caterpillar, Apion, Mealy bug and Yellow mite are the major ones. Moreover, there exists a huge yield gap compared to the potential yields of the Bangladesh Jute Research Institute (BJRI) developed varieties. Therefore, the researchable area in jute should be targeted to address the above issues. Under the following thematic areas, researchable areas/issues for fibre crops with priority ranking have been presented in Table 7.

Thematic Areas

a) Jute Production - Crop improvement
b) Jute Production -Crop Management
c) Crop Protection - Diseases and Pests
d) Processing Marketing (Value addition)

Table 7. Priority Researchable Areas/Issues for Jute and Allied Fibre Crops

Thematic Areas	Researchable Areas/Issues	Priority Ranking	Types of research	Research Duration
1. Jute Production - Crop improvement	1.1. Molecular characterization and conservation of germpleasm including released verities of jute, kenaf and mesta (JAF)	High	Basic/Applied	Medium-Long
	1.2. Development/screening of high yielding varieties of jute, kenaf and mesta, resistant against various stresses (biotic and abiotic)	High	Basic /Applied	Long
	1.3. Up scaling of off season jute seed production technology	High	Adaptive	Medium
	1.4. Development of GMO jute with desirable traits	High	Basic	Long
2. Jute Production - Crop Management	2.1. Nutrient management including micronutrients for maximizing yield	High	Applied	Short
	2.2. Development of jute based profitable cropping patterns for sustained soil fertility	Medium	Applied	Short
	2.3. On farm participatory research for maximizing jute yields and reduce yield gap	High	Applied	Short
3. Crop Protection - Diseases and Pests	3.1. Biological control of soil borne fungal pathogen and other major disease	Medium	Basic & Applied	Medium
	3.2. Molecular characterization of physiological races of pathogens	High	Basic & Applied	Medium
	3.3. Identification of sources of resistance against apion, mites, spiral borer and mealy bug	Medium	Applied	Medium
	3.4. IPM of major insect pests of JAF	Medium	Basic & Applied	Long
	3.5. Surveillance occurrence of new disease pathotypes and insect pests due to climatic change	Medium	Basic	Long

Thematic Areas	Researchable Areas/Issues	Priority Ranking	Types of research	Research Duration
4. Processing Marketing (Value addition)	4.1. Development of fungal inoculum packages for acceleration of jute retting	High	Basic & Applied	Long
	4.2. Improvement and Scaling-up of ribbon retting technology	High	Adaptive	Short-Medium
	4.3. Using micro organisms for quality up-gradation of fiber	Medium	Basic & Applied	Long
	4.4. Manufacture fancy jute products using jute blended yarns with other textile fiber	High	Applied	Medium
	4.5. Improvement of jute fiber using chemicals and blended with other natural and synthetic fiber for diverse use in textile sectors	High	Applied	Medium
	4.6. Bio-pulping of Jute by using enzymes instead of chemicals	Medium	Basic & Applied	Long

4.2.2.Oilseed Crops

Oil seed crops are grown in 338.0 thousand hectares in Bangladesh which is 2.47% of the cultivable land (BBS 2008). Although about seven oilseed crops are grown in the country but mustard *(Campestris and Juncea)* alone occupies about 70% of the oilseed land followed by sesame, *(Sesamum indicum)* groundnut *(Arachis hypogaea),* linseed *(Linum usitatissimum),* soybean, sunflower and niger. Groundnut and soybean are not currently being used for oil extraction. The total quantity of groundnut is used as roasted and in the bakery industries and soybean is used as an ingredient of poultry feed or fish meal.

Majority of the oil crops (mustard, niger, soybean, linseed and sunflower) are grown in the rabi (winter) season. Sesame is grown in kharif season and groundnut is grown in both rabi and kharif seasons. The area and production of oilseeds are gradually declining due to the similar reasons as pulses. But unlike pulses, most oilseeds crops respond positively with high management, yet they cannot compete with other high value crops. Usually, farmers do not allocate their good piece of land and also they do not follow modern cultural practices for oil crops, thus their yields are low.

Almost all oilseed crops grow throughout the country in specific niches and cropping patterns. Such as Tori-7 mustard is grown largely in between Aman and Boro rice, groundnut in sandy soils and char lands, soybean in greater Noakhali and Mymenshing districts. Compared to pulses, oilseeds are less suffered by disease and pests. However, some of the most important diseases of oilseeds are Alterneria blight in mustard and sunflower, Tikka and Foot rot in groundnut, stem rot and wilt in sesame. Some important pests across crops are Aphids, Hairy caterpillar, Thrips and Mites (in groundnut).

At present, the domestic production of edible oil can only meet about 20% of the country's annual demand and rest is imported which costs more than Tk. 20.00 billion. Therefore, oilseed research should be directed towards minimization of yield gap through adoption of modern cultivation practices, development of high yielding short duration varieties to fit into the niches of profitable cropping patterns. Research on seed viability and preservation techniques especially for groundnut, soybean and sunflower should be emphasized.

In addition to the development, refinement of the management practices and management of biotic and abiotic stresses of oilseed crops should be addressed. Under the following thematic areas, researchable areas/issues for oilseed crops with priority ranking have been presented in Table 8.

Thematic Areas

a) Crop Production Crop improvement
b) Crop Management
c) Crop Protection - Diseases and Pests
d) Food/Feed and nutrition

Table 8. Priority Researchable Areas/Issues for Oilseed Crops

Oilseed, (Mustard (*Brassica comprestis*), sesame (*Sesamum indicum*), groundnut (*Arachis hypogaea*), Soybean (*Glycine max*), Sunflower (*Helianthus annuus*)

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
1. Crop Production Crop improvement	1.1. Development/Screening of disease resistant high yielding varieties of oil crops	High	Basic/Applied	Long
	1.2. Hybrid variety development for sunflower	High	Basic/Applied	Long
	1.3. Short duration variety development of mustard for specific niches	High	Basic/Applied	Long
	1.4. Development of water logging/submergence tolerant, wilt and stem rot resistant variety of sesame	High	Basic/Applied	Long
	1.5. Introduction of newly developed high yielding varieties of oilseeds in traditional and new areas, like soybean and sunflower and sesame in southern belt	High	Adaptive	Short
	1.6. Collection, evaluation and conservation of germplasm and inbred lines (for sunflower) from local and exotic sources	Medium	Basic	Long
	1.7. Molecular characterization of released/ recommended varieties of oilseed crops	Medium	Basic	Long
	1.8. Exploration for alternative edible oil crops	Medium	Basic	Long
2. Crop Management	2.1. Intensification of short duration mustard cultivation in between Aman and Boro rice	High	Applied/Adaptive	Medium
	2.2. Introduction of improved groundnut varieties in char land and traditional areas	Medium	Adaptive	Medium-Short
	2.3. Standardize fertilizer package especially Micronutrients, for different oil crops in deficient areas	High	Applied	Medium

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
	2.4. Adaptive trials on yield maximization of oil crops to minimize yield gap	High	Adaptive	Medium-Short
	2.5. Develop seed storage technique in groundnut, soybeans and sunflower	High	Adaptive	Medium-Short
	2.6. Up scaling of seed production of new varieties through block demonstration	High	Adaptive	Medium
3. Crop Protection - Diseases and Pests	3.1. Chemical control of major disease of oil crops (like Alterneria in mustard, stem rot and wilt in sesame, foot rot, leaf spot and wilt of groundnut, leaf disease of sunflower)	High	Applied	Medium
	3.2. Molecular characterization of major fungal pathogens of oils crops	Medium	Basic	Long
	3.3. Study of storage diseases and control measures of oil crops (groundnut, soybean)	Medium	Applied	Medium
	3.4. Yield loss assessment due to disease of major oil crops	Medium	Basic	Medium-Long
	3.5. Surveillance of new diseases/pathogenic races of oil crops	High	Basic	Long
	3.6. Develop control measures against major insect pests of oil crops (like aphid, hairy caterpillar, hawk moth in sesame, thrips in soybean, termite and white grub in groundnut etc.)	High	Applied	Medium
	3.7. Surveillance of new insect pest of oil crops and natural enemies	Medium	Strategic	Long
	3.8. Biological control of major pests of oil crops	Medium	Basic	Long
4. Food/Feed and nutrition	4.1. Assessment of aflatoxin status in groundnut (in storage as well as in roasted)	Medium	Basic	Medium

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
	4.2. Quality assessment of the feed/meal prepared from oilseed like soybean, sunflower cake, mustard cake etc. (specially aflatoxin status)	Medium	Basic	Long
	4.3. Up scaling of the different food products produced from soybean	High	Adaptive	Medium

4.2.3. Pulses

Pulses are protein rich crops, which can be used to substitute animal protein in our diets. Many different varieties of pulses are grown in Bangladesh. Traditionally pulses are grown under rainfed condition with minimum inputs. During mid-eighties pulses covered an area of 782.0 thousand hectares. With the expansion of irrigation facilities during green revolution other high yielding crops like Boro rice, wheat, potato, vegetables came into the scene and gradually occupied pulses area. by these high value crops. Pulses area reduced from 782.0 thousand hectares in 1985 to 337.0 thousand hectares in 2006. The present production of pulses can only meet about 30% of total consumption and the rest is imported. Abrupt reduction has occurred in chickpea, lathyrus, and blackgram due to expansion of Boro rice cultivation. Some minor pulses like Arhar, Horsegram, Faba bean have almost been eliminated. According to the present area coverage and production the ranking of pulses are as follows: Lathyrus >Lentil > Mungbean >Blackgram >Field pea and >Cowpea. Among these, Mungbean and Blackgram are grown in kharif season and the rest in rabi.

Pulses cultivation is not distributed uniformly throughout the country. Cowpea and Mungbean are grown in the southern belt, lathyrus is grown throughout the country with major concentration in southern and central parts of the country. More than 70% area of lentil, chickpea, kharif-1 mungbean and blackgram are concentrated in the Ganges flood plain covering Rajshahi, Jessore and Faridpur region. So crop zoning is important for pulses on the basis of major areas of cultivation. Accordingly, research on cowpea should be concentrated for the southern region only; Lathyrus for the whole country; lentil, mungbean, field pea and blackgram for the Gangetic flood plains and northern region; and chickpea in Barind Tract, part of Barisal and Faridpur region.

Although pulses are grown almost without any inputs but its area and production are gradually reducing, (except mungbean) mainly due to (i) Low yield potential of the pulse varieties; (ii) High infestation of diseases and pests, compared to other crops; (iii) Instability of yield due to micro-climatic fluctuation; (iv) Negative response of pulses to high inputs; and (v) Expansion of irrigation facilities and more profitable crops are available in place of pulses in the cropping patterns. So in future the research thrust on pulses should be targeted to address these problems/issues.

Under the following thematic areas, researchable areas/issues for pulses with priority ranking have been presented in Table 9.

Thematic Areas

a) Crop Production - Crop improvement
b) Crop Production - Crop Management
c) Crop Protection – Diseases and Pests

Table 9. Priority Researchable Areas/Issues for Pulses

Lentil (*Lens culinaris*), Lathyrus (*Lathysus sativus*), field pea (*Pisum sativum*), Chickpea (*Cicer arietinum*), Mungbean (*Vigna radiata*), Blackgram (*Phaseolus mungo*), Cowpea (*Vigna unguculata*)

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
1. Crop Production - Crop improvement	1.1. Collection, evaluation and conservation of gemplasm from different sources including International centres	High	Basic	Long
	1.2. Development of short duration disease resistant (stemphylium blight, rust and foot rot) high yielding variety of lentil	High	Basic/Applied	Long
	1.3. Development of BGM resistant variety of chickpea	High	Basic/Applied	Long
	1.4. Downy and powdery mildew resistant high yielding variety for relay cropping of lathyrus	High	Basic/Applied	Long
	1.5. YMV and cercospora resistant high yielding variety for mungbean, and cowpea (for southern region)	High	Basic/Applied	Long
	1.6. Short duration, powdery mildew and sclerotinia resistant blackgram variety for late planting (post flood)	High	Basic/Applied	Long
	1.7. Short duration, powdery mildew resistant variety of field pea	High	Basic/Applied	Long
	1.8. Molecular Characterization of released varieties and local cultivars of pulses	Medium	Basic	Long
	1.9. Development of abiotic stress tolerant pulse variety for specific niches	Medium	Applied	Long
2. Crop Production - Crop Management	2.1. Introduction of short duration pulse varieties (lentil, mungben) in appropriate cropping system, specially mungbean in *Kharif-1* season in new areas	High	Applied	Medium
	2.2. Validation of economic advantage of pulses over Boro through participatory adaptive research	High	Adaptive	Medium

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
	2.3. Design new cropping patterns including short duration pulses like lentil, pea, grasspea (as fodder) in between Aman and Boro rice	High	Applied	Medium
	2.4. Design new cropping patterns for incorporating short duration pulses like lentil, pea, grasspea (as fodder) in between Aman and Boro rice	High	Applied	Medium
	2.5. Relay cropping of lentil, chickpea, field pea and backgram in suitable areas	High	Adaptive	Medium
	2.6. Introduction of biofertilizer in pulse, especially in non-traditional areas	High	Adaptive	Short
	2.7. Introduction of pulses in new areas	Medium	Adaptive	Medium
	2.8. Yield maximization of pulses through optimum management practices	High	Adaptive	Medium
3. Crop Protection – Diseases and Insect pests	3.1. On-farm chemical control of major diseases of pulses like stemphylium and rust of lentil, BGM in chickpea, YMV in Mung and black gram, powdery mildew in field pea, blackgram, mungbean	High	Adaptive	Medium
	3.2. Biological control of soil borne fungal disease of pulses like Sclerotium rolfsii in chickpea and lentil, Fusarium wilt, Rhizochonia solani in chickpea, lentil etc.	Medium	Applied	Long
	3.3. Surveillance of new races of disease pathogens	Medium	Basic	Long
	3.4. On farm chemical control of major insect pests of pulses like pod-borer complex of mungbean, chickpea, cowpea, aphids in lentil and lathyrus, thrips, mites, apion in mungbean etc.	High	Applied/Adaptive	Short
	3.5. Development of IPM against major pests of pulses	High	Basic	Long

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
	3.6. Surveillance of new insect pests and natural enemies of pulses pests	Medium	Strategic	Long

4.2.4. Roots and Tuber Crops

Roots and tuber crops include mainly potatoes, sweet potatoes, yams and aroids; and are mostly rich in carbohydrates. The edible parts of these crops are perishable and cannot be stored for long under ordinary conditions.

There had been a remarkable increase in the area and production of potato in Bangladesh during the period from 1960-61 to 2008-09, with the highest production of 6,648 thousand tonnes from an area of 402 thousand hectares of land in 2007-08. The yield of potato ranged between 6.1 to 10.1 tonnes per hectare during 1960-61 to 1990-91, and between 12.6 to 16.5 tonnes per hectare during 2000-01 to 2008-09. Recently, potato has become an important food crop in Bangladesh, and has drawn special attention of the growers, traders, input suppliers, seed producers, processors, exporters, researchers, extension workers and policy level people of the country (Hussain, 2008; Rabbani et al., 2009).

The gradual increase in area, yield and total production of potato in Bangladesh took place during 1960-61 to 2008-09. Increase in production and yield is attributed to several factors, namely, improvement of variety, supply of high quality seed potatoes, increase in the number of cold storage facilities, participation of private sector organizations and commercial approach in production and marketing (Hussain, 2008; Hossain et al., 2008; Ali and Haque, 2009; Rabbani et al., 2009).

Other than improvement of varieties, potato research were conducted on true potato seeds (TPS), indigenous potato varieties, traditional and tissue culture techniques of seed potato production, agronomic practices, diseases, insect pests and post-harvest management. Using these technologies remarkable increases in area and production have occurred in potato. But research on other tuber crops like aroids, yam, and sweet potato were very limited. Further research on these crops needs to be strengthened.

Under the following thematic areas, researchable areas/issues for roots and tubers with priority ranking have been presented in Table 10.

Thematic Areas

a) Crop Production - Crop improvement
b) Crop Production - Crop Management
c) Crop Protection – Disease and Pests
d) Post-Harvest Processing and Marketing (value addition)

Table 10. Priority Researchable Areas/Issues for Tubers and Root Crops

Potato (*Solanum tuburusum*), Sweet Potato (*Ipomea batata*), Aroid (*Araceae*), Yam (*Dioscrea sps*.), Cassava (*Manihot esculenta*)

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
1. Crop Production - Crop improvement	1.1. Germplasm collection, evaluation, Conservation of root and tuber crops	High	Basic	Long
	1.2. Disease resistant and stress tolerant high yielding variety development for roots and tuber crops	High	Applied	Long
	1.3. Disease resistant variety for specific purposes like potato variety for export, for starch, for flakes, for chips (less sugar and high dry matter)	High	Applied	Long
	1.4. Development of GM potato against late blight, early blight etc.	High	Basic/Strategic	Long
	1.5. High yielding variety for yam and aroids	Medium	Applied	Long
	1.6. Early maturing high yielding variety of Mukhikachu and high yielding variety for stolon (Loti) and other aroids	High	Applied	Long
	1.7. Molecular Characterization of released varieties	Medium	Applied	Long
2. Crop Production - Crop Management	2.1 Standardize cultivation practices for higher yield of potato, Mukhikachu and Panikachu	High	Applied	Medium
	2.2 Standardize zero tillage potato cultivation with mulching, especially for southern region	High	Applied	Medium
	2.3 Introduce high yielding Yam, Olkachu, Mankachu varieties in the homestead through out the country	High	Applied	Medium
	2.4 YMV free seed tuber production of potato through tissue culture and enhance breeder's seed production	High	Applied	Medium

3. Crop Protection – Diseases and Pests	3.1 Update control measure against late blight and the major diseases of potato with newly available fungicides	Medium	Applied/	Medium-Short/Long
	3.2 Biological control of potato diseases	Medium	Basic	Medium
	3.3 Identify physiological races of pathogens of major diseases of potato and Aroids using molecular marker	Medium	Basic	Medium
	3.4 Surveillance of disease to detect new race of diseases, if any	Medium	Basic	Long
	3.5 Survey the disease status of roots and tuber crops like, Aroids and yam and develop control measure for the major disease	High	Basic/ Applied	Long
	3.6 Survey the insect-pest status of yam, and aroids and identify the major and minor pests	High	Basic	Long
	3.7 Update control measure against major insect pests of potato	High	Applied	Medium
4. Post-Harvest Processing and Marketing (value addition)	4.1 Low cost storage technique of potato for farmers	High	Applied	Medium
	4.2 Prepare various food products like potato chips. Finger chips, noodles etc for commercial use	High	Applied	Medium
	4.3 Develop delicious food stuff from potato as a substitute of rice and popularize it among the farmers and urban consumers	High	Applied	Short

4.2.5. Sugarcane and Other sugar crops

Sugarcane is the important food-cum-cash-cum-industrial crop in Bangladesh. It covers 2.05% of the total cultivable land. Currently, on an average sugarcane is grown on 160 thousand hectares of land annually of which almost 50% area is located within the sugar mills zone, and the remaining in the non-mills zone, where sugarcane is mostly diverted for jaggary and juice production. Presently, 15 sugar mills are in operation under Bangladesh Sugar and Food Industries Corporation (BSFIC) with a production capacity of 0.21 million tonnes of sugar per year (BSFIC, 2008). Although Bangladesh Sugarcane Research Institute (BSRI), has a broader mandate to conduct research on sugarcane and other ancillary sugar crops all over the country limited attention was given to other ancillary sugar crops.

In Bangladesh, the yield of sugarcane is about 40 tonnes per hectare only whereas it is about 70 tonnes per hectare in other sugar producing countries. Recovery percentage of sugar in is 7.0 to 8.5 only, but in other countries it ranges from 8.5 to 11.0. This low yield and recovery is caused mainly for management factors at production level. However, it is still an insurance crop under rainfed condition and in waterlogged situation in the northern and western regions of the country where most of the sugarcane are cultivated. The average production of sugar and jaggary (gur) of last ten years was 0.136 and 0.372 million tonnes and the recovery of sugar and jaggary was 7.18 and 10.30 per cent respectively. Although most of the sugar industries are loosing concern but jaggary production is profitable because cost of production is lower than sugar.

During the last ten years (1999-00 to 2008-09) sugarcane was grown on an average 160.54 thousand hectares of land producing 6.5 million tonnes of sugarcane. Statistics show a declining trend in area and production due to various reasons. The main reason is sugarcane is an annual crop and cannot compete with other crops. Although production technologies are available but farmers do not follow them properly as a result their yields are low and uneconomic compared to other competing crops. Moreover, sugarcane also suffers from a number of biotic, abiotic and social constraints which contribute to low yield. Among the biotic constraints the major ones are: dearth of appropriate genetic materials, lack of high yielding stress resistant varieties, diseases like red rot, smut, wilt, white leaf and pineapple disease and insects like top shoot borer, stem borer, root borer, white grub and termites. Among the abiotic constraints flood, waterlogging, drought, soil factors and low management by farmers are the major causes of low productivity.

According to FAO recommendation 13 kg sugar is required per capita annually and as such the present requirement is 1.89 million tonnes of which 0.40 million tonnes (21.29%) is locally produced. On this basis, 2.53 million tonnes of sugar will be required in 2030 for a projected population of 195.53 million.

Keeping the constraints and future demand of sugar in view the research priority areas were identified. Under the following Thematic Areas, researchable areas/issues for sugar crops with priority ranking have been presented in Table 11.

Thematic Areas

a) Crop Production - Crop improvement
b) Crop Production - Crop Management
c) Plant Protection – Diseases and Pests

Table 11. Priority Researchable Areas/Issues for Sugarcane and alternative sugar crops

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
1. Crop Production - Crop Improvement	1.1. Collection, evaluation and conservation of germplasms of sugarcane and alternative sugar crops	Medium	Basic	Long
	1.2. Genetic enhancement through inter-specific crosses	High	Basic	Long
	1.3. Development of red rot resistant, high sugar, flood, salinity tolerant, high yielding varieties using conventional and biotechnological tools	High	Basic/Applied	Long
	1.4. Molecular characterization of sugarcane varieties	High	Basic	Medium
	1.5. Exploration on the possibility of growing sugar beet as substitute of sugarcane.	High	Adaptive	Medium
2. Crop Production - Crop Management	2.1 Farmer's participatory adaptive research on multiple cropping with sugarcane, intercropping with high value winter crops, Ratoon management and yield maximization with appropriate nutrient management packages	High	Adaptive	Short/Medium
	2.2 Biological Nitrogen Fixation (BNF) in sugarcane	High	Basic	Long
	2.3 Stress management research against flood, drought, water logging etc.	Medium	Applied	Medium
	2.4 Crop management research for enhancing yield and sugar content	High	Applied	Medium
3. Crop Protection – Diseases and Pests	3.1 Search for resistant sources against major disease and pests of Sugarcane	High	Basic	Long
	3.2 Molecular characterization of major disease pathogens of sugarcane	Medium	Basic	Medium
	3.3 Disease surveillance and integrated disease management of major diseases of sugarcane	Medium	Applied	Medium
	3.4 Integrated Control of major insect pests like borers, root borers, scale insect and pyrilla	High	Applied	Long
	3.5 Control of major insect pests using bio-agents	High	Basic	Long

4.2.6. Spices

Asia is known to be the place of origin of most spices. Asia is also known for spices production, consumption and export. Out of 109 plants grown as spices in the world, only six are considered as major spices in Bangladesh. The most important spices produced in the country are- onion, chilli, turmeric, ginger, garlic, and coriander. These are the spices are essential for all types of curry.

The agro-ecological conditions of Bangladesh are congenial for the production of different spice crops, namely, onion, garlic, chilli, ginger, turmeric, coriander and fenugreek. Bangladesh produces about 1.334 million tonnes of spices from about 321.0 thousand hectares of land. The land area covered by spice crops is about 3.38 % of the total cultivated land of the country. Bangladesh is producing 1.30 -1.40 million tonnes of spices against annual demand of about 2.60 million tonnes. Among the major spice crops, the area and production of onion, garlic, turmeric, ginger and coriander increased at different levels during the recent years, but decreasing trend was noticed for chilli.

The major problems with spices are high price in the local and foreign market and poor quality of the finished product due to microbial infection and toxic chemical contamination. The existing post-harvest processing and storage practices, in most cases, are of sub-standard.

Bangladesh Bank data show that the cost for the import of five major spices (onion, garlic, chilli, ginger and turmeric) in the year 2006-07 was Tk. 6,108 million; of which 70.2% was for onion, 20.0% for garlic, 0.6 % for chilli, 7.0% for ginger and 2.2% for turmeric (Bangladesh Bank, 2007). The present export of spices from Bangladesh is negligible. Only a small quantity of green chilli and some powdered hot chilli, turmeric and coriander are exported to some European and Middle-East markets. Investments in the large scale production factories of spice powder and paste for local and foreign markets are increasing. Taking the projected population under consideration, the demand for six major spices would be around 3.493 million tonnes in the year 2030. So, major research thrust needs to be given on these crops. Under the following Thematic Areas, researchable areas/issues for spices crops with priority ranking have been presented in Table 12.

Thematic Areas

a) Crop Production - Crop improvement
b) Crop Production - Crop Management
c) Plant Protection – Diseases and Pests
d) Processing and Marketing

Table 12. Priority Researchable Areas/Issues for Spices crops

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
1. Crop Production - Crop improvement	1.1. Germplasm collection, evaluation, and conservation	High	Basic	Long
	1.2. Development of disease resistant high yielding varieties of spice crops	High	Applied	Long
	1.3. Development of HYVs and Hybrids of chilli for different planting times and for different regions	High	Applied	Long
	1.4. Seed production technique for onion, especially summer onion.	High	Applied	Medium
2. Crop Production - Crop Management	2.1 Standardize production packages (including micronutrients) for different spice crops	High	Applied	Medium
	2.2 Introduction of ginger in the homestead area	Medium	Adaptive	Medium
	2.3 Preservation technique for seed storage at farmer's level	Medium	Adaptive	Medium
	2.4 Introduction of spices varieties in the non-traditional areas like southern belt	Medium	Adaptive	Medium
3. Plant Protection – Diseases and Pests	3.1 Survey and identify major and minor diseases of the spices crops	High	Basic	Long
	3.2 Study etiology of major diseases of spices	Medium	Basic	Long
	3.3 Molecular characterization of fungal pathogens of major diseases of spices	Medium	Basic	Long
	3.4 Control measure development of major diseases like rhizome rot of ginger, leaf blight of turmeric, Alterneria leaf blight of onion and garlic etc.	High	Applied	Medium
	3.5 Yield loss assessment due to major diseases in spice crops	Medium	Basic	Medium
	3.6 Validation and Up-scaling of controlling alterneria blight of onion and garlic	High	Adaptive	Medium
	3.6 Survey of insect pest and mites status of spice crops	High	Basic	Medium
	3.7 Yield loss assessment due to insect pests of spices	Medium	Basic	Medium
	3.8 Development of control measures of major insect pests of spices crops	High	Applied	Medium

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
	3.9 Validation and Up-scaling of controlling thrips of onion and garlic	High	Adaptive	Short
4. Processing and Marketing	4.1 Processing of different spices for powder and paste products development and design suitable packing materials (packets, cans etc.)	High	Applied	Long
	4.2 Determine the quality of different packed spices (especially causes of rancids)	Medium	Basic	Medium
	4.3 Survey the quality of available processed spices in the market and suggest improvement	Medium	Basic	Medium

4.2.7. Vegetables

In general, horticultural crops include fruits, vegetables, ornamentals and spices. Despite some controversies, plantation crops and medicinal plants are also considered as horticultural crops. Crops like, potatoes, sweet potatoes, aroids and yams are the staple food crops in some countries, but are considered as horticultural crops in Bangladesh.

Vegetables are the most important component of our food, and are rich in vitamins, minerals and fibers that are essential for human health. A number of vegetables are known to be as protective food items which prevent many diseases and ailments like, dislipidemea, cardiac disease, diabetes and constipation.

Although the production of food grains has reached to 'near self-sufficiency' in Bangladesh, the production of fruits and vegetables, though increased remarkably, but are still far behind of our requirements. While mentioning self-sufficiency in food, the nutritional aspects are often not duly recognized. Vegetables are the most important component of food, and are rich in vitamins, minerals and fibers that are essential for human health. The present consumption is only 44 grams/day/head against 220 grams of RDA.

Vegetables can be grown round the year, utilize homestead lands, provide high economic return and help in employment and income generation. Currently, vegetables are grown on 30.0 thousand hectares with a production of 2.247 million tonnes. Among the winter vegetables, brinjal (eggplant), pumpkin, cabbage, cauliflower, tomato, bottle gourd, radish, country bean and spinach are important; and among the summer vegetables, pumpkin, brinjal, pointed gourd, lady's finger (okra), ribbed gourd, snake gourd, bitter gourd, yard long bean, cucumber, ash gourd, amaranths and Indian spinach are important.

During the year 2005-06, according to BBS, brinjal (winter and summer) occupied the highest percentage of land under cultivation of vegetables in Bangladesh. The index values show that the increase in area under cultivation was relatively higher in okra, pointed gourd, snake gourd, cucumber and summer pumpkin; and the increase in total production was higher in okra, summer pumpkin, pointed gourd, cabbage and bitter gourd.

This can be achieved through use of improved varieties, for early, optimum and late planting, off season varieties, high quality planting material and modern technology of production covering optimal soil management, plant density, plant nutrients, irrigation, disease management and pest control and protective culture.

However, there is always a gap between the present level of production and demand. Efforts should be made to minimize this gap through research leading to increased yields.Conversely, increased production of vegetables in Bangladesh often causes problems in marketing as most of the vegetables are perishable lack of storage facilities. Consequently, drastic fall in vegetable price occurs in the major growing areas; and such aspects also deserve due attention. Post-harvest management, processing and export potentials are the areas to be looked at. Under the following thematic areas, researchable areas/issues for vegetables with priority ranking have been presented in Table 13.

Thematic Areas

a) Crop Production - Crop Improvement
b) Crop Production - Crop Management
c) Plant Protection – Diseases and Pests
d) Processing and marketing

Table 13. Priority Researchable Areas/Issues for Vegetables

Brinjal (*Solanum melongena*), Cucurbits, Tomato (*Lycopersicon esculantus*), Okra *(Abelmoschus esculentus)*, Country bean (*Lablab niger*), Bushbean (*Phaseolus vulgaris*), radish (*Raphanus sativus*)

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
1. Crop Production -Crop Improvement	1.1 Collection, evaluation and conservation of all local vegetables and exotic germplasm of selected crops	High	Basic	Long
	1.2 Development of hybrids in curbits, tomato and brinjal	High	Basic/Applied	Long
	1.3 Molecular characterization of released varieties	Medium	Basic	Medium
	1.4 Development of major disease resistant HYVs of brinjal, okra, country bean, bush bean, YMV resistant variety of tomato, okra bush bean and country bean	High	Basic/Applied	Long
	1.5 Development of short duration varieties to fit into special niches (like summer radish, tomato, year round brinjal etc.) and specific purpose	High	Basic/Applied	Long
	1.6 Quality seed production and preservation techniques at farmer's level	High	Adaptive	Medium
	1.7 Development of suitable varieties of vegetables for hills, saline and haor regions	Medium	Applied	Long
2. Crop Production - Crop Management	2.1 Refine production technologies especially for micronutrients for commercial vegetables	High	Applied	Medium
	2.2 Up-scaling of HYVs and hybrids of vegetables in the southern regions and hilly regions	High	Adaptive	Short
	2.3 Develop organic culture and protective culture, Hydroponics for high value vegetables (Tomato, lettuce, capsicum etc.)	Medium	Applied	Medium-Short
	2.4 Development of pot culture techniques and potting Medium for selected vegetables, like tomato, capsicum, chili for roof gardening	Medium	Applied	Short
	2.5 Study on irrigation requirement, mulching techniques, weed control for vegetable crops	High	Applied	Medium

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
3. Plant Protection – Diseases and Pests	3.1 Management of fungal/bacterial/nemic disease of cucurbits (especially pointed gourd) solanaceous vegetables, virus (tomato, Okra, cucumber, leguminous vegetables like country bean, powdery mildew in sweet pea, etc.)	High	Applied	Long
	3.2 Molecular characterization of fungal pathogens of major disease of vegetable	Medium	Basic	Long
	3.3 Control of seedling disease of vegetables, especially winter vegetables	Medium	Applied	Medium
	3.4 Surveillance and monitoring of pathotypes of disease of major vegetables	Medium	Basic	Long
	3.5 Integrated disease management of major vegetables	High	Applied	Medium
	3.6 Control of Foot rot, stem rot, die back of betel leaf (e.g. Rajshahi & Barisal region)	High	Applied	Short-Medium
	3.7 Identification of major insect pest (including mites) of major vegetables.	High	Basic	Long
	3.8 Chemical, biological and integrated pest management of major vegetables (brinjal, country bean, cabbage, cauliflower, tomato etc.)	High	Applied	Medium-Short
	3.9 Surveillance of appearance of new insects pest of major vegetables	Medium	Basic	Long
4. Processing and marketing	4.1 Determination of post harvest loss of different vegetables	Medium	Applied	Long
	4.2 Develop appropriate packaging, transportation system for local & export market	High	Applied	Medium
	4.3 Contract farming and marketing channel development for vegetables	Medium	Strategic	Short
	4.4 Value addition and supply chain development for selected vegetables	High	Applied	Short
	4.5 Preservation technique development for increasing shelf life of vegetables	High	Applied	Short

4.2.8. Fruits

Fruits in general are rich in vitamins and minerals, and are essential items of a balanced diet. A daily consumption of 85 grams of fruits is recommended for a person (Bhuyan and Hossain, 2009). But the availability per head per day of locally produced fruits in 2007-08, was only 66 grams (BBS, 2009). Fruits are grown on about 134.0 thousand hectares which is about only 0.98% of the total area under cultivation. Among fruits banana occupies the highest area (42.2%), followed by mango (19.6%), pineapple (12.8%) and jackfruit (7.0%). (BBS 2008).

Banana is the most important fruit crop of Bangladesh. Although the area and production of banana increased significantly during the period from 1971-72 to 2006-07, the per hectare yield remained almost static. Among the other quick growing fruits, the area, production and yield of pineapple although increased significantly after 2001-02, remained almost similar during the recent years (2004-05 to 2007-08). In case of papaya, although the yield remained similar during the period from 1971-72 to 2001-02, there was an increase in production due to increase in area under cultivation.

The area and production trends of perennial fruit crops, namely, mango, jackfruit, litchi and guava show that during the period from 1971-72 to 2001-02, there was a little increase in the area under mango (established orchards plus isolated trees) with a gradual fall in production due to decrease in yield. Similarly, the increase in total production was highest in guava (1128 times) followed by jujube (1018), lime & lemon (837), mango (494) and jackfruit (441) during the last 30 years.

Recent progresses in research and development of fruits in Bangladesh include, collection and evaluation of germplasm, development and release of improved varieties of major and minor fruits, standardization of propagation techniques, improvement in production technology, production and distribution of quality planting material and training of fruit growers and nurserymen (HRC, 2009). Involvement of HRC of BARI, Agricultural Universities, private sector organizations, NGOs and donor supported projects in the fruit research and development activities is well-recognized. But these efforts were inadequate.

Among the identified major constraints of the fruit industry of Bangladesh, insufficient improved varieties, irregular bearing habit of some fruits, seasonality in bearing and harvesting, inadequate supply of quality planting material, sub-optimal management practices, high post-harvest losses and inadequate disease and pest management are notable. There is a strong feeling among the senior horticulturists that fruit research should be directed to limited fruit crops rather than a large number of crops. To overcome all these fruit related constraints more organized research should be undertaken.

Under the following thematic areas, researchable areas/issues for fruits with priority ranking have been presented in Table 14.

Thematic Areas

a) Crop Production - Crop improvement
b) Crop Production - Crop Management
c) Crop Protection - Diseases and Pests
d) Post harvest Management and Processing

Table 14. Priority Researchable Areas/Issues for Fruits

Mango (*Mangifera indica*), Jackfruit (*Artocarpus heterophyllus*), litchi (*Litci chinensis*), Banana (*Musa sapientum*), Pineapple (*Ananas comosus*), Guava (*Psidium guajava*), citrus (*Citrus sps.*), melons (*Cucumis sps.*), coconut (*Cocos nucifera*)

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
1. Crop Production - Crop improvement	1.1. Germplasm collection, evaluation, and maintenance of different fruits	High	Basic	Long
	1.2. Development of high yielding good quality regular bearing varieties of mango, Jackfruit, litchi, guava (year round) and coconut, with regional suitability	High	Basic/Applied	Long
	1.3. Molecular characterization of released fruit varieties	Medium	Basic/Applied	Long
	1.4. Develop early, Medium and late varieties for major fruits	Medium	Basic/Applied	Long
	1.5. Development of virus resistant varieties of papaya using conventional molecular techniques	High	Basic/Applied	Long
	1.6. Selection of suitable melon varieties for different planting time from within the local germplasms	High	Basic/Applied	Long
	1.7. Development of specific purpose varieties of selected fruits (i.e. processing, export etc.)	Medium	Basic/Applied	Long
2. Crop Production - Crop Management	2.1. Standardize management packages for major fruits and coconut	High	Applied	Medium
	2.2. Yield decline in BAU & Apel kul (Rajshahi region)	High	Applied	Short
	2.3. Land management of orchards	Medium	Applied	Medium
	2.4. Develop training, pruning, fruit thinning practices for important fruit crops	Medium	Applied	Medium
	2.5. Use of growth regulators for flower induction, fruit set and fruit retention in mango, pineapple	High	Applied	Short
	2.6. Introduction of grafting technique of jackfruit	High	Adaptive	Medium
	2.7. Introduction of improved fruit species in hills and saline coastal area	High	Adaptive	Medium

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
	2.8. Development of vegetative propagation techniques for difficult to propagate fruits	Medium	Applied	Medium
	2.9. Improvement of *in-vitro* propagation techniques and rapid multiplication of selected fruit crops	Medium	Applied	Medium
3. Crop Protection - Diseases and Pests	3.1. development of control measures for major diseases of mango, jackfruit, guava, banana, watermelon	High	Applied	Medium
	3.2. Dropping of flower and fruits of mango	High	Applied	Medium
	3.3. Die back, gummosis in mango, jackfruit, citrus, and canker disease in lime	High	Applied	Short
	3.4. Powdery mildew in BAU and Apel kul (Dinajpur)	High	Applied	Short
	3.5. Molecular characterization of major disease pathogens of major fruits	Medium	Basic	Medium
	3.6. Surveillance and monitoring of new diseases and insect pests of fruit crops	Medium	Strategic	Long
	3.7. Management of mites in coconut, chilli, watermelon etc.	High	Adaptive	Short
	3.8. Management Fruit borer in mango, jackfruit, BAU and Apel kul	High	Applied	Long
	3.9. Pest risk assessment of exotic fruits	High	Strategic	Long
	3.10. Integrated pest management (IPM) for major insect pest of fruits	High	Applied	Medium
4. Post harvest Management and Processing	4.1. Standardize maturity indices for major fruits like watermelon, pineapple, mango, and banana	High	Applied	Short
	4.2. Standardize, post harvest handling, packaging, transportation and storage techniques for selected fruits	High	Applied	Short
	4.3. Study on post harvest loss of different fruits and develop techniques to minimize the losses through pre and post harvest treatments	High	Basic/Applied	Medium
	4.4. Development of safe technique for ripening of fruits and extending shelf life	High	Applied	Medium

4.2.9. Flowers and Ornamentals

Floriculture is a growing industry in Bangladesh. Commercial production and marketing of cut flowers, saplings of ornamental plants and potted ornamentals has emerged as an important potential area of agri-business in this country in the recent years (Rashid, 2003; Dadlani, 2004). Nursery business is a good source of income for many male and female persons throughout the country, and most of the nurseries have some involvement with production and marketing of flowers and ornamentals.

The most important cut flowers of Bangladesh are: rose, tuberose, gladiolas, marigold and kathbeli, and the present total area under cultivation of different cut flowers and foliages is about 3,350 hectares. The major ornamental plants maintained in different nurseries for sale are, Crotons, Ixora, Thuza, Palms, Araucaria, Mussaenda, Dahlia, Cactus, Ferns, Aralias, Dracaena, China Box, Century Plants, Bromeliads, Needle Pine, Chlorodendrum, Hydrangea and Kalonche. The ornamental plants maintained in the nurseries are either produced by the nurserymen or collected from local and foreign sources. The approximate area under nurseries producing ornamental plants is about 1,100 hectares, and the total area of land under the floriculture industry at present is about 4,450 hectares.

The annual turnover in the wholesale markets is more than Tk. 1.00 billion, and in the retail market it is about Tk. 2.00 billion. It is estimated that about 80-90 thousand people of the country are directly or indirectly involved in the floriculture industry for livelihood.

The scope for export of cut flowers and ornamentals from Bangladesh has not yet been properly explored. In the year 2004-05, an amount of US$7.34 million was earned through export of flowers and ornamentals (EPB, 2007). Generally, chrysanthemum, tuberose and gladiolus are imported from India, and orchids, gerbera, anthurium and roses are imported from Thailand.

The major constraints identified in the floriculture industry of Bangladesh are access to modern varieties and quality planting material; narrow product range and poor quality of flowers and ornamental plants; inadequate knowledge and use of traditional practices in the production and post-harvest handling techniques; and poor knowledge on plant nutrition, diseases and insect pests, and improper use of ago-chemicals. Besides these, high cost of production and poor marketing system with little or no application of modern techniques in sorting, grading, packaging, transport and value addition is depriving those who are involved in this industry.

Systematic research and scientific intervention in the production, post-harvest management and marketing of flowers and ornamental plants could bring revolution in the country. Therefore, research on floriculture should be strengthened to overcome the above identified constraints. Under the following Thematic Areas, researchable areas/issues for flowers and ornamentals with priority ranking have been presented in Table 15.

Thematic Areas

a) Crop Production - Crop improvement
b) Crop Production - Crop Management
c) Crop Protection - Disease and Pests
d) Post harvest processing and marketing

Table 15. Priority Researchable Areas/Issues for Flower and Ornamental

Gladiolus (*Gladiolus communis*), Rose (*Rosa sps.*) Mari gold (*Tagetes sps.*), Orchid (Orchidaceae), Chrysanthemum (*Chrysanthemum sps.*), Dahlia (*Dahlia sps.*), Cactus (Cactaceae), Gerbera (*Gerbera sps.*), Tuberose (*Polianthes tuberosa*)

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
1. Crop Production - Crop improvement	1.1. Collection, evaluation and conservation of germplasms (local and exotic)	High	Basic/Applied	Long
	1.2. Developments of hybrids (in selected flowers like Marigold, Dahlia, Chrysanthemum etc.) especially dwarf plant with large flower	High	Applied	Long
	1.3. Development of flower varieties for local and export market with desired traits	High	Applied	Long
	1.4. Introduce new flowers for diversity as well as export potential	Medium	Applied	Long
2. Crop Production - Crop Management	2.1. Standardize cultivation practices for commercial cultivation of major flowers (from seedling to harvest)	High	Applied	Medium
	2.2. Develop tissue culture technique for rapid multiplication	High		
	2.3. Standardize seedling raising techniques	High	Applied	Short
	2.4. Standardize pot culture technique, pot size, potting media using commercially available compost and mix fertilizers	High	Applied	Medium
3. Crop Protection – Diseases and Pests	3.1. Survey of diseases of major flowers and ornamentals	High	Basic	Medium
	3.2. Standardize control measures for important diseases of commercial flowers of the country	High	Applied	Medium
	3.3. Survey and identify major pests of commercially cultivated flowers	High	Basic	Long
	3.4. Develop control measures for major insect pests of commercial as well as pot plants of flowers and ornamentals	High	Applied	Long

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
4. Post harvest processing and marketing	4.1. Exploration of the opportunities for export of flowers and ornamentals in the world market	Medium	Strategic	Short
	4.2. Standardize packaging, transportation and preservation of flower for local as well as export market (like, tissue culture seedlings with culture media)	High	Applied	Medium
	4.3. Market research and value chain for local as well as export market of flowers and ornamentals	Medium	Strategic	Short
	4.4. Standardize preservation of flowers using Medium and chemicals for increasing shelf life	Medium	Applied	Medium

4.3. Sub-Sector: Livestock

Livestock is an integral component of agricultural economy of Bangladesh. This sub-sector of agriculture is has multifarious functional aspects as food, nutrition, income generation, savings, foreign currency earning, draft power, manure, fuel, transport, etc. About 36% of the total animal protein comes from the livestock.

The present Government is committed to take necessary steps to achieve self sufficiency in milk, chicken and livestock production with a view to meet the protein demand of the nation. In FY 2008-09 the estimated share of the livestock sub-sector in GDP at constant prices is 2.73 percent. In the current fiscal year, the estimated growth rate in this sector is 3.46 percent which was 2.44 percent in FY 2007-08.

The export earning from leather and leather goods is 4.31% of the total export, 20% of the population is directly and 50% is partly dependent on this sector (Draft SFYP-2009).

Bangladesh has huge number of livestock and poultry population with a very high density and low productivity. The country has about 23.0 million cattle, 1.3 million buffalo, 22.0 million goats, 3.0 million sheep, 221.30 million chicken and 41.23 million ducks (DLS-2009). Productivity of all species of local livestock and poultry is far below the world average due to low genetic potentials and weak management practices.

Although an upward trend in the production of meat, milk and egg from 2001–2008 is evident, the per capita availability of meat was 20gm/day, milk- 51ml/day and 40 eggs/year in the year (2007-08, DLS). Total production in the years 2002-2008 was milk 1.82-2.65 million tonnes at a growth rate of (145.6%), meat 0.91–1.04 million tonnes at a growth rate of (114.3%), and eggs 4770–5653 million numbers at a growth rate of (118.5%). Demand and supply gap is more evidenced. As per FAO estimates there is a deficit of 80% in milk, 82% in meat and 63% in eggs.

To achieve the projected demands for milk, meat and eggs appropriate research plans will have to be implemented to get 1.3–1.5 times increase in the production in the years 2015 and 2020 from the base line year 2008 and in the years 2020 and 2030 an increase of 1.5 – 1.8 times.

The major constraints affecting the livestock productivity are : absence of appropriate breed, shortage of quality feed and fodder, absence of appropriate technology for improving the feed efficiency of feed stuffs, inadequate veterinary coverage, inadequate technologies for disease diagnosis, poor/lack of epidemiological information about major livestock disease, strategic disease control program, poor/lack of appropriate quality control, poor/lack of preservation techniques for livestock products and bi-products, absence of systemic marketing network and their products and value addition.

Under the following Thematic Areas, researchable areas/issues for Livestock with priority ranking have been presented in Table 16.

Thematic Areas

a) Livestock Production
b) Feed and Nutrition
c) Livestock Protection
d) Safety, Quality Improvement and Control
e) Processing, preservation and marketing of livestock products & by-products (Value addition & supply chain development)

Table 16. Priority Researchable Areas/Issues for Livestock

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
1. Livestock Production	1.1. Baseline survey on the productive performances of cattle and buffalo at all stages of productive life in Bangladesh	High	Strategic	Long
	1.2. Characterization, conservation and improvement of local/native animal/poultry genetic resources for increasing meat and milk egg production	High	Basic	Long
	1.3. Studies on the genetic variability for disease resistance to infectious diseases and parasites in livestock and identification of genes related to diseases	Medium	Basic	Long
	1.4. Studies on the hormone profile in the cyclic and pregnant indigenous and cross-bred cows in relation to fertility	Medium	Strategic	Medium
	1.5. Fine wool yielding sheep development for commercial wool production	Medium	Basic	Long
	1.6. Conserve and improve the hill livestock species	Medium	Basic	Long
	1.7. Standardization of embryo transfer technology for livestock	High	Strategic	Long
	1.8. Evaluation of existing AI (artificial insemination) service and factors affecting infertility in cattle and buffalo	High	Applied/Adaptive	Medium
	1.9. Screening the breeding males for breeding soundness, infectious and genetic diseases	Medium	Strategic	Long
	1.10. Development of abiotic stress tolerant breeds of livestock/poultry for low input management system	Medium	Basic	Long
	1.11. Assorted dairy cattle/beef cattle/buffalo breed development and production	High	Basic	Long
2. Feed and Nutrition	2.1. Feed information, feeding standard and feeding system development for cattle/buffalo /sheep /goat /poultry /duck	High	Applied/Adaptive	Medium
	2.2. Development of salt, drought and submergence tolerant forage /fodder varieties	High	Applied/Adaptive	Long
	2.3. Development of improved and appropriate feeds and feeding systems for the hill species	Medium	Adaptive	Medium
	2.4. Commercial prebiotic and probiotic development for calves, growing, lactating and beef cattle/buffalo	Medium	Applied/ Adaptive	Medium

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
	2.5. Development of cost-effective complete feed formulations for cattle, buffalo, sheep, goat and poultry for different productive functions	High	Adaptive	Medium
	2.6. Develop suitable fodder/forage crops in the forest lands, tree plantations, fruit plantations, sugar cane areas, haors and baors, roadsides and bund areas	High	Applied/Adaptive	Medium
	2.7. Develop appropriate technology for the utilization of NCFR such as algae, duckweed, water hyacinth, silkworm pupae, tree leaves, herbs and shrubs	High	Applied/Adaptive	Long
	2.8. Commercial milk replacer and calf starters	Medium	Applied/Adaptive	Medium
	2.9. Tissue culture technique for forage crop seed production and distribution	Medium	Strategic	Medium
3. Livestock Protection	3.1. Development of vaccine against mycoplasmosis.	High	Basic	Long
	3.2. Development of antiserum against different types of FMD virus	High	Basic	Long
	3.3. Development of new vaccine seed viruses against immerging diseases	High	Basic	Long
	3.4. Development of recombinant vaccine for important viral and bacterial diseases	High	Strategic	Long
	3.5. Epidemiology, surveillance and characterization of PPR, Goat Pox, Contagious Ecthyma	Medium	Strategic	Long
	3.6. Epidemiology, surveillance and characterization of Foot and Mouth Disease (FMD), Tuberculosis (TB), Brucellosis, Anthrax and HS, etc.	Medium	Strategic	Long
	3.7. Sero-surveillance of important (zoonotic) diseases of public health significance	High	Strategic	Long
	3.8. Epidemiology, surveillance and characterization of Newcastle disease, Avian Influenza, Infectious Bursal Disease, Marek's disease, avian leucosis, egg drop syndrome, etc.	Medium	Strategic	Long
	3.9. Studies on repeat breeding and retention of placenta in cattle and buffalo and development of mitigation measures	High	Strategic	Medium
	3.10. Development of a binaryethylenemine (BEI) inactivated polyvalent foot and mouth disease (FMD) vaccine	Medium	Strategic	Long

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
	3.11. Isolation, identification and molecular Characterization of FMD, Rota, PPR, Goat Pox and immerging viruses of poultry	Medium	Strategic	Long
	3.12. Surveillance studies on reproductive diseases	Medium	Strategic	Medium
	3.13. Cell culture techniques for diagnosis of viral diseases and vaccine production	High	Basic	Long
	3.14.			
	3.15. Development of recombinant vaccine for important viral and bacterial diseases	High	Strategic	Long
	3.16. Development of appropriate cost-effective zoo-sanitary and bio-security measures for farm animals and poultry	High	Adaptive	Medium
	3.17. Development of appropriate herd health management system	Medium	Adaptive	Medium
	3.18. Development of reproductive health management system (Hormone assay, AI service quality & efficiency, ovulation synchronization, tools for predicting bull fertility, application of ultrasonography, color dopler, etc.)	High	Applied/Adaptive	Medium
	3.19. Molecular and immunological events in host-pathogen interaction	Medium	Basic	Long
	3.20. Epidemiological studies on protozoal and gastro-intestinal parasitic diseases	Medium	Strategic	Medium
	3.21. Prevention and control of gastro-intestinal parasitic and protozoal infestations	Medium	Applied	Medium
	3.22. Development of new vaccine seed viruses against immerging viral diseases	High	Basic	Long
	3.23. Identification of causes of high calf mortality specially in crossbreed cattle and buffalo and their mitigation measure	High	Applied	Medium
	3.24. Assessment of climate change effects on health and disease problems of farm animals	Medium	Strategic	Long
	3.25. Surveillance and development of disease control systems of livestock in hill areas.	Medium	Applied/Adaptive	Medium

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
4. Safety, Quality Improvement and Control	4.1. Quality improvement of local vaccine and drugs following OIE standard guidelines.	High	Strategic	Medium
	4.2. Tools and techniques for determination of drug residues and toxins in livestock products, by-products and feeds	Medium	Strategic	Medium
	4.3. Investigation of drug (antibiotics, steroid, hormones, etc.) residues and toxins in livestock products, by-products and livestock feeds	Medium	Applied/Adaptive	Medium
	4.4. Safety, potency, efficacy of locally produced and imported vaccines	High	Applied/Adaptive	Medium
	4.5. Feed preservation and processing and quality management system development	Medium	Strategic	Medium
	4.6. Evaluation and development of mitigation measures of the effects of hazardous toxic chemicals on animal health	Medium	Applied/Adaptive	Medium
	4.7. Development of effective bio-secured housing system for rural poultry	High	Adaptive	Medium
	4.8. Quality control of different vaccines, drugs, biologics and diagnostics available in Bangladesh	High	Strategic	Medium
	4.9. Quality control of livestock products and by-products, seed materials, feed and fodder	High	Strategic	Medium
	4.10. Development of hygienic and safe processing and preservation techniques of livestock products and by-products	Medium	Applied/Adaptive	Medium
	4.11. Development of cost-effective and rapid diagnosis systems against different diseases	Medium	Applied/Adaptive	Medium
	4.12. Development of effective and hygienic slaughter house management system	Medium	Applied/Adaptive	Medium
	4.13. Development or adoption of biotechnological tools including PCR, RT-PCR, RFLP, PCR-ELISA, etc. for diagnosis of different diseases	Medium	Applied/Adaptive	Medium
	4.14. Development of techniques to identify dead livestock meat	Medium	Applied/Adaptive	Medium
	5.1. Development of an effective milk marketing system with special emphasis on small and Medium dairy farms	High	Applied/Adaptive	Medium

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
	5.2. Development of suitable bio-fertilizer mixture using livestock and poultry manure appropriate for different crops	Medium	Applied/Adaptive	Medium
	5.3. Socio-economic and environmental impact analysis of livestock and poultry farming	Medium	Applied/Adaptive	Medium

4.4. Sub-Sector: Fisheries

Fisheries represent the second most productive and dynamic sub-sector of agriculture. Fish and fisheries are equally important for the livelihoods, food and income generation of the people of Bangladesh. The sector contributes about 4.65% of GDP, 20.60% of gross agricultural product, and 4.04% of export earnings. An estimated 1.25 million people are directly employed in this sub sector. Over 12 million additional rural people indirectly earn their livelihoods from fisheries related activities. Bangladesh's fisheries resources are generally classified into inland and marine fisheries. Inland fisheries comprise of capture or openwater fishery and culture or closedwater fisheries.

According to the 2007-2008 catch statistics, fish production in Bangladesh was 2.57 million tonnes. Based on the present trend in growth the production will stand at 5-7 million tonnes in the yaer 2030. Well conceived strategies, improved management practices and effective targeted investment with right mix of policy and political commitment it is not impossible to achieve. Technology generation is a prime requisite and important for the production support. In absence of need-based appropriate technologies, based on local resources and farmers condition vast potential and existing opportunities could not be exploited. In this context prioritization of researchable problems and issues is essential for research and technology generation.

Future fisheries will be challenging. The gap between production and requirement will be further increased with the population growth. Global climate change and weather abnormality may reduce the potentials of fisheries over the coming decades. In mitigating the adverse effects, pragmatic research on priority issues is needed. In combating the challenges, simultaneous development and management of the fisheries resources in all areas namely; floodplain, marine and cultured should get importance.

However, greater emphasis should be given on research to increase the output from culture based fisheries, side by side, maintaining the present output level of capture fisheries is important for livelihood support of the fishermen community. Further, resource allocation for development and management of brackish water and marine fisheries resources would be immensely useful for total production enhancement. Under the following Thematic Areas, researchable areas/issues for fisheries with priority ranking have been presented in Table 17.

Thematic Areas

a) Fish production and productivity
b) Fisheries protection/ conservation/management
c) Fish feed and nutrition
d) Fish health management
e) Socio economics and marketing
f) Climate change

Table 17. Priority Researchable Areas/Issues for Fisheries

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
1. Fish production and productivity	1.1. Development of improved brood fish and breeding protocol for commercial, threatened and endangered fish species	High	Basic	Medium-Long
	1.2. Intensification and zoning of fish culture practices in different agroecological zones for productivity enhancement	High	Adaptive/Applied	Medium
	1.3. Effect of antibiotics, growth promoters, inducing agents and hazardous chemicals use in aquaculture and its impact on human health	Medium	Applied/Strategic	Medium-Long
	1.4. Diversification of aquaculture practices	Medium	Adaptive	Medium
	1.5. Bio-physical characteristics of brackish waters to intensify shrimp culture	Medium	Applied/Adaptive	Long
	1.6. Development of culture and management practices for commercially important marine fisheries resources	High	Adaptive/basic	Medium-Long
	1.7. Biotechnology and genetic engineering for development of high yielding fish varieties	High	Basic/Strategic	Long
2. Fisheries protection/ conservation/ management	2.1. Designing sanctuaries for conservation and biodiversity of fisheries resources	High	Adaptive/Applied	Medium-Long
	2.2. Effect of pollution of water-bodies on fish health, habitat and its management	High	Strategic/basic	Long
	2.3. Sustainable management of hilsa fisheries	High	Strategic/Applied	Long
	2.4. Community approach in floodplain aquaculture and management	Medium	Adaptive/Applied	Medium
	2.5. Harvesting, handling, processing and preservation of fish and fisheries products to HACCP standard	High	Applied/Adaptive	Medium
3. Fish feed and nutrition	3.1. Cost effective quality feed development for diverse aquaculture practices	High	Adaptive	Medium

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
	3.2. Standardization of feeding and fertilization principles/techniques of aquaculture for sustainable environment	High	Adaptive	Medium
4. Fish health management	4.1. Fish diseases diagnosis, treatment and development of fish health management protocol	High	Applied/Adaptive	Medium-Long
	4.2. Identification, characterization and treatment of shrimp diseases and health management	High	Applied/Basic	Medium-Long
5. Socio economics and marketing	5.1. Impact of shrimp farming in the coastal ecosystem	Medium	Applied/Strategic	Medium
	5.2. Value addition in fish and fish products and development of supply chain	High	Applied/Strategic	Short-Medium
	5.3. Social and economic implications of adopted technologies on productivity and livelihood	Low	Strategic	Medium-Long
6. Climate change	6.1. Impact of climatic factors on fish migration, breeding, growth and productivity	High	Basic/Strategic	Long
	6.2. Fish migration, breeding and propagation in extreme and diverse climatic conditions	High	Basic/Strategic	Long

4.5. Sub-Sector: Natural Resources

4.5.1. Land and Soil Resources

Soil is the greatest resource of Bangladesh. Over the last three decades, enormous pressure has been exerted on the soil resource to produce more food for its vast population. During this period agricultural land use has increased remarkably, along with increased use of modern crop varieties, which in turn has resulted in deterioration of soil health. Many soil health related problems have been identified which hinder crop production. The problems are depletion of organic matter and soil fertility, nutrient deficiency, soil salinity, soil acidity, topsoil erosion, degraded rice soils, sandy soils, drought, drainage impedance, and water logging. As time advances, new nutrient deficiency arises. Deficiency of micronutrients e.g. Zn, B and Cu has arisen in some soils and crops. These problems have arisen largely due to irrational human interventions.

There is a rapidly changing demand that soil research should address vital issues in the coming 20 years. Soil research needs to be integrated with other areas of research (e.g. irrigation, crops) in solving increasing complex problems. Sustainability goals demand that adequate strategies are developed to reduce further degradation of productive soil and all-out efforts are made to rehabilitate the already degraded soils.

Research on land and soil resource management should given special attention to ecologically disadvantaged areas e.g. coasts, hills, char lands where research has not yet been strengthened. Soil erosion is a major constraint in hilly areas. Sloppy lands and light textured soils, coupled with jhum cultivation are responsible for soil erosion. So, conservation agriculture techniques e.g. cover crops, contour, strip cropping needs to be investigated.

To solve these problems, target-oriented efficient research is needed. Not all problems are researchable, so problems need to be prioritized that constraint production, growth and development. Since available resources are limited, careful thought is needed to solve the priority problems. Under the following Thematic Areas, researchable areas/issues for land and soil resource with priority ranking have been presented in Table18.

Thematic Areas

a) Soil Organic Matter Management
b) Soil Fertility and Fertilizer Management
c) Ecologically Unfavorable Land and Soil Management
d) Bio-Fertilizers
e) Soil and Water Pollution
f) Impact of Climate Change on Natural Resources

Table 18. Priority Researchable Areas/Issues for Land and Soil Resources

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
1. Soil Organic Matter Management	1.1. Conservation agriculture with minimum tillage, mulch, cover crops etc. for upland crops under light textured soil	High	Applied	Medium-Long
	1.2. Organic amendments with FYM/PM/Bio-slurry/GM, crop residue/compost etc. for intensive cropping systems	High	Applied	Medium-Long
	1.3. Carbon sequestration in soils under single, double and triple cropping systems	High	Basic	Long
2. Soil Fertility and Fertilizer Management	2.1. Fertilizer need assessment for major crops and cropping patterns	High	Applied/ Adaptive	Medium
	2.2. Integrated nutrient management for major crops and cropping patterns	High	Applied/ Adaptive	Medium
	2.3. Nutrient use efficiency for major crops and cropping patterns	High	Applied/ Adaptive	Medium
	2.4. Micronutrient management for major crops and propping patterns	High	Applied/ Adaptive	Medium
	2.5. Nutrient dynamics in soil-crop-water system	Medium	Basic	Long
	2.6. Fertilizer need assessment model for major crops and cropping patterns	Medium	Applied	Medium-Long
	2.7. Delineation of OM and nutrients status in soils in 5-year intervals and GIS mapping	Medium	Basic	Medium
3. Ecologically Unfavorable Land and Soil Management	3.1. Adaptation of crops with soil and water management in coastal saline environment	High	Applied/ Adaptive	Medium
	3.2. Adaptation of crops with land/soil and water shed management in hilly areas	High	Applied/ Adaptive	Medium
	3.3. Sedimentation, nutrient accretion, crop adaptation and soil – crop management in char lands	High	Applied/ Adaptive	Medium

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
	3.4. Adaptation of crops with soil amendment, nutrient and water management in different agroecosystems like peat and piedmont areas, char lands, hills, terraces, etc.	High	Applied/ Adaptive	Medium
	3.5. Soil organic matter and water management for major crops and cropping patterns in Barind areas	High	Applied/ Adaptive	Medium
	3.6. Conservation of soil and soil fertility in hilly areas	Medium	Applied	Long
4. Bio-Fertilizers	4.1. Microbial inoculants for N and P in legume/rice/wheat/ sugarcane	High	Applied	Medium-Long
	4.2. Mycorrhizal inoculants for vegetables/fruits/forest crops.	Medium	Applied	Medium-Long
	4.3. Bio-activators for rapid composting/decomposition of crop residues and methane bacteria for bio-gas production	Medium	Applied	Medium-Long
5. Soil and Water Pollution	5.1. Heavy metal /Arsenic contamination and its management in water, soils and crops in arsenic contaminated areas	High	Applied	Medium-Long
	5.2. contamination and its management in water, soils and crops	Medium	Applied	Medium-Long
	5.3. Pesticide residues in soils and crops (vegetables and fruit)	High	Applied	Medium-Long
6. Impact of Climate Change on Natural Resources	6.1. Climate change effects on soil and water salinity/ drought/ inundation regimes and crop production practices in coastal, drought and flood prone areas	Medium	Applied	Long
	6.2. Estimation of CH_4 and N_2O emission from rice field	Medium	Basic	Medium

Note:-Title of the Project Proposal will be given by the Proponent Researcher from a Specific Priority Researchable Areas /Issue listed against a Specific Thematic Area.

4.5.2. Water Resources for Agriculture

The hydrological cycle of Bangladesh is influenced very much by the presence of the Himalayas in the north and the Bay of Bengal in the south. The major watersheds that are important for the country are the Brahmaputra and the Ganges. About 93% of water that flows through the country comes from trans-boundary sources. Annual river flow from other countries is 1105.6 km3 and annual internal renewable 105.0 km3, while annual withdrawal is only around 15.0 km3. The sectoral withdrawal is dominated by agriculture (86%) followed by domestic (12%) and industry (2%).

Water is an essential component of sustainable agriculture. For rainfed or irrigated crop cultivation, livestock production, fisheries, and forestry development, an adequate supply of good quality water is essential. In Bangladesh, about 90 percent of the rainfall occurs in the monsoon from June to September. Due to scanty rainfall in other months, in areas with low soil moisture content and physical soil constraints to tillage, crop diversification are hampered considerably (Karim et al., 1986). Proper irrigation plays a vital role in crop production in the country and will be of more importance in the future, when the scarcity of fresh or irrigable water is feared to increase. Another complexity is the occurrence of a large variety of soils and land types in Bangladesh. The soils vary conspicuously with respect to moisture holding capacities, infiltration rates, and other related properties (Karim et al., 1990). Therefore, more emphasis should be given to low water consuming agriculture.

During the past three decades irrigated agriculture has played a major role in total rice production. In the fiscal year 2007-08 the total irrigated area was 6.13 million hectare among which 5.74 and 0.39 million hectare were irrigated by modern and traditional methods, respectively. Currently, about 78.5% of the total rice grown in the country is irrigated. During the boro season rice is primarily an irrigated crop, occupying about 69.14% of the total irrigated area (BBS, 2010).

During the period of 1981-82 to 2006-07 the total irrigation coverage was increased from 1,726 to 5,898 thousand hectares (342%) whereas irrigation potential is estimated at 7,550 thousand hectares (Ernest, 2007). According to irrigation potential there is still scope for expanding 28 percent of irrigated area. At present groundwater contributes to 77% of total irrigated area in Bangladesh (BBS, 2008). About 80% of groundwater was used for crop production in which Boro paddy consumed 73% of total irrigation (Rahman and Ahmed, 2008). Hence, Boro rice production is increasing at about 1% annually and contributes to 55% of the total rice production (BBS, 2007). The application of groundwater irrigation increased with the expansion of High Yielding Variety (HYV) rice cultivation.

Although there is potential to increase irrigated areas through development of major river water and regional surface water system, irrigation has virtually not increased in the last five years. Most of the present large scale gravity irrigation systems are operating at much below the planned capacity, mainly because of poor operation and maintenance. The cost of irrigation has also increased substantially with rapid deterioration of existing facilities. The future development of surface water would require a large public investment.

The irrigation water use efficiency in STW and DTW command areas is below 60%. The water productivity is equally low at about 0.3 kg grain per cubic meter of water on the other hand, the cost of pump irrigation has been estimated at about Tk. 3,500 per hectare per season at present. It is projected to further increase with increasing

cost of operation and maintenance including the cost of diesel, since a vast majority of pumps (90%) are operated by diesel. Diesel supply and high price problems do occur during peak irrigation season. Adequate supply of diesel at reasonable prices is essential to support irrigated agriculture.

Reduced water availability, climate change and intensive agricultural practices through changing crops and cropping patterns result increased demand for water in Bangladesh. Agricultural water management is considered one of the important areas of research today. All types of water saving technology, storing and processing are equally demanding areas. Considering the above, the following thematic areas with researchable areas/issues for and priority ranking have been presented in Table19.

Thematic Areas

a) Water Resources for Agricultural Use
b) On Farm Irrigation Water Management

Table 19. Priority Researchable Areas/Issues for Water Resources for Agriculture

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
1. Water Resources for Agricultural Use	1.1. Quantitative and qualitative assessment of surface and groundwater resources for agriculture	High	Strategic	Medium-Long
	1.2. Watershed management for hilly areas	High	Applied/Adaptive	Medium
	1.3. Rainwater harvesting and use for agriculture	High	Applied/Adaptive	Medium
	1.4. Decline in groundwater resources and associated pollution	High	Applied/Adaptive	Medium
2. On Farm Water Management	2.1. Increasing water productivity through water saving techniques(increasing irrigation water use efficiency/alternate wetting and drying technology) for major crops and cropping patterns	High	Applied/ Adaptive	Medium
	2.2. Cost effective and high efficiency irrigation system for upland crops (including high value crops) and wetland rice	High	Applied/ Adaptive	Medium
	2.3. Development of water management techniques for major cropping patterns as a way towards adaptation to climate change	High	Strategic/Applied	Medium
	2.4. Use of alternative energy (CNG and Solar energy) for pumping	High	Applied/ Adaptive	Medium
	2.5. Water management for coastal saline soil; methods of reducing water logging in cultivable land; technology for conversion of sweet water from saline water	High	Applied/ Adaptive	Medium
	2.6. Modeling of crop-soil-water-weather system	High	Strategic	Medium

Note:-Title of the Project Proposal will be given by the Proponent Researcher from a Specific Priority Researchable Areas /Issue listed

4.5.3. Forestry

Bangladesh is a small thickly populated country. Because of high population density and shrinking natural resource base there is enormous pressure on the natural resources of the country. As obvious, there is a crying demand for wood for the swelling population. As a consequence of rapid economic growth through industrialization and agriculture, forests are continuously shrinking at an alarming rate. Mangrove forests are encroached for shrimp culture, which provides a quick economic return at the cost of deterioration of the complex and fragile coastal ecosystem that protects the people from cyclone and tidal surges. Hill forests are being cleared to meet the increasing demand.

The population density is one of highest figures in the world. As a result, there is a tremendous pressure on the natural resources of the country. There is, naturally, a crying demand for wood for the swelling population. Considering the two dominant development paths –rapid economic growth through industrialization and agriculture, forests are continuously deleted shrinking at an alarming rate. Mangrove forests are encroached for shrimp culture. This provides a quick economic return at the cost of complex coastal ecosystem that protects the people from cyclone and tidal surges. Hill forests are being cleared to increase visibility in order to control insurgencies during last two decades. In addition, some serious natural problems like top-dying of sundri (Heritiera fomes) trees in the Sundarbans and dieback of sissoo (Dalbergia sissoo), and bamboo blight in village forests have also contributed to the depletion of forest resources. On the other hand, contrary, the yield of forests is very low. A bulk of the wood produced after long gestation period is lost due to improper post harvest handling technologies.

The people in general, with a low level of literacy are little aware of forest and environment. Such lack of awareness has definitely a negative impact on forestry in Bangladesh. The high demand of wood coupled with the lack of awareness generates a very high pressure for causing leads to illicit felling. The overall poor socioeconomic conditions of the people lead them to harvest or collect wood especially fuel-wood, mostly for cooking from the government owned forest areas. All these factors also contribute to depletion of the resources. In addition, natural calamities, pollution, etc., also contribute to depletion of forest resources. Climate change is a very important issue. There is an urgent need to undertake appropriate measures to face the escalating issue. Assessment of carbon stock in different forests is essential in order to harness the benefits of carbon trading.

To combat these problems, forestry activities are to be strengthened through undertaking need-based priority research and development in this sector. Being the only national research organization in forestry in the country, the primary responsibility goes to the Bangladesh Forest Research Institute (BFRI) in generation of demand-driven technology. The role of universities in Bangladesh cannot be ignored as they also conduct some basic research. Nevertheless, the liability of the Forest Department (FD) is not overlooked. It must have to provide all support and cooperation in conducting research. In some cases, there are scopes for FD to be involved in generation of new knowledge.

Technological interventions needed to overcome the problems in the march to minimize the demand-supply gap are have been grouped under the following Thematic Areas. Researchable areas/issues for forestry with priority ranking have been presented in Table 20.

Thematic Areas

a) Forests and biodiversity conservation
b) Low productivity
c) Adverse effect of climate change
d) Livelihood improvement
e) Non-timber forest products including medicinal plants
f) Post harvest technology
g) Technology transfer

Table 20. Priority Researchable Areas/Issues for Forestry

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
1. Forests and Biodiversity Conservation	1.1. Study the drivers of deforestation and develop appropriate participatory approaches for forests and biodiversity conservation	High	Strategic/Applied	Medium
	1.2. Study the biodiversity resources (flora and fauna including soil microbes) of different forest types including home gardens	High	Strategic	Long
	1.3. Inventory and assessment of wildlife species and their keystone species in different forests (and wetland areas) of Bangladesh	High	Strategic	Long
	1.4. Assessment of ecological impacts of different exotic species including rattan in forests	High	Strategic	Long
	1.5. Ecosystems analysis of mangrove forests and developing measures for preservation under varied climatic situations and risks	Medium	Basic/Applied	Long
2. Low Productivity Management	2.1. Identification of best provenances/ clones of commercial species of trees and establishment of their breeder seed orchards	High	Applied	Long
	2.2. Establishment of a seed bank for sustained supply of quality planting stock	High	Applied	Medium
	2.3. Collection and testing of seeds collected from plus trees and mother trees, and develop storage techniques in seed bank	High	Applied	Short
	2.4. Development of high yielding clones of bamboo and cane (rattans)	High	Applied	Long
	2.5. Establishment of germplasm centre of endangered indigenous species in different ecological regions	High	Applied	Long
	2.6. Identification/standardization of control measures for major insect pests and diseases of important tree species in the forests and homestead areas	High	Applied	Long

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
	2.7. Development and screening of diseases and pests resistant tree species	High	Applied	Long
	2.8. Screening of diseases and pests resistant tree species and their expansion	High	Applied	Long
	2.9. Coordinated regional program for controlling common diseases and pests of forest tree species	Medium	Basic/Applied	Long
	2.10. Development of nursery practices of endangered indigenous species	Medium	Applied	Long
	2.11. Identification of pests and diseases of nurseries and their control	High	Applied	Long
	2.12. Assessment of wood production trends and consumption pattern in non-forest or poorly forested areas	Medium	Strategic	Long
	2.13. Development of conservation techniques of soil and soil fertility in hilly areas	Medium	Applied	Long
	2.14. Identification and economic analysis of existing (traditional, introduced, farmer-innovated) agroforestry practices in Bangladesh and development of improved agroforestry practices	High	Strategic/Applied	Medium
	2.15. Development of agroforestry models for forest and newly accreted land	High	Applied	Long
	2.16. Development of improved shifting cultivation in the hilly areas	High	Applied	Long
	2.17. Development improved management technique for degraded forest land	High	Applied	Long
3. Adverse effect of climate change	3.1. Development of appropriate social forestry techniques for forest land	High	Applied	Long
	3.2. Mitigation of impact of climate change on food security of forest dependent people	High	Applied	Long
	3.3. Assessment of carbon stock in different forest land	Medium	Strategic	Long
	3.4. Assessment of climate change impact on forests using remote sensing and GIS	High	Strategic	Long

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
	3.5. Investigating possible impacts of climate change and sea level rise on different forest types with particular emphasis on the mangrove forests	High	Strategic/Applied	Long
4. Livelihood improvement	4.1. Exploring forest resources and livelihood linkages in different forest regions with socioeconomic, quantitative and qualitative data	Medium	Basic/Applied	Long
	4.2. Development of IGA for improving livelihood of forest dependent people	Medium	Applied	Long
	4.3. Development of community based eco-tourism in forest areas for forest conservation *inter alia* poverty alleviation, women empowerment and creating environmental awareness	Medium	Applied	Long
5. Non-timber forest products including medicinal plants	5.1. Selection of appropriate varieties of commercially important medicinal plants for their best medical efficacy and higher yield	High	Applied	Long
	5.2. Development of mass propagation techniques including tissue culture of commercially important medicinal plants	High	Applied	Long
	5.3. Development of end-use specific silvicultural/ agronomic management packages for commercial production of important medicinal plants	High	Applied	Long
	5.4. Development of appropriate technologies (processes, equipment) for processing of commercially important medicinal plants	High	Applied	Long
	5.5. Screening of effective bio-pesticides for medicinal plants and other crops	High	Applied	Long
6. Value Addition and Technology transfer	6.1. Packaging mature technologies for dissemination to the clienteles through training, advisory services and information supply	High	Applied	Long
	6.2. Development of marketable products from waste woods and wood products	Medium	Applied	Long

4.6. Sub-Sector: Food and Nutrition

Food Availability and Consumption, Post Harvest Losses, and Agro processing Technology, Food Safety and Human Nutrition

During the period from 1994-95 to 2008-09, rice production in the country has steadily increased from 16.83 to 34.22 million tonnes, though wheat production declined slightly from 1.25 to 0.958 million tonnes. It indicates an overall increase in production of cereal crops and per capita availability. Production of fruits, vegetables and all kinds of animal food (meat, egg, milk and fish) are far behind the intake level to meet nutritional requirements. Pulses, the so-called "poor man's meat" as well as oil seeds, known as the most energy-dense food, showed a rather steep fall in growth. The increases in domestic production together with import of food commodities led to per capita increase in intake by 6.9%. Interestingly, though the total food intake increased, but the intake of cereals shows a slow decreasing trend by 9.5%, with increased intake of non-cereal food items, particularly meat, egg, potato, fruits and vegetables. Food and nutrition security is a matter of multi-sectoral and dimensional issue; where agriculture has a pivotal role to play. Agricultural production system should therefore be reoriented into a food based system to ensure the nation a balanced diet and to develop a talented and healthy new generation through undertaking innovative efforts.

Post harvest loss of food commodities remains as yet a neglected area. In FY 2005-06 post harvest loss of commodities like cereals, fruits, vegetables and potatoes, was 6.27 million tonnes, while this loss stood at 8.86 million tonnes in 2008-09. If this trend goes on, this loss will be increasing proportionately to a colossal national loss in the year 2015 and beyond.

In order to overcome the food deficiencies, two lines of actions being traditionally emphasized on (a) reducing future demand by slowing down population growth and (b) augmenting food supplies by increasing production. But the other option like, development of appropriate implements and technology for harvesting and handling methods in the context of reduction of huge post harvest losses will be important and helpful. Agro-processing is considered as an appropriate intervention for reduction of post-harvest loss, improvement of fair price for the producers, generating employment, extension of shelf-life of the commodities for consumption, making products available in lean seasons and contributing to nutritional well being.

Various studies and survey reports reveal that a good number of different food items available in the market are below standard and many of these are not in compliance to the BSTI standards. Uncontrolled and widespread use of hazardous chemicals, additives and preservatives for early ripening and preservation are posing serious threat to human health and increasing the proportion of non-communicable diseases.

It is estimated that by 2030, more people will suffer from the nutrition related non-communicable chronic diseases (NCCD) than from the long known common infectious diseases. These are much discussed issues now-a-days, which have been depicted frequently both in printed and electronic media. Besides the immediate measures, a medium and a long term plan for improving the situation is a need of the day.

Hence to make visible positive change interventions in priority areas through coordinated effort from all relevant stakeholders is needed. Under the following

themes, researchable areas/issues for nutrition with priority ranking have been presented in Table 21.

Thematic Areas

a) Food Production, Consumption and Human Nutrition
b) Post-Harvest Loss and Agro Processing
c) Food Safety and Quality, Hazards and Risk

Table 21. Priority Researchable Areas/Issues for Human Nutrition: Food Availability and Safety, Agro-processing and Post-harvest Loss

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
1. Food Production, Consumption and Human Nutrition	1.1. Re-orientation of agricultural extension approach focusing on both production and consumption of nutritious foods for balanced nutrition	High	Applied	Medium
	1.2. Integrated farming of crops, livestock, fisheries and agro-forestry for improved nutrition and livelihood	High	Basic	Medium
	1.3. Food based approaches in alleviating nutritional problems and sustainable improvement nutritional status	High	Basic	Long
	1.4. Diversification and intensification of agriculture production system emphasizing on protein- and micronutrient-rich foods through bio-fortification	Medium	Basic/ Applied	Long
	1.5. In-depth national survey to determine nutritional status and factors associated with malnutrition in order to take necessary remedial measures	High	Basic	Long
	1.6. Formulation of low cost balanced, nutritious and safe diet including street food with multiple options for the vulnerable section of the population	High	Basic	Long
	1.7. Comprehensive analysis of different food items for determining their nutritional values including flatulent and anti-nutritional factors of existing and newly developed varieties	High	Basic/Applied	Medium-Long
	1.8. Formulation of nutritious foods like corn flakes, bakery items, etc. blended with non-conventional food items e.g. cassava and maize powder/flour	Medium	Applied	Medium
	1.9. Screening for Quality Planting Materials (QPM) with high carotene and minerals for human consumption	Medium	Applied	
	1.10. Determination of nutrients loss of different food items in cooking, marketing, transportation and handing processes and develop measures for their retention	High	Basic/Applied	Medium-Long

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
2. Post-Harvest Loss and Agro-processing	2.1. Popularization of appropriate technologies for practicing at farmers' level to minimize the post harvest losses of agricultural commodities	High	Applied	Medium-Long
	2.2. Development of low cost processing technologies for crop, livestock and fisheries products	High	Basic/Applied	Medium-Long
	2.3. Developing traceability system in agro-products and development of value chain for improved marketing system for the processed ago-products	High	Basic/Applied	Medium-Long
	2.4. Processing, fortification and preservation of different food items and their products for the vulnerable groups	Medium	Basic/Applied	Short-Medium
3. Food Safety and Quality, Hazards and Risk	3.1. Development and adoption of appropriate standards on various food and additives	High	Applied	Medium
	3.2. Study on contaminants (arsenic/heavy metals), adulterants and additives and their implications on human health	High	Basic/Applied	Medium-Long
	3.3. Sanitary and phytosanitary measure for protection of food borne diseases	High	Basic/Applied	Medium-Long
	3.4. Identification of phyto-toxin and myco-toxin in food items and feeds and develop mitigation measures	High	Basic/Applied	Medium-Long
4. Post harvest technology	4.1. Development of better conversion and utilization methods of different food and food products	Medium	Applied	Long
	4.2. Harnessing alternate sources and means to reduce dependency on naturally occurring food product	High	Applied	Long

4.7. Sub-Sector: Agricultural Economics

In recent years agriculture in Bangladesh is growing at an annual rate of around of four per cent against the country's GDP growth of six percent leading to per capita income rise of over four per cent. On the other hand, population of the country is rising by about 1.26 %. The increase in population and higher income needs greater domestic production of food and fibre. It is estimated that in 2020 and 2030 Bangladesh will have a population of 166.90 and 195.53 million respectively i.e. an increase by 17 and 32% over the current population of 144.2 million (2008). Therefore, increased amount of food have to be produced from the same amount of land or even less as agricultural land is declining by about one per cent a year due to other non-agricultural use.

To achieve the required increased production, future research in Agricultural Economics is needed to overcome the several constraints. In one hand, there are dominance of small size farms, deterioration of land quality due to intensive cropping and nutrition depletion, high degree of pollution of surface and groundwater and declining availability for irrigation. On the other hand, higher domestic production cost owing to high cost of inputs, stagnation of yield or wide yield gap, increase in labour cost, inadequate and availability of credit support not in time, and global competition, ineffective market and value chain development, farmers' weak financial and technical capacity to the adoption of knowledge-intensive technologies. Above all inadequate policy support is impinging the total process of development. Researchers in agricultural economics need to and can play a major role by assisting the government, donors, and other stakeholders through fact-based implementable policy and technical support.

Issues for research in Agricultural Economics are continuously changing due to changes in socio-economic condition of the people and generation of new technologies. Research areas in this field are very wide and are influenced by local and external factors. The main factors that usually limit the research in Agricultural Economics by the NARS institutes are (a) allocation of research fund (b) availability of required trained manpower (c) targeting for small, medium and large farms. In the present context, the broad subject areas for future research are i) Production environment ii) Efficiency in farm production iii) Food security iv) National policies v) Domestic and international trade vi) Institutional capacity building and reorganizations vii) Public-Private sector and NGOs participation in research and technology dissemination. viii) climate change and natural hazards affecting production and supply and ix) Policy issues like input-output price, subsidy, crop insurance and epidemic/endemic in livestock and fisheries sectors, etc. Considering all issues, under the following thematic areas, researchable areas/issues for Agricultural Economics with priority ranking have been presented in Table 22.

Thematic Areas

a) Policy and Planning
b) Production and Farm Productivity
c) Supply chain and Marketing

Table 22. Priority Researchable Areas/Issues for Agricultural Economics

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
1. Policy and Planning	1.1. Policy impact on farm productivity, output and resource management	High	Strategic	Medium
	1.2. Policy investigation on price of inputs and outputs towards productivity and profitability	High	Applied	Medium
	1.3. Production and business model development on crops (seed and high value crops), livestock and fisheries	High	Strategic	Medium
	1.4. Impact of research innovations on return to investment including factors effecting their adoption	High	Applied	Medium
	1.5. Impact of research and development programmes/projects on productivity, profitability and environment	High	Strategic/Applied	Short
	1.6. Assessment and policy direction in "Research -Extension-Farmers linkage" contributing to productivity and income	High	Applied	Short
	1.7. Agricultural subsidy, insurance and credit and their impact on small, medium and commercial enterprises	High	Strategic/Applied	Short
	1.8. The quality of agricultural education impacting research and extension performance	Medium	Strategic/Applied	Short
	1.9. Assessing effectively of demo and block demo in relation to farm productivity and income	Medium	Strategic/Applied	Short
	1.10. Effectiveness of training of researchers, extension personnel and farmers on productivity and profitability	Medium	Strategic/Applied	Short
2. Production and Farm Productivity	2.1. Managing risk factors in agriculture with appropriate coping mechanism	High	Applied	Medium
	2.2. Combination of profitable enterprises for elevating productivity and farm income	Medium	Applied	Medium
3. Supply chain and Marketing	3.1. Empirical mapping of supply chain analysis for high value added commodities	High	Strategic	Long
	3.2. Development of market chain for farmers' participation in all types of markets (local and city markets)	High	Strategic	Medium
	3.3. International trade (Export-Import) analysis quality and safely issues for different agricultural commodities	Medium	Strategic/Applied	Short

4.8. Sub-Sector: Agricultural Mechanization and Farm Machinery

Bangladesh agriculture has been facing serious challenges of scarcity of agricultural labour not only in peak working seasons but also in normal time. This is because of migration of rural work force . The reason behind migration is mainly for natural hazards, increased non-farm job opportunities having higher wage, and low status of agricultural labourer in the society. Those who left their villages, one-tenth moved to other rural areas, just under one-quarter went to other countries, while two thirds moved to urban areas (Rahman et al. 1996). This trend is still continuing. On the other hand, cultivable land is decreasing due to urbanization. Wide scale migration of farm labourer has already created negative pressure on the agricultural productivity.

Furthermore, 2.0 million people are adding per year into Bangladesh population, demanding additional 0.35 million tonnes of food grain each year. Therefore, land and labour productivity of the country has to be increased. Focusing on the complementary agriculture, agricultural machinery sector provides an appropriate opportunity to do so. In doing this, The country should pursue complementary farm mechanization, not from the supply side, but from the demand side, organizing market pressure and developing strategic services that enable manufacturers to respond appropriately.

Limited agricultural activities such as land preparation, irrigation, weeding, spraying and threshing of crops have been mechanized at least partially in Bangladesh. It needs to be extended horizontally throughout the country to harness more benefits out of it. Other labour intensive agricultural activities such as sowing seed and seedling, fertilizer applicator, drying, water saving technology and water management, storing and processing are equally demanding areas of mechanization.

Agricultural Mechanization, Post-harvest Processing Equipment and Water Management are considered as the important areas of research today in the field of agricultural engineering. In general, agricultural mechanization has gained popularity among farmers for its multi-dimensional benefits such as reduction of operational cost and human drudgery, timeliness of operation, increased labour productivity and efficiency.

Fortunately, there are many opportunities to move forward with agricultural mechanization as the country has skilled manpower for research and extension, favourable policy, machine and spare parts manufacturers, traders and service providers including custom hire service of agricultural machinery. The government is patronizing agricultural mechanization though subsidy/loans to the farmers. Because of fast changing of parameters of agricultural technologies in Bangladesh, identification and updating of research priority has becomes a dynamic process. Furthermore, limitation of resources for research and the extent of field problems, currently facing the farmers, researchers and extension workers, pushing us all to review and update the research priorities.

Based on the farmers' current problems and their severity, needs and size of beneficiaries, some of the areas of research have been short-listed for immediate research interventions in the field of agricultural engineering. Under the following thematic areas, researchable areas/issues for Agricultural Mechanization and Farm Machinery with priority ranking have been presented in Table 23.

Thematic Areas

a) Pre-Harvest Farm Machinery
b) Post-Harvest Farm Machinery

c) Utilization of Renewable Energy
d) Precision Farming
e) Survey & Policy Research

Table 23. Priority Researchable Areas/Issues for Agricultural Mechanization and Farm Machinery

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
1. Pre-Harvest Farm Machinery	1.1. Appropriate machinery/equipments for upland crops and wetland rice culture (tiller/seeder/planter/weeder/fertilizer applicator/harvester/irrigation device) including their marketing	High	Applied	Medium-Long
	1.2. Development of different tillage and weed control equipment and techniques (power operated weeder/furrower for maize, wheat, potato and sugarcane; laser leveler)	High	Applied	Medium-Long
	1.3. Hydraulic design and manufacture of irrigation equipment	High	Basic/Applied	Medium-Long
	1.4. Investigation of appropriate pump zoning and tubewell spacing.	High	Basic/Applied	Medium-Long
2. Post-Harvest Farm Machinery	2.1. Small and medium scale machinery/equipment for crop (threshing/sorting/cleaning/storage device/drying/rice parboiling and milling)	High	Applied	Medium-Long
	2.2. Appropriate machinery and equipment for agro-processing (Crops/Livestock/Fisheries/Forestry)	High	Applied	Medium-Long
	2.3. Improved oil extraction technology from rice bran, rai, mustard and palm, improved juice extraction for sugarcane and gur processing	Medium	Applied/Adaptive	Short-Medium
3. Utilization of Renewable Energy	3.1. Renewable energy (solar, wind, bio-fuel, bio-gas etc.) use in farm machinery/equipment and application (rice drying and parboiling and irrigation of selected crops)	High	Applied	Medium-Long
4. Precision Farming	4.1. Computer vision/model to identify insect-pest, soil health; application of crop image for identifying precise amount of fertilizer, water & other inputs; modelling of rice cultuvation system; modelling of rice milling system	Medium	Applied/Adaptive	Short-Medium

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
5. Survey & Policy Research	5.1. Survey on current status of mechanization; impact study of mechanization on rural livelihood and environment	Medium	Strategic	Short-Medium
	5.2. Utilization of vast fallow land through mechanization in specific areas	High	Strategic	Short-Medium
	5.3. Policy issues about quality and standardization of agricultural machinery	Medium	Strategic	Short-Medium

Note:-Title of the Project Proposal will be given by the Proponent Researcher from a Specific Priority Researchable Areas /Issue listed against a Specific Thematic Area.

4.9. Sub-Sector: ICT and Disaster Management in Agriculture

Basically, Information Communication Technology (ICT) is a tool that can be used for many different purposes and fields. ICT plays a vital crosscutting enabler role in addressing many problems. This tool can be used in solving problems, increasing efficiency and providing effective service delivery in agriculture and disaster management.

Although, computer was introduced in Bangladesh more that 50 years ago, application of ICT in agriculture initiated only in 1979 when the FAO/UNDP Agricultural Development Advisor Project was undertaken by the Ministry of Agriculture. Under this project the information on landforms, soils, inundation regime and climate were computerized during 1980-86. As follow up of this, several ICT initiatives were undertaken, especially at BARC and SRDI and the outputs of these used for agricultural research and development and extension. Services are being provided to the Ministry of Agriculture and other Ministries, various NARS institutes, and extension agencies, Universities, International Organizations, and GOs and NGOs by catering to their needs.

The proposed National ICT Policy-2008 of Bangladesh states that ICT is one of the most important tools to achieve economic prosperity of a country through improving the management and efficiency in every sphere of life. Review of various National policies and other relevant documents revealed the importance of ICT in agricultural research and development. Further, disaster management is the topmost priority of the Government.

Disaster management, climate change and other related issues in agriculture are cross-cutting in nature. All the sub-sectors of agriculture are vulnerable to natural hazards, shocks and stresses. According to Intergovernmental Panel on Climate Change (IPCC, 2007), Bangladesh will be one of the worst victims of climate change. Sea level will be increased due to rise in temperature and the frequency of cyclone-storms will be increased. As a result, food security will be in jeopardy and different types of natural calamities will put lives at risk. On top of these, high population density in will make the problem more serious.

Although, all the sub-sectors might not be impacted equally, but it is likely that some would be more susceptible. The people of Bangladesh have been adapting to the risks of floods, droughts and cyclones for centuries. Heavy reliance of rural people on agriculture and natural resources increases their vulnerability to climate change. Therefore, supporting rural and urban communities to strengthen their resilience and to adaptation to climate change will remain a high priority in coming decades.

Media is emerging as an important instrument to disseminate the knowledge, success story and technology. Both electronic and print media are organizing regular programs on agriculture and much awareness has developed among the policy makers and growers. Extension service may be strengthened with the help of ICT at the grassroots level. Public private collaboration may be established in quick dissemination of farm technology

Information and Communication Technology in Bangladesh in respect of infrastructure and applications has made significant progress during the last two decades. Government's policy towards development of infrastructure and enabling condition is highly positive. As ICT can play a significant role in research and development of agriculture and disaster management in Bangladesh proper use of this tools must be ensured. In this context, priority must be set in order to make best use of time and resources.

Research themes in ICT in Agriculture and Disaster Management are quite varied from those in case of commodity based sub-sectors. Since ICT is a tool for information generation and

dissemination, its outputs is basically service oriented in nature. However, computer based modeling research could be undertaken to solve problems.

The studies may cover both short and long-term objectives including future projections or forecasts/predictions through development of Expert Systems (ES) and Decision Support Systems (DSS) for food security and disaster management. ICT should be used as a carrier of dissemination of technologies generated by the ARIs. The technology should be used as a tool for monitoring and evaluation. It could also be used to manage institutional human resources, resource inventories, database development (both spatial and textual). The major thematic areas identified from the above mentioned efforts are as follows:

In order to address all the above mentioned activities ICT must be institutionalized in the NARS and other affiliated organizations. Enabling conditions must be created at the Institution and at the National levels. This should be both in the context of infrastructure and trained and devoted human resources. Under the following Thematic Areas, researchable areas/issues for ICT in Agriculture and Disaster Management with priority ranking have been presented in Table 24.

Thematic Areas

a) MIS for Research Management
b) Databases on NRM and Socioeconomics
c) GIS and Remote Sensing
d) Web-enabled databases
e) Disaster Management
f) Climate Change
g) Human Resource Development

Table 24. Priority Researchable Areas/Issues for ICT and Disaster Management in Agriculture

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
1. MIS for Research Management	1.1. MIS of NARS institutes	High	Applied	Short-Medium
	1.2. Database of equipments/laboratory of NARS institutes	Medium	Applied	Short
	1.3. Databases related to research management on completed and on-going projects of NARS	High	Strategic/Applied	Short-Medium
	1.4. Database on monitoring and evaluation	High	Strategic/Applied	Short-Medium
	1.5. Database on financial management	High	Strategic/Applied	Short-Medium
2. Databases on NRM and Socioeconomics	2.1. Updating of AEZ database with land, soil, climate, hydrological parameter	High	Strategic/Applied	Medium -Long
	2.2. Development of variety/agricultural technology database	High	Applied	Short-Medium
	2.3. Development of socio-economic database	High	Applied	Short-Medium
3. GIS and Remote Sensing	3.1. GIS based information system on surface and groundwater resources	High	Strategic	Short-Medium
	3.2. GIS based pest and disease information system	High	Applied	Short-Medium
	3.3. GIS based information system for agro-ecologically constraint areas	High	Strategic	Medium-Long
	3.4. GIS based information system on Plant/Animal Genetic Resources	High	Applied/Adaptive/ Strategic	Short-Medium/Long
	3.5. Assessment of climate change impact on Agriculture/forests using remote sensing and GIS	High	Strategic /Applied	Medium -Long
	3.6. Development of Remote sensing and GIS based applications for crop/fisheries/forest resources	Medium	Adaptive/Strategic	Short-Medium
	3.7. Development of Remote sensing and GIS based applications for crop agriculture	High	Applied/Adaptive	Short-Medium
	3.8. Assessment of AEZ based suitability of major crops	High	Strategic/Applied	Medium-Long
	3.9. Crop zoning for land use planning	High	Strategic/ Applied	Short-Long
4. Web-enabled databases	4.1. Web-based agro-market intelligence systems	High	Applied/Adaptive	Short-Medium

Thematic Areas	Researchable Areas/ Issues	Priority Ranking	Types of research	Research Duration
	4.2. Web-based information systems for natural resources	High	Applied/Adaptive	Short-Medium
	4.3. Development of virtual knowledge centre	Medium	Strategic	Short-Medium
5. Disaster Management	5.1. Early warning systems for abiotic and biotic hazards (Flood, drought, rainfall, pests, diseases, etc.	High	Applied/Strategic	Medium-Long
	5.2. Expert Systems/Decision Support Systems for food security and disaster management	High	Applied/Strategic	Medium-Long
	5.3. Farmer information system /disaster management	Medium	Applied	Short-Medium/Long
6. Climate Change	6.1. Assessment of climate change effects along with adaptation technique on crops/fisheries/livestock production in different agro-ecological zones	Medium	Applied	Long
	6.2. Modeling of aquaculture practices in diverse climatic condition	Long	Basic/Strategic	Long
7. Human Resource Development*	7.1. Mainstreaming ICT at NARS Institutes	High	Strategic	Long
	7.2. Develop HR for assessing impact, generating climate change scenarios for simulation studies on crop, forestry, livestock and fisheries	High	Strategic	Long

** These are not research issues, but essential for undertaking research programs.*

5. References

Ahmed, F. (2007) Climate Change: Bangladesh Takes Its Trauma to Bali. URL: http://ipsnews.net/

Ali, M.S. and A. Haque. 2009. Development of potato industries for food security (in Bengali). In: Bangladesh Seed Conference and Fair-2009, Seed Wing- MOA and Bangladesh Seed Grower Dealer and Merchants Association, Dhaka.

BBS. 2007. Statistical year book of Bangladesh," Bangladesh Bureau of Statistics, Statistics Division, Ministry of planning, Government of People's Republic of Bangladesh, Dhaka.

BBS (Bangladesh Bureau of Statistics). 2008. Population Census, 2001. Bangladesh Bureau of Statistics. Planning Division, Ministry of Planning. Government of the Peoples Republic of Bangladesh

BBS. 2008. Statistical Yearbook of Bangladesh, Bangladesh Bureau of Statistics, Statistics Division, Ministry of planning, Government of People's Republic of Bangladesh, Dhaka. (http://www. bbs.gov. bd/ agriculture wing/ annual_agri_stat. pdf).

Bangladesh Bank. 2009. Economic Trends, January 2009. URL: http://www.bangladesh-bank.org/pub/monthly/econtrds/tmarchive/jan09.zip

BBS. 2009. Population Census, 2001. Bangladesh Bureau of Statistics. Planning Division, Ministry of Planning. Government of the Peoples Republic of Bangladesh

BBS, (2010). Satistical Yearbook of Bangladesh 2009. Bangladesh Bureau of Statistics, Statistics Division, Ministry of planning, Government of People's Republic of Bangladesh, Dhaka.

Bhuiyan, N.I., D.N.R. Paul and M.A. Jabber, 2002. Feeding the extra millions by 2025-challenges for rice research and extension in Bangladesh. Proceedings of the National Workshop on Rice Research and Extension, 2002, Jan. 29-31, Bangladesh Rice Research Institute, Joydebpur, pp: 9-9.

Bhuyan, M.A.J. and M.A. Hossain.. 2009. Research and development activities of BARI : An overview. The Guardian, June 2009. pp.79-85.

Bryson, J.M. 1988. Strategic Planning for Public and Nonprofit Organizations. Sage Publ. Drucker, P.F. 1973. Management: Tasks, Responsibilities, Practices.

Dadlani, N.K. 2004. Mission Report. Integrated Horticulture and Nutrition Development Project (BGD/97/41), DAE, Khamarbari, Dhaka.

DLS 2009. Directorate of Livestock Services, Khamer Bari Road. Dhaka .Personal Communication.

Eicher, C.K. 2001. Africa's Unfinished Business: Building Sustainable Agricultural Research Systems. MSU Department of Agricultural Economics Staff Paper No. 2001-10. East Lansing: Michigan State University.

EPB (Export Promotion Bureau). (2007). Bangladesh Export Statistics, Information Division, EPB, TCB Bhaban (1st & 4th Floor), 1, Kawran Bazar, Dhaka-1215. URL:http://www.epb.gov.bd/upload/ Bangladesh_Export_Statistics%202006-2007_PDF%20file.pdf

Ernest T. 2007. Water profile of Bangladesh, In: Encyclopedia of Earth. Eds. Cutler J. Cleveland (Washington, D. C.: Environmental Information Coalition, National Council for Science and the Environment), FAO, 2007.

FAO (Food And Agriculture Organization Of The United Nations). (2008). FAOSTAT. FAO Statistics Division. URL: http://faostat.fao.org/site/

Hossain, M., T.K. Dey, S. Akhter, M.K.R. Bhuiyan, M.A. Hoque, B.C. Kundu, M.A. Hossain and S.N. Begum. 2008. Activities and Achievements of Tuber Crops Research Centre at a Glance. TCRC, BARI, Joydebpur. 23 p.

HRC. 2007. HRC. Horticulture Research Centre, BARI, Joydebpur. 28 p.

Hussain, M.M. 2008. Prospects of potato in Bangladesh. In: Bangladesh Potato Campaign 2008. MOA, FAO & CSD, Dhaka, Bangladesh.

IPCC. (2007). Summary for Policymakers. In: Climate Change (2007) The Physical Science Basis. Contribution of Working Group I to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change [Solomon S., Qin D, Manning M., Chen Z, Marquis M., Averyt KB, Tignor M., Miller HL (eds)]. Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA.)

IWRM-Net (Integrated Water Resources Management). 2007. Short, Medium or Long? How do you define timescales of research? Towards a European-wide exchange network for integrating research efforts on Integrated Water Resources Management.

Li Pun, High. and Koala, S.. 1994. Priority Setting in Agricultural Research: A Comparison of Different Types of Networks. Environment and Natural Resources Division, IDRC. Ottawa-Canada. Paper presented at the Roundtable Discussion on Setting Regional Priorities for Agricultural Research. Le Hague-Netherlands. April 18-20 1994.

Manicad, G. 1997. Priority Setting in Agricultural Research: A brief conceptual background. Biotechnology and Development Monitor, No. 31, p. 26.

MoA (Ministry of Agriculture). 2006. Transformation of Agriculture for Sustainable Development and Poverty Alleviation in Bangladesh: Actionable Policies and Programmes. Government of Bangladesh

MoSICT (2008). Bangladesh National ICT Policy – 2008. URL: http://www.mosict.gov.bd/ index.php?option=com_docman&task=doc_download&g id=310&Itemid=390

Rabbani , M.G., M.A. Siddique, M.M. Islam and M.S. Islam. 2009. The Potato Sector of Bangladesh : Its Opportunities and Growth Hindrances. Bangladesh Agri. University, Mymensingh. 177 p.

Rahman, M.W. and Ahmed, R. 2008. Shallow tube well irrigation business in Bangladesh. Paper Presented at Summary and Synthesis Workshop at Kathmandu, Nepal, March 20-24, 2008.

Rashid, M.M. 2003. Fuler Chash (in Bengali). Dibyaprokash, Bangla Bazar, Dhaka. 203 p.

Wikipedia, 2008. Economy of Bangladesh. RL:http://en.wikipedia.org/wiki/Economy_of_Bangladesh

Annex-1: Sectoral Study in connection with the preparation of 'Vision Document-2030 and beyond'

Twelve Experts Teams have recently been formed by BARC in connection with the above in order to work for a maximum period of 2 Months each. Through discussion of the Group Leader and the Member-Secretary/Rapporteur, maximum 3 other relevant and contributing members for consultation purpose may be picked up in the Team. The team may sit at their convenience and as per their requirements.

Terms of Reference (ToR) of the Group Leaders:

1. Consultation and review of the documents related to agriculture and rural development. These are, but not limited to the followings. To accomplish the task the team may need to visit the concerned institutes.
   a. Planning Commission Reports on five year plan, annual budgetary documents etc.
   b. National Agriculture Policy
   c. Poverty Reduction Strategy of the GoB
   d. World Bank document on revitalizing agriculture and related others
   e. Agricultural sector review /Actionable policy briefs of the FAO
   f. Reports of the DFID, DANIDA and others on the performance of the agriculture sector in Bangladesh
   g. National Food policy
   h. National land use policy
   i. National livestock Policy
   j. National Fisheries Policy
   k. National Forestry Policy
   l. Vision document –2020 of BARC and Strategic plan of 1996
   m. Land, Soil and management of natural resources
   n. Reports on Food Security, quality and Safety
   o. Reports on MDG
   p. Master Plan & Annual Reports of ARIs
   q. Websites of various agencies

      (***Source:*** BARC Library, P & E Division, BARC, Concerned Institutes, Websites of the concerned Ministry/Organization)

2. Through collection and collation of the information as stated in Sl.-1, work out the countries situation/issues by the sub-sector/area (in total 12 nos.) of agriculture. These are;
   a. Rice
   b. Cereals other than Rice, Sugarcane and Jute
   c. Horticultural crops(Potato, Fruits, Vegetables, Spices including Flowers
   d. Pulses and Oilseeds
   e. Soil and fertility management
   f. Forestry
   g. Livestock
   h. Fisheries
   i. Agricultural mechanization and water management
   j. ICT in agriculture

k. Agricultural economics, marketing and supply chain development
l. Technology development, agro-processing post-harvest technology, food quality and human nutrition

(Sub-sectors/Areas modified and revised during the study period, as may be seen in the Annex-2)

3. Sub-sectoral studies are expected to be in-depth and detailed in nature. This to cover all component's current trend in production, demand-supply and gap, opportunities, problems and constraints, required technological interventions and their analysis in the country's context. By the process determine the priority need of the concerned sector/area by the year 2030 and beyond.

4. Population dynamics, reduction in land resource base and degradation, issues pertaining to climate change and sea level rise (SLR), economics of commodity and non-commodity related activities, income growth rate etc. all these to be taken into account in formulating the research priority.

5. Undertake other related tasks as may be deemed necessary or evolved while performing this assignment

6. Draft report of the teams to be presented in the workshops to be organized by the Planning & Evaluation Division of BARC at suitable dates.

7. Draft final report incorporating the comments/opinion obtained from the workshops, different agencies/individuals to be submitted within 2 (Two) months from the date of assignment to the MD (P&E), Bangladesh Agriculture Research Council, Dhaka.

Annex-2: Sub-sectoral Studies: Group Leaders and Member-Secretaries/ Rapporteurs

SI. No	Sector/Sub-Sector	Areas to be covered (but not limited to)	Group Leader	Member-Secretary/Rapporteur
1.	Rice	Improvement of Rice varieties, Disease and Pest Management, Crop Adaptation to Climate Change, Biotechnology, Coastal Agriculture, Drought Management, etc.	Dr. Md. Nasir Uddin Director (Research), BRRI	Dr. Mian Sayeed Hassan PSO (Crops), BARC
2.	Cereals other than Rice, Sugarcane and Jute	Cereal Crops Improvement, Disease and Pest Management, Crop Adaptation to Climate Change, Biotechnology, Coastal Agriculture, Drought Management, etc.	Dr. M. Matiur Rahman, former Director General, BARI	Dr. Md. Rafiqul Islam Mondal CSO (Crops), BARC
3.	Horticultural Crops (Fruits, Vegetables, Spices & Flowers including Potato)	Crop Improvement, Disease and Pest Management, Crop Adaptation to Climate Change, Biotechnology, Coastal Agriculture, Propagation Technique, Hill Agriculture, etc.	Prof. Dr. Md. Abdus Siddique Dept. of Horticulture, BAU, Mymensingh	Dr. Abul Kalam Azad CSO (Crops), BARC
4.	Pulses and Oil Crops	Crop Improvement, Disease and Pest Management, Crop Adaptation to Climate Change, Coastal Agriculture, Drought Management, etc.	Prof. Dr. Md. Lutfor Rahman Department of Plant Breeding and Genetics, BAU, Mymensingh	Dr. Md. Aziz Zilani Chowdhury, PSO (Crops), BARC
5.	Land and soil Resource Management	Soil Quality, Nutrient Status, Soil Health, Land Management & Degradation, Fertilizer Use Efficiency, Coastal Soil Management , etc.	Prof. Dr. Md. Jahir Uddin Dept. of Soil Science, BAU, Mymensingh	Dr. M. A. Satter CSO (Soils) (a.c.), BARC
6.	Forestry	Nursery Mangement, Disease & Pest Management, Agro-forestry, Climate Change, Afforestation in hilly and coastal regions, Medicinal Plants, etc.	Mr. Fariduddin Ahmed Executive Director Arannyak Foundation	Dr. Mohammad Shahjahan CSO (Forestry) (a.c.), BARC
7.	Livestock	Epidemiology & Surveillance of diseases, Developments of Vaccines, Zoonatic diseases, Breed development and testing, Conservation of endangered species, Feed, Nutrition & product development, etc.	Prof. Dr. M. M. Tareque Faculty of Veterinary Science and Animal Husbandry, BAU, Mymensingh	Dr. Shah Md. Ziqrul Haq Chowdhury CSO (Livestock) (a.c.), BARC
8.	Fisheries	Integrated farming, Intensification of fish culture & management technologies, Quality feed development, Fresh water & Marine Fishery, Aquatic Pollution, Conservation of endangered species, etc.	Dr. Khabir Ahmed Former Executive Chairman, BARC	Dr. Md. Kabir Ikramul Haque CSO (a.c.), (Fisheries)

SI. No	Sector/Sub-Sector	Areas to be covered (but not limited to)	Group Leader	Member-Secretary/Rapporteur
9.	Farm Machinery, Irrigation & Water Management and Post-harvest Technology (Engineering aspects)	Design & Development of low-cost farm machineries, Post-harvest Equipment, Water Management/ Efficiency, Water quality, etc.	Prof. Dr. A T M Ziauddin Department of Farm Power & Machinery, BAU, Mymensingh	Dr. Sultan Ahmmed CSO (Agril. Engg), BARC
10.	ICT in Agriculture and disaster management	Agricultural Databases & Knowledge Management, Use of GIS & Remote Sensing, Use of ICT in Vulnerable Environmental Monitoring, disaster in agriculture etc.	Dr. Sk. Ghulam Hussain Member-Director, BARC	Mr. Md. Abeed Hossain Chowdhury Director (Computer), BARC
11.	Agricultural Economics, Marketing and Supply Chain Development	Yield gap minimization, Profitability, Return over investment, Economics of Irrigation and Water Management, Impact Assessment of different technologies and projects, Public Intervention, Agricultural Price Policy & farm support, Land use and Land resource management, etc.	Dr. Md. Abul Quasem Former Senior Research Fellow BIDS	Dr. Fauzia Yasmin PSO (AERS) (a.c.)
12.	Food Availability and Consumption, Post Harvest Losses, Agro-Processing Technology, Food Safety and Human Nutrition	Agribusiness & Agro-processing, Post-harvest Handling, Food Adulteration, etc.	Mr. Md. Abdul Quddus Former DG, BARD & WFP Advisor, Dhaka	Dr. M. Moslem Uddin Mia Director (Nutrition), BARC

Annex-3: Group Work Guidelines

Step 1 : After formal briefing, disperse by ***group*** of broad research area/sub-sector. Of course, this does not prevent an interested individual of other discipline to join/make change in joining a particular group of choice. Find the research area/sub-sector in the **Annex-1**.

Step 2 : The ***Group Leaders*** shall present the draft report in the group prepared earlier.

Step 3 : ***Group Leaders*** to initiate discussion and invite comments/opinion and ideas on the presentations and subject matter. The group together/ individually/by mini group may first prepare the fatty ***'wish list'*** of the research agenda/themes. The group to analyze all the listed problems (please see Annex-3 'Problem Analysis') in respect of their magnitude, success probability, expected beneficiary and anticipated adoption by the users. The group then through discussion and agreement may list down (discarding duplication) only those; which are most urgent, important and result-oriented and thus narrow down to the 'priority list'. Ideally this should not be more than 5.

Step 4 : During group work, the ***Group Leader and*** the ***Rapporteur/Member-Secretary*** to note deliberations. Group Leader to compile and incorporate those, if agreed and found to be useful/required to improve the draft report.

Step 5 : Under each priority research agenda/thematic area, list down most pressing ***priority research topic(s).*** Exact title not really necessary at this stage but would be useful. In order to assist in framing the researchable areas or issues by the drafting committee, only the key words would do.

Step 6 : Decide and fill the column of ***Priority Ranking*** agreed by majority *(See Annex-3)* of the group.

Step 7 : Decide and fill the columns of ***Research Tenure*** agreed by majority of the group *(See Annex-3).*

Step 8 : Prepare power point presentation of the group.

Step 9 : ***Group leader to submit hard & soft copy*** of the group work to the Member-Director(P&E) , BARC and the Convener of the workshop.

Step10 : Group Leaders to ***finalize the draft report*** covering outcome of the workshop activities

Annex-4: Problem Analysis Format

1. Research Area/sub-sector :…….

2. Research Agenda/Thematic Area(s):

2.1 ***Research Agenda/Thematic Area-1:*** ……(continue 2.2 and so on)

Problem/Constraints	**Research Title/Key Words**	**Magnitude** ***(% of the total area/coverage)***	**% of beneficiary***	**Probability of success**	**Priority Ranking**	**Research Tenure**		
						Long	**Med**	**Short**

* If the problem could be solved through research intervention in an area/out of the total- facing the problem.

Signature:
(----------)
Name (Group Leader)……..
Date:…….

Priority Ranking **:** 1- Highest, 3- Lowest

Probability of Success **:** 1- High, 3- Low

Research Tenure **:** Long - Over 5 years
Medium - 3 to 5 years
Short - < 3 years