Government of the People's Republic of Bangladesh
Bangladesh Water Development Board
Flood Plan Coordination Organisation

FLOOD ACTION PLAN

NORTHEAST REGIONAL WATER MANAGEMENT PROJECT (FAP 6)

SPECIALIST STUDY

AGRICULTURE IN THE NORTHEAST REGION

FINAL REPORT
November 1994

SNC ♦ LAVALIN International
Northwest Hydraulic Consultants

in association with

Engineering and Planning Consultants Ltd.
Bangladesh Engineering and Technological Services
Institute For Development Education and Action
Nature Conservation Movement

Canadian International Development Agency

COVER PHOTO: A typical village in the deeply flooded area of the Northeast Region. The earthen village platform is constructed to keep the houses above water during the flood season which lasts for five to seven months of the year. The platform is threatened by erosion from wave action; bamboo fencing is used as bank protection but often proves ineffective. The single *hijal* tree in front of the village is a remnant of the past lowland forest that used to cover much of the region. The houses on the platform are squeezed together leaving no space for courtyards, gardens or livestock. Water surrounding the platform is used as a source of drinking water and for waste disposal from the hanging latrines. Life in these crowded villages can become very stressful especially for the women, because of the isolation during the flood season. The only form of transport from the village is by small country boats seen in the picture. The Northeast Regional Water Management Plan aims to improve the quality of life for these people.

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ACRONYMS AND ABBREVIATIONS

ADB	Asian Development Bank
ASP	ammonium sulphate
ASSP	Agricultural Support Service Program
AEZ	Agro-Ecological Zone
BADC	Bangladesh Agricultural Development Corporation
BARC	Bangladesh Agricultural Research Council
BARI	Bangladesh Agriculture Research Institute
BAU	Bangladesh Agricultural University
BBS	Bangladesh Bureau of Statistics
BFRI	Bangladesh Forest Research Institute
BMSS	Bittahin Mohila Samabay Samity
BIDS	Bangladesh Institute of Development Studies
BINA	Bangladesh Institute of Nuclear Agriculture
BJRI	Bangladesh Jute Research Institute
BKB	Bangladesh Krishi Bank
BLRI	Bangladesh Livestock Research Institute
BRDB	Bangladesh Rural Development Board
BRRI	Bangladesh Rice Research Institute
BS	Block Supervisor
BSS	Bittahin Samabay Samity
BYC	Bangladesh Tabacco Company
BTRI	Bangladesh Tea Research Institute
Ca	calcium
CEC	cation exchange capacity
CERDI	Central Extension Resource Development Institute
DAE	Department of Agricultural Extension
DAU	Draught Animal Units
DLS	Directorat of Livestock Services
DTW	deep tube well
DAP	diammonium phosphate
FAO	Food and Agriculture Organization
FCDI	flood control, drainage, and irrigation
FRI	Fisheries Research Institute
ha	hectare
HTW	hand tube well
HYV	high yielding variety
IDRC	International Development Research Centre
IFDC	International Fertilizer Development Centre
IFPRI	International Food Policy Research Institute
IRRI	International Rice Research Institute
K	potassium
KSS	*Krishak Samabaya Samity* (Farmers' Co-operative Society)
LLP	low lift pump
m	metre
MFL	Ministry of Fish and Livestock
MLGRDC	Ministry of Local Government, Rural Development and Co-operatives
MOA	Ministry of Agriculture

MP	murate of potash
MPO	Master Plan Organization
N	nitrogen
NARS	National Agricultural Research System
NERP	Northeast Regional Water Management Project
P	phosphorus
PET	potential evapotranspiration
S	sulphur
SOP	sulphate of potash
SRDI	Soil Resources Development Institute
SRTI	Sugar cane Research and Training Institute
SSP	single super phosphate
STW	shallow tube well
t	metric ton
TCCA	Thana Cooperative Credit Association
TSP	triple super phosphate
UNDP	United Nations Development Programme
USAID	United States Agency for International Development
WARPO	Water Resources Planning Organization
Zn	zinc

GLOSSARY OF TERMS

Alluvium	Mineral material (sand, silt and clays) deposited by rivers.
Aus	Pre-monsoon rice or rice grown in Kharif I season.
B. aman	Broadcast or deepwater aman rice grown in Kharif I and II seasons.
Barbati	Vegetable (*Vigna catiang*) grown in Kharif I season.
Bajra	Millet (*Pennisetum typhoideum*)
Beel	Floodplain lake, which may hold water permanently or dry up during the winter season.
Brinjal	Egg plant
Bittaheen	Destitute
Boro	Winter rice or rice grown in Rabi season.
Calcareous	Soil containing lime.
Chal Kumra	White gourd (Ash Pumpkin).
Char	Islets in the rivers.
Cheena	Millet (*Panicum millaceum*)
Chichiinga	Snake gourd.
Clay	Mineral particles less than 0.002 mm in diameter.
Danta	Amaranthus.
Deep Soil	A soil without a layer which impedes root or water penetration within about 90 cm from the surface.
Dhainchya	*Sesbania aculeta,* a green manuring and wood fuel crop.
Dissected	Landscape cut into by valleys.
Friable	Easily broken between the fingers (or by ploughing) when moist.
Haor	Depression in the floodplain located between two or more rivers, which functions as a small internal drainage basin
Jhinga	Ribbed gourd.
Joar	Millet (*Andropogen sorghum*)
Karala	Bitter gourd.
Kaun	Italian millet (*Setaria italica*)
Khal	Canal
Kharif	The crop growing period (March to October) when the moisture supply from rainfall plus soil storage is sufficient to support un-irrigated kharif crops. The period begins on the date from which precipitation continuously exceeds 0.5 PET and ends on the date when the combination of precipitation plus assumed 100 mm of soil moisture storage after the rainy season falls below 0.5 PET.
Kharif I	Pre-monsoon season (March to June).
Kharif II	Monsoon season (July to October).
Large Farm	A farm household owning more than 3 ha of cultivated land.
Medium Farm	A farm household owning 1 to 3 ha of cultivated land.
Mesta	Rozelle hemp (*Hibiscus subdarifa* var. attissima)
Mohila	Woman
Mottled	Patches of different colour occur in the soil.
Noncalcareous	Soil without lime.
Non-farm	A farm household owning less than 0.2 ha of cultivated land.
Palang	Spinach.
Patal	Palwal (*Trichosanthes diocia*).
Ploughpan	A compact layer of soil, usually about 5 cm thick, occurs immediately below the cultivation layer in some areas.

Pre-kharif	The period which is characterized by unreliable rainfall, varying in timing, frequency and intensity from year to year, and providing only an intermittent supply of moisture for growing crops during this period. The period is considered to start on the first date after end-February when precipitation first exceeds 0.5 PET. The period ends on the date from which precipitation continuously exceeds 0.5 PET (i.e., the beginning date of kharif growing period.
Puishak	Indian Spinach.
Rabi	The crop growing period between the end of the humid period (when rainfall exceeds PET) and the time when 250 mm soil moisture have been exhausted by evapotranspiration (i.e., between points end of kharif humid moisture period and end of rabi humid moisture period with 250 mm soil moisture supply).
Rabi crops	Crop grown in Rabi season (winter).
Samabaya	Cooperative
Shallow Soil	Soil in which substratum occurs within 60-90 cm from the surface.
Small Farm	A farm household owning 0.02 to 1 ha of cultivated land.
Substratum	The layer below the soil (topsoil or subsoil) which has not been altered by soil forming process.
T. aman	Transplanted aman rice grown in Kharif II season or monsoon season
Thana	An administrative unit. Several thanas make a district.

NERP DOCUMENTS

The Northeast Regional Water Management Plan is comprised of various documents prepared by the NERP study team including specialist studies, the outcome of a series of public seminars held in the region, and pre-feasibility studies of the various initiatives. A complete set of the Northeast Regional Water Management Plan Documents consists of the following:

Northeast Regional Water Management Plan

Main Report
Appendix: Initial Environmental Evaluation

Specialist Studies

Participatory Development and the Role of NGOs
Population Characteristics and the State of Human Development
Fisheries Specialist Study
Wetland Resources Specialist Study
Agriculture in the Northeast Region
Ground Water Resources of the Northeast Region
Surface Water Resources of the Northeast Region
Regional Water Resources Development Status
River Sedimentation and Morphology
Study on Urbanization in the Northeast Region
Local Initiatives and People's Participation in the Management of Water Resources
Water Transport Study

Public Participation Documentation

Proceedings of the Moulvibazar Seminar
Proceedings of the Sylhet Seminar
Proceedings of the Sunamganj Seminar
Proceedings of the Sherpur Seminar
Proceedings of the Kishorganj Seminar
Proceedings of the Narsingdi Seminar
Proceedings of the Habiganj Seminar
Proceedings of the Netrokona Seminar
Proceedings of the Sylhet Fisheries Seminar

Pre-feasibility Studies

Jadukata/Rakti River Improvement Project
Baulai Dredging
Mrigi River Drainage Improvement Project
Kushiyara Dredging
Fisheries Management Programme
Fisheries Engineering Measures
Environmental Management, Research, and Education Project (EMREP)
Habiganj-Khowai Area Development
Development of Rural Settlements
Pond Aquaculture
Applied Research for Improved Farming Systems
Manu River Improvement Project
Narayanganj-Narsingdi Project
Narsingdi District Development Project
Upper Kangsha River Basin Development
Upper Surma-Kushiyara Project
Surma Right Bank Project
Surma-Kushiyara-Baulai Basin Project
Kushiyara-Bijna Inter-Basin Development Project
Dharmapasha-Rui Beel Project
Updakhali River Project
Sarigoyain-Piyain Basin Development
Improved Flood Warning
Baulai River Improvement Project

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EXECUTIVE SUMMARY

Agriculture is one of the vital sectors of the Northeast Region of Bangladesh. The Region accounts for 20% of the net cultivated area in the country. The farmers in the Region, however, are faced with production problems and risks associated with complex hydrology. More than two-thirds of the cultivated lands are medium to deeply flooded. Only 16.4% of the total cropped area of the country is in the Northeast.

CHARACTERISTICS OF FARMING

Cropping patterns and the types of crops grown in the Region are mainly determined by flooding characteristics. Traditionally there has been three crop seasons in the Region. These are: kharif I (pre-monsoon to early monsoon season), kharif II (late monsoon season), and rabi (dry/winter season). During the peak of the monsoon, almost two-thirds of the Region may be inundated to a depth of 1 m or more. As a result crops can be grown on only two-thirds of the cultivable land in kharif I, and less than half of the cultivable land in kharif II. Only 40% of the cultivable area supports both kharif I and kharif II crops. The crop environment during rabi seasons is favourable for higher yields. However, less than the potential cultivable land is used because of late monsoon flood drainage and early pre-monsoon flash floods.

Rice is the main crop occupying more than 82% of the total cropped area. More than 75 non-rice crops occupy less than 18% of the total cropped area. About two-thirds of the total rice cropped area is under low-yielding traditional varieties. The high-yielding varieties are mainly cultivated in the dry season. Most of non-rice crops are also grown in the dry season, and use traditional varieties of seed.

Livestock forms only a small component of the farming system. It plays a small but vital role in the local economy. Most of the livestock are kept by the farm household in small numbers to meet local requirements for draught power and food. There is no large commercial scale livestock production.

There are problems with livestock production due to a shortage in feed and fodder. Livestock animals are fed mainly with rice straw, which is very difficult to manage when floods damage the rice crop. Grazing on fallow lands which are used on a communal basis takes place only in the winter season. Most of common grazing lands in the Region have been converted into cultivated land.

PRESENT AGRICULTURAL PRODUCTION

There has been an overall improvement in the agricultural production. This resulted mostly from an increase in rice production which accounts for 98% of the total food grain production. The primary reasons for this increase include an expansion of the irrigated area and increasing yields per unit area of land due to the introduction of HYVs. There has been a slight increase in annual per capita production of non-rice crops as well. Even though the absolute level of agricultural output has increased, the rate of growth has declined. Annual per capita production of major food items declined by 10% during the past decade.

Crop production in most of the area is unstable and low yields are common because of the ever present risks of flood. The Region produces only 14% of the total crop production in the country. Typical crop yields are below the national average. Damage estimates of the past decade show that floods could result in the loss of thousands of tons of food grains. These losses could only be avoided if farmers were not to attempt growing crops in flood risk areas. Economic circumstances, however, are such that farmers have no option but to take risks in order to produce food for their own consumption.

Present livestock resources do not meet requirements. Growth in livestock production is discouraging, particularly in meeting the draught power requirements of crop production. The growth rate has not keep pace with the need of draught animals. The average farm household owns 1.3 head of draught animals. However, many small farmers have no draught animals. Small farmers account for 70% of the farm households in the Region, but own only 40% of the draft animals. The shortfall of draught power is a constraint to increased agricultural production.

LAND USE AND TENANCY

The total area of the Region is about 2.4 million ha. Net cultivated area accounts for two-thirds of the total area. Under the present conditions less than one-third of the cultivated area is free from flooding. On these lands, cropping patterns consist of two or three crops - 1.9 crops per year, on average. About two-thirds of the cultivated area floods to a depth of more than 90 cm during the monsoon season. Short stature rice varieties are difficult to grow on these lands during the monsoon season, and deepwater aman rice varieties, which have elongation ability, may not survive if there is rapid and deep flooding or high wave action. On these lands crops are mainly grown in the winter season. On average, each unit of cultivated land in these low-lying areas support 1.0 to 1.4 crops per year.

The average farm size in the Region is estimated to be 0.6 ha. The large farm households, which comprise five percent of all farm households, cultivate 27% of the net cultivated area. The small farm households represent 70% of the farm households, but cultivate 42% of the area. Farm households owning medium sized farms comprise about 25% of all farm households and cultivate almost 30% of the net cultivated area.

AGRICULTURAL DEVELOPMENT POTENTIAL

The Region has a huge potential for increased agricultural production by increasing crop intensity, diffusing of modern technology, improving of present farming systems, and increasing output per unit area of land. There is, however, a great variation in the agricultural potentials within the Region due to a variance of soil characteristics, crops types, and farming practises.

In the western part of the Region the floodplain landscape is comprised of broad gentle ridges and almost level basins. Ridges are shallowly flooded. Depressions and basins are moderately deeply flooded. Basin centres are subject to early and rapid flooding. The soils range from sandy loams, silty loams and silty clay loams on ridges to clays in basins. Flood protection and drainage improvement in this part can increase modern varieties of rice and dryland non-rice crop areas. Expansion of irrigation facilities, and improved soil and crop management can ensure higher crop yields. Improvement of fodder and food resources can increase the number of livestock animals. Increased homestead plantations can play an important role in the economy and constitute an important renewable resource.

The central part of the Region has a level to gently undulating landscape of floodplain ridges, and is characterized by large saucer-shaped seasonally flooded depressions called *haors*. Virtually all of the land is deeply flooded during the monsoon season. Areas close to hills are subject to flash floods. Soils are grey silty clay loams and clays with developed profiles or raw alluvium. The greatest demands in this part are flood protection, drainage and irrigation to increase the production of winter rice. Flood protection and drainage improvement need to be considered wherever feasible to protect this rice from early floods. Furthermore, the aquatic environment prevailing in this area has a substantive comparative advantage in terms of production of fish, duck and wetland products. Attempts need to be made to improve and diversify the present farming systems to take advantage of the aquatic environment. This would also result in adequate supply of feed and fodder to increase livestock numbers.

Most of the eastern part includes relatively high areas with broad basins in between. Nearly all the land is flooded for some months each year. Flood hazard and heavy rainfall restrict crop production. Soils are mainly grey, heavy, silty clay loams on the ridges and clay in the basins. Soils patterns in the hills are complex due to local differences in sand, silt and clay content of the underlying sedimentary rocks. The large extent of high floodplain ridge soils have high agricultural potential. Flood protection and drainage can increase cropped area protecting crops from early floods and flash floods. Expansion of existing irrigation facilities would increase crop production in the dry season. Improvement in the quality and quantity of the fodder and feed supply can overcome the constraints to future growth in the livestock sector. Appropriate forms of land use through plantation of tree crops on hilly lands can reduce the frequency and severity of flash floods on adjoining floodplain areas.

1. INTRODUCTION

1.1 Background

This study is a general review of agriculture in the Northeast Region of Bangladesh. The area covered includes parts of the old administrative districts (now regions) of Sylhet, Dhaka, Jamalpur, Mymensingh, and Rangpur. The inputs of this report were used by the Northeast Regional Water Management Project (NERP) in preparing the Northeast Regional Water Management Plan. NERP is component six of the Flood Action Plan (FAP #6). Specialist reports on Groundwater, Hydrology, River Sedimentation and Morphology, Wetlands, and Fisheries were also prepared by NERP.

The Northeast Region is densely populated. Unstable agricultural production is common in many parts. Agriculture in the Region is subsistence oriented and uncertain, due to the ever present risk of flooding. A small area is undergoing agricultural commercialization, mainly for tea production.

1.2 Objectives

The specific objectives of the study are to provide information on agricultural policy and institutional frameworks of Bangladesh; discuss the agricultural production systems, characteristics of agro-ecological zones in the Northeast; present regional issues, and to develop preliminary strategies for development in the Region.

1.3 Methodology

The study is based mostly on information from secondary sources including the Bangladesh Bureau of Statistics, Department of Agricultural Extension, Water Resources Planning Organization, Agricultural Research Institutes, Bangladesh Agricultural Development Corporation, Soil Resources Development Institute, FAO/UNDP Land Resource Appraisal of Bangladesh, Food Planning and Monitoring Unit of Ministry of Foods, and the International Fertilizer Development Centre. Information collected by the NERP field team has also been incorporated into the report. Views and findings of other studies have been used where applicable.

1.4 Outline

The report is divided into nine chapters. Chapter 2 describes the policy framework. Institutional framework is described in Chapter 3. Chapter 4 deals with the present production system. Trends in the agriculture production system are described in Chapter 5. Chapter 6 deals with the physiography of the region. Chapter 7 presents the characteristics of Agro-ecological zones. Chapter 8 describes the food situation and Chapter 9 identifies the issues in the region. Strategy is described in Chapter 10.

2. POLICY FRAMEWORK

The economy of Bangladesh is predominantly based on agriculture. Despite agriculture's decline in importance relative to other sectors, since independence, it still accounts for about one-half of the country's output, and employs nearly three-quarters of the civilian labour force. Rice alone accounts for almost one-quarter of the national output, while all crops combined account for about two-fifths. Agricultural has a direct, and significant, impact on the national economy. A close link between the government's macro-economic objectives and its goals and policies for the development of agriculture is essential.

The livestock sector plays a crucial role in the largely subsistence level agricultural economy of Bangladesh. In addition to providing the necessary draught power for various agricultural operations and for transport, livestock provides a major source of protein, and is an important source of cash income of the rural poor. Livestock products, particularly leather and leather goods, are important export items.

2.1 General Objectives

The broad objectives of agricultural development, as adopted by the Government of Bangladesh (GOB), are to facilitate and accelerate a technology transformation with a view to becoming self-sufficient in food production and thereby improving the nutritional status of the population. Under the circumstances prevailing in the agriculture sector, GOB would pursue the following major objectives:

- Attain self-sufficiency in food grain production along with an increased production in other nutritional crops,
- Ensure sustained agricultural growth through a more efficient and balanced use of the country's water and other natural resources,
- Promote rapid and appropriate technology transformation,
- Diversify agricultural production especially along nutritional lines,
- Contribute to increased foreign exchange earnings through agricultural exports,
- Contain areas under cereals (specially rice) within the limits of soil and ecological balance in order to progressively release land for other crops, specially legumes and fodder crops, and achieve cereal production targets through increased per hectare output,
- Reduce rural poverty and promote income equality for socio-economic groups/regions,
- Promote economic and employment opportunities and access to resources such as credit for landless and small farmers and other disadvantaged groups especially in backward regions.

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Major objectives in the livestock sector are:

- Increased supply of livestock products, through increases in productivity.
- Expansion of employment opportunities, both full time as well as in the form of supplementary activity, for poverty alleviation.
- Increased supply of draught power to support planned crop production activities.

2.2 Major Strategies

In view of serious resource constraints, major emphasis would be placed on a strategy of increased efficiency in resource use so that higher growth rates could be achieved with a relatively lower incremental capital-value added ratio. Achieving higher growth rates with lower capital investment calls for not only selection of projects according to suitable criterion based on contributions to production and productivity but also presumes effective elimination/reduction of wastage and inefficiencies. Cost-efficiency and implementation capacity will ultimately determine the level of efficiency that would be achieved in resource allocation. In this respect GOB's adopted policy is to emphasize the following issues:

- Appropriate rehabilitation and maintenance/management of existing/ongoing projects,
- Efficient planning, effective implementation and appropriate O & M of schemes according to planned schedules,
- Elimination/reduction of wastage/inefficiencies,
- Selection of appropriate projects/programmes.

For achieving the objectives, the strategy would focus on the following five major areas:

- Maximization of yields,
- Development of least-risk areas,
- Improvement in farming practices taking into consideration agro-ecological conditions of the country,
- Proper diversification with less dependence on cereal crops,
- Achieving sustained growth.

In the livestock sector, strategies and policies would focus on the following:

- Increased livestock husbandry with genetic upgrading and avoiding genetic erosion with emphasis on selection of exotic breeds,
- Improved animal health with provision of prophylactic and routine farmer-

administered treatment for infectious diseases and parasitic infections of livestock,

- Adequate emphasis on non-ruminant livestock which subsist on a more concentrated intake with advantages of better feed conversions and fewer locational constraints on production,

- Special emphasis on poultry husbandry as a value added activity capable of operating in small units with significant labour absorption and poverty alleviation potentials. In this respect, adequate focus would be placed on medicine, feed, marketing and other problems along with the development of proper breeds.

- Increased fodder supply,

- Emphasis on the development of dairy cattle at farmer level for increased supply of milk and dairy products,

- Generation of employment opportunities in the rural areas through dairy farming, cattle and poultry rearing and further development of animal husbandry practices for distressed women and unemployed youth.

- Adequate policy supports by providing marketing facilities, price incentives, organization and extension systems, education and manpower training in relevant activities, appropriate technology transfer and information system and realization of export potentials.

- Proper review and necessary changes in the import policy for livestock products.

- Strengthening of the organizational and institutional framework of the livestock sub-sector for undertaking effective research, manpower training and development activities.

3. INSTITUTIONAL FRAMEWORK

Government agencies currently engaged in agricultural development include the Ministry of Agriculture (MOA), Ministry of Fisheries and Livestock (MFL), Ministry of Local Government Rural Development and Co-operatives (MLGRDC), and autonomous organizations working directly or indirectly under the control of these ministries. A brief description of activities carried out by these agencies is provided below recognising the fact that local communities must be accepted as the target groups which need to be reached for growth in agriculture.

3.1 Agricultural Extension

Agricultural extension activities are carried out mainly by the Department of Agricultural Extension (DAE), which is the main arm of the Ministry of Agriculture. The functions of the DAE are:

- to motivate and help farmers adopt improved production practices;
- to develop self-reliance and co-operation by training local leaders in organised group action;
- to provide efficient linkage between the various research institutions and the farmers;
- to serve as a liaison agency between farmers and other organizations, both public and private, concerned with overall socio-economic development of rural people;
- to help promote storage and a fair price for farm produce.

The institutional foci for the management of the extension services are the Block (Union), Unit (Thana), Zone (District), and the Headquarters (National Level). At the national level, DAE is comprised of five Divisions: Food Crops, Cash Crops, Plant Protection, Field Services, and Training. The Specialist Divisions provide technical supervision over the field extension personnel through Subject Matter Specialists. These Divisions also maintain liaison with agricultural research institutes. The Field Services Division manages the field extension services.

The Zone (District) is the most important focal point for managing the operation of DAE. The managerial direction and administrative professional support for Units (*thanas*) is provided by a Deputy Director of Agriculture (DDA). He is supported by a team of specialists and supervisory staff (Subject Matter Specialists and Training Officers). The Unit (*thana*) is the closest point of institutional service to farmers. Each Unit is under a Thana Agricultural Officer (TAO) who is supported by Subject Matter Officers. At the block level (Union) there is a Block Supervisor (BS) who provides extension services to farmers or group of farmers. A Block Supervisor covers 600 to 1200 farm families depending upon the intensity of agriculture in a given area.

Agricultural Extension is organised through the Training and Visit (T&V) system. This involves a programme of regular visits by the Block Supervisor to eight sub-blocks on a fortnightly programme. At each sub-block there are ten contact farmers through which information concerning improved practices are passed on to the farming community. In addition, the Block Supervisor attends one training and one conference session during the fortnight where he/she is

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given the next fortnight's message and farmers' problems are discussed. He also maintains demonstration plots in the farmers' fields.

Experience of the T&V system has highlighted a number of weaknesses, in particular: (1) the relevance of simple messages for the varied and sometimes complex problems faced by the farmers, and (2) the high management cost of maintaining 12,000 Block Supervisors in the field. The T&V system is now being overhauled under the Agricultural Support Services Programme (ASSP) which is assisted by the World Bank, ODA and USAID. The programme aims to concentrate activities in key areas including minor irrigation operation and on-farm water management.

3.2 Livestock Service

The Directorate of Livestock Service (DLS) is principally responsible for the planning and implementation of the government's programmes and policies for livestock development. It also supports milk production through its breed improvement programme which has its central cattle breeding farm in Dhaka. The responsibilities of the DLS include:

- administration, coordination, planning, training, and extension advisory services;
- animal health services including prevention and control of disease outbreaks, treatment, disease investigation, and manufacturing, distribution and storage of biological products (vaccines), procurement, storage and distribution of medicines, equipment and appliances
- animal production services including promotion of livestock farms, breed improvement including artificial insemination, promotion of feed mills, fodder production, collection of livestock statistics, zoological survey and zoo managements.

The DLS has the following Divisions:

- Administrative, Establishment and Animal Health. This Division includes District Units, Thana Veterinary Dispensaries, Veterinary Hospitals, District Artificial Insemination Units, District Artificial Insemination Sub-centres and Artificial Insemination points, and a central veterinary hospital. The Division also includes a livestock section, a planning and evaluation section, and other various administrative sections.
- Research Training and Evaluation. This Division deals with aspects of vaccine production, disease investigation, nutrition research, and training in veterinary institutes.
- Animal Production, Zoological Garden, and Zoological Survey. This Division has a Central Cattle Breeding and Dairy Farm in Dhaka, four Cattle Breeding Farms (One in the Northeast Region), a Buffalo Breeding Farm, an Artificial Insemination and Fodder Cultivation programme, Zoological Garden, and Zoological Survey.

- Poultry. This Division runs a Central Poultry Breeding Farm, Regional Poultry Farms and District Poultry Farms.

3.3 Agricultural Research

The National Agricultural Research System (NARS) in Bangladesh has ten component institutes. These are:

- Bangladesh Agriculture Research Institute (BARI)
- Bangladesh Rice Research Institute (BRRI)
- Bangladesh Jute Research Institute (BJRI)
- Sugar-cane Research and Training Institute (SRTI)
- Bangladesh Tea Research Institute (BTRI)
- Soil Resources Development Institute (SRDI)
- Bangladesh Institute of Nuclear Agriculture (BINA)
- Bangladesh Livestock Research Institute (BLRI)
- Bangladesh Forest Research Institute (BFRI)
- Fisheries Research Institute (FRI)

Most of the institutes work with a single commodity (rice, jute, tea, sugar cane), or with a group of related commodities: non-rice food crops, livestock, forestry, fisheries. Only two institutes, SRDI and BINA, work in disciplines that deal with all commodities. The Agricultural University (BAU) and Institute for Postgraduate Studies in Agriculture (IPSA) are also involved in some agricultural research, though they are mainly engaged in teaching. The research programmes of all the institutes are co-ordinated and supported by Bangladesh Agricultural Research Council (BARC). A short description of each of the research institutes programs is given here.

BARI deals with a wide range of non-rice food crops. These include field and horticultural crops. To make research more applicable to farmers' problems, BARI has an On-farm Research Division (OFRD) which operates a farming system research programme. The institute also has an Engineering Division working on the development of agricultural machinery. It has four regional stations and 21 sub-stations under OFRD, with special crop stations working on tobacco, cotton, coconut, mango, citrus, oilseeds, wheat, and potatoes. BARI has three institutes of agricultural science for undergraduate studies in Patuakhali, Dinajpur and Dhaka districts. BARI is also responsible for working with DAE through farming systems and on-farm trials. In the Northeast region, there are two sub-stations, one in Sylhet and another in Moulvibazar, which work with fruit and spice crops. There is, however, no university or institute in the region which teaches agriculture.

BRRI deals exclusively with rice. It is responsible for working with DAE for rice and rice based cropping systems through demonstrations and training. BRRI has five sub-stations located in specific rice ecological zones (deep water, boro, upland, saline). Two of the sub-stations are working on rice cropping systems. The sub-station in the Northeast region dealing with deepwater rice is at Habiganj.

Research on jute is the responsibility of BJRI. It has six regional stations and two seed production and distribution farms. There is no regional station or farm in the Northeast region.

SRTI, which is located in the North-west of Bangladesh, conducts research on sugar cane. It has no sub-station in the Northeast region.

Research on tea, a speciality crop of the Northeast Region, is conducted by the Tea Research Institute (TRI) located in Moulvibazar district. The institute has three sub-stations.

SRDI is responsible for surveying, mapping, sampling and keeping a resources inventory of soils in Bangladesh. It also provides training to the block supervisors of DAE.

BINA is located in Mymensingh. It is mainly working on the improvement of crops through nuclear and conventional techniques.

BLRI is responsible for livestock research in Bangladesh. Research takes place at the veterinary research institute in Dhaka, the animal husbandry research institute in Comilla, the sheep development farm in Noakhali, Central disease investigation laboratory in Dhaka, and seven field disease investigation laboratories. One of the field investigation laboratories is in Sylhet. BLRI also works with BARI on farming system research.

BFRI is located in Chittagong. Its role is to support the Government's plan of maintaining the current supply levels of wood and wood products, and to increasing them in future. It has seven silviculture research stations and sub-stations, one mangrove research station, and nine seed orchard centres. The Northeast Region has one silviculture research station and one seed orchard research centre in Moulvibazar district.

FRI has a training as well as a research role. The institute works to expand the fisheries in Bangladesh.

Agricultural research suffers from many of the same problems as extension work. Most of the budget is absorbed by salaries and staff costs leaving inadequate funds for field trials and research. Research programmes have been funded by the World Bank and USAID, and a review is presently underway which will determine future support.

3.4 Agricultural Education

Agricultural education in Bangladesh is the responsibility of the Bangladesh Agricultural University (BAU). The University is under the direction of the Ministry of Education, and is located in Mymensingh. There are six faculties: Agriculture, Agriculture Economics and Social Science, Animal Husbandry, Veterinary Science, Fisheries, and Engineering and Food Technology. Education in forestry is the responsibility of the Forestry Department of the Chittagong University. BAU's enrollment is about 4,000 undergraduates (B. Sc. students), and about 450 postgraduates (about 400 at Master's level and approximately 50 Ph. D. candidates). The three agricultural institutes, which are components of BARI, have an undergraduate enrolment of about 400 B.Sc. students. The institutes are located in Dhaka, Patukahali (Southwest Region), and Dinajpur (Northwest Region). They are under the academic jurisdiction of BAU. The postgraduate facilities at the Institute for Postgraduate Studies in Agriculture (IPSA) has a capacity for about 200 students; there are presently about 50 students. The institute is under the direction of the Ministry of Agriculture.

3.5 BADC and Input Supplies

The Bangladesh Agricultural Development Corporation (BADC) was established in 1961 to:

- make arrangements, on a commercial basis, for the procurement, transport, storage and distribution of essential supplies such as seed, fertilizer, plant protection equipment, pesticides, and agricultural machines and minor irrigation equipments including low lift pumps (LLP), shallow tube wells (STW), and deep tube wells (DTW);

- promote the development of co-operatives.

As agricultural inputs and services develop, many of BADC's functions are being transferred to the private sector. BADC is no longer the sole supplier of agricultural inputs. The production and distribution of improved seeds are now supplied through BADC and the private sector.

The supply of fertilizers and pesticides is now in the hands of the private sector. BADC no longer has any responsibility for procurement or distribution of fertilizers. Fertilizer prices are no longer subsidised, but despite sharp rise in prices, consumption has continued to grow at about 10 percent per year, partly because of a more efficient distribution by the private sector, and its cost relative to the price of rice remains favourable compared with other countries of the region.

Seeds for major crops are provided from the farmer's previous harvest or purchased in the local market. The volume of improved seeds produced by BADC is limited and accounts for less than five percent of the total seed requirement. The ASSP project is providing assistance to BADC in seed production technology.

BADC no longer monopolizes the sale and servicing of LLPs and STWs, and has sold all of its previously procured LLPs and STWs. It now deals mainly with the installation, operation and maintenance of DTWs. There are approximately 24,000 DTWs installed throughout Bangladesh and the process of turning these over to the private sector has already commenced.

3.6 Agricultural Credit Systems

Even though the agricultural credit system of Bangladesh is still dominated by non-institutional credit sources, institutional sources have greatly increased their disbursement in recent years. The main agencies with agricultural credit programmes are:

- The Central Bank (Bangladesh Bank).
- Bangladesh Krishi Bank (BKB).
- Participating Commercial Banks.
- The Bangladesh Samabaya Bank Ltd.
- Bangladesh Rural Development Board (BRDB).

Bangladesh Bank formulates agricultural credit policy, and controls, supervises and coordinates the activities of all the agricultural credit institutions. The Bank created two special funds to support the agricultural credit system: Rural Credit Fund (RCF) and Agricultural Credit Stabilization Fund (ACSF).

BKB is the main agricultural credit institution in Bangladesh. It provides short, medium and long term credit to individuals for financing in agriculture, sericulture, fisheries, livestock, and agricultural processing and storage. The short term credit is provided for crop production. The medium term credit is provided for purchasing draft animals, machineries and implements, and fisheries. The long term credit is provided for orchard development, land reclamation, ware-house construction, and so on.

Participating Commercial Banks are second to BKB in terms of the size of agricultural credit. They provide direct loans to farmers.

Bangladesh Samabaya Bank is the leading bank of the traditional cooperative institution in the country. It includes the Central Cooperative Banks, the Central Sugar-cane Growers' Societies, and Cooperative Land Mortgage Banks. The bank provides short term credit to farmer members through Union Multipurpose Cooperatives and farmers cooperatives (KSS).

BRDB provides credit through the Thana Central Cooperative Association (TCCA). The TCCAs operate the farmers cooperatives (KSS), as well as the Bittaheen Samabaya Samity (BSS), and Bittahin Mahila Samabaya Samity (BMSS) under its Rural Poor Programme. Allocation of loans per *thana* is set by BRDB headquarters. The loans are issued by a commercial bank.

3.7 Rural Development

BRDB is the main government agency in charge of social and socio-economic aspects of rural development. It is responsible for the supervision of farmers' co-operatives (Krishok Samabaya Samity or KSS) and assisting and guiding the Thana Central Co-operative Association (TCCA). This involves:

- coordinating with concerned governmental organizations for mobilizing supplies, services and support for KSS and TCCA; including channelling institutional credit to KSS and TCCA while encouraging the accumulation of shares and savings by KSS members;
- promotion of intensive agriculture by farmers, particularly through the use of mechanised facilities and liaison with BADC;
- provision of appropriate training to KSS managers, model farmers and other members to increase their technical and managerial skills;
- encourage TCCA to expand their activities to include marketing the inputs and products of KSS groups and to diversify into other kinds of business ventures.

BRDB operates at three levels with a board of directors based in Dhaka, a Deputy Director based in each district and a Rural Development Officer with one Assistant Rural Development Officer attached to each TCCA.

KSSs are village based farmers' groups, the membership of which is comprised of farmers with holdings of more than 0.2 ha. These groups are formed into co-operative societies to derive benefits from farm operations, input supplies and output marketing through their collective strength and bargaining power. KSS groups are able to secure cheap institutional credit and are provided with regular training by officials of various government departments involved in rural development. Their ultimate goal is self-reliance in terms of their own funds and management capabilities. The key objectives of the KSS groups are to:

- increase crop production and yields;
- expand irrigation;
- organize the mechanization of irrigation.

The TCCA was established as the central institution in each thana to co-ordinate, support and supervise the activities of the KSS. Its main functions are to:

- train and educate KSS members in new skills, attitudes and motivation necessary to successfully attain the goals of the KSS. Particular emphasis is placed on developing leadership and management skills;
- organize procurement and supervise the distribution of production inputs and services;
- assist with the marketing of outputs;
- provide servicing centres for repair and maintenance of machinery operated by KSS groups;
- operate central co-operative banks owned and managed by KSS members.

3.8 Non-Government Organisations (NGOs)

Non-Government Organizations (NGOs) are increasingly being recognised for their involvement in development activities in Bangladesh.

A directory published by the Directorate of Social Welfare in 1985 listed 6,946 registered locally functioning General Voluntary Social Welfare Organizations of which 1,113 were located in the Northeast Region. The directory also listed 17 National Social Welfare Organizations operating on a nation-wide scale with local resources. In June 1992, there were 513 registered Bangladeshi NGOs operating with foreign donations, and another 109 NGOs of foreign origin working in Bangladesh.

The main thrust of the NGO activities over the past years was social welfare activities. According to a study sponsored by the ADB (1989), the highest proportion of Bangladeshi NGOs operating with foreign donations were implementing various programmes with a major focus on social welfare. During the period from July 1991 to June 1992, 610 projects proposed by Bangladeshi and foreign NGOs were approved by the NGO Bureau. Most of these were in the field of relief and rehabilitation, rural and urban development, education, and family planning. Only two percent of the projects were in the field of agriculture. In fact, as the target group of most NGOs is the landless and women, agriculture in general and the crop sector in particular rank very low in the mandate of the NGOs.

4. PRESENT PRODUCTION SYSTEM

4.1 Crops

The Northeast Region grows more than 100 different crops. The census of Agriculture and Livestock (1983-84) reports that 85 field crops were grown in the Region. They include 22 cereals, 9 pulses, 8 oilseeds, 7 cash crops, 28 vegetables, 9 spices, 1 fodder crop and 1 fuel crop. According to the Survey of Farm Forestry (1988) more than 30 horticultural crops are grown. A list of major crops and the percentage of area under each crop is presented in Table 4.1.

About 85% of the total cropped area in the Region is under rice crops, with the remainder under non-rice crops. Jute is a major crop among the non-rice crops, occupying three percent of the total cropped area. Wheat and oilseeds, each occupy about two percent of the total cropped area. Pulses, potato, sugar cane and spices each occupy about one percent. The minor crops, which occupy four percent of the total cropped area, include minor cereals (maize, barley, *kaun, cheena, bajra* and *joar*), other fibres (*mesta*, cotton and sun-hemp), beverage and narcotics (tea, tobacco, betel nut and betel leaves), vegetables and fodder. About one percent of the total cropped area is occupied by orchards.

4.1.1 Crop Season

Temperatures in the Region are suitable for cultivation and growth of crops throughout the year. The main parameter determining the growth of crops is soil moisture supply. Rainfall and flooding are the natural sources of soil moisture, which is supplemented by irrigation.

Variations in agro-climatic conditions during the year have led to the division of the crop year into two distinct crop seasons: kharif and rabi. The kharif season starts at the end of March and continues until the end of October. The rabi season starts in late October and ends in March.

Kharif is the main crop season. Crops grown during this season occupy about two-thirds of the total cropped area (Table 4.2). The kharif season can be divided into kharif I (end of March to June) and kharif II (July to October) depending on adaptability and culture of crops. Unreliable rainfall, high temperature and evaporation, drought at planting times, and pre-monsoon flash floods are the characteristics of kharif I. Major crops which are grown during kharif I are aus rice.

Table 4.1: Area of Major Crops

Crop	Percent of Total Cropped Area
Rice	84.9
Wheat	2.1
Sugar cane	0.6
Potato	0.8
Jute	3.0
Pulses	1.3
Oilseeds	1.9
Spices	0.6
Minor Crops*	2.0
Tea	1.9
Orchard	0.9
Total	**100.0**
Total Cropped Area ('000 ha)	**2326**

* Vegetables, maize, tobacco, cotton, etc.
Source: Average for 1989/90 and 1990/91, BBS.

jute, and photosensitive broadcast aman or deepwater aman rice. These are sown or transplanted so that the crops can be established before the flood water level rises. The other crops grown in this season are maize, black gram, sesame, groundnut, summer vegetables, chili, ginger and turmeric. Boro rice is harvested in this season.

The Northeast Region is characterized by high and intense rainfall. Relatively short but intense rain storms, of April and May, in the northern and eastern hills gives rise to flash floods. Deep flooding along with a rapid rise of water are the major limiting factors of crop production during kharif I. Early flash floods also damage mature boro. It appears that about 0.3 million ha are not cropped because of flooding during kharif I (based on a net cropped area of 1.59 million ha, Table 4.10).

Kharif II is characterized by high humidity, heavy rainfall, and monsoon floods. Crop production in this season is mainly limited by the variable flood depths, high and late floods which damage crops, and waves which uproot rice plants. The major crop grown in kharif II is transplanted aman. Deepwater aman also continues to grow through this season. The photosensitive crops flower with the advent of shorter days. During kharif II about 0.65 million ha are not cropped because of flooding and late drainage (based on a net cropped area of 1.59 million ha, Table 4.10).

Table 4.2: Area of Major Crops During Kharif and Rabi Seasons

Crop Season	Crop	Area ('000 ha)
Kharif	Aus	423
	B. Aman	152
	T. Aman	735
	Jute	70
	Sugar cane	13
	Oilseeds	1
	Spices	3
	Minor	8
	Tea	44
	Orchard	22
	Total	**1471**
Rabi	Boro	665
	Wheat	48
	Potato	18
	Sugar cane	13
	Pulses	31
	Oilseeds	42
	Spices	12
	Minor	39
	Tea	44
	Orchard	22
	Total	**934**

Source: Average for 1989-90 and 1990-91, BBS.

The rabi season is characterized by low rainfall and humidity, high solar radiation and evapotranspiration rate, and relatively low temperature with a large difference between day and night temperatures. The crop environment during the season is very favourable; crop production is mainly governed by the availability of residual soil moisture or irrigation water. Factors which limit crop production during the rabi season include: poor drainage which delay sowing or transplanting, inadequate residual soil moisture, low temperature, and early flash floods. In this season, boro rice is extensively cultivated on vast areas of the Region's seasonal wetlands. Local boro is cultivated in the lower elevations, and HYV boro in the higher area where drainage is better. Other crops grown in this season include wheat, potato, tobacco, khesari, lentil, pigeon pea, mustard, groundnut, winter vegetables, coriander seeds, and melons. The rabi season is well suited for such diversified crops. During this season about 0.65 million ha are not cropped due to late drainage and a lack of soil moisture (based on a net cropped area of 1.59 million ha, Table 4.10).

4.1.2 Cropped Area

Rice

Rice is the most important crop in the Region. Rice dominates crop farming, and accounts for 97% of the total food grain cropped area. It is grown in a multitude of environments, either solely or in rotation with dryland crops. Thus, the major cropping patterns in the Region are rice based and almost all segments of the cultivated land are cropped with at least one rice crop a year (Figure 1). Recent BBS data indicates that 1.88 million hectares in the Region are cropped under different rice cultures: aus (0.34 million ha), broadcast (deepwater) aman (0.11 million ha), transplanted aman (0.74 million ha), and boro (0.69 million ha).

It is estimated that in 58% of the area under rice cultivation local varieties are grown (Table 4.3). Most of these are aus and aman type rice. High Yielding Varieties (HYV) are cultivated in 42% of the total rice cropped area. The ratio of HYVs in the boro season is much higher than in the other two rice seasons. The HYVs occupy about 70% of the total area of boro rice compared to about 28% of aus and 29% of aman (about 34% of transplanted aman rice).

Non-rice

Among the non-rice crops jute is the most important, occupying about 70,000 ha. It is a major industrial crop. Almost 85% of the jute cultivated is of the improved varieties. The other fibre crops, mesta and cotton, only occupy about 600 ha and 250 ha, respectively. The mesta cropped areas include both local and improved varieties. The total cotton cropped area is all of improved varieties.

Wheat is the second most important cereal crop after rice, occupying about 50,000 ha. It accounts for 2.5% of the total food grain cultivated in the Region. Almost all of the wheat is HYV. Maize is a cereal that can be grown year round. This crop was established in Bangladesh after it received recent attention by the agricultural research institutes. But maize occupies only a small area (51 ha) in the Region. The other cereal crops, which occupy a total of about 8,000 ha, are barley, *kaun*, *cheena*, *bajra* and *joar*.

Table 4.3: Local and HYV Rice Cropped Area

Type of Rice	Area ('000 ha)	
	Local	HYV
Aus	277	99
B. Aman	138	
T. Aman	494	241
Boro	203	479
Total	**1112**	**819**

Source: Average for 1990/91 and 1991/92, BBS 1993.

Tea is the second most important industrial crop after jute in Bangladesh. In the Northeast Region tea occupies about 44,000 ha mostly in the hilly areas along the eastern border. Of the 152 tea estates in the country, 130 are in the Region. The plant clones developed by BTRI as well as conventional plants are used in these estates. Sugar cane is also an important industrial crop; it occupies 13,000 ha. Almost the entire sugar cane cropped area is planted with improved varieties.

Pulse crops are cultivated on 30,000 ha. *Khesari* (*Lathyrus sativus*), lentil, mung (green gram), black gram, and chick pea are the major pulse crops grown in the Region. Other pulse crops include pigeon pea and soya bean. Most of the pulses grown are local varieties.

The oilseed crops grown in the Region are mustard, rape, linseed, sesame, groundnut, castor, safflower, niger seed, and sunflower. More than two-thirds of the 43,000 ha of oilseed are either rape or mustard. The use of improved variety oilseeds is increasing with the recent introduction of new varieties of mustard, sesame and groundnuts.

Spices and condiments are cultivated on about 22,000 ha. The major spice and condiment crops grown in the Region are chili, onion, garlic, ginger, turmeric, and coriander. Aniseed, black cumin, bay leaf, fennel, dill, spearmint, sweet basil, and fenugreek are also cultivated in small areas. Spice crops are mostly local varieties.

Potato and sweet potato are the important tuber crops covering about 26,000 ha. The potato varieties grown in the Region include local and HYV. The area under local varieties decreased to about one-third of the total potato area. About 23,000 ha in the Northeast are used for vegetable cultivation. The important vegetables grown are *brinjal*, pumpkin, arum, cauliflower, cabbage, water gourd, tomato, radish, and beans. The other vegetables include *wol copy* (*Brassica caula-rapa*), turnip, lettuce, *shajna* (*Moringa oleifera*), *pahari rai* (*Brassica rugosa* var. *Cuneifolia*), *bokful* (*Sesbania grandiflora*), *lal shak* (*Amaranthus gangeticus*), neteshak (*Amaranthus mangovanus*) and *kalmi* (*Ipomoea reptans*). Vegetables include local, improved local, and modern varieties.

Fruits are cultivated on about 22,000 ha. Pineapples, jackfruit, banana, mango, limes, lemons, and oranges are major fruits produced in the study area. Oranges are produced in Sylhet region. Other fruits grown in the Region are papaya, pomelo, custard apple, jujubi, Bengal olive (*Elaeocarpus serratus*), bale or Bengal quince (*Aegle marmelos*), tropical persimmon, water chestnut, rose apple, *jam* (*Eugenia jambolana* or *Syzygium cumini*), *amloki* (*Phyllanthus emblica*), star apple, tamarind, *amra* (*Spondias mangifera*) and *dephul* (*Artocarpus lakoocha*). Betelnut, which is used as a masticatory with betel leaf, is also grown in the Region.

Other crops, which are also grown in some areas include tobacco, betel leaf, date palm, palmyra palm, sun-hemp, fodder, mulberry, and so on. These crops cover about 5,000 to 6,000 ha.

4.1.3 Use of Inputs

New Variety

A major part of the total cropped area in the Region is under local varieties. The spread of HYVs started in the 1960s with the introduction of the dwarf IR8 rice variety where irrigation was available. Several other HYVs were subsequently introduced by the IRRI plus a large number of new varieties by the BRRI. The wheat HYVs were introduced in the 1970s. There has been a significant increase in the proportion of HYVs in major cereal crops during the past decades.

Rice HYVs have been introduced in all three rice seasons. As HYVs require a stable water regime to respond well to fertilizers, they are best suited for irrigated conditions. BRRI has released 15 HYVs for the aus season, 10 HYVs for the transplanted aman season, and 16 HYVs for the boro season. BAU has developed three HYVs for the transplanted aman and boro seasons. Moreover, the HYVs which were brought from outside the country are also grown in some areas.

More than a dozen HYVs of wheat are available, most developed by the BARI. BJRI has developed several deshi (*Corchorus capsularis*) and tosha *(C. olitorious)* varieties of jute. A dozen improved varieties are available for sugar cane cultivation. These varieties have been developed by SRTI. There are 16 exotic HYVs of potato. BARI has developed 3 potato HYVs. The institute has developed improved varieties of pulses, oilseeds, spices and vegetables. Six exotic varieties of tobacco are also available. Several tea clones have been developed by BTRI. The clones are high yielding and produce good quality tea.

Seeds

The seed requirement for broadcast rice cultivation is 90 kg/ha, and 25 kg/ha for transplanted rice cultivation. For wheat cultivation, it is 130 kg/ha under irrigated conditions and 105 kg/ha under un-irrigated conditions. The average seed requirement for jute, potato, maize, and mustard is 7 kg/ha, 1,600 kg/ha, 35 kg/ha and 12 kg/ha, respectively. About 0.12 million tons of major crop seeds are required annually in the Region.

Usually, farmers save their seeds from the harvested crop. They sometimes exchange seeds among themselves. Seeds are also available in local markets. Multiplication, production, and distribution of certified seeds of HYVs and improved varieties are the responsibility of BADC. BADC has two dozen farms occupying 2,400 ha nucleus/breeder seeds are multiplied. It also has a seed production programme with growers contracted, guided, and supervised by the organization. Mainly rice and wheat seeds are multiplied by the BADC. It also produces jute, potato, mustard, groundnut, chickpea and mung seeds.

The total amount of improved and HYV seeds distributed to the farmers is lower than that requirement for most crops. However, sufficient improved seeds for wheat are available. Due to an inadequate capacity and poor distribution facilities, BADC is unable to meet demands for improved and HYV seeds, especially during the *rabi* season.

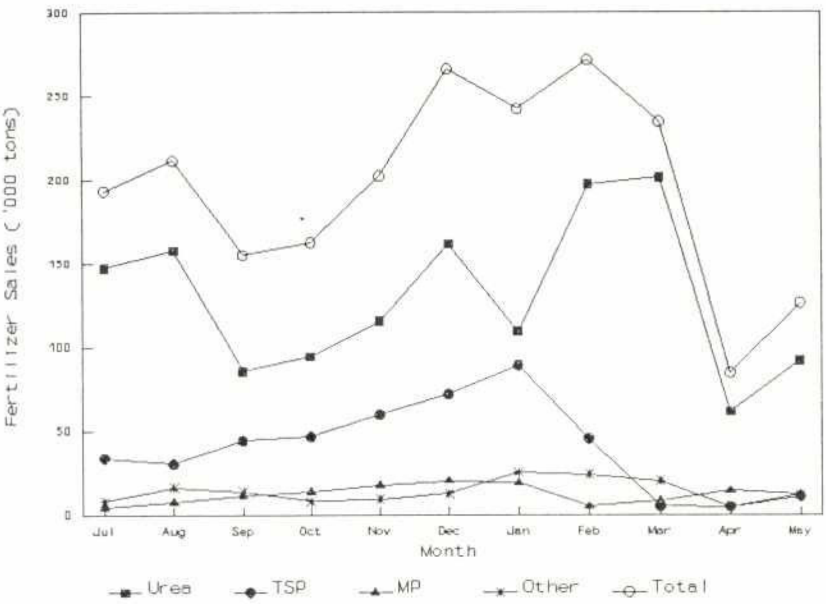
Fertilizer

Chemical fertilizers are an important input for crop production, particularly in HYV rice production. The major fertilizer is urea which accounts for more than two-thirds of the total fertilizer distributed. Other fertilizers are: TSP, with 20% of the distribution; MP, with seven percent; and zinc sulphate, gypsum, ASP, SSP, SOP and the old stock of DAP with five percent of the fertilizer distributed.

Nitrogen is the most common and widely used nutrient; urea is the major source of nitrogen. In the Region, annual consumption of urea is about 0.2 million tons. Phosphate is second only to nitrogen in frequency and total volume of use as a fertilizer. The most widely consumed phosphate fertilizer in the country is TSP. Annual consumption of TSP is about 60,000 tons. Potash is the third most widely used nutrient, and MP is the only source of potash. The Region consumes about 20,000 tons of MP annually. The other fertilizers account for 15,000 tons.

Data on the application of fertilizer in different seasons or months are not available. However, IFDC data on the national sales of fertilizer (Graph 4.1) during July-May suggest that fertilizer application increases during the rabi season. It is estimated that most of the fertilizer is applied to the HYV boro rice, which accounts for more than 50% of the sown area during the rabi season.

Graph 4.1: Monthly Fertilizer Sales Trend



Pesticide and Herbicide

Annually, 450 tons of pesticides and 70 tons of herbicides are used in the Region. More than three-quarters of the pesticides used are granular. The other pesticides include 70 tons of conventional pest complex, 14 tons of soil insecticide, 17 tons of acaricide, 20 tons of fungicides and one ton of rodenticide. Pesticides are mainly applied on HYV rice. They are rarely used in local rice varieties. Herbicides are used in the tea estates. It was estimated that about four percent of the total cultivated land in the Region is treated with insecticides and 0.4% with fungicides.

Irrigation

A contributing factor to the recent increase in food production is the increased availability of irrigation water. Fertilizer responsive HYVs have caught on well in those areas with good irrigation systems.

Most irrigation development has taken place through the use of small-scale equipment such as DTW, STW and LLP. Tube well irrigation accounts for 40% of the total irrigated area. About 29% of the total irrigated area is irrigated by LLP. Areas irrigated by lifting water through traditional methods, such as swing baskets and *doons*, account for 24% of the total irrigated area. Traditional methods of irrigation are mostly practised in the *haors* and flood basins, where surface water is available at a level of 1 to 2 meters below the cultivated land in the rabi season. Canal irrigation, which also is mainly practised in these areas, accounts for about seven percent of the total irrigated area in the Region.

The irrigation rate, or the ratio of irrigated area to the total cropped area, is 25%. It is higher in the western part of the Region. Irrigation is mainly done for boro rice in the rabi season. Of the 0.57 million hectares irrigated in the Northeast, 0.50 million ha, or about 88%, are for boro rice. Over 27% of the boro land is rainfed. About 90% of the sugar cane area, two-thirds of the wheat cropped area, and more than 50% of the potato area, are not irrigated. Irrigation is rarely practised in the kharif season.

4.1.4 Cropped Area Damaged by Floods

Crops are damaged by floods, drainage congestion, hailstorm, cyclones, pests, and so on. Flooding is the major cause of crop damage and rice is the major crop damaged by floods in the Region (Figures 2a and 2b). Based on available data related to flood damage of crops in the Region from 1981 to 1991, it is estimated that more than 6 percent of the total cropped area is completely damaged. During that period about 1.22 million ha of rice, 25,000 ha of jute, 2,000 ha of sugar cane and 4,000 ha of pulses, vegetables and other crop areas were completely damaged by floods (Table 4.4).

In 1982 floods damaged more than 3,000 ha of aus rice. The crop was damaged mainly in the lowland floodplains in the eastern part of the Region. In 1983, the total rice cropped area damaged by floods was more than 73,000 ha. The major rice crops damaged were boro and transplanted aman. Boro was extensively damaged in the haor and flood basin in the central part of the Region. Transplanted aman was extensively damaged in the lowland floodplain in the western part of the Regions in August and September. In both cases, mostly local varieties were damaged. Some aus and deepwater aman cropped areas were also damaged in July and August, mainly in the haor basin.

Table 4.4: Cropped Area Damaged by Flood

Year	Damaged Area ('000ha)	Percent of Damaged Area				
		Rice	Jute	Wheat	Sugar cane	Other
1981[a]	2	49	51			
1982[b]	3	100				
1983	73	99	<1	<1		<1
1984	180	96	4			
1985	48	99*	<1			
1986[a]	49	100				
1987	132	99	1		<1	
1988[c]	677	98	1		<1	<1
1991	138	94	5	<1	<1	<1

a: the crop was damaged by hailstorm and heavy rainfall.
b: excluding the 6,440 ha of boro, 690 ha of aus, 1,110 ha of deepwater aman and 880 ha of T. aman damaged by cyclone, hailstorm and drought.
c: excluding the 23,355 ha of T. aman, 7,220 ha of wheat and 11,870 ha of pulse, vegetables and other crops damaged by cyclone.
*: Excluding 8,120 ha of boro damaged by hailstorm and heavy rainfall.
Source: BBS 1989 and 1993.

In 1984, 0.17 million ha of boro, aus and deepwater aman cropped areas were damaged. In May, HYV boro in the south-western part of the Region and local aus and deepwater aman cropped areas in the lowland floodplain and haor basin in the eastern part of the Region were extensively inundated. Farmers could not harvest boro. Aus and deepwater aman were damaged at their early growing stages. Recurrence of floods with heavy rainfall in September extensively damaged standing deepwater aman and transplanted aman in the eastern part of the Region. Aus and deepwater aman were the major crops damaged by the floods in 1985. In June floods due to the overflow of the Surma, Kushiyara and Khowai Rivers coupled with heavy rainfall, submerged aus and deepwater aman cropped areas extensively in the lowland floodplains and haor basins in the eastern part of the Region. Consequently, standing crops were substantially damaged. The total area damaged in the Region was 48,000 ha.

In 1987, flooding occurred in July and August, damaging more than 0.13 million ha of aus, deepwater aman, and transplanted aman. Aus was damaged at the maturing stage, extensively in the south-eastern part of the Region. Standing deepwater aman in the south-western and newly transplanted aman in most parts of the Region was extensively damaged. In 1988, an exceptionally bad year, the total rice cropped area damaged was about 0.66 million ha. The major crop damaged was transplanted aman. The crop was damaged extensively in the eastern and north-western parts of the Region. Aus and deepwater aman were also damaged considerably in this area.

Major crops damaged in 1991 were aus, boro and deepwater aman. Aus and deepwater aman were extensively damage in the eastern part, and boro was extensively damaged in the haor and flood basins. Transplanted aman was damaged in the western part of the Region.

The estimates of cropped area damaged by floods during 1981 to 1991 shows that the rice cropped area is more vulnerable to floods than other crops in the Region. As more areas are cropped in the transplanted aman season, damage of the rice cropped area was higher in this season than in most flood years (Table 4.5).

Table 4.5: Rice Cropped Area Damaged by Flood

Year	Damaged Area ('000 ha)	Percent of Total Damaged Area			
		Boro	Aus	B. Aman	T. Aman
1982	3		100		
1983	72	53	5	6	36
1984	173	29	33	29	9
1985	48	<1	58	40	2
1987	131	0	31	12	57
1988	663	1	26	26	48
1991	130	38	30	26	6

Source: BBS 1989 and 1993.

During the period from 1981 to 1991 about 0.44 million ha of the rice cropped area was damaged during the transplanted aman season. The total rice cropped area damaged in the aus season was 0.34 million ha. During the deepwater aman season about 0.30 million ha were damaged and about 0.14 million ha were damaged in the boro season.

4.1.5 Crop Production

Rice

The Northeast Region produces 3.3 million tons of rice a year, 45% of which is boro, 41% aman and 14% aus (Table 4.6). The average rice yield is 1.69 ton/ha, which is below the national average of 1.75 ton/ha. Present low yields of rice in the Region are associated with wide use of local varieties in rainfed aus, lowland transplanted aman and boro, and deepwater aman and the damage caused by floods and drainage congestion.

Of the total rice production local varieties account for 43%, and HYVs for 57%. The average HYV rice yield is nearly 2.26 ton/ha, compared with 1.0 ton/ha for local aus, 1.15 ton/ha for deepwater aman, 1.37 ton/ha for local transplanted aman, and 1.47 ton/ha for local boro varieties. The current average HYV rice yield in the Region is still less than the national average (2.43 ton/ha) and about half of what has been demonstrated possible in Bangladesh. The barriers to getting higher yields are, in most cases, physical and economic.

In the Region, about 400 local varieties are grown in the aus season. The varieties are mostly broadcast. The local aus varieties give a little higher yield when they are transplanted.

The yields of deepwater aman depend on the pattern of flooding. A rise of water level at the booting stage results in sterility. In the deepwater aman season more than 500 varieties are grown. The varieties have an elongation or floating ability. The elongation ability is expressed by a rapid elongation of internodes to keep pace with the rise of water level. The plants require six to eight weeks to establish and acquire the ability to elongate with a gradual rise of water level. The varieties produce tillers (stem branches) and adventitious roots from submerged nodes. Even uprooted in water, the plants survive and produce panicles. Selection of deepwater rice varieties according to the flooding characteristics and their cultivation may help to increase production in the Region.

The yields of transplanted aman depend on the date of transplantation. Late transplanting brings down the yield level in many areas. In 1993 the NERP agronomy team observed that the yield was low for both local varieties and HYVs in areas where transplantation was delayed by late drainage of flood waters.

Local boro varieties grown in the Region can be classified into two groups, according to growth duration and land requirement: they are *jagli* boro or boro and *shail* boro. Jagli boro varieties (such as *kaliboro, khoiaboro, deshiboro*) are early maturing, with a growth duration of 145-150 days. These varieties are well adapted for conditions where flooding occurs early. Jagli boro varieties are usually transplanted in late December and harvested in early April. Shail boro varieties (such as *gochi, aknisail, pashusail*) are transplanted in late December or early January and harvested in late April. The growth duration of these varieties is 155-160 days. Shail boro varieties have a higher tillering capacity than the jagli boro. This means that the shail boro varieties are higher yielding, since a high tillering capacity is an important factor for achieving maximum yield in transplanted rice cultivation. Spikelets depend on the tillering capacity, and the rice yield increases linearly with increasing spikelets per unit area. The number of spikelets per unit area appears to be higher in shail boro varieties than in jagli boro varieties (Table 4.7).

Non-rice

About 0.6 million bales of jute are produced in the Region annually. The average yield of jute is 0.9 bale/ha. Annual production of cotton is 825 bales, with an average yield of 4.0 bale/ha.

Wheat accounts for two percent of the annual food grain production. About 70,000 tons of wheat are produced annually, with an average yield of about 1.5 ton/ha.

The Region produces 40 tons of maize annually. Maize has the potential of producing more food per unit area than either rice or wheat. It provides food and fodder, and can be transformed to a fuel. Annual production of other cereals is 7,000 tons.

The tea estates in the Region produce 96% of the country's tea (45,880 tons). The average yield is about 1 ton/ha.

Annual production of sugar cane is about 0.43 million tons. The average yield is 33.6 ton/ha.

Table 4.6: Rice Production ('000 tons)

Type of Rice	Production
Aus Local HYV Total	278 186 464
Aman Local HYV Total	838(159) 497 1335
Boro Local HYV Total	298 1175 1473
All Types Local HYV Total	**1414 1858 3272**

Note: Numbers in parenthesis indicate deepwater aman rice production.

Source: Average for 1990/91 and 1991/92, BBS.

About 22,000 tons of pulse and 35,000 tons of oilseeds are produced in the Region annually. The average yields for pulses and oilseeds are about 0.7 ton/ha and 0.8 ton/ha, respectively. The yields are very low since traditional varieties are cultivated.

Annual production of spices and condiments is 31,000 tons. The average yield is 0.9 ton/ha for chili, 4.0 ton/ha for onion, 2.8 ton/ha for garlic, 6.2 ton/ha for ginger, 2.0 ton/ha for turmeric, and 0.5 ton/ha for coriander.

Table 4.7: Differences Between Local Boro Rice Varieties

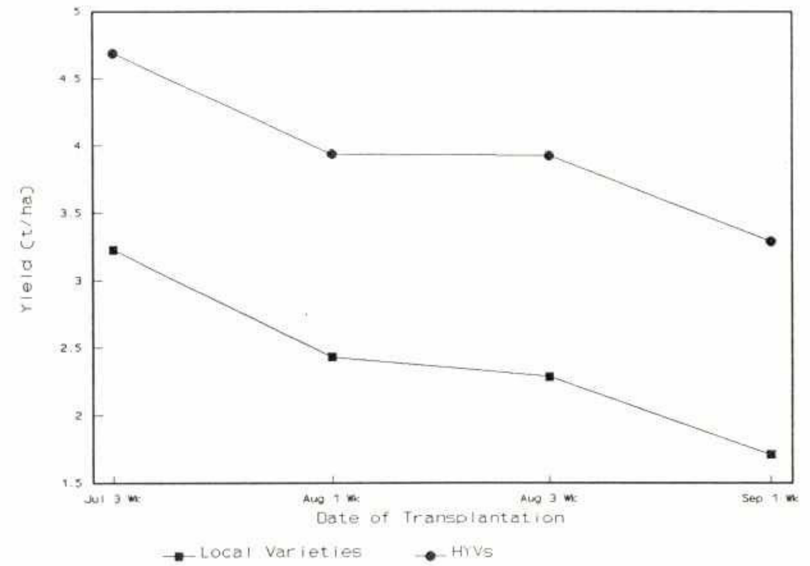
Group	No. of Panicle/Hill	No. of Spikelet/Panicle	Percentage of Filled Spikelet	1000 Grain Weight (g)
Jagli Boro[a]	7.6±1.2	63.8±8.2	86.9±5.3	17.2
Shail Boro[b]	8.0±0.8	138.5±13.7	92.6±3.5	16.3

a: deshi boro variety, b: gochi variety, ±: standard deviation.

Note: For each variety five hills were examined.

Source: NERP Agronomy Team.

Graph 4.2: Relation between Yield and Date of Transplantation in Transplanted Aman Season (each dot represents average yield for three locations)



Annually, about 0.16 million tons of potato, and 0.10 million tons of sweet potato are produced. The average yield for local varieties and HYVs of potato is 7.1 ton/ha and 13.2 t/ha, respectively. The average yield is 12.1 ton/ha for sweet potato.

Annual production of vegetables is 0.15 million tons. Of the total vegetable production, 75% is produced in winter and 25% in summer. The Region produces 0.2 million tons of different fruits. Among them, pineapple, banana, and jackfruit together account for three-quarters of the annual fruit production.

4.1.6 Loss of Crop Production by Flood

During the period from 1981 to 1991, 1.76 million tons of rice, 26,000 tons of jute, 75,000 tons of sugar cane, and 25,000 tons of pulses, vegetables and other crops could not be harvested because of flood damage (Table 4.8). In addition, about 71,000 tons of rice, 11,000 tons of wheat and 47,000 tons of pulse, vegetable and other crops were lost by hailstorms, heavy rainfall, cyclone, and drought. Crop production losses by flooding were more frequent than for other natural disasters. The loss of rice production was more severe than that of other crops in the Region.

The loss of rice due to flooding is higher in the transplanted aman season since a greater area is under cultivation at this time of the year (Table 4.9). Even though the area of rice damage during the boro season was lower than the other seasons, the loss of boro rice was significant and almost comparable to the areas of aus or deepwater aman that were lost. During the same period, about 0.74 million tons of transplanted aman, 0.37 million tons of aus, 0.34 million tons of deepwater aman and 0.32 million tons of boro rice could not be harvested.

The loss of rice caused by flooding depends on the length of submergence and the growth stage of the crop at the time of flooding. In some areas submergence occurs almost every year.

In the pre-monsoon season, floods can damage the boro rice which is in the reproductive or ripening stage, and deepwater aman rice which is in the early vegetative growth stage. In a preliminary study the NERP agronomy team observed that the yield of local boro decreased by 50% when 75% of plant height is submerged at ripening stage. When boro crops are completely submerged farmers often manage to collect the partially matured panicles from underneath the

Table 4.8: Loss of Crop Production by Flood

Year	Total Loss ('000 tons)	Percent of Total Loss				
		Rice	Jute	Wheat	Sugar cane	Other
1981[a]	3	57	43			
1982[b]	3	100				
1983	122	99	<1	<1		<1
1984	259	96	4			
1985	50	99*	<1			
1986[a]	102	100				
1987	200	88	1		11	
1988[c]	1038	93	<1		5	2
1991	214	93	5	<1	<1	2

a: damaged by hailstorm and heavy rainfall.
b: excluding 11,600 tons of boro, 810 tons of aus, 840 tons of B. aman and 35 tons of T. aman damaged by cyclone, hailstorm and drought.
c: excluding 43,230 tons of T. aman, 10,715 tons of wheat and 46,960 tons of pulse, vegetables and other crops damaged by cyclone.
*: Excluding 13654 tons of boro damaged by hailstorm and heavy rainfall.
Source: BBS 1989 and 1993.

water. Local varieties of deepwater aman seedlings are damaged when they are submerged before they acquire the ability to elongate with the gradually rise of water levels. The plants which survive grow profusely when flood waters recede.

The yields of local varieties and HYVs of transplanted aman rice decrease due to flooding and drainage congestion in the monsoon season. The plants are submerged mostly at the tillering stage. It was observed that yields of these crops decreased by about 20% when 25% of the plant height is submerged at the tillering stage. Impaired tillering and a decrease in the area of photosynthetic leaf surface may be the reason for the decrease in yields at submergence.

The yields of boro crops are also decreased by flood damage in the winter when young plants are inundated in the *haors* and flood basins. The winter inundation is often due to heavy rainfall in the basins. Flooding mostly occurs in low depressions which do not have sufficient drainage outlets. Flood conditions intensify when the major rivers are also high and their waters spill into the basin.

4.2 Livestock

Livestock play a crucial role in the agricultural system of the Northeast Region. For the subsistence farm economy, livestock is essential for a number farming activities including providing draught power for ploughing, threshing and farm transport, and providing organic manure for cropland. In addition, cattle and other livestock provide (1) animal protein through milk, meat, and eggs, (2) a cash income through the sale of animals, milk and eggs, and by the hiring out of draft animals, and (3) fuel (in the form of dry cow dung) for rural households. Manure is an important byproduct of livestock that is useful for agriculture. However, it is mostly carried out of the system to be used for fuel and as a building material. The management of livestock animals is quite poor due to a shortage of feeds and fodder, inadequate health care, low fertility, and overwork. The genetic potential of livestock for meat and milk production is also low.

4.2.1 Population

The most recent data on livestock are provided by the Livestock Survey 1983-84. According to the Survey, there are 3.75 million cattle, 78,000 buffalo, 0.98 million goats, 71,000 sheep, 9.7 million chickens, and 1.7 million ducks in the Northeast Region.

About 58% of the total cattle and 76% of the total buffaloes are working animals. Among the working animals, 93% of working cattle and 85% of working buffaloes are used for cultivation. Although buffaloes are better work animals and produce more milk, their use is not as widespread as cattle.

4.2.2 Ownership

About 52% of the total households in the project area have cattle or buffaloes, 31% have goat and/or sheep, and 71% have poultry. Per capita availability of cattle or buffaloes is about 0.3, goat/sheep is 0.2 and poultry is 0.8.

On average, farm households own 96% of the total bovines and non-farm households own four percent. The distribution of the total bovines according to farm size is as follows: small farmers and medium farmers households own 39.6% each, and large farmers households own 16.8%. Similarly, farm households own 85.5% of goat/sheep and 84.7% of the poultry. The small farm households own about half of the total goat/sheep and poultry, medium farmers households own about 27% and large farmers households own about 8 percent. The non-farm households own 14.6% and 15.3% of the total goat/sheep and poultry, respectively.

Table 4.9: Loss of Rice Production by Floods

Year	Total Loss ('000 tons)	Percent of Total Loss			
		Boro	Aus	Deepwater	T. Aman
1982	3		100		
1983	122	62	3	4	31
1984	248	49	22	21	8
1985	50	1	56	41	2
1987	174		26	9	65
1988	967	1	19	22	58
1991	198	53	24	18	5

Source: BBS 1989 and 1993.

4.2.3 Draught Power Supply

The use of animal power is essential for land preparation (ploughing, laddering), weed control (raking), threshing, crushing, and hauling. Land preparation is the most important function performed by bullock/buffalo on most farms. There are very few power-tillers or tractors used in the Region for land preparation.

Draught animal units (DAU) are used to compare the draught power available. Usually, 1 DAU equals 1 bullock or 2 cows or 0.5 buffalo. The 1989 UNDP Agriculture Sector Review reports that generally a pair of DAU can cultivate 1.62 ha of land provided that the ploughing time is widely distributed throughout the year. However, there are an estimated 1.26 head of draught bovine or 1.23 head of draught cattle per ha of cultivated land in the Northeast. This means that there are about 2.3 ha of cultivated land per pair of DAU.

The 1983 IDRC study indicates that on average one ha of land requires 6.2 to 7.5 days of work by one pair of bullock. Therefore, for the total cropped area of 2.32 million ha in the Region, about 184 million days of animal (bullock) labour are required for land preparation (estimating that cropped areas are ploughed six times). The total number of animals available for this work has been estimated at 1.93 million. Therefore, each of these animals has to work for almost 95 days to plough the total cropped area completely. In view of this, it is evident that draught animals are scarce in the Region.

4.2.4 Livestock and Food Supply

Cattle and buffalo are the major sources of meat providing more than two-thirds of the total meat consumed in the Region. Goats and sheep provide about 10 percent of the total meat, and poultry provide about 20%. Milk is produced in the rural households with cows. The cows, however, are mainly for draught purposes. Some large farmers have one or two cows for milk production and a draught bullock. Eggs of chickens and ducks are produced in rural farms under a scavenging system. A few commercial poultry farms have been reported in the urban areas. About one-third of the total poultry population is laying birds. More than two-thirds of the egg production comes from chickens and the remainder from ducks.

4.2.5 Livestock Diseases

Bangladesh has a number of serious livestock diseases such as Foot and Mouth Disease and Rinderpest which can kill livestock in large numbers. There are, however, vaccination programmes which are in place or are being planned. Reproductive disorders are a primary focus of veterinary researchers but much of the reproductive failure in livestock may be due to the low nutritional status caused by the overstocking of grazing lands and dependence on rice straw. Rice straw is the most abundant and the least nutritious of fodders available. Internal and external parasites also contribute to the stress of livestock. Official estimates of mortality in cattle are that 25% die in the first year of life and 10% die per year as adults. This means that barely half of the heifer calves are likely to survive to calve at four years of age and, due to low reproductive rates, only half of these will conceive.

Combined high mortality and low conception rates have several adverse implications. If 10% of the cows must be replaced each year, little room is left for culling without diminishing the national breeding herd. If only half of the cows calve each year, half of the calves are heifers, and only half of the heifer calves survive to enter the cow herd, virtually no opportunity exists for selection of superior heifers.

Important goat and sheep diseases are Anthrax, Clostridial and Parasites. The main poultry diseases include Fowl Cholera, Fowl Pox and Duck Plague. A FAO/UNDP study (1990) suggested that Duck Plague and Duck Cholera are the main constraints to the expansion of ducks in the wetland areas. DLS is producing duck plague and duck cholera vaccines and has put in place a vaccination network serving the farmers at the thana level. Viral hepatitis of ducks is also a highly contagious disease causing sudden death and high mortality. The mortality and morbidity due to organic diseases suffered in duck production is not as serious as those in chicken production.

Severe flooding of the Region is a hazard to livestock though the losses may not be as dramatic as crop losses. However, loss of fodder, exposure to rain, and drowning contribute to animal stress.

4.2.6 Livestock Feeds and Fodder Supply

The main source of cattle feed is rice straw, complemented by rice fields, roadside grazing, and communal grazing fields in winter. A study by BARC suggests that 87% of all animal feeds in Bangladesh come from cultivated land. Only 13% of animal feeds come from non-cultivated lands such as embankments, road sides, forests, and low lands which are usually used on a community basis and therefore are not available for managed forage production. The small areas of communal grazing lands are now over-grazed. Animals hardly receive any concentrated feed except a small amount of salt and a handful of rice bran/polishing which is produced in the households. There are only about 200 ha of land used for forage production in the Region. Moreover, the quality of rice straw has reportedly deteriorated due to an increase in the HYV rice area replacing local rice varieties. The 1984 BAU estimate of supply of animal feeds and nutrients shows that there was a shortage of dry matter (56%), crude protein (74%), and metabolic energy (80%).

4.2.7 Genetic Character

The cattle in Bangladesh in general are indigenous (*Bos indicas*). There are three varieties of cattle: large Deshi (indigenous), small Deshi, and Red Chittagong. The animals are small in size, slow growers, and poor milk producers. Their relative low reproductive inefficiency is characterized by late sexual maturity with first parturition at four years of age, conception rates of about 50% or less resulting in calving every other year, and long gestation period of 9-10 months which further contributes to prolonged calving intervals. There are some crossbreed cattle located mainly around the Central Cattle Breeding Station in Dhaka, and in some milk pocket areas in other Regions. The most productive dairy/beef breeds adapted to the Northeast Region are the Sahiwal, Hariana, Red Sindhi, and Tharparkar.

Buffalo are also a major source of draught power and milk. The animals are, however, relatively small in size. The buffaloes of Bangladesh are classified as being of the Riverine type. Three breeds of buffaloes have been reported in Bangladesh: the Manipuri and Bangar of the Sylhet district, and the Kachhar which may be a Manipuri hybrid. The Manipuri is described as a massive breed with large backswept horns which indicates a relationship to the riverine breeds of Southern India.

Goats are also indigenous. The main varieties are Black Bengal and Jamunapuri, the former accounting for most of the population. The local Black Bengal is small but very prolific. The local sheep of the Region are prolific but very small. Their wool is of poor quality and is

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discarded if shorn. Although their economic value is low, their ability to survive under wet conditions gives sheep a certain advantage over goats.

Chickens and ducks are mostly indigenous. They are small and poor layers. About 90% of the chickens are an indigenous type producing 35-50 eggs/laying hen/year. Improved breeds include various commercial layer hybrids of White Leghorn and New Hampshire origin, and broiler hybrids of White Rock and Cornish origin. Heavy bodied black chickens without neck feathers identified as the "French Naked-Neck" breed are found in Sylhet. Egg laying duck breeds include the local Deshi and Khaki Campbell. Average egg production is estimated at 70-80 eggs/laying duck/year. Three indigenous breeds of ducks have been reported. They are the Nageswari, Sylhet Mete, and Indian Runner. Other breeds include the Thai and White Pekin. The Muscovy is of a different species with a longer incubation period and can not be hybrid with the layer breeds.

4.3 Land Use

4.3.1 Present Land Use Pattern

The total area of the Northeast Region is 2.4 million ha. The net cultivated area, which is comprised of the net cropped area and current fallow land, covers about two-thirds of the total area. Waste land, which is cultivable, but remains un-cropped for more than one year, constitutes about five percent of the area. Land, which is not available for cultivation, such as homesteads, roads, market places, rivers, canals, and so on, accounts for 26%. The forested area occupies four percent of the Region.

The hilly areas, which cover seven percent of the Region, occur in the eastern and northern part. The hills are mainly forested, but rice and tea are grown in the valleys and on the hill slopes, respectively.

4.3.2 Land Classification

The use of land in the Region for crop production is largely determined by the depth, timing, rate and duration of flooding. According to the MPO land classification system, which is based upon depth and period of flooding (flood phase), the net cultivated area within the Region can be divided into five land types: highlands (FO), medium highlands (F1), medium lowlands (F2), lowlands (F3), and very lowlands (F4).

The highlands (F0) account for one-quarter of the net cultivated area in the Region, where occasionally the flood depth reaches 0 to 30 cm. The medium highlands (F1), where seasonal flooding ranges from 30 to 90 cm, occupy 16% of the area. These lands are subject to moderate cropping constraints during the monsoon season. The medium lowlands (F2) account for 22% of the net cultivated area where seasonal flooding ranges from 90 to 180 cm during the monsoon. The lowlands (F3) where the seasonal flooding depth is more than 180 cm occupy more than one-third of the Region's cultivated area. The very low lowlands (F4) consisting of *haors, beels*, river beds, canal beds and so on, account for one percent of the net cultivated area. These lands are almost perennially flooded and the flood depth (more than 180 cm and may exceed 6 m during the peak monsoon) does not permit any crop to grow in the monsoon. Under present conditions, less than one-third of the Region's net cultivated area can be considered to be free from flooding and more than two-thirds are subject to major flooding constraints for cropping during the monsoon season.

4.3.3 Major Cropped Area by Land Type

The important crops on the highlands (F0) are local and HYV aus, local and HYV transplanted aman, and jute (Table 4.10). On the medium highlands (F1), local and HYV aus, local and HYV transplanted aman, and HYV boro are the important crops. On medium lowlands (F2), mainly deepwater aman, HYV boro, and wheat are grown. Local varieties of transplanted aman are grown in this land type where water recedes early. Local and HYV boro are almost the only crops that can be grown on lowlands (F3), with HYV being the major crop. On the very low lowlands (F4), local boro is the only crop.

Boro rice is the main crop in the deeply flooded area and accounts for 36% of the net cultivated area in the Region. It is grown in the winter season. The moderately deeply flooded area occupies 22% of the net cultivated area. In this area, mainly photoperiod-sensitive deepwater aman rice with the ability to elongate internodes with the gradual rise of water levels and long stemmed transplanted aman rice are grown in the pre-monsoon and monsoon seasons, and HYV boro in winter. The remaining 0.7 million ha are suitable for aus rice, jute, transplanted aman, pulses, oilseeds, spices, vegetables, and sugar cane.

4.3.4 Land Distribution by Farm Size

According to the 1983-84 Agriculture Census, 70% of all farm households in the Region own small farms. Medium-sized farms comprise 25% of the households. While large farm owners comprise the remaining five percent.

The medium-sized farm households cultivate 42% of the net cultivated area in the Region. The small and large farm households account for 31% and 27%, respectively. The average land per farm households is 1.0 ha; it is 0.4 ha for small farms, 1.7 ha for medium-sized farms, and 5.2 ha for large farm households. The cropping intensity and crop production are usually higher on the small and medium farms than for the large farmers. The large farmers usually operate lands through tenants or hired labour, and do not work in the field themselves.

The 1989 UNDP Agriculture Sector Review study suggests that small farm holdings are mostly used for intensive cultivation, as these farmers who depend on their crops for survival have little choice. Large farmers choose crops and cropping pattern which give a high rate of return and can therefore have less intensive cultivation.

4.3.5 Intensity of Land Use

Of the net cultivated area, 39% is single cropped, 42% is double cropped, and eight percent is triple cropped. More than one-tenth of the net cultivated area remains fallow each year, mostly due to excessive flooding and late drainage. The eastern part of the Region is mostly single cropped. Double cropping is mainly practised in the northern and western parts. The western part of the Region accounts for most of the triple cropped area (see Figure 3).

For the single cropped pattern, local boro is the major crop followed by HYV boro and deepwater aman. Aus-transplanted aman, aus/jute-rabi crops, transplanted aman-HYV boro, and transplanted aman-rabi crops are the major cropping patterns of the double cropped areas. The jute/aus-transplanted aman-rabi is the main triple cropping pattern in the Region.

4.3.6 Land Use under Different Crop Patterns

Considering the use of land for specific crop and crop patterns and the wide range of crops grown, crop patterns in the Region differ from farm to farm. Crop patterns are not determined by physical factors (topography, flooding characteristics, climate, availability of moisture, length of the growing season) only, but biological factors (growth duration of crops, varietal characteristics, availability of draught power, food habits, incidence of pest and diseases, and so on) and socio-economic factors (financial resources, availability of labour and credit, ratio of input and output of the produce, and so on) are also important. Farmers are continuously changing cropping patterns, mainly in response to changing physical and socio-economic conditions. The predominate cropping patterns in different land types and water regimes in the Region are as follows:

Table 4.10: Distribution of Major Cropped Area by Land Types

Name of Crop	Percent of Net Cultivated Area					TOTAL ('000 ha)
	F0	F1	F2	F3	F4	
Local Aus	38.0	54.0	9.3			325
HYV Aus	15.2	14.0				98
B aman			31.0	7.6		152
Local T Aman	52.0	66.0	37.3			512
HYV Aman	42.0	19.8				223
Local Boro				33.8	100.0	202
HYV Boro	2.0	10.0	34.0	55.3		463
Wheat	3.0	3.0	8.0			48
Potato	1.0	2.2	2.3			18
Jute	11.7	3.0	4.0			70
Sugar cane	2.0	1.8				13
Pulse	1.0	2.0	2.5	2.3		31
Oilseeds	4.0	3.0	3.0	1.5		43
Spices	2.4	2.0				15
Minor Crops	5.7	13.0	10.0			91
Orchard	5.4					22
Net Cultivated Area ('000 ha)	**411**	**253**	**353**	**559**	**13**	**1589**
Total Cropped Area ('000 ha)	**762**	**490**	**499**	**562**	**13**	**2326**
Cropping Intensity*	**1.85**	**1.94**	**1.41**	**1.01**	**1.00**	**1.46**

*: Ratio of total cropped area to the net cultivated area.
Source: Average for 1989/90 and 1990/91 BBS data and MPO (WARPO) 1987.

On highland areas the crop patterns are: B. aus-Local T. aman; Local T. aus-Local/HYV T.aman; B. aus-Local T. aman-Rabi Crops (Pulses, Oilseeds, Winter Vegetables, and so on); B. aus/Jute-Rabi/Vegetables; Jute/B. aus-Local T.aman-Rabi/Fallow; Local/HYV T. aman-HYV boro; T. aman-Rabi-Fallow/Summer vegetables; and Sugar cane.

On medium highlands the crop patterns are: B. aus/Jute-Local T. aman-Rabi; B. aus/Local T. aus/Jute-Local T. aman-Wheat/Potato/Rabi/Fallow; HYV aus-Potato/Rabi; Local/HYV T. aman-HYV boro; Local T. aman relayed by Mustard-HYV boro, and Sugar cane.

On medium lowlands the crop patterns are: mixed B. aus and Deepwater aman-Rabi; Deepwater aman-Pulses/Oilseeds/Fallow; Jute/B. aus-Wheat/Potato; Local T. aman-HYV boro; HYV boro-Fallow; and Groundnut-Fallow.

On lowlands the crop patterns are: Local boro-Fallow; HYV boro-Fallow; Deepwater aman-Fallow. On very low lowlands a single local boro is the major crop. However, a single broadcast aman is also grown in some areas.

Some of the common crop patterns used in the different land types and water regimes in the Region are shown in Figures 4a to 4d.

5. TRENDS IN THE AGRICULTURAL PRODUCTION SYSTEM

5.1 Crops

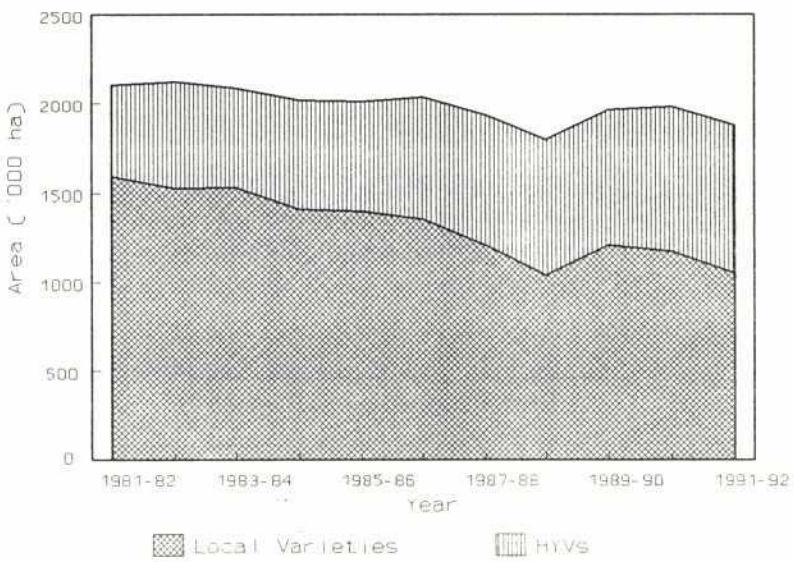
5.1.1 Cropped Area

Rice

Rice remains the most important crop produced in the Northeast Region. Traditionally, rice has been the staple food of the people, and is their main source of calorie intake. There have been significant changes in rice production of the region over the last ten to fifteen years.

During the late 1970s, rice covered 1.9 to 2.0 million ha per year. In the early 1980s the area reached more than 2.1 million ha. But by 1991-92 the rice cropped area declined back to levels of the late 1970s level. Annual rice areas during the 1981-82 to 1991-92 are provided in Annex B.

Graph 5.1: Trends in Rice Cropped Area



While the total rice cropped area has declined between 1981-82 and 1991-92, the area for HYVs has increased by more than 0.3 million ha. The HYVs now share more than 40% of the total rice cropped area. The share had increased from zero in 1960-62 to 18% in the late 1970s. The local varieties have decreased by more than 0.4 million ha.

A major factor contributing to the increase in the HYV rice is the expansion of irrigation facilities. The HYV cropped area has increased by more than two-fold in the boro season, and by one-third in the transplanted aman season during the period of 1981-82 to 1991-92 (Graph 5.2). In the aus season, the HYV cropped area has tended to decline. It appears that the HYV aus cropped areas have been converted into HYV boro cropped areas. The increase in the transplanted aman season is in areas where flood water recedes early and where rabi crops could be grown. The major constraint to the expansion of the HYV area in this season is that about

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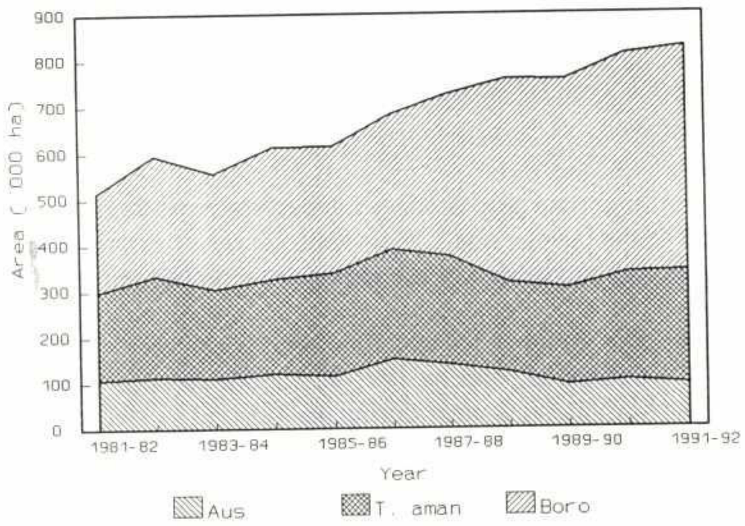
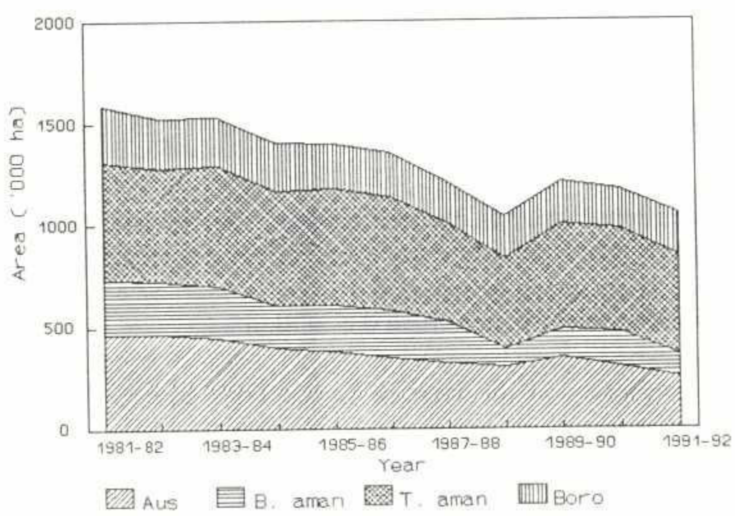
Graph 5.2: Trends in High Yielding Varieties Rice Cropped Area by Season



50% of the transplanted aman cropped area remains under deep flood water at the transplantation time.

The local rice varieties cropped area has declined in all seasons (Graph 5.3). It has declined more in the aus, deepwater aman or broadcast aman, and boro seasons than for the transplanted aman season. Local aus rice lost a small area and deepwater aman a substantial area to HYV boro.

Graph 5.3: Trends in Local Varieties Rice Cropped Area by Season



Non-rice
Between 1981-82 and 1991-92 the jute area has declined by more than two-thirds, while the wheat cropped area has doubled. A fall in jute prices has led to the reduction in jute cultivation. Wheat varieties are now all high yielding and local varieties have all but disappeared.

In the early 1950s, tea was produced on about 28,000 ha. By 1980-81 the area was expanded to 41,000 ha and by 1991-92 it was 44,000 ha.

The area under sugar cane cultivation has increased by eight percent. The area sown with pulses has increased by 60%. A strong increase in rape, mustard and groundnut has resulted in an overall increase in the oilseeds production. For onion, turmeric, garlic, ginger, and coriander there has been no noticeable increase. The area under chili cultivation has increased in the kharif season, but declined in the rabi season.

The area of potatoes cultivation has increased by 10%, while for sweet potato it has decreased by more than 30%. Vegetables production has increased, however, the growth rates are slow. There has been a significant increase in water gourd, tomato, radish and bean. Traditionally, most vegetables are grown in household gardens; only recently have vegetables been grown commercially.

There is also an increase in areas sown with minor crops. The area under cotton has increased, while for tobacco it has declined.

Increase in jackfruit area is noticeable. There is also an increase in area under banana, mango, litchi, guava, lime and lemon production. The pineapple area, however, has declined. And there is a dramatic decrease in the area under orange cultivation in Sylhet, which was the leading producer among the four orange growing regions in the country. The area decreased from about 900 ha in the mid 1970s to 200 ha in 1988. Annual nonrice areas for 1981-82 to 1991-92 are provided in Annex C.

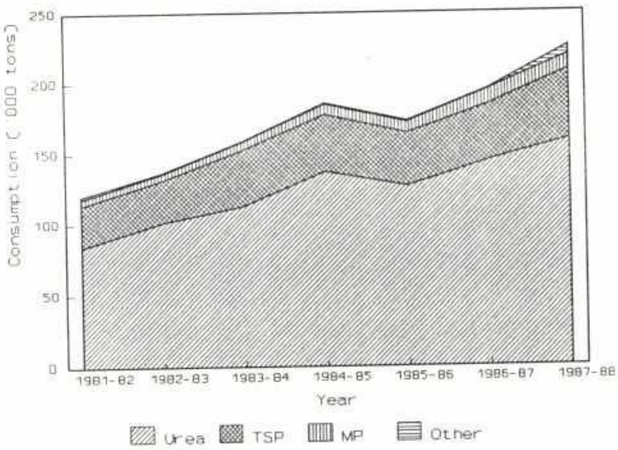
5.1.2 Use of Inputs

Seed
Distribution of seed has increased in all regions. In 1981-82, a total 210 tons of HYV rice seeds were distributed in the Northeast Region, more than 52% in the boro season, 24% in the aus season, and 23% in the transplanted aman season. In 1991-92, 216 tons of HYV rice seeds were distributed in the aus season alone, along with 376 tons in aman, and 403 tons in the boro season. During the same period, seed potato distribution increased from 219 to 663 tons, and wheat seeds from 1,144 tons to 2,982 tons.

Fertilizer
There is a significant increase in the total consumption of chemical fertilizers (Graph 5.4). Chemical fertilizer was introduced to Bangladesh in 1951 with the import of ASP. Urea, TSP and MP were introduced in the late 1950s. Zinc sulphate and gypsum have been introduced in the country more recently. In the early 1960s, 18,000 tons of chemical fertilizers were used annually in the Region, while 0.23 million tons were used in 1987-88. Data on the Region-wide distribution of fertilizers are available until 1987-88. However, continuous growth of fertilizer use in the country suggests that the Region now consumes more than 0.3 million tons of chemical

fertilizers. The fertilizers have helped in the gradual increase of rice production, particularly in the boro season.

Graph 5.4: Trends in Fertilizer Consumption



Pesticide and Weedicide

Pesticide and weedicide consumption increased from 304 tons in 1982-83 to 531 tons in 1988-89. Granular use has increased by 50% and the use of conventional pest complex doubled over the same period. The use of weedicide has increased from 15 to 69 tons. The use of soil insecticide increased from 3 to 14 tons, acaricide from 3 to 17 tons, and fungicide from 11 to 19 tons. Data on region-wide distribution of pesticides are available only until 1988-89 (Annex D). However, the trend in the country suggest that pesticide use is increasing.

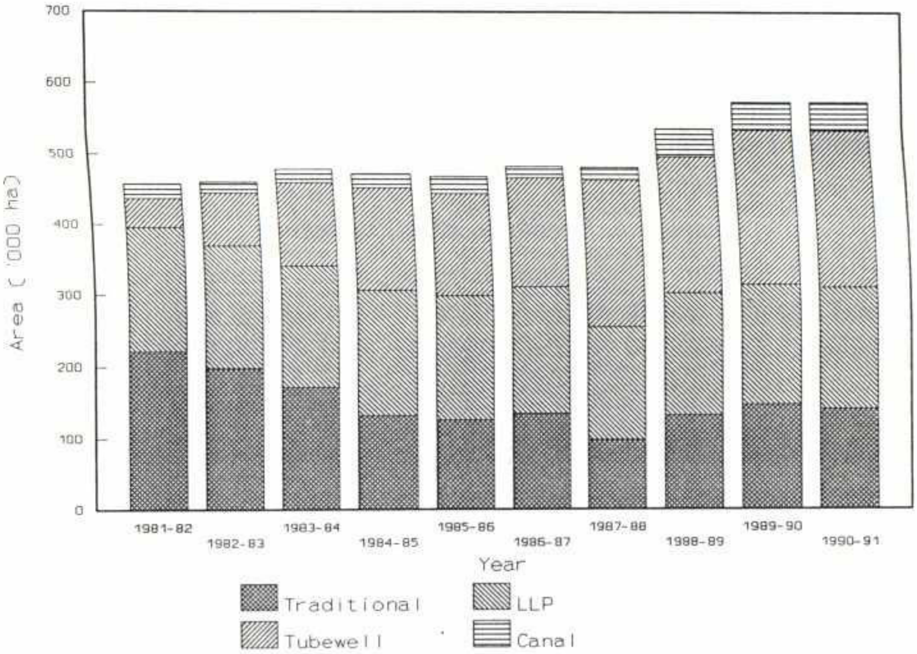
Irrigation

The rapid rise in the use of irrigation water has increased rice production through the adoption of HYVs. The irrigated area has mostly increased through ground water development with the use of deep and shallow tube wells. In 1981-82, tube well irrigation accounted for only nine percent of the total irrigated area. But this increased dramatically to 39% by 1990-91 (Graph 5.5). In the same period the area under traditional irrigation has declined significantly, while the canal irrigated area increased. There was a slight decrease in the LLP irrigated area.

Irrigation for wheat, sugar cane, and vegetables has increased, but it has decreased for rice and potato during the past decade (Table 5.1). There is also a slight increase for other crops. Boro rice remains the major irrigated crop, and the proportion of the total irrigated area under this crop has increased. The proportion of irrigated area under aus and aman has decreased. Total irrigated area has increased from 0.45 in 1981-82 to 0.57 million ha in 1990-91.

Field studies in the Region suggest that insufficient irrigation and inefficient water distribution are frequently the limiting factors for crop growth in irrigated rice fields. An improved distribution system, involving improved conveyance systems and selection of appropriate irrigation methods can further increase rice production in many areas. Moreover, higher yields can be achieved by the practice of drainage and intermittent irrigation on well-drained fields. These practices help to expose the soil surface to air, remove toxic substances and maintain healthy roots, increasing root-shoot ratio and improving root growth.

Graph 5.5: Changes in Area Irrigated



5.1.3 Crop Production

Rice

Rice production, which was between 2.2 and 2.8 million tons per year during the late 1970s, reached 3.3 million tons in 1991-92. The higher rice production was due mainly to the increased use of high-yielding, lodging resistant, and fertilizer-responsive varieties (HYVs). Other contributing factors included the increased use of chemical fertilizers and pesticides, and expansion of irrigation facilities.

Rice production would have increased further had there not been large crop losses caused by severe flooding during the 1980s. The two catastrophic floods of 1987 and 1988 caused substantial damage. The 1984 flood severely damaged crops as well. About 1.3 million tons of rice were lost in these three years.

Adoption of HYVs has been a significant factor in the growth of rice production. The HYV rice production has increased from 1.2 million tons accounting for 41% of the total rice production in 1981-1982 to 1.9 million

Table 5.1: Changes in Irrigated area under Different Crops

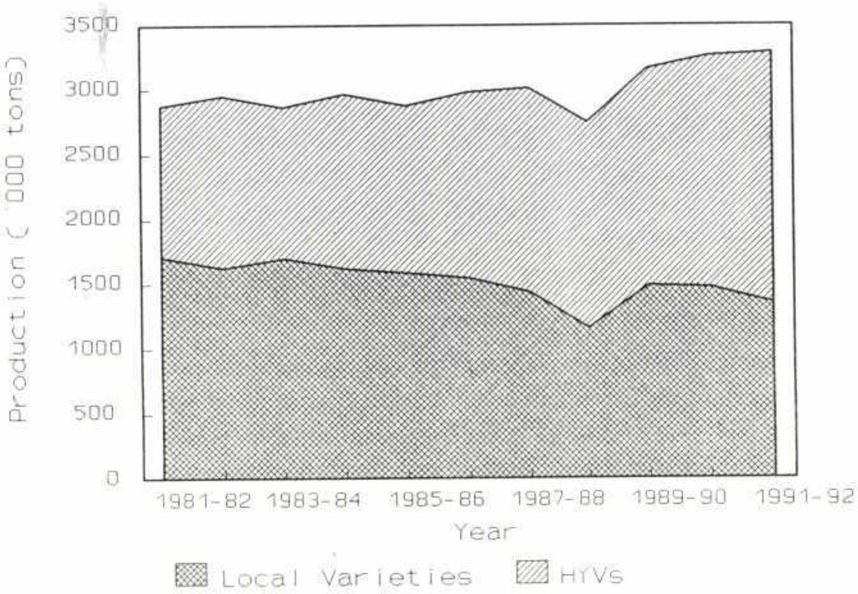
Crops	1981-82	1990-91
Rice	94.6	91.6
Aus	1.9	1.5
Aman	5.4	2.4
Boro	87.3	87.7
Wheat	1.2	3.5
Potato	2.2	1.4
Vegetables	1.2	2.0
Other	0.8	1.5
Total ('000 ha)	**458**	**574**

Source: BBS 1987 and 1992.

tons accounting for 59% of the total rice production in 1991-92.

The increases in HYV rice production have mainly occurred in the boro season during the past decade. The production has increased more than two-fold in this season. In the transplanted aman season, the HYV production has increased by 50%. In the aus season, the HYV rice production has declined by 35%.

Graph 5.6: Trends in Rice Production



The production of local varieties declined from two-thirds of the total rice production in the early 1980s to about two-fifths of the total rice production in 1991-92 (Graph 5.6). It has mainly declined in the aus, deepwater aman, and boro seasons. There is, however, a slight improvement in the production in the transplanted aman season. (Annex B).

Yield levels of HYVs fluctuate. Average yield levels have changed from 2.3 ton/ha in 1981-82 to 2.2 ton/ha in 1990-91, and back to 2.3 ton/ha in 1991-92. The yield level of HYVs has rapidly fallen in the aus season with a slight improvement since 1989-90. It has also fallen in the boro season, but has shown a slight improvement in the transplanted aman season. In general, the yields of HYVs are lower in the aus and aman seasons compared to that in the boro season. Rice yields for 1981-82 to 1991-92 are provided in Annex B.

Yield levels of local varieties showed only slight improvements over the period in the aus and aman seasons. In the boro season the yield levels fluctuate. Local varieties have lower yields and usually do not respond to nitrogen application as favourably as HYVs.

Recent increased yields of the local varieties in the aus season could be due to an expansion of the aus being transplanted. Usually, local varieties are broadcast in the aus season. But, farmers in many areas have begun to transplant selected local varieties. The yield of deepwater rice is, however, generally unstable and fluctuates in response to the changing pattern of flood water level which differs from year to year. The seeds of deepwater aman are also broadcast. But, as with aus farmers have begun to transplant instead. A slight improvement in the yield of deepwater rice appears to be related to this practice.

An increase in the yield of local varieties of transplanted aman suggests that there are improvements in agricultural practices. Fluctuation in yield levels of local boro may be associated with the use of aged seedlings, insufficient irrigation, inefficient distribution of irrigation water and low temperature stress.

Non-rice

There has been a significant fall in jute production. Since 1985-86, the jute cropped area has rapidly declined. This appears to be in response to low market demand, fluctuating prices, and unstable yields. Suspension of the government Statutory Minimum Price (SMP) in 1980-81 may be another factor.

Wheat has increased its share of the total food grain production. The production almost doubled between 1981-82 and 1991-92. The average yield is very low, and declined from more than 2 ton/ha in the early 1980s to 1.5 ton/ha in the late 1980s. The low yields suggest that the present level of fertilizer application is insufficient. Moreover, about 60% of wheat is cultivated without irrigation, mostly after the harvest of aman rice. Yields can be expected to decline without improvements in fertilizer application, and increase in irrigated areas. All present wheat varieties are high yielding; local varieties disappeared in the 1970s. The use of a wheat variety that can withstand drought conditions may be one of the reasons for the increase in production. Most of the wheat consumed in Bangladesh is imported.

There has been an abrupt fall in sugar cane production since 1988-89. Sugar cane requires heavy doses of fertilizer, 70% more than that required for HYV rice. Sugar cane, grown in the Region, is used to produce refined sugar as well as the local *gur* (brown sugar). Some is consumed in its natural state. There are three sugar mills in the Region. Bangladesh imports some sugar.

Tea production increased from 38,000 tons in 1980-81 to 44,000 in 1991-92. The yields have increased gradually since the early 1950s. Bangladesh is an exporter of tea.

Pulses provide a major part of people's daily protein requirement in Bangladesh. The increases in the production of these crops in the past decade are encouraging. The low yielding traditional varieties of pulses are competing with wheat and HYV rice varieties.

The production of oilseeds has also increased in the period. New mustard varieties, which produce good yields, are replacing traditional varieties. Production of groundnut has increased in the Region. The groundnut is superior to rape and mustard in its oil content, and unlike rape and mustard can be grown in both kharif and rabi seasons. Farmers usually plant groundnut in poor, sandy soil where nothing else grows. Bangladesh imports oil including rape, mustard, groundnut, soya bean, safflower, cotton and coconut oil to meet its domestic requirements.

Improvements are noticeable in the production of onion, turmeric, garlic, ginger and coriander in the past decade. Production of chilies have increased in the kharif season, and have declined in the rabi season. Production of other spice crops has declined.

There have been an important shift in the potato production pattern. Local varieties have decreased in production while HYVs have increased. Potato requires heavy fertilization and irrigation. Sweet potato is mainly grown on the levees in the lowlands. It is adapted to a low input, low cost production technology. The production of the crop has decreased by 50%, due mostly to a lack of institutional support. The availability of cold storage for the preservation of both seed potato and table potato could lead to an increase in potato production in many areas. Recent BBS data indicates that cold storage capacity is one-tenth of production in the Region.

Vegetables are increasing in production in the kharif and rabi seasons. The production of water gourd, radish, tomato and bean has increased significantly. Intensive production in well-planned gardens can increase vegetable production in the Region.

Tobacco is declining in production. Tobacco is produced to meet both the domestic requirements and international demand. Bangladesh Tobacco Company (BTC), a multi-national cigarette producer, provides input costs on credit and extension service to its registered growers in several districts outside of the Region. Tobacco growers in the Region depend on local companies which do not provide any support.

There is a gradual increase in the production of cotton. Bangladesh has gone into producing yarn with the introduction of medium staple American Upland Cotton in the mid 1970s, although rough and short staple types of cotton have been cultivated in Susang hills and the hill tract districts in the country. Bangladesh imports raw cotton and cotton yarn to meet its domestic requirements. Cotton also provides oil and livestock feed in the form of seed cake.

The production of jackfruit, banana, guava, lime, and lemons has increased. However, mango, pineapple, litchi and orange production has declined. Fruit farming has not been established as a large scale commercial enterprise. Only recently have farmers started to engage in commercial cultivation. Establishment of agro-based industries (jam, jellies, juice, tinned fruits) could significantly increase fruit production in the Region. Bangladesh is an importer of fruits including mango, pineapples, citrus and banana. Annual nonrice production and yields for 1981-82 to 1991-92 are provided in Annex C.

5.2 Livestock

5.2.1 Population

The Livestock Survey 1983-84 reports an increase in livestock population in the Region from that reported by the Agriculture Census which was carried out in 1977 (Annex E). The largest growth occurred in poultry with an annual increase of 6.4%. Buffaloes showed an annual increase of 5.5%. The sheep population has increased by 2.7% annually and the goat population by 0.7%. The cattle population increased from 3.67 million to 3.75 million with a growth rate of 0.3%. However, the number of bovine animals per hectare of cultivated land decreased to 2.67 in 1983-84 from 2.99 in 1977. Similarly, per capita bovines in farm households has declined. Per capita availability of goat/sheep and poultry has increased. The low growth rate of livestock population in the Region can be attributed to present production technology. Livestock are mainly kept by the farm households in small numbers under a mixed crop-livestock farming situation. The animals are fed on crop residues. This predominantly subsistence livestock farming system is the major constraint to increase the size of the livestock units.

5.2.3 Feeds and Fodder Supply

According to the 1989 UNDP Agriculture Sector Review, shortages of dry matter, digestible protein, and total digestible nutrient have increased in the country over the past decades. The Sector Review identified the following reasons for these shortages: conversion of traditional grazing lands into cereal crop land, replacement of traditional rice varieties by short stemmed and low digestible HYVs, and increased use of straw for domestic fuel and housing materials.

The Fourth Five Year Plan also lists "conversion of traditional grazing lands into cereal crop lands" as a prime reason for the "acute shortage of feeds and fodder". That the fodder base is diminished by grazing lands being converted into cultivation of rice and other crops is widely asserted but may not necessarily be true. Productivity of grazing lands is under some negative constraints. Native grasses are assumed to be less productive than are introduced forage grasses though this may not be well documented.

Whatever the case, the practice of communal grazing leads to levels of overstocking that drive the productivity of the grazing livestock toward maintenance levels of performance with marginal growth, reproduction, and lactation. Evidence of this can be seen in the very high proportion of dry cows and the low proportion of young stock.

In the absence of controlled grazing, animals are added to the pasture without regard to ensuing productivity levels. The Fourth Five Year Plan has cited "difficulty of organization and access" as impediments to improving production of forage on public lands.

Conversion of grazing lands to crops is widely held to have reduced potential fodder production though this may not necessarily be true in view of the by-products and residues from food crops. Having food crops as a fodder base has the advantage of controlled access as numbers of livestock can be more carefully adjusted to the fodder available as compared to uncontrolled access to public grazing lands. If livestock are kept stabled under cut and carry feeding, young stock may be less exposed to internal parasites encountered in grazing.

Rice offers multiple opportunities for diversion of all or parts of the rice plant to livestock production directly or as by-products and residues. It can provide about 1 million tons of rice bran and husks. Rice herbage can be of great value as animal feed. Wheat can be an important fodder. The feeding of wheat at all stages is better documented than that of rice. The pasturing of wheat can be considered. Sugar cane produced in the Region has the potential to supply 0.3 million tons of tops and leaves which can be used as fodder. The feeding and supplementation of whole chopped sugar cane and by-products is generally well known. Less well known may be the use of cane juice with appropriate supplements as a substitute for grain in feeding ducks. Pineapple leaves cut after harvest have reportedly yielded up to 80 tonnes of leaves per hectare and have similar feeding value as sugar cane when fed chopped to lactating dairy cows. Where pineapples are processed, the outer husk and waste are called "bran" and are fed fresh or dried.

Certain aquatic plants, especially water hyacinth, are abundant in the Region. Dry matter content is low but water hyacinth can be fed fresh, hay, silage, or haylage with appropriate supplements including cereal and oilseed by-products. Azolla, an aquatic fern, has proven to be an effective replacement to a concentrate mixture as a supplement to wheat straw. Duckweed has feeding value as a protein supplement for both ruminants and poultry. Care should be taken that aquatic plants in polluted water can absorb various pollutants including pesticides, weedicides, and heavy metals making the plants toxic to livestock.

Aerial parts of pulse plants have high protein value for ruminants of the order of 10-20% of Dry Matter, 10% or less in the haulm, and 15%-25% in the seeds. Pigeon peas, chick peas, lablab, and lentils also offer potential for both human food and high protein legume fodder. Tobacco seed yields a high protein (36%) oilcake free of the toxic alkaloid nicotine found in the leaf.

Para grass (*Brachiaria mutica*) and napier/elephant grass (*Pennisetum purpureum*) are considered potential forage grasses. However, neither are as productive as sugar cane and neither have alternative uses other than as fodder.

Ipil-ipil (*Leucaena leucocephala*), *glyricidia*, and *Sesbania* spp. are multi-use trees which yield high protein leaf fodder for ruminants, sometimes pods for human use, and wood for fuel or industry.

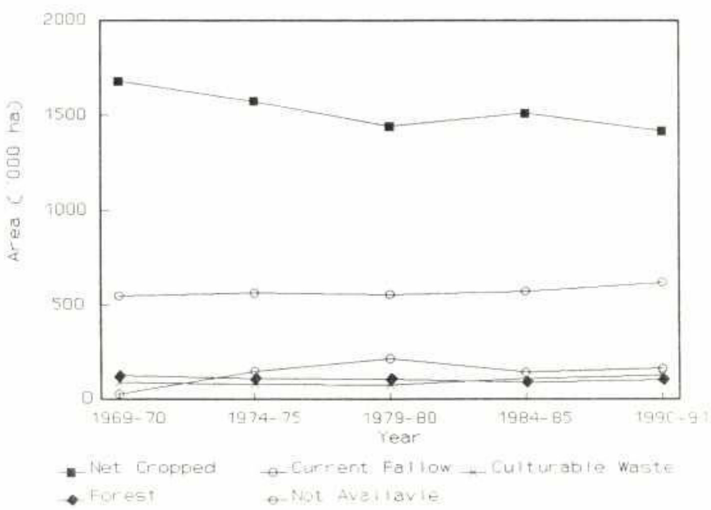
The slurry from biogas digesters makes a suitable source of non-protein nitrogen for ruminants. The digestion process renders dung odourless and unattractive to flies. Parasite eggs are largely destroyed in the process. Poultry litter has been widely used in ruminant rations as a protein and mineral supplement.

5.3 Land Use

5.3.1 Land Use Patterns

In 1969-70, the net cropped area was 1.7 million ha or 68% of the Region. About one percent of the Region was fallow. Forest land and culturable waste land occupied five percent and four percent, respectively. The area not available for cultivation was 22%. The net cropped area has tended to decrease with the increase in the current fallow land, culturable waste land, and the land not available for cultivation (Graph 5.7). The decrease in the net cropped area is about 16% over twenty years. The forest area has also decreased. Land utilization statistics are summarized in Annex F.

Graph 5.7: Changes in Land Use patterns



5.3.2 Land Distribution by Farm Size

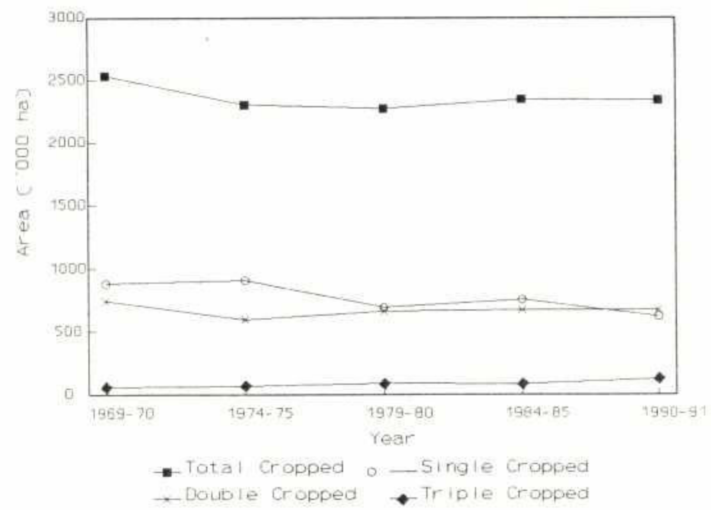
According to the Agriculture Census of 1977, the number of farm households in the Region was 1.1 million and the average farm size was 1.4 ha. The Agriculture Census carried out in 1983-84 reported that the number of farm households had increased to 1.7 million and the average farm size had decreased to 1.0 ha. The farm households owning small farms increased by 21% over the same period. On the other hand, the medium farm owners decreased by 17% and the large farm owners decreased by four percent.

The share of the net cultivated land taken by small farm households increased by 12% over the period from 1977 to 1983-84. On the other hand, the share of cultivated land of medium and large farm households decreased by six percent each. Assuming a continued break up of farm households it is estimated that the number of farm households in the Region is now about 2.6 million and the farm size is about 0.6 ha.

5.3.3 Intensity of Land Use

With the decrease in the net cropped area and increase in fallow land, the total cropped area has tended to decline. Over 20 years the total cropped area has decreased by about eight percent (Graph 5.8). There has been a decrease in single and double cropped areas. Slow drainage in the post-monsoon season prevents the cultivation of transplanted aman in many areas where the crop is grown either as a single crop or after the harvest of aus or HYV boro. The triple cropped area has tended to increase gradually. Increase in the pulse and oilseeds cropped area resulted in the slight rise in the triple cropped area.

Graph 5.8: Changes in Intensity of Land Use



5.3.4 Changes in Crop Patterns

There have been changes in the cropping patterns of the Region. Farmers have been innovative in selecting and adapting profitable practices within given sets of farming conditions that match their requirements and resources. Some farmers could produce two or even three crops annually, but they have limited resources and no reserves for emergencies caused by floods and other natural disasters. However, the farmers through years of experience have developed their own strategies to manage the risks. Some typical examples of these in the Region are as follows:

- Transplanting deepwater aman after the harvest of HYV boro on single cropped medium lowland.

- Cultivation of pulse/oilseed crops immediately after the harvest of transplanted aman, followed by HYV boro on double cropped medium highland and medium lowland. In transplanted aman-HYV boro patterns under irrigated areas, the land remains fallow for 80 to 90 days after the harvest of the aman. During this period pulse/oilseed can be grown. Early maturing transplanted aman varieties are selected to allow for timely sowing of pulse/oilseed crops. This third crop gives additional benefits in that the fertilizers applied to pulse/oilseed crops have a residual effect on the next crop, and these leguminous crops maintain productivity and fertility of soil.

- In single cropped HYV boro areas in the medium lowlands, which can be drained early, rape and mustard are grown initially, followed immediately by HYV boro.

- Cultivation of grass pea after the deepwater transplanted aman harvest, and before transplanting HYV boro, on double cropped medium lowlands. Grass pea is relayed at the maturity stage of deepwater transplanted aman.

- Cultivation of short duration sesame after harvest of early maturing potato on single cropped medium lowlands. The fertilizers applied to potato have a residual effect on sesame.

- Cultivation of HYV boro replacing aus rice in some areas where the previous crop pattern was aus-transplanted aman. Total rice production in these areas has increased with the new crop pattern.

- Plant wheat after the harvest of transplanted aman or broadcast aus rice on double cropped medium highlands and medium lowlands.

6. PHYSIOGRAPHY

6.1 PHYSIOGRAPHY

Six main landform units are found in the region. These units include: Uplands, Terraces, Alluvial Fans, Piedmont Floodplains, Lowland Floodplains, and Flood Basin (Figure 5). Table 6.1 summarizes the extent of each unit. Land unit boundaries have been synthesized from the classifications published by the Geological Survey of Bangladesh (1990) and Rashid (1991).

Table 6.1: Summary of Land Unit Areas

Landform Unit	Physiographic Unit	Area (km^2)	Percent of Region	Percent by Landform Unit
Uplands	Susang Hills	120	0.5	7.8
	Sylhet Hills	1750	7.3	
Terrace	Madhupur Tract	494	2.1	2.1
Alluvial Fan	Meghalaya Fans	1486	6.2	6.2
Piedmont Floodplain	Tripura Piedmont	960	4.0	4.0
	Susang Piedmont			
Lowland Floodplain	Surma/Kushiyara	4635	19.3	55.2
	Old Brahmaputra	7220	30.1	
	Meghna	727	3.0	
	Jamuna	678	2.8	
Flood Basin/Haor	Central Basin	5605	23.3	24.7
	Meghalaya Basin			
	Sylhet Lowland	335	1.4	

Most of the landform units are of fluvial origin, although some have been modified by tectonic processes (subsidence or uplift). The following discussion illustrates the main features of each landform unit as well as the terrain characteristics.

Flood Basins

Flood basins and *haors* are the dominant landform throughout the Central Basin, Meghalaya Basin and Sylhet Lowland. The Central and Meghalaya Basins together form a low lying, bowl-shaped depression in the middle of the Region known as the Sylhet Depression and occupy an area of 5,940 km^2 (about 25% of the region). Virtually all of the land lies below 8 m (PWD datum) and is deeply flooded (to depths of 5 m) during the monsoon season. This unit is characterized by large saucer-shaped seasonally flooded, interfluvial areas known as *haors* within which small, permanent lakes, called *beels*, exist.

The Meghalaya Basin is bordered by the Meghalaya Foothills on the north, by the Surma/Baulai River on the south, and by the Old Brahmaputra River floodplain deposits on the west. Most of the *haors* in this basin are typically poorly drained, flat, featureless areas that are adjacent to active or abandoned stream channels. Natural levees from these channels prevents rapid drainage from the *haors* after the monsoon season so that permanently flooded beels occupy the lowest point of the *haor*.

The Central Basin is bounded by the Surma River on the north, the Surma/Kushiyara floodplain on the east, and the Old Brahmaputra River on the west. Land elevations typically range between 3 to 7 m. The area is occupied primarily by backswamp and flood basins. Much of the land is traversed by distributary spill channels and other old partially infilled channels which at one time connected the Surma River system to the Kushiyara River.

The Sylhet Lowland is a discontinuous area of *haor* and flood basin land located east of the Central Basin. These features are generally surrounded by higher floodplain land with a gradual transition between floodplain and *haor* boundaries.

Lowland Floodplains

Lowland Floodplains have been created as a result of deposition and erosion from the Surma, Kushiyara, Meghna, Old Brahmaputra, and Jamuna Rivers. This landform unit covers an area of 13,260 km^2 (about 55% of the region). Land elevations typically range between 16 m to 9 m on the Surma/Kushiyara floodplain, 22 m to 9 m on the Old Brahmaputra floodplain and less than 7 m on the Meghna floodplain. Levees are wedge shaped ridges and are most highly developed on the convex (outer) side of meanders. They often are the highest points of land on the floodplain and project 3 to 5 m above the adjacent lower lying back basins. Natural levees are formed by deposition of sediment when flood waters of a stream overtops its banks.

Piedmont Floodplains

Piedmont floodplains are found along tributary streams that join the larger mainstream rivers. The landform unit covers an area of 960 km^2 (about four percent of the region). Land elevations range between 24 m and 9 m. Principal piedmont streams include the Khowai, Manu, Sutang, Dhalai and Juri Rivers which flow northwards from the Tripura Hills in India and join into the Kushiyara River. Piedmont floodplains have also developed at the extreme north west corner of the region along the Malijhee, Chillakhali, and Bhogai Rivers. Gradients of the streams are generally steeper than the mainstream.

Alluvial Fans

Alluvial fans are found along the foot of the Meghalaya Plateau and cover an area of 1,485 km^2 (about six percent of the region). The fans are produced when steep mountainous streams exit from their canyons and spread over the flat, unconfined land of the Lowland Floodplains and the Sylhet Depression. The decrease in channel gradient and reduction in velocity as the streams leave their canyons causes deposition of sand and gravel sediments in the form of a "fan-shaped", conical delta. The long-term aggradation on the fans appears to be more or less in balance with the lowering of the land due to subsidence. Principal streams which have developed alluvial fans include the Someswari, Jadukata, Jhalukhali Umium and Dauki/Piyain Rivers. Typically, elevations range from 16 m through 12 m in the west and from 11 m through 9 m in the east.

Terraces
The Terraces occur along the western edge of the Region and the confined portions of the Old Brahmaputra River. This landform unit covers an area of 500 km^2 (about two percent of the Region). It was raised by uplifting and faulting so that it is no longer subject to inundation by normal flooding. Elevations range from 10 m to 8 m.

Uplands
Uplands occur as outliers extending into the Region from the Tripura hills and cover an area of 1,870 km^2 (about eight percent of the Region). These hills are composed of weathered and poorly consolidated sandstone, siltstone and conglomerate.

6.2 Agro-Ecological Zones

According to the reconnaissance soil survey carried out by SRDI between 1963 and 1975 there are 34 physiographic units and subunits in the country. They have been recognized by the geological material in which particular kinds of soil have formed, and the landscape on which they occur. These physiographic units have been grouped into 30 agro-ecological regions in the FAO/UNDP Land Resources Appraisal of Bangladesh (1988). The Regions are divided into agro-ecological sub-regions. In this report, the agro-ecological region has been termed as an agro-ecological zone (AEZ). The subdivision of the AEZ has been termed as agro-ecological sub-zones. They are differentiated on details of relief and flooding characteristics. The Northeast Region has 10 AEZs (Figure 6). The extent of each AEZ is provided in the Table. 6.2 The characteristics of these AEZs and the agro-ecological subregions are described in the following chapter.

Table 6.2: Agro-Ecological Zones

Name of AEZ	No. of AEZ	Area (km_2)	Percent of Region
Active Brahmaputra-Jamuna Floodplain	7	364	1.5
Young Brahmaputra and Jamuna Floodplain	8	1484	6.2
Old Brahmaputra Floodplain	9	4970	20.7
Middle Meghna River Floodplain	16	543	2.3
Old Meghna Estuarine Floodplain	19	1467	6.1
Eastern Surma-Kushiyara Floodplain	20	4544	18.9
Sylhet Basin	21	4301	17.9
Northern and Eastern Piedmont Plains	22	3812	15.9
Madhupur Tract	28	192	0.8
Northern and Eastern Hill	29	2333	9.7

7. CHARACTERISTICS OF AGRO-ECOLOGICAL ZONES

An essential element for assessing the ecological potential of an area for agricultural production is information on the physical properties of the natural environment, namely of the landscape, drainage, climate, soils, and water availability. The influence of agro-ecology on agriculture in the Northeast Region is provided in the following descriptions of the AEZs. Each AEZ is described on the following topics: location, agro-ecological sub-zone, physiography, drainage, climate, soils, water resources, land use, existing projects, development constraints, development opportunities, ecological hazards, and agricultural research needs.

7.1 Active Brahmaputra-Jamuna Floodplain (AEZ 7)

Location
AEZ 7 occurs in the north-western part of the Northeast Region comprising part of Kurigram district (Figure 6). The AEZ's boundaries are liable to change with time due to bank erosion.

Agro-Ecological Sub-zone
No agro-ecological sub-zones have been recognized in AEZ 7.

Physiography
AEZ 7 is comprised of irregular relief of broad and narrow ridges and depressions, and interrupted by cut-off channels and active channels. Both the outline and relief of char formations are liable to change each flood season due to bank erosion by shifting channels and to depressions of irregular thickness of new alluvium. Local differences in elevation are mainly 2-5 m.

Drainage
Virtually the whole area is subject to seasonal flooding: shallow on higher parts, deep in the lower parts. Depression sites and thick new silty deposits remain wet through the dry season. The percentage of the land in different flood depth classes is shown below:

Table 7.1: Percentage of Land in Different Flooding-Depth

Highland	Medium Highland	Medium Lowland	Lowland	Very Lowland	Homesteads, Water
5	37	20	8	0	30

Climate
Mean annual rainfall is about 2,200 mm, and mean monthly rainfall exceeds 500 mm in June. The mean date when minimum temperatures start to fall below 20 C (in effect, the cut off date or the safe time limit for aman flowering) is 24 October. The mean length of the cool winter period ranges from 70-90 days with minimum temperatures below 15 C. The maximum summer temperatures exceed 40 C for 0.5-5 days, but are very unusual because of the moderating influence of the river water. The mean starting date of the pre-kharif transition period is 20 March and the end date is 1 May. The mean begin date of reference for the kharif growing period is 1 May, and the mean end date ranges from 10-15 December. The mean starting date

of reference for the rabi growing period is 20 October, and the mean end date ranges from 1-10 March.

Soils

AEZ 7 is a belt of unstable alluvial land along the Brahmaputra River where land is constantly being formed and eroded by shifting river channels. This AEZ has complex mixtures of sandy and silty alluvium, rich in weatherable minerals and slightly alkaline. The proportions of sandy and silty alluvium vary from place to place and year to year. Silty deposits are more extensive than sandy deposits. However, large areas of sand may be deposited in high flood years.

Organic matter content ranges from 1.0-2.0 percent in the cultivated layer. Cultivated top soils are neutral to strongly acidic, but lower layers and unripened silt deposits are neutral to moderately alkaline. Fertility status is low to medium. In general, N and P are limiting whereas K, S and Zn status is reasonable. Permeability is mainly moderate but rapid in deep sands and slow where raw silt layers occur. Soil moisture-holding capacity depends on soil depth over sand or raw silt layers. Moisture-holding capacity is high in the developed soil layers and low in the substratum.

Six General Soil Types occur in this AEZ, and Noncalcareous Alluvium occupies the greater part. Noncalcareous Grey Floodplain Soils also occupy a considerable area. The other soil types which occupy minor areas are Calcareous Brown Floodplain Soils, Calcareous Dark Grey Floodplain Soils, Noncalcareous Brown Floodplain Soils, and Noncalcareous Dark Grey Floodplain Soils. A correlation between these soil types and major international soil units is provided in Table 7.11. Physical and chemical properties of these soil types are given in Table 7.12.

Water Resources

There are ample surface water resources, but they are difficult to exploit for irrigation, except by some small scale traditional devices or hand pumps, because of shifting river channels and changing land qualities. Investment in STWs might be economic on some older, more stable, soil areas near the boundaries of the AEZ.

Land Use

Raw sand and silt deposits usually are bare or carry sparse grasses, herbs and woody plants. Silty alluvium is usually brought under cultivation within 2-3 years of deposition. Major crops grown are early aus, jute, deepwater aman, cheena, mustard, pulses, groundnut and sugar cane. Transplanted aman is some times grown on silty alluvium or silty soils as the flood water recedes, and boro is grown in depressions, usually using traditional irrigation devices or hand pumps.

Existing Project

There are no flood protection, drainage or irrigation projects in the area. Large scale irrigation, flood control and drainage projets are not considered feasible because of channel instability.

Agricultural Development Constraints

The major constraints to agricultural development are shifting river channels which constantly erode cultivated land, including settlements. There are frequent changes in land quality due to the deposition of silty alluvium. Early floods cause damage to boro and summer crops. Transplanted aman and deepwater aman are damaged by late flooding. These constraints provide poor prospects for intensive agricultural development.

Agricultural Development Opportunities
Agricultural development needs to focus on increased production of dryland rabi crops and early summer crops on silty soils. Early aus and jute varieties would secure crop production in the kharif season. Improved communication would help to increase sugar cane cultivation in some areas. Application of more fertilizers on silty soils and more manure/compost on sandy soils would increase rabi crop production. The following should be considered: (1) increase social and economic security by giving priority in the settlement of new char lands to local cultivators, and (2) construction of flood shelters in the interior to accommodate people and livestock during high floods.

Ecological Hazards
The active floodplain environment seems likely to become increasingly unstable with time due to increased erosion, and increased river flow where embankments prevent floodwaters from spilling over adjoining floodplain land. For these reasons, the proportion of sandy char deposits may be expected to increase with time.

Agricultural Research Needs
Agronomic trials with rabi and early kharif crops which could increase and stabilize production are required. Soil management trials are needed to test techniques for bringing new silty and sandy alluvium under cultivation more quickly. Appropriate tree species need to be identified to grow on the highest ridge sites.

7.2 Young Brahmaputra and Jamuna Floodplain (AEZ 8)

Location
AEZ 8 occurs on the western side of the Northeast Region, extending from Rajibpur *thana* of Kurigram district to Kapasia *thana* of Gazipur district through the western part of Jamalpur and Sherpur districts and south-west of Mymensingh, Netrokona and Kishoreganj districts, including the southern part of Bandar *thana* in Narayanganj district.

Agro-Ecological Sub-zone
AEZ 8 is divided into four agro-ecological sub-zones: Upper Brahmaputra-Jamuna Floodplain (AEZ 8a), Lower Brahmaputra Floodplain (AEZ 8b), High Jamuna Floodplain (AEZ 8c), and Low Jamuna Floodplain (AEZ 8d). The sub-zone AEZ 8c, however, does not occur in the Northeast Region. The sub-zones are differentiated on details of relief and flooding characteristics.

Physiography
AEZ 8 is occupied by a complex relief of broad and narrow ridges, inter-ridges, depressions, partially infilled cut-off channels, and basins. Relief is most irregular in AEZ 8a, and in parts of the AEZ 8b and AEZ 8d near to river channels. AEZ 8b occupies a generally smooth relief of broad ridges and shallow basins. AEZ 8d has the most extensive basins. The difference in elevation between the tops of ridges and adjoining basins varies from 2-5 m. It is least in AEZ 8b, and greatest in AEZ 8d.

Drainage
The highest floodplain ridge soils lie above the normal flood plain. The middle and lower parts of ridges are subject to shallow flooding. Basins are mainly shallowly flooded, but basin centres

and old channels are generally moderately deeply flooded. Basin centres are subject to early and rapid flooding by run-off from adjoining higher land when there is heavy pre-monsoon or early rainfall, and generally stay wet for part or all of the dry season. Depressions and basins in AEZ 8b and AEZ 8d are mainly moderately deeply flooded, with some basin centres deeply flooded. Drainage of the land begins earlier in AEZ 8a and AEZ 8b. The percentage of the land in the different flooding depth classes in each sub-zone is given in the following table.

Table 7.2: Percentage of Land in Different Flooding-Depth

Subregion	Highland	Medium Highland	Medium Lowland	Lowland	Very Lowland	Homesteads, Water
AEZ 8a	16	49	26	<1	0	9
AEZ 8b	27	41	14	2	0	16
AEZ 8d	13	34	22	19	0	12
Total	**17**	**40**	**21**	**10**	**0**	**13**

Climate

Mean annual rainfall increases from around 1,500 mm in the south-west to almost 2,500 mm in the north-east. The mean date when minimum temperatures start to fall below 20 C ranges from 2 November (or possibly earlier) in the north-west to 12 November in the south-east. The mean length of the cool winter period increases from 50-70 days with minimum temperatures below 15 C in the east and south-east to 70-90 days in the greater part of the AEZ. Western areas have an average of 0.5-5 days with maximum summer temperatures exceeding 40 C, whereas eastern areas only rarely experience such temperatures. The mean starting date of the pre-kharif transition period ranges between 15 March in the east and 25 March in the extreme west. The mean length of the period increases from 30-40 days in the east to more than 50 days in the west. The mean starting date of reference for the kharif growing period is about 25 April in the north-east and 15 May in the west. The mean end date is about 5 December in the west and 25 December in the east. The mean starting date of reference for the rabi growing period is 15 October in the west and 25 October in the east. The mean end date of reference for the rabi growing period is 25 February in the west and 10-15 March in the extreme north-east.

Soils

The Region is comprised of Brahmaputra sediments. The soils range from shallow, permeable, sandy loams and silty loams on ridge crests to impervious heavy clays in some basin centres. Silt loams and silty clay loams occupy the greater part of the area.

AEZ 8a has complex soil patterns, with an overall pattern of sandy loams and silt loams occupying 10-60% of the relief on ridges and silty clay loams occupying 5-60% in depressions. Old river channels often are infilled with sand in this part, irregular patches of recent sandy and silty alluvium occur near to active channels, and clay soils are rare. In AEZ 8b, ridge soils are mainly deep silt loams which occupy 10-50% of the relief in different areas. However, there are erratic occurrences of shallow fine sandy loams and silt loams overlying sand, especially in the west. Lower ridge sites are mainly occupied by silty clay loams, occupying 20-65% of the relief. Clays occupy up to 20% in deep basin centres; in many basins they are dark grey. AEZ 8d has an overall pattern of silt loams on the upper parts of ridges, silty clay loams on the lower ridges, and silty clays in basins. The proportions between these different soil textures vary greatly from locality to locality: silt loams 10-40%; silty clay loams 10-60%; and clays 5-45%. Heavy dark grey clays occupy some deep basin centres in the south.

Organic matter content ranges from one percent in the cultivated layers of the basin centres to two percent in most depressions and basins. It is 2.0-5.0% in basin centres which stay wet for most or all of the dry season. Soils are deficient in N, P and S, but the status of K and Zn is reasonable. The cultivated layer varies from neutral to very strongly acidic in reaction, generally being less acidic in permeable ridge soils than in lower soils on which transplanted aman is grown or which are seasonally deeply flooded. Lower soil layers are typically neutral to slightly alkaline in reaction. The highest ridge soils are permeable. Lower soils are moderately permeable, but basin clays and those higher soils whose top soil are puddled for transplanted rice cultivation are slowly permeable. Moisture-holding capacity is high, except in heavy basin clays and in ridge shallow soils.

Eleven General Soil Types occur in the AEZ. Noncalcareous Grey Floodplain Soils is the predominant type throughout the AEZ. They are developed in Brahmaputra alluvium which is rich in weatherable minerals, especially biotite. Noncalcareous Alluvium occurs mainly in AEZ 8a and AEZ 8d, and Acid Basin Clays mainly in AEZ 8d. The other soil types which occupy minor areas are Calcareous Alluvium, Calcareous Brown Floodplain Soils, Calcareous Dark Grey Floodplain Soils, Noncalcareous Brown Floodplain Soils, Noncalcareous Dark Grey Floodplain Soils, Shallow Red-Brown Terrace Soils, Deep Red-Brown Terrace Soils, and Made-land. Table 7.11 provides a correlation between these soil types and major international soil units. Physical and chemical properties of these soil types are given in Table 7.12.

Water Resources
Usable surface water supplies are fully exploited by LLPs. Ground water supplies are not adequate for tube well irrigation (HTW, STW or DTW).

Land Use
Aus or jute, followed by local transplanted aman or by dryland rabi crops is grown on ridges. Mixed aus and aman or jute, followed by dryland rabi crops are grown on lower ridges and basin boundaries. Deepwater aman followed by pulses or fallow is grown in early draining basins, and local boro in late draining basins. On shallowly flooded ridge soils, mainly HYV boro which is usually followed by HYV aman, is grown with irrigation. On medium lowland, pulses and oilseeds are grown on residual moisture in some areas after deepwater aman is harvested and before HYV boro is transplanted. Long seedlings of aus or deepwater aman are transplanted after the boro harvest in some areas. On lowland, the risk of early flooding is generally too great for farmers to grow any kharif crop after harvesting boro rice.

Existing Projects
A total of nine surface water resource projects have been constructed or are nearing completion in AEZ 8. The projects are intended to provide flood control and drainage to a net area of 16,740 ha, and drainage improvement to a net area of 5,660 ha.

Agricultural Development Constraints
High Brahmaputra floods occasionally occur in August or September (about once in 5-10 years), and may destroy aman transplanted after a July or early August flood peak. Such late floods may also keep basins flooded longer into the dry season than usual. Deposition of new alluvial

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deposits on cultivated soils adjoining Old Brahmaputra channels in high flood years destroys standing crops in AEZ 8a. There are erratic occurrences of shallow fine sandy loams and silt loams overlying sand in AEZ 8b. Shifting channels of the Lower Meghna cause new alluvium to be deposited on older soils, and the silting up of drainage channels in sub-zone AEZ 8d.

Agricultural Development Opportunities
To ensure high crop yields the following is required: (1) expansion of command areas of existing irrigation facilities with improved distribution systems and efficient water management; (2) providing additional DTWs, STWs, HTWs and LLPs in areas where surface water or groundwater supplies are known to be adequate; (3) identification of local schemes for early drainage of flood water from basins after the rainy season; and (4) improved soil and crop management. The date of transplanting HYV boro can be shifted towards the kharif season to reduce dependency on irrigation. The efficient use of fertilizers is essential to protect depression soils and groundwater from nitrogen accumulation due to leaching of nitrogen through permeable ridge soils and lateral losses.

Ecological Hazards
Deposition of a thick new layer of raw silt or sand reduces cropping potential, either temporarily or for a longer period. Breaching of flood embankments causes damage to crops, erodes soils near the site of the breach, and buries adjoining land with sand. Drainage impedance has occurred in some areas due to the construction of roads across natural drainage lines without providing adequate bridges and culverts. Change in top soil structure and consistency has occurred where irrigated boro rice is substituted for deepwater aman which was grown in the kharif season after rabi crops in the dry season. Puddling and compaction of the soil twice a year for growing transplanted aus and transplanted aman, and elimination of the strong-rooting jute crops from the rotation, reduce the suitability of the soils for dryland rabi crops. Increased use of organic residues for fuel are expected to reduce top soil organic matter content.

Agriculture Research Needs
New varieties of crops and improved cultural practices need to be tested on different soils and land types under rainfed and irrigated conditions. Possible ways of improving farmers' existing practices need to be identified through crop diversification/intensification trials including (1) the identification of suitable methods for growing dryland rabi crops after transplanted aman, and (2) identification of suitable intercropping patterns with perennial crops, dryland kharif, and rabi crops. Fertilizer trials on different soils and cropping patterns would help farmers to select optimum doses, the most efficient method of application, and optimum times of application in crop rotation. Soil management trials are needed to find ways of breaking up the ploughpan in soils used for transplanted rice, and to improve the moisture-holding capacity of light textured or shallow ridge soils. Studies are essential to monitor and assess changes in the fertility and physical properties of different soils and land types. Improved methods of seed/grain drying and storage need to be developed.

7.3 Old Brahmaputra Floodplain (AEZ 9)

Location
AEZ 9 occurs in the western part of the Northeast Region. It occupies the north-eastern part of Jamalpur district, central part of Sherpur district, western part of Mymensingh district, western and southern part of Netrokona district, northern and central parts of Kishoreganj district, eastern

part of Gazipur district, most of Narsingdi district, and the northern part of Narayanganj district.

Agro-Ecological Sub-zone

AEZ 9 is divided into five agro-ecological sub-zones: High (AEZ 9a), Medium High (AEZ 9b), Bansi valley (AEZ 9c), Medium Low (AEZ 9d), and Low (AEZ 9e). AEZ 9c, however, does not occur in the Northeast Region. The boundaries between the sub-zones are transitional. There is a gradual transition from the north-west of AEZ 9a and AEZ 9b to the east and south of AEZ 9e in proportion to different flood depths.

Physiography

AEZ 9 is comprised of mainly broad ridges and basins. AEZ 9a has some inter-ridge depressions. Relief is locally irregular, especially near old and present river channels. The basins are relatively more extensive in AEZ 9d and AEZ 9e. Usually, the differences in elevation between ridge tops and basin centres is 2-5 m. It exceeds five metres in AEZ 9d and AEZ 9e, especially in areas adjoining Sylhet Basin (AEZ 21).

Drainage

Ridge soils are generally wet or shallowly flooded at the peak of the annual floods. Basin centres are subject to early and rapid flooding by run-off from adjoining higher land when heavy pre-monsoon or early monsoon rainfall occurs locally or in adjacent AEZs. At other times, flood-levels are controlled by water levels in the Old Brahmaputra River and the Sylhet Basin (AEZ 21). Flooding is almost entirely by rainwater or is backed-up by high external flood-levels. Rainwater is retained on fields by bunds on slowly permeable soils on highlands and medium highlands. Basin centres generally stay wet for most or all of the dry season. The highest ridges in AEZ 9a are moderately well drained. Broad ridges and inter-ridge depressions in this sub-zone lie above normal flood-level. Depressions are mainly shallowly flooded. In AEZ 9b, the highest ridge soils stand above normal flood-levels. However, they become wet during periods of heavy monsoon rainfall. Lower ridge and basin margin soils are shallowly flooded seasonally. Small areas in basin centres are moderately deeply flooded, and stay wet for most or all of the dry season. Depressions and *haors* are moderately deeply flooded in AEZ 9d, and deeply flooded in AEZ 9e. The percentage of the land in different flood depth classes in each sub-zone is given in Table 7.3.

Table 7.3: Percentage of Land for Different Flood Depths

Subregion	Highland	Medium Highland	Medium Lowland	Lowland	Very Lowland	Homesteads, Water
AEZ 9a	70	17	3	0	0	10
AEZ 9b	28	43	16	3	0	10
AEZ 9d	23	28	31	9	<1	9
AEZ 9e	7	19	31	33	0	10
Total	**28**	**35**	**20**	**7**	**<1**	**10**

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Climate
Mean annual rainfall increases from less than 2,000 mm in the west to almost 4,000 mm in the north-east on the border with AEZ 21. The mean date when minimum temperatures start to fall below 20 C, ranges from 2 November in the north-west to 12 November in the south-east. The mean length of the cool winter period increases from 50-70 days with minimum temperatures below 15 C in the east to almost 100 days with such temperatures in the north-west. Western areas have an average of 0.5-5 days with maximum summer temperatures above 40 C. Such temperatures occasionally occur in central and western parts. The mean starting date of the pre-kharif transition period is 15 March in the east and 25 March in the west. The mean length of the period increases from about 25 days in the north-east to almost 50 days in the west. The mean begin date of reference for the kharif growing period is around 20 April in the north-east and 5 May in the west. The mean end date is about 10 December in the west and 25 December in the east. Thus, the mean length of the reference rainfed kharif growing period increases from about 215 days in the west to 260-270 days in the north-east.

Soils
The AEZ has a large area of Brahmaputra sediments. Ridge soils are mainly silt loams and silty clay loams. Clays predominate in *haors*. Silt loams and silty clay loams predominate in AEZ 9a and AEZ 9b, especially in the highest ridge sites. Clays predominate in AEZ 9d and AEZ 9e.

Organic matter content in the cultivated layer ranges from 1.0-1.5% in ridge soils to 2.0-5.0 percent in basin soils. In the latter soils, organic matter is also more deeply distributed down the profile. Fertility level is low. The status of P and CEC is medium and K status is low on highlands and medium in lowlands. Top soil is moderately acidic but subsoils are neutral in reaction. The cultivated layer is usually medium to very strongly acidic, higher in permeable ridge soils and lower in basin soils and in soils puddled for transplanted rice cultivation. Lower layers are between slightly acidic and slightly alkaline, but some heavy basin clays have medium or strongly acidic subsoils. The highest ridge soils are rapidly permeable, especially in sub-zone AEZ 9a. Lower ridge soils used for transplanted aman cultivation are slowly permeable, so are basin clays. Moisture holding capacity is high in the deep silt loams on the ridge, but is moderate or low in more sandy or shallow ridge soils, in soils puddled for transplanted aman cultivation and especially in basin clays.

Eleven General Soil Types occur in AEZ 9. The predominant soil type in AEZ 9a is Noncalcareous Brown Floodplain Soil. In other sub-zones the predominant soil type is Noncalcareous Dark Grey Floodplain Soil. Varying proportions of Noncalcareous Grey Floodplain Soils occur in all sub-zones. The other soil types which occupy minor areas are Noncalcareous Alluvium, Acid Basin Clays, Grey Piedmont Soils, Shallow Red-Brown Terrace Soils, Deep Red-Brown Terrace Soils, Brown Mottled Terrace Soils, Deep Grey Terrace Soils, and Grey Valley Soils. Table 7.11 shows the correlation between these soil types and major international soil units. Physical and chemical properties of these soil types are given in Table 7.12.

Water Resources
A limited amount of surface water is available for irrigation, mainly in the Old Brahmaputra River. Ground water supplies are not adequate for tube well irrigation for the entire AEZ area.

Land Use
Aus or jute followed by early rabi crops or groundnut, and sugar cane are the main crops on high ridges, especially in AEZ 9a. On highland and medium highland aus or jute is grown, followed by transplanted aman. After the harvest of transplanted aman pulse or wheat are grown in some areas. HYVs have replaced local aus in some areas, and HYV transplanted aman is widely grown. On medium lowland mixed aus and deepwater aman or jute are the main crops. In the lowland basins, deepwater aman partly followed by pulse, oilseed, or wheat are grown in higher margins; HYV boro with irrigation is grown in basin centres; and low-lying parts subject to early flooding are used for local boro.

Existing Projects
There are 11 surface water resource projects in AEZ 9. The projects have been constructed or are nearing completion. The projects are intended to provide flood control, drainage and irrigation to a net area of 45,200 ha; flood control and drainage to a net area of 35,060 ha; and drainage improvement to a net area of 1,600 ha.

Agricultural Development Constraints
Monsoon flash floods from Kangsha River and its tributaries are a major problem, especially in the north and north-west of AEZ 9b. The floods damage standing transplanted aman and carry sand which is deposited on the land, burying crops and reducing soil fertility. The depth of floods is uncertain and varies from year to year. The floods occur more than once in a year, between June to September and damage the re-transplanted aman. In some years, floods occur so late that farmers can not re-transplant aman and keep their land fallow. Late floods also keep basins flooded longer into the dry season. The heavy clay soils in the basin are, however, difficult to cultivate and many stay wet for all of the dry season. Damage of mature aus by early flooding has also been reported in some areas. Pre-monsoon flash floods damage boro crops in low-lying parts, especially in AEZ 9d and AEZ 9e. Increased rainfall and drainage congestion due to filling of canals with sediment cause boro and aman to be severely damaged in some areas. Puddled top soil and strong ploughpan in soils used for transplanted aman cultivation prevent or restrict the cultivation of wheat, pulses and oilseeds in some parts.

Agricultural Development Opportunities
Flood protection and drainage would enable HYV aman and dryland rabi crops to be grown more extensively than at present. However, consideration of water control projects should take into account the possibility that embankments would block drainage or increase overland flooding in adjoining unembanked areas. The use of STW, DTW and LLP irrigation has increased HYV boro rice production in many parts of AEZ 9a and AEZ 9b. Small-scale irrigation and improved distribution of irrigation water can further intensify crop production in these sub-zones. Considering the increased demand for non-rice foods in the Dhaka urban area, there is a high potential for diversification of agriculture and production of high value crops in this AEZ, especially in the southern part. The potential is, however, less in the low-lying parts of AEZ 9d and AEZ 9e. Increased production in these sub-zones will depend on groundwater resources being confirmed and developed for growing dryland rabi crops (e.g., wheat) on ridges and HYV boro in basins. Efforts are needed to improve soil and crop management by increased use of fertilizers and organic manure, and more efficient ways of using them. Deeper ploughing needs to be practised to increase the moisture-holding capacity of the top soil.

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Ecological Hazards

Accumulation of nitrogen due to heavy fertilizer use might have adverse consequences for crops growing in depression sites. Intensification of cultivation practices may be expected to reduce top soil organic matter contents and water infiltration rates in soils used for dryland crops. Cultivation of irrigated HYV boro instead of pulse and oilseed crops after aman has compacted the top soil layer and may gradually reduce natural fertility.

Agriculture Research Needs

New varieties of crops and improved cultural practices need to be tested on different soils and land types under rainfed and irrigated conditions. New aus and deepwater rice varieties should be developed for use on impermeable soils on land where the risk of damage by early floods is low. Crop diversification/intensification trials are needed to improve farmers' existing intensive practices, and to identify suitable methods for growing dryland rabi crops after transplanted aman. Suitable intercropping patterns with perennial crops, dryland kharif, and rabi crops are needed. Soil fertility and ground water quality need to be monitored in areas of heavy fertilizer use.

7.4 Middle Meghna River Floodplain (AEZ 16)

Location

AEZ 16 occurs along Meghna River bank occupying the south-eastern part of Kishoreganj district, eastern part of Narsingdi district, and north-eastern part of Narayanganj district.

Agro-Ecological Sub-zone

No agro-ecological sub-zones have been recognized in AEZ 16.

Physiography

The AEZ is comprised of various kinds of relief: low-lying basins with surrounding low ridges along Meghna River banks; areas with low ridges, inter ridge depressions and old channels; and highest sandy ridges. River banks are mainly stable, but bank erosion occurs on a small scale locally.

Drainage

Most soils are seasonally deeply flooded, except on high floodplain ridges. *Haors* and inter-ridge depressions flood early and drain late. River-levels usually start to rise in March, following early rains in the upper catchment area of the Meghna. The rivers are tidal in the dry season, but not saline. The percentage of the land in different flooding depth classes is given in Table 7.4.

Table 7.4: Percentage of Land in Different Flooding-Depth

Highland	Medium Highland	Medium Lowland	Lowland	Very Lowland	Homesteads, Water
<1	8	29	25	11	27

Climate
Mean annual rainfall ranges from 2,200 mm in the north to 2,300 mm in the south. It is lower in the centre. The AEZ has an average 50-70 days with minimum temperatures below 15 C and less than 0.5 days with maximum summer temperatures above 40 C. The mean starting date of the pre-kharif transition period is 20 March and the end date 25 April- 5 May. The mean begin date of the reference kharif growing period is around 20 April in the north and 5 May in the south. The mean end date is about 10-20 December. Thus, the mean length of the reference rainfed kharif growing period increases from about 220-225 days in the south and centre to almost 240 days in the north. The reference rabi growing period is earlier in the south than in the north. It extends from 15-20 October in the south and 25 October to 5-10 March in the north.

Soils
The AEZ occupies an abandoned channel of the Brahmaputra River. Three main kinds of soils occur: (1) Grey loams and clays on ridge and basin sites in areas of Meghna alluvium; (2) Grey loamy ridge soils and dark grey basin soils in included areas of Old Brahmaputra alluvium; and (3) Grey sands to loamy sands with a compact silty top soil in areas of Old Brahmaputra char land.

Organic matter content in the cultivated layer ranges from a 0.5-1.5% in ridge soils and 1.5-3.0% in basin clays. Organic matter content is low in grey loams and clays and in grey sands to loamy sands with a compact silty top soil. In the perennially wet grey loamy ridge soils and dark grey basin soils the organic matter content is 2.0-5.0% or more. General soil fertility levels are medium with low N. Most soils have a strong or very strong to medium acidic cultivated layer with slightly acidic to near-neutral lower layers. Cultivated top soils are medium to strongly acidic. Subsoils are slightly acidic to slightly alkaline. Permeability is rapid in loamy and sandy soils, and is moderate to slow in basin clays. It is lower where the top soil has been compacted by cultivation. Moisture-holding capacity is moderate to high, except in those ridge soils which contain sand at a shallow depth in association with old sandy char areas.

The dominant General Soil Type is Noncalcareous Grey Floodplain. The other three soil types which occur in the AEZ are Noncalcareous Alluvium, Noncalcareous Dark Grey Floodplain Soils, and Acid Basin Clays. A correlation between these soil types and major international soil units is given in Table 7.11. Table 7.12 provides the physical and chemical properties of these soil types.

Water Resources
Surface water is available in the Meghna channels to irrigate the eastern part of the AEZ. It is difficult to irrigate the western part using surface water from Meghna channels due to topographical constraints. Groundwater is available in this part for use by tube wells if needed to supplement surface water supplies. The groundwater resources, however, is not adequate.

Land Use
Irrigated HYV boro is grown on the higher margins of basins Local boro varieties are grown in depressions which are subject to flooding. Some higher lands are used for triple cropping (Aus/jute-transplanted aman-rabi). Deepwater aman or mixed aus and deepwater aman followed by dryland rabi crops (except on sands) are grown in low ridge and basin sites.

Existing Project
There are no flood protection, drainage or irrigation projects in AEZ 16.

Agricultural Development Constraints
The main constraints are early rise of flood water, deep flooding, and slow drainage of basins and depressions after the rainy season. Early flooding causes damage to mature HYV boro. Deepwater rice is damaged by deep flooding in low ridges and basin sites. Slow drainage causes basin centres and low inter-ridge depressions to stay wet for part of the dry season. Sandy soils, irregular relief and river-bank erosion restricts crop production in some areas.

Agricultural Development Opportunities
Local schemes for providing protection against early flooding of boro rice areas need to be identified. Cultivation of rabi crops can be intensified on loamy ridge soils. Expansion of existing irrigation facilities and additional LLP, STW and HTWs can increase crop production in areas of irregular relief and sandy soils. Increased and efficient use of fertilizers and organic manure are essential to improve soil fertility. Dryland rabi crops can be planted on time by making field drains on basin margins.

Ecological Hazards
Construction of flood embankments alongside the Meghna River could increase the risk of bank erosion where the river flow is confined. It can also cause ponding of water in depressions. There could be a risk of nitrogen being washed from higher fields into basin sites and into the groundwater with increased use of chemical fertilizers.

Agriculture Research Needs
Early-maturing boro HYVs need to be developed for irrigated areas which are subject to early flooding. Transplanting of deepwater rice after the harvest of boro needs to be tested. Fertilizer trials can help to identify optimum doses, the most efficient method of application, and use of organic manures, especially on sandy soils. Water management trials need to be considered on irrigated land. Soil fertility and groundwater need monitoring.

7.5 Old Meghna Estuarine Floodplain (AEZ 19)

Location
AEZ 19 occurs in the southern part of the Northeast Region. It occupies the eastern part of Kishoreganj district, western part of Habiganj district and southern part of Araihazar *thana* in Narayanganj district.

Agro-Ecological Sub-zone
AEZ 19 is divided into ten agro-ecological sub-zones mainly on differences in flooding characteristics. The sub-zones which occur in the Northeast Region are: Medium Low (AEZ 19b), Low: Habiganj (AEZ 19c), Low: Narayanganj (AEZ 19f), and Low: Eastern Kishoreganj (AEZ 19h).

Physiography
AEZ 19 has boundaries with several other AEZs. It is comprised of smooth, almost level, floodplain ridges and shallow basins.

Drainage
Areas close to the eastern hills are subject to flash floods. Basin centres are subject to early rapid flooding. Seasonal flooding ranges from shallow to deep. In AEZ 19b, seasonal flooding is shallow in the higher parts. The proportion of moderately deeply flooded land is greater in AEZ 19b than in the surrounding areas. The areas near the eastern hills in Habiganj district are subject to flash floods. In AEZ 19c seasonal flooding is moderately deep and basin centres are subject to early rapid flooding. Deep silts in Habiganj district are predominantly moderately deeply and deeply flooded. Depression sites are subject to a rapid rise of flood levels, especially in the east, and depression centres stay wet for part or all of the dry season. In both AEZ 19f and AEZ 19h, seasonal flooding is moderately deep. AEZ 19h is subject to a rapid rise in flood-levels. The percentage of the land in different flooding depth classes in each sub-zone is given in Table 7.5.

Climate
Mean annual rainfall is about 2,000 mm over most of the AEZ. It exceeds 2,500 mm in the north-east and 3,000 mm in the extreme south-east. The mean date when minimum temperatures start to fall below 20 C ranges between 7 November and 15 November. The mean length of the cool winter period ranges from 50-70 days with minimum temperatures below 15 C. Maximum summer temperatures above 40 C are rare. The mean starting date of the pre-kharif transition period ranges from 15-20 March. The mean length of the period increases from about 25 days in the north-east to about 50 days in the south-west. The mean length of the reference rainfed kharif growing period ranges from 220-240 days, increasing gradually from the west to the east. It exceeds 260 days in the extreme north-east. The reference rabi growing period is longer in the north (140 days) than in the south (120 days). The period starts and ends earlier in the centre-west (20 October to 20 February) than in the south-east (1 November to 5 March) and in the north-east (25 October to 15 March).

Table 7.5: Percentage of Land in Different Flooding-Depth

Subregion	Highland	Medium Highland	Medium Lowland	Lowland	Very Lowland	Homesteads, Water
AEZ 19b	<1	42	37	4	<1	17
AEZ 19c	1	7	42	31	10	9
AEZ 19f	8	24	29	22	0	17
AEZ 19h	0	0	1	89	1	9
Total	**2**	**25**	**33**	**23**	**3**	**14**

Soils
Soils are relatively uniform. Silty soils predominate. There are significant proportions of silty clay or clay basin soils in sub-zone AEZ 19f. This AEZ has a significant proportion of basin clays. Most soils have dark grey to black top soil. In depression soils, the upper part or all of the subsoil is dark coloured. In higher soils, the subsoil is grey-brown to yellow-brown with dark grey coatings on the faces of subsoil cracks.

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Organic matter content in the cultivated layer ranges from 1.0-2.5% in most ridge soils and from 2.0-5.0% or more in depression soils. The fertility level is medium. Status of K is low in uplands and low to moderate in lowlands. Top soils are moderately acidic. Subsoil reaction is neutral to slightly alkaline, but depression soils tend to be slightly to strongly acidic in upper subsoils, gradually becoming neutral or alkaline in deeper layers. Permeability is mainly moderate in the higher soils and slow in depression soils. Higher soils used for transplanted aman have puddled top soils and strong ploughpans which make permeability slow. Moisture-holding capacity is medium. The predominant deep silty soils have a high capillary potential which keeps most soils wet (and poorly aerated) in the early part of the dry season and moist for most or all of the dry season. Depression soils generally stay wet early in the dry season and many areas stay wet through the dry season, especially in AEZ 19f.

Seven General Soil Types occur in AEZ 19. The Noncalcareous Dark Grey Floodplain Soil is the predominant type in all the sub-zones. Varying proportions of Acid Basin Clays occur in AEZ 19c and AEZ 19h; Calcareous Brown Floodplain Soil in AEZ 19f; Noncalcareous Alluvium in AEZ 19b, AEZ 19e and AEZ 19f; Grey piedmont Soils in AEZ 19b; and Calcareous Dark Grey Floodplain Soil in AEZ 19f. The other soil type which occurs throughout the AEZ is Noncalcareous Grey Floodplain. Table 7.11 shows a correlation between these soil types and major international soil units. Table 7.12 provides the physical and chemical properties of these soil types.

Water Resources
Surface water which could be used for irrigation is available or could be provided by large scale diversion from the Meghna and Lakhya Rivers. Higher parts are difficult to irrigate as the rivers are silted up. Groundwater resources require detailed examination in AEZ 19b, AEZ 19c and AEZ 19h. In AEZ 19f, groundwater apparently is readily available for use by tube wells.

Land Use
On highland and medium highland, aus-transplanted aman is the major cropping pattern. Transplanted aman is partly followed by rabi crops. HYVs are grown widely in both aus and aman seasons. With irrigation HYV boro-HYV transplanted aman is the dominant crop pattern. Mustard is grown on residual moisture between transplanted aman and HYV boro in some areas. On medium lowland, the general practice is mixed aus and deepwater aman or jute followed by rabi crops. Deepwater aman followed by rabi crops is grown on lowlands where drainage is early. When slow drainage delays sowing of rabi crops on medium lowland and lowland, HYV boro is grown partly preceded by mustard and followed by transplanted deepwater aman. In the low-lying parts of AEZ 19c and AEZ 19h, local boro is grown on residual water supplemented by irrigation water. HYV boro and deepwater aman (or mixed aus and deepwater aman) are grown on relatively higher land in low-lying parts.

Existing Projects
Six surface water resource projects have been constructed in AEZ 19. The projects are intended to provide flood control, drainage and irrigation to a net area of 3,500 ha; flood control to a net area of 1,300 ha; partial flood control to a net area of 17,685 ha; and drainage and irrigation to a net area of 4,400 ha.

Agricultural Development Constraints
Moderately deep or deep seasonal flooding over most of this AEZ together with risk of early floods and flash floods restrict crop production. Early floods and flash floods damage deepwater

aman, aus and HYV boro. Deep flooding damages transplanted aman and prevents HYVs being grown in the aman season. Deep flooding in basin centres, with rapid rise of flood water, prevents cultivation of deepwater aman. Frequent breaching of embankments along rivers draining from the eastern hills aggravates these problems in AEZ 19b, AEZ 19c and AEZ 19h. Slow drainage tends to delay the sowing of rabi crops and prevents these crops being grown at depression sites in years when late floods keep soils wet until late December or January. Silting up of river channels and khals has contributed to the slow drainage of much land after the rainy season. Heavy basin clays are difficult to cultivate in AEZ 19f and AEZ 19h.

Agricultural Development Opportunities
The greatest need is to extend flood protection, drainage and irrigation to low-lying areas. Many areas are already developed, especially under irrigated conditions. Improved soil and crop management by making field drains, deeper ploughing, efficient use of fertilizers, increased use of manures and transplanting of aus and deepwater aman would increase crop production. Expansion of command areas of existing irrigation facilities with improved distribution and adequate drainage systems; providing of additional DTWs, STWs, HTWs and LLPs in present rainfed areas; identification of local schemes to protect boro and kharif crops against early floods and flash floods would ensure a high crop yield. Small river channels and khals need to be de-silted periodically.

Ecological Hazards
There is a possibility that provision of flood protection embankments along rivers entering this AEZ from the eastern hills would aggravate flood hazards in down-stream areas by increasing the flow (and sediments) and by increasing the severity of crop damage when embankments are breached. Silting up of river channels and khals would unduly restrict water flow and cause undue siltation. Heavy use of fertilizer could lead to accumulation of nitrogen in depressions. Provision of flood protection could introduce environmental degradation. For example, compaction of top soils due to the substitution of transplanted HYV boro cultivation for deepwater rice reduces soil suitability for dryland crops. More widespread Z and S deficiencies could also appear. With the continued degradation of vegetation and soils in adjoining eastern hills, flash floods must be expected to increase in frequency and intensity in rivers draining from those hills.

Agriculture Research Needs
Quick-maturing HYVs need to be developed or tested to reduce exposure of boro, aus and transplanted aman crops to early floods. Transplanting of deepwater rice after the harvest of boro (local and HYV) needs to be tested. Agronomic trials with the cultivation of pulse or oilseed crops before HYV boro and after the harvest of transplanted aman would help farmers to increase rabi crop production. This would also help to increase cropping intensity. Improved methods of land preparation on heavy clays need to be developed. Soil fertility, and changes in physical and chemical properties of soil need to be studied.

7.6 Eastern Surma-Kushiyara Floodplain (AEZ 20)

Location
This AEZ occurs in the eastern part of the Region and is comprised of parts of Sunamganj, Habiganj, Sylhet and Moulvibazar districts.

Agro-Ecological Sub-zone
No agro-ecological sub-zones have been recognized.

Physiography
AEZ 20 is comprised of mainly smooth, broad ridges and basins, with 3-6 m local differences in elevation. Along the lower Kushiyara River, there is a broad belt of irregular relief, with narrow, linear, ridges and inter-ridge depressions. Minor areas of small, low, hillocks occur locally in the east. This AEZ includes some perennial wetlands where several *haor* complexes exist.

Drainage
Ridges are shallowly flooded within field bunds and when high floods occur. *Haors* are deeply flooded. The whole area is subject to early floods and a rapid rise in water levels following heavy rainfall locally and in adjoining hills. Early flood flows contain high proportions of sediment. Otherwise, flooding is mainly by rain water retained within field bunds. Water drains rapidly from the ridges at the end of the rainy season. However, basin centres stay wet for most or all of the dry season. The percentage of land in different flood depth classes is given in Table 7.6.

Climate
Mean annual rainfall increases from about 2,500 mm in the extreme south to more than 5,000 mm in the extreme north. Mean monthly rainfall exceeds 500 mm in June in the south. It exceeds 500 mm in 3-4 monsoon months (May-August/September) and reaches 1,000 mm in June-July in the north. The mean date when minimum temperatures start to fall below 20 C ranges from 29 October in the north to 12 November in the south. The western part and eastern part have, respectively, 70-90 days and 90-110 days with minimum temperatures below 15 C. Maximum summer temperatures in this AEZ do not exceed 40 C. Mean length of the pre-kharif transition period is shortest in the north (about 20 days) and increases to about 30 days in the south-west. The reference kharif growing period starts in 1-10 April in the north-east and in 15 April in the south-west. The period ends in 1-10 January in the north-east and in end-December in the south-west. The reference rabi growing period is more than 140 days throughout AEZ 20. It begins around 25-31 October in the south and 1-10 November in the north. The period ends around 20 March in the south and 25 March or later in the north.

Table 7.6: Percentage of Land for Different Flood Depths

Highland	Medium Highland	Medium Lowland	Lowland	Very Lowland	Homesteads, Water
5	25	20	36	<1	14

Soils
AEZ 20 occupies the relatively higher parts of the Surma-Kushiyara Floodplain formed by river sediments draining into the Meghna catchment area from the hills. Grey, heavy, silty clay loams predominate on the ridges; clay in the basins. Small areas of loamy soils occur alongside rivers, together with mixed sandy and silty alluvium. Peats occupy some wet basin centres. Except in basin centres, the cultivated layer of the predominant soils is lighter in texture than lower layers, and there is a strong ploughpan.

Top soil organic matter content ranges from about two percent in ridge soils to about five percent in basin soils. It is much higher in perennially wet soils. The level of CEC and Zn is high while that of other essential nutrients is medium. Top soil reaction is strongly or very strongly acidic. Ridge soils have near-neutral subsoils, but basin soils are medium to very strongly acidic in the upper subsoil, gradually becoming less acidic or neutral below about 50 cm. Permeability is slow in most soils. Moisture-holding capacity is inherently moderate but is reduced by puddling of the surface layer and the formation of a strong ploughpan in soils used for transplanted rice cultivation. Except in wet basin centres, therefore, top soil quickly becomes hard and dry after the end of the rainy season, and basin soils crack widely.

Seven General Soil Types occur in this AEZ. Noncalcareous Grey Floodplain is the predominant soil type. Varying proportions of Noncalcareous Alluvium, Acid Basin Clays, Peat, Noncalcareous Brown Floodplain Soils, Grey Piedmont Soils, and Brown Hills Soil occur throughout the AEZ. A correlation between these soil types and the major international soil units is provided in Table 7.11. The physical and chemical properties of these soil types are given in Table 7.12.

Water Resources

Surface water in rivers and *haors* is almost fully utilized for dry season irrigation (and fish production). Ground water resources appear to be erratic and require more detailed examination.

Land Use

Aus-transplanted aman is the predominant cropping pattern on highland and medium highland floodplain soils. Aus is widely transplanted. The transplanted aus includes both HYVs and local varieties. The land remains fallow in the rabi season. In some areas, HYV boro is cultivated after the harvest of transplanted aman. On lower land, deepwater aman or mixed aus and deepwater aman are the traditional practices on basin margins, with local boro or grassland in basin sites. Early maturing local boro growing land has expanded in the past reducing the area under grassland and reed swamps. On loamy river bank soils, dryland crops are grown in the rabi season. Hills are mainly under scrub forest, grassland and bamboo, with fruit trees around the settlements.

Existing Projects

Ten surface water resource projects have been constructed or are nearing completion in AEZ 20. The projects are intended to provide flood control, drainage and irrigation to a net area of 26,820 ha; flood control and drainage to a net area of 25,665 ha; partial flood control and drainage to a net area of 21,690 ha; flood control to a net area of 10,800 ha; partial flood control and irrigation to a net area of 5,460 ha; and drainage improvement to a net area of 7,285 ha.

Agricultural Development Constraints

Severe flood hazards and very heavy rainfall are the major constraints to crop production in AEZ 20. Flash floods destroy aus and transplanted aman on higher land, and boro in basins. The damage prevents farmers from shifting to HYVs. Deep flooding of basins, with a rapid rise of flood water, prevents deepwater aman from being grown in basin sites. Waves on open water surfaces up-root deepwater aman rice plants during the monsoon season. Heavy rainfall and persistence cloudiness hamper harvesting, drying and storage of rice. Predominance of heavy soils with a compact cultivated layer and ploughpan prevents or hampers cultivation of dryland crops in the rabi season. Extensive areas stay wet through the dry season. Road embankments without adequate numbers and sizes of bridge/culverts and flood protection embankments cause ponding of water in adjoining depressions with consequent damage to crops.

Agricultural Development Opportunities

There is a large extent of high floodplain ridge soils in this AEZ that have high agricultural potential, but flood hazards and heavy rainfall restrict crop production. Flood protection and drainage schemes might be considered wherever feasible to protect boro and kharif crops from early floods and flash floods. However, consideration of these types of projects in this AEZ should take into account the integrity of the wetlands and fisheries production systems as this AEZ includes some major perennial wetlands. Possibilities to improve rainfed crop production are limited because of the slow drainage of basin soils after the rainy season, the poor moisture supply in most top soils for growing rabi crops, and the severe flood hazard in the kharif season. Prospects for large-scale irrigation projects in this AEZ are poor because of the difficulty of controlling the huge quantities of flood water entering from adjoining AEZs. Diversion bunds and drains are suitable in some areas to protect boro and kharif crops from early floods and flash floods. Use of HYVs, transplanting of aus and deepwater aman, increased and efficient use of fertilizers and manures, deeper ploughing to increase the thickness of the cultivated layer above the ploughpan would improve rainfed crop production. Expansion of existing irrigation facilities would increase crop production in the dry season. Raised soil platforms would intensify vegetables, spices, betel leaf and banana cultivation in flood-prone areas which cannot easily be protected. The principle of controlled flooding may be introduced as a short term measure.

Ecological Hazards

Increasing frequency and severity of floods has occurred due to degradation of vegetation and soils in neighbouring hills which has intensified. Increasingly rapid run-off of heavy monsoon rainfall has taken place. Associated with the increasing flood intensity, increasing amounts of sediments must be expected to be deposited. This may be aggravated by provision of flood protection embankments along rivers and clearing of natural vegetation in basins along the foot of the adjacent hills. Degradation of hill land could reduce dry season river flows. The construction of road embankments without adequate numbers and sizes of bridge/culverts and flood protection embankments can cause ponding of water in adjoining depressions and consequent damage to crops. Excessive rainfall or irrigation following the use of fertilizers may cause excessive leaching of nitrogen from higher fields into basin soils.

Agriculture Research Needs

Integration of crops, livestock, and fish is needed in low-lying areas. Quick-maturing and cold tolerant HYVs need to be developed to replace existing local boro varieties. Deepwater aman varieties with high yield potential need to be developed for transplanting. Soil management trials are needed to increase the thickness of the cultivated layer above the ploughpan. Various methods for making puddled top soils suitable for growing rabi crops need to be tested. Trials and demonstrations with more efficient methods of fertilizer application are needed (especially for urea) with the objective of reducing nitrogen losses. Water management trials on irrigated and rainfed land are essential. Soil fertility needs to be monitored regularly in areas of heavy fertilizer use. Studies are required to improve threshing, drying and storage methods.

7.7 Sylhet Basin (AEZ 21)

Location

AEZ 21 is the deepest area in the Northeast Region. It occurs in the central part of the Region and is comprised of parts of Netrokona, Kishoreganj, Sunamganj and Habiganj districts.

Agro-Ecological Sub-zone

Three agro-ecological sub-zones are recognized in AEZ 21. They are, Western (AEZ 21a), Central and Southern (AEZ 21b), and Northern (AEZ 21c). The sub-zones are differentiated on the proportions of shallowly developed soils (which reflect different proportions of land which remain perennially wet).

Physiography

This AEZ is comprised of smooth, broad basins with narrow rims of higher land along rivers. Relief is locally irregular near to rivers. The differences in elevation between river banks and adjoining basin centres is 3-6 m or more. This AEZ includes many perennial wetlands where about 25 major *haor* complexes exist.

Drainage

Generally, ridges are moderately deeply flooded. However, they are shallowly flooded along the Surma River in the north. Basins are deeply or very deeply flooded. The whole area is subject to early floods and a rapid rise in flood-levels, particularly in the north. Flood-water drains rapidly from the ridges after the rainy season, but *haors* stay wet for most or all of the dry season. However, they are not saline. The percentage of the land in different flooding depth classes in each sub-zone is given in Table 7.7.

Climate

Mean annual rainfall increases from about 2,500 mm in the south to more than 5,000 mm in the extreme north. Mean monthly rainfall exceeds 500 mm in June at Habiganj. It is more than 500 mm in May and exceeds 1,000 mm in June-August at Sunamganj. The mean date when minimum temperatures start to fall below 20 C ranges from 29 October in the north to 12 November in the south. The western part has 50-70 days and the eastern part has 70-90 days with minimum temperatures below 15 C in winter. Maximum summer temperatures do not exceed 40 C. The pre-kharif transition period increases in length from less than 20 days in the north-east to 35 days in the south-west. The reference kharif growing period starts on 10 April in the north-east and in 20-25 April in the south. The period ends in 1-10 January in the north-

Table 7.7: Percentage of Land in Different Flooding-Depth

Subregion	Highland	Medium Highland	Medium Lowland	Lowland	Very Lowland	Homesteads, Water
AEZ 21a	0	2	14	59	17	8
AEZ 21b	0	4	25	37	20	14
AEZ 21c	<1	4	12	35	42	7
Total	**<1**	**4**	**19**	**43**	**23**	**11**

east and in 15-20 December in the south. The reference rabi growing period increases in length from south (135-140 days) to north (140-145 days). It begins around 20-25 October in the south and 1-5 November in the north. The period ends around 1-10 March in the south and 20-25 March or in the north.

Soils

Two main kinds of soils occur in the AEZ. They are: (1) Grey silty clay loams and clays with developed profiles on the relatively higher land which dries out seasonally; and (2) Grey (often bluish grey or greenish grey) clays with raw alluvium at a shallow depth which occupy basins and stay wet throughout the year. There are minor inclusions of dark grey loamy and clay soils of the adjoining Old Brahmaputra Floodplain (AEZ 9) in the west and Old Meghna Estuarine Floodplain (AEZ 19) in the south, grey loams and clays of the piedmont belt to the north, and peat in some *haors*. AEZ 21a has predominately grey heavy clays occupying extensive basins. There are small inclusions of dark grey loamy and clayey Old Brahmaputra soils on ridges of relatively higher land in the west. AEZ 21b has grey, heavy, silty clay loams and clays on ridges and basin margins, and grey (or bluish grey), shallowly developed, clay soils in perennially wet basin centres. There are inclusions of dark grey, loamy, Old Meghna Floodplain soils in the south. The AEZ 21c has predominately grey (or bluish grey), shallowly developed, clay soils in perennially wet basins, together with grey loams and clays on high river banks and small areas of peat in some basin centres. Small areas of grey piedmont loams and clays penetrate into the north-west of the sub-zone.

Organic matter content ranges between 0.5-2.0% in ridge soils and 2.0-4.0% in basin soils. The soils, which occupy basin centres, and stay wet for most or all of the dry season, generally have 2.0-5.0% organic matter in the cultivated layer. General fertility level is medium to high with low P and high Zn content. The soil reaction is mainly acidic. Permeability is generally slow, except in some loamy ridge soils of Grey Floodplain. Moisture-holding capacity is moderate in deep loamy ridge soils, but low in basin clays. Un-irrigated soils become very hard when dry, and basin clays crack widely. Soils which dry out in the dry season become very hard and widely cracked, but most soils stay wet because of irrigated boro rice cultivation.

Six General Soil Types occur in the AEZ. Noncalcareous Grey Floodplain Soils and Acid Basin Clays are the major components of the General Soil Types. The former type predominates in AEZ 21a and AEZ 21c and the latter predominates in AEZ 21b. The other General Soil Types which occur in the project area are: Noncalcareous Alluvium, Noncalcareous Dark Grey Floodplain Soils, Peat and Grey Piedmont Soils. A correlation between these soil types and major international soil units is provided in Table 7.11. The physical and chemical properties of these soil types are given in Table 7.12.

Water Resources

Surface water in rivers and *haors* is extensively used for dry season irrigation. Irrigation could be further extended with the help of LLPs. Groundwater supplies require detailed study, but may be available to supplement surface water supplies in marginal areas where the latter may be insufficient or the land may be too high to be easily commanded from surface water sources.

Land Use

Since lowlands occupy a major area in the AEZ, almost all the cultivated area is used for single cropping. Local boro is the main crop which is grown in the dry season. HYV boro is grown on some floodplain ridges and the upper part of basin margins. In some areas which can be drained earlier, rape and mustard are grown initially, followed immediately by irrigated HYV boro. During the flood period deepwater aman is grown in moderately flooded areas along the flood periphery. Transplanted aman is grown on high ridges adjoining rivers in the north and east. Groundnut, sweet potato, mustard and other rabi crops are grown in some areas on the highest land near rivers.

Existing Projects

Twenty four surface water resource projects have been constructed or are nearing completion in AEZ 21. The projects include mostly flood embankments and submersible embankments. They are intended to provide partial flood protection to a net area of 76,700 ha; partial flood protection, drainage and irrigation to a net area of 10,420 ha, partial flood protection and drainage to a net area of 19,370 ha, and partial flood control and water retention to a net area of 6,680 ha.

Agricultural Development Constraints

Deep flooding together with pre-monsoon flash floods restricts crop production. Flood levels rise very quickly. This rapid rise creates problems for cropping in the monsoon season in many parts. Most of this area remains under two to six meters of water for more than six months of the year. The pre-monsoon flash floods occur more than once a year, mostly between March and June. The floods inundate most of the *haor* depressions, and cause severe damage to boro crops. Deepwater aman seedlings are damaged when submerged before the plants are able to acquire the ability to elongate with the gradual rise of flood levels. Drainage congestion delays transplantation of boro crops in many areas. Slow drainage in the post-monsoon season prevents land being made available for cultivation of rabi crops. Shortage of feeds and fodder has been increased due to rice damage, decrease in the traditional grazing lands, and increased use of straw for domestic fuel and housing materials. This has resulted in the shortfall of draught power. The construction of road embankments without adequate numbers and sizes of bridge/culverts and flood protection embankments causes ponding of water in adjoining depressions.

Agricultural Development Opportunities

Rice is well-suited to conditions found in much of the area which is deeply flooded. However, the aquatic environment prevailing in this area has a substantive comparative advantage in terms of production of fish, ducks, and wetland products. The wetlands environment creates a good habitat for number of submerged and rooted floating plants. More than 120 fish species have been identified in this area. Some of aquatic plant species and fish species have been reported to be endemic. Hundreds of local rice varieties grown in this part are well suited to the agro-hydraulic regime. Considering the environment in this AEZ as a whole, the present farming systems need to be developed taking advantage of the aquatic environment. Promising possibilities for improvement include the development of improved local rice varieties and cropping systems, more intensive livestock production, greater duck production, increased reliance on more productive fisheries, and identification and increased production of wetland products. Flood protection and drainage improvement projects might be considered wherever feasible to protect boro and kharif crops from early floods. Submersible embankments, diversion bunds and drains, and other local schemes are suitable in some areas provided that adequate arrangement are made for their maintenance.

Ecological Hazards

The major hazard is an increasing frequency and severity of floods resulting from increasing degradation of hill areas upstream as well as from the embanking of rivers in adjoining AEZs.

Deposition of sediments burying existing boro cultivated land is likely to be increased. A further effect of the increasing degradation of hill lands upstream is likely to be a decrease in dry-season river flow. Reduced river flow could reduce the surface water availability for boro. Excessive rainfall or irrigation following fertilizer use may cause excessive leaching of nitrogen from higher fields into basin soils.

Agriculture Research Needs
Present farming systems in this AEZ need to be improved and diversified. Research needs to focus on closer integration of crops, livestock, fish and multi-purpose trees in farming systems. Potential solutions and strategies are needed to indicate the use of natural resources in a sustainable and environmentally sound way. Quick-maturing and cold tolerant HYVs need to be developed to replace existing local boro varieties. Deepwater aman varieties with high yield potential need to be developed for transplanting. Soil management trials are needed to improve land preparation on heavy basin clays, to increase the thickness of the cultivated layer above the ploughpan, and to control weeds on wet basin soils. Suitable rabi crops are needed to be tested before HYV boro and after transplanted aman. Trials and demonstrations with more efficient methods of fertilizer application are needed (especially for urea) with the objective of reducing nitrogen losses. Water management trials on irrigated and rainfed land are essential. Soil fertility needs to be monitored regularly in areas of heavy fertilizer use. Studies are required to improve threshing, drying and storage methods.

7.8 Northern and Eastern Piedmont Plains (AEZ 22)

Location
AEZ 22 occurs as a narrow strip of land at the foot of the northern and eastern hills in the Northeast Region. It extends from the northern part of Jamalpur to Sylhet districts through the northern border of Sherpur, Mymensingh, Netrokona and Sunamganj districts. This AEZ also occupies the southern parts of Moulvibazar and Habiganj districts.

Agro-Ecological Sub-zone
Four agro-ecological sub-zones have been recognized: North-western plain and basins (AEZ 22a), Northern and eastern plains and basins (AEZ 22b), South Sylhet piedmont plains (AEZ 22c), and Northern and eastern basins (AEZ 22d). The sub-zones are separated based on different soils and flooding characteristics.

Physiography
This AEZ is comprised of merging alluvial fans which slope gently outward from the foot of northern and eastern hills into smooth, low-lying basins. The latter merge imperceptibly into adjoining floodplain basins. Locally the relief is irregular close to rivers and streams crossing the AEZ 22, especially on higher land near the hills. Small hills occur within the boundaries of this AEZ in the north. Some major *haors* lie within this AEZ.

Drainage
Large parts of AEZ 22a, AEZ 22b, and AEZ 22c stand above normal flood levels. The sub-zones are, however, subject to shallow flash floods and rainwater is retained on the surface within field bunds. Lower parts are shallowly to moderately deeply flooded in the rainy season. AEZ 22d is mainly moderately deeply to deeply flooded, but the extreme western parts (Sherpur district) are only shallowly to moderately deeply flooded. This sub-zone is also subject to early

flash floods and a rapid rise of flood-levels following heavy rainfall in neighbouring hills. *Haor* centres stay wet during the early part of the dry season. The percentage of the land in different flooding depth classes in each sub-zone is given in Table 7.8.

Climate

Mean annual rainfall is lowest (about 2,000 mm) in the north of Jamalpur district, and increases toward the northern border of Sunamganj and Sylhet districts. Mean monthly rainfall exceeds 500 mm in 2-5 monsoon months along the northern border in eastern Sylhet district. The mean date when minimum temperatures start to fall below 20 C ranges from 24-29 October in the north-east to 15 November in the extreme south. The western and eastern parts have 90 days and other northern areas have 75-90 days with minimum temperature below 15 C in winter. The extreme western part has more than 0.5 days per year, on the average, when summer temperatures exceed 40 C. The pre-kharif transition period increases in length from less than 20 days in the north-east to more than 30 days in the west and also southward from Habiganj district. The begin date of the reference kharif growing period ranges from 1-10 April in the north-east to 1 May in the north-west and south. The period ends earlier in the north-west and south (20 December) than in the north-east (1-10 January). The reference rabi growing period extends from 25 October to 1 March in the north-west. In the south, the period extends from 1 November to 1-5 March. In the north-east, the rabi growing period (assuming 250 mm soil moisture supply) extends beyond the starting date of the following pre-kharif moisture period in more than half the years. In the west and south, such an overlap occurs in less than 20% of the years.

Soils

This AEZ has complex soil patterns due to the irregular deposition of sediments of different textures during successive flash floods. The sub-zones AEZ 22a and AEZ 22b have the most complex relief and soil patterns, especially in areas close to the hills. Deposits range from sands to clays, though AEZ 22a has, in addition, some older soils (Grey Terrace Soils) with a grey silty top soil over a grey and red mottled clay loam subsoil. Sub-zone AEZ 22c has soils similar tothose in sub-zone AEZ 22b, but they occupy smoother relief, and silty clay loams and silty clays predominate. The Piedmont Plains in AEZ 22a and AEZ 22b grade into moderately deeply to deeply flooded basins with predominantly clay soils. The largest *haor* areas have been mapped separately in sub-zone AEZ 22d. Relatively small areas of more loamy soils occur on higher land near rivers streams.

Table 7.8: Percentage of Land in Different Flooding-Depth

Subregion	Highland	Medium Highland	Medium Lowland	Lowland	Very Lowland	Homesteads, Water
AEZ 22a	42	44	5	1	0	8
AEZ 22b	35	26	24	7	0	8
AEZ 22c	46	36	6	<1	0	12
AEZ 22d	6	24	22	31	4	13
Total	**33**	**31**	**16**	**9**	**1**	**10**

Organic matter content is less than 1.5% in the top soil of ridges, and higher in basin soils. It is less than one percent in recent alluvium. Heavy basin or valley clays have 2.0-5.0% organic matter in the cultivated layer. Organic matter content ranges from low to moderate in the cultivated layer of grey Piedmont Soils. General soil fertility is low to medium. Soils are loams to clays in texture with slightly acidic to strongly acidic reactions. Top soil acidity in clay soils is generally strong to very strong. Subsoils are moderately acidic to neutral. Heavy basin or valley clays are extremely acidic in reaction. Top soil acidity in grey piedmont soils ranges from extreme to medium. The more loamy ridge soils have rapidly permeable subsoils, but the puddled top soil and ploughpan of soils used for transplanted rice cultivation have slow permeability. Heavy basin or valley clay soils have slow permeability. Moisture holding capacity is low in heavy basins or valley clays and ridge soils used for transplanted rice cultivation, especially in puddled top soils and ploughpans.

Nine General Soil Types occur in this AEZ. Grey Piedmont Soils and Noncalcareous Grey Floodplain Soils occupy the greater part in AEZ 22a and AEZ 22c. Acid Basin Clays occupy a greater part of AEZ 22b and AEZ 22d. Deep Grey Terrace Soils occur only in AEZ 22a occupying a considerable area. Noncalcareous Dark Grey Floodplain Soils occupy a considerable area in AEZ 22d and minor pockets in other sub-zones. The other soil types which occur in minor areas are: Noncalcareous Alluvium, Noncalcareous Brown Floodplain Soils, Brown Hill Soils, and Peat. Table 7.11 provides a correlation between these soil types and major international soil units. The physical and chemical properties of these soil types are given in Table 7.12.

Water Resources
Dry season surface water supplies from rivers or streams are limited and are fully used, either within the AEZ or in downstream areas. Supplies are also uncertain in AEZ 22c due to diversions upstream in India. Groundwater resources are erratic in occurrence and need to be investigated in more detail. Artesian supplies occur locally.

Land Use
Transplanted aman-HYV boro is the main cropping pattern in AEZ 22a. In AEZ 22b and AEZ 22c, the major cropping pattern is Aus-transplanted aman. In AEZ 22d, mainly irrigated HYV or local boro is grown. Deepwater aman is grown on some moderately deeply flooded land, mainly in AEZ 22b and AEZ 22d. Non-irrigated basin clays in AEZ 22d remain under grassland or under reed swamp. High old piedmont fans in Sylhet and Moulvibazar are used for tea production.

Existing Projects
Five surface water resource projects have been constructed or are nearing completion in AEZ 22. The projects are intended to provide flood control and drainage to a net area of 2,600 ha; flood control and irrigation to a net area of 1,200 ha; flood control to a net area of 25,790 ha; partial flood protection to a net area of 6,070 ha, drainage and irrigation to a net area of 2,280 ha. The AEZ also occupies part of a flood control and drainage project in adjoining AEZ 29.

Agricultural Development Constraints
Floods damage rice on all land types. Flash floods damage boro and aus between March and May. Early floods and deep floods damage aman crops. Flash floods also occur in the post-monsoon season. Flood levels and the duration of floods have increased due to the deposition of sediments in rivers. Flash floods from the hills bring down enormous quantities of sediments.

Drainage is delayed in low-lying lands due to this siltation. Thus farmers can not transplant boro in time. There is also a loss of land due to channel shifting along some rivers. The construction of road embankments without adequate provision for drainage causes ponding of water in adjoining depressions with a consequent damage to crops. The damage of crops prevents farmers from growing HYVs. Compact top soil and ploughpan in ridge and basin soils make tillage difficult, and restrict cultivation of dryland rabi crops. Low moisture-holding capacity of the soils, reinforces the constraints.

Agricultural Development Opportunities
Flood protection and water control projects need to be constructed to protect boro as well as kharif crops in their early stages. Drainage improvement projects might be considered wherever feasible. The projects, however, need to be planned jointly with projects in adjoining parts of AEZ 9, AEZ 19, AEZ 20 and AEZ 21. Flood protection and drainage would enable HYVs to replace traditional varieties, and rabi crops to be grown more widely. Expansion of the present irrigation facilities, where possible, would increase HYV rice cropped areas and other crop production. Diversion bunds and drains would protect boro and aus from early floods in some areas. Raised platforms would intensify production of vegetables, spices, betel leaf in flood prone areas which cannot easily be protected. Development of tree crops and forestry are needed in hill areas.

Ecological Hazards
Flash floods are likely to become more frequent and more severe with increasing degradation of vegetation and soils in upstream hill areas. They may cause direct damage to crops. Moreover, the floods may be expected to bury more land in the foot hills with sandy sediments which are less suitable and less fertile for rice production. Deposition of new sediments may also be expected to increase in basin soils in this AEZ and in adjoining AEZs making them less suitable for boro production. Increased degradation of vegetation and soils may be expected to reduce the amount of dry-season river-flow. Heavy rainfall or irrigation following fertilizer application may cause excessive leaching of nitrogen from higher fields into adjoining basin soils.

Agriculture Research Needs
A multitude of diverse micro-environments in the AEZ implies that particular care is needed in selecting sites for agricultural research. Quick-maturing and cold tolerant HYV boro needs to be developed to reduce exposure to early floods. Agronomic trials with transplanting of aus and deepwater aman would ensure high yield on basin margins. Cultivation of rabi crops before HYV boro and after transplanted aman need to be considered. Soil management trials are needed to improve land preparation on heavy basin soils. Trials with more efficient methods of fertilizer application and use of organic manure are needed on different soils and cropping patterns. Socio-economic surveys would identify progressive farmers willing to adopt the improved practices. Water management trials on irrigated and rainfed land are essential. Changes in soil fertility and physical properties need to be studied. Studies are required to improve threshing, drying and storage methods.

7.9 Madhupur Tract (AEZ 28)

Location
AEZ 28 occurs in the south-western part of the Northeast Region. It occupies the northern part of Gazipur district, extreme northern and south-western parts of Narsingdi district, and western part of Kishoreganj district.

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Agro-Ecological Sub-zone
Six agro-ecological sub-zones have been recognized in the AEZ. They are differentiated based on landscape. The sub-zones which occur in the Region are: level terrace with deep, well drained soils (AEZ 28a); dissected terrace with deep, well drained soils (AEZ 28b); dissected terrace with shallow soils and narrow valleys (AEZ 28c); dissected terrace with deep and shallow soils (AEZ 28d); and broad valleys (AEZ 28e). The sub-zones are mapped as AEZ 28a-e.

Physiography
AEZ 28a and AEZ 28d are comprised of level upland areas. There are, however, a few valleys in AEZ 28d. Closely dissected upland areas and deep broad valleys occur in AEZ 28b. AEZ 28c is characterized by closely dissected areas and shallow valleys. Broad valleys occur in AEZ 28e.

Drainage
Upland areas range from well drained to poorly drained in different sub-zones. Shallow valleys occurring mainly in AEZ 28c are mostly shallowly flooded by rainwater retained within field bunds in the upper parts. Lower parts of these valleys are shallowly to moderately deeply flooded by run-off water impounded by deep flooding in adjoining AEZs. Broad valleys in AEZ 28b and AEZ 28e are moderately deeply or deeply flooded with run-off water (or a high ground-water table) which is impounded by high external flood-levels. Extensive areas adjoining floodplain regions occupy *beels* which stay wet or submerged throughout the dry season. Areas of floodplain alluvium included within the boundaries of this AEZ are mainly moderately deeply flooded. The percentage of the land in different flooding depth classes in each sub-zone is given in Table 7.9.

Climate
Mean annual rainfall increases from about 2,000 mm in the south to more than 2,300 mm in the north. The mean date when minimum temperatures start to fall below 20 C is 2-5 November. A small area in the south-east has 50-70 days with minimum temperatures below 15 C in winter. The north-western part has 0.5-5 days per year, on the average, when summer temperatures exceed 40 C. The mean length of the pre-kharif transition period is 40-45 days throughout the AEZ. The reference kharif growing period begins earlier in the south-east (25-30 April) than in the north-west (1-5 May). The period ends slightly latter in the north-east (20-25 December)

Table 7.9: Percentage of Land in Different Flooding-Depth

Subregion	Highland	Medium Highland	Medium Lowland	Lowland	Very Lowland	Homesteads, Water
AEZ 28a	77	13	2	2	0	6
AEZ 28b	53	15	9	10	0	13
AEZ 28c	66	22	6	2	0	4
AEZ 28d	56	34	1	3	0	6
AEZ 28e	2	11	17	61	0	9
Total	**56**	**17**	**8**	**9**	**0**	**10**

than in the west and south (15-20 December). The reference rabi growing period extends from 20 October to 5 March in the south, and 25 October to 15 March in the north.

Soils
AEZ 28 has complex relief and soils, developed over the Madhupur clay. Level upland areas include deep red and brown soils in AEZ 28a. AEZ 28b has deep red soils on level upland sites. Brown soils occur on gently undulating uplands and shallow valleys in AEZ 28c. Level upland areas in AEZ 28d are comprised of deep and shallow silty soils. In AEZ 28e, broad valleys have mainly dark grey heavy clays. Some floodplain lands included in this AEZ have grey loamy soils on ridge and silty clay basins.

Organic matter content is low in red, brown, and yellow upland soils. Some grey and dark grey heavy clays include buried top soil or organic layers mostly with 2.0-5.0% organic matter content. General fertility level is low. Soils are mainly phosphate fixing, and low in K, S and Ca. Red, brown and yellow upland soils are mainly strongly or very strongly acidic in the top soil and upper subsoil, but they generally become less acidic with depth. Grey and dark grey heavy clays are very strongly or extremely acidic. Permeability and moisture-holding capacity is low. Soils become very hard and crack widely in the dry season.

Eleven General Soil Types exist in this AEZ. Deep Red-Brown Terrace Soil is the predominant soil type in AEZ 28a and AEZ 28b. The predominate type in AEZ 28c is Shallow Red Brown Terrace Soils. Shallow Grey Terrace Soils are predominant in AEZ 28d and Acid Basin Clays in AEZ 28e. Deep Grey Terrace Soils occur mainly in AEZ 28d. Grey Valley Soils occur throughout the AEZ. Brown Mottled Terrace Soils occur extensively in AEZ 28a. The other types which occupy minor areas are Noncalcareous Alluvium, Noncalcareous Grey Floodplain Soils, Noncalcareous Brown Floodplain Soils, and Noncalcareous Dark Grey Floodplain Soils. The soils on the terrace are better drained, friable clay loams over friable clay substratum. Soils in the valleys are dark grey, heavy clays. Table 7.11 provides a correlation between these soil types and major international soil units. The physical and chemical properties of these soil types are given in Table 7.12.

Water Resources
Only limited amounts of surface water are available in rivers and *beels*, and these are almost fully exploited. Groundwater is generally available, though at greater depths in the north than in the south. There is some uncertainty at present on the absolute amounts that can safely be extracted.

Land Use
Aus is the main crop in AEZ 28a. Black gram or mustard follows aus, with jackfruit trees on field boundaries. Sugar cane is also an important crop in this sub-zone. Wheat, potato and vegetables are cultivated with irrigation. Cropping practices in AEZ 28b are similar to those in AEZ 28a. However, higher parts of valleys are used for deepwater aman or mixed aus and deepwater aman. Irrigated boro is produced in lower parts. Cultivated upland soils in AEZ 28c grow poor crops of aus, mesta, groundnut, mustard and black gram. Valleys are used for aus and transplanted aman in the highest parts, and mixed aus and deepwater aman in the lower parts. Aus and transplanted aman are the main crops in AEZ 28d. HYV boro, partly followed by transplanted aman, is grown in the northern part of this sub-zone. In AEZ 28e, local boro is the main crop in depressions subject to early flooding, and HYV boro is cultivated on relatively higher sites.

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Existing Project
The AEZ includes one flood control and drainage project. The project covers a net area of 3,700 ha in Kapasia *thana* of Gazipur district.

Agricultural Development Constraints
Complex relief and soil patterns, low moisture-holding capacity and low natural fertility of upland and Grey Valley Soils restrict crop production. The broken relief makes it difficult to provide irrigation lay-outs. Drainage congestion due to pre-monsoon rainfall and rapid upland run-off damages HYV boro in valleys. Deep flooding in the monsoon season damages aman in broad valleys. Parts of this AEZ suffer from both uncertain flooding and drought in dry spells.

Agricultural Development Opportunities
Flood protection and drainage need to be provided in low-lying parts of AEZ 28e where boro is damaged by pre-monsoon rainfall and rapid upland run-off from the adjoining high lands. However, the greatest need is to increase soil fertility and moisture-holding capacity on seasonally-flooded valley soils. Increased use of organic manures, efficient use of fertilizers, and deeper ploughing would increase productivity in these soils. More crop residues need to be returned to the red and brown soils. Expansion of existing irrigation facilities would increase rabi and kharif crops. Slopes of hillocks and terrace edges need to be protected against erosion by appropriate conservation measures.

Ecological Hazards
Cultivated upland soils are reported to be depleted of organic matter and fertility due to long-sustained cultivation without an adequate return of organic matter and nutrients to the soils. Run-off water from field to field during heavy rainfall can wash N fertilizer from higher land to lower lands.

Agriculture Research Needs
New crops and varieties need to be tested which can be adapted for local conditions. Cultural practices need to be improved. Fertilizer trials are needed on different soils and cropping patterns. The effects of using groundwater containing large amounts of iron to irrigate crops on different soils needs to be studied. Orchard management needs to be improved. Studies are required to monitor and assess changes in soil fertility and physical properties.

7.10 Northern and Eastern Hills (AEZ 29)

Location
AEZ 29 includes the Region's hill areas. It occurs in the northern margin of Jamalpur and Sherpur districts, southern part of Moulvibazar and Habiganj districts, and some areas in Sylhet district.

Agro-Ecological Sub-zone
Three agro-ecological sub-zones have been recognized. They are: mainly high hill ranges (AEZ 29a), mainly low hills (AEZ 29b), and low hills and piedmont plains (AEZ 29c). Each of these sub-zones includes several different kinds and combinations of relief and soils. The sub-zones are differentiated based on their rock type and on the proportion of piedmont plain and valley soils.

Physiography
The AEZ has a complex relief. Hills have been dissected to different degrees over different rocks. Slope are mainly very steep in AEZ 29a. In AEZ 29b and AEZ 29c, the relief varies from very steeply dissected to gently rolling. High hill ranges mainly occur in AEZ 29a. Floodplains occupy a greater area in AEZ 29c than in AEZ 29a and AEZ 29b. Some major *haors* lie within this AEZ.

Drainage
The hills are well drained, but some valley bottoms are imperfectly drained. Narrow strips of alluvial terraces in some broader valleys are moderately well drained, but valley soils are poorly drained and are subject to flash floods. The percentage of the land in different flood depth classes in each sub-zone is given in Table 7.10.

Climate
The mean annual rainfall exceeds 5,000 mm on hills in the north of Sylhet and Sunamganj districts. It is 2,000-2,500 mm in the west of Sherpur district and in Habiganj district. The mean date when minimum temperatures start to fall below 20 C ranges from 24 October in the north to 15 November in the south. The mean length of the cool winter period with minimum temperatures below 15 C ranges form 70-110 days in the northern hill area and 50-70 days in the southern hill areas. Summer temperatures do not exceed 40 C. The mean length of the pre-kharif transition period is less than 20 days in the north-east and less than 40 days in the west and south. The reference kharif growing period is longest in the north-east (less than 280 days) and decreases to about 230 days in the west and to 220-240 days in areas south of Habiganj district. The period extends from 1-10 April to 1-10 January in the north-east and 20-30 April to 20 December in Sherpur. The reference rabi growing period starts around 25 October to 5 November in all parts, but it ends earlier in the south (20-28 February) than in the north-east (20-25 March).

Table 7.10: Percentage of Land in Different Flooding-Depth

Subregion	Highland	Medium Highland	Medium Lowland	Lowland	Very Lowland	Homesteads, Water
AEZ 29a	98	<1	<1	0	0	2
AEZ 29b	85	2	<1	0	0	13
AEZ 29c	84	8	1	<1	<1	7
Total	**92**	**2**	**<1**	**<1**	**<1**	**5**

Soils
The major hill soils are yellow-brown to strong brown, permeable, friable, loamy, very strongly acidic and low in moisture-holding capacity. However, soil patterns generally are complex due to local differences in sand, silt and clay content of the underlying sedimentary rocks, and in the amount of erosion that has occurred. Deep soils (more than 120 cm) predominate. Shallow soils (less than 60 cm) occur mainly over hard sandstones and shales on very steep slopes in parts of

AEZ 29a. The soils occupy relatively small parts of AEZ 29b and AEZ 29c over hard rock and ironpan (laterite), and on some very steep eroded slopes over soft shales.

Organic matter content in the top soil varies with vegetative cover, from less than 1.5% under scrub and grassland to 2.0-5.0% under forest. Most soils are very strongly acidic in reaction throughout the AEZ, but some become medium or slightly acidic in the lower layers. General fertility level is low. Most soils are rapidly permeable, but permeability is impeded in the lower parts where soils cover clay rocks. Moisture content is generally low in the upper soil layers.

Eleven General Soil Types have been recognized in AEZ 29. Brown hill is the predominant soil type throughout this AEZ. Noncalcareous Grey Floodplain and Grey Piedmont Soils occur mainly in AEZ 29c and resemble those of the neighbouring areas in AEZ 22. Varying proportions of other soil types which occur are: Noncalcareous Alluvium, Noncalcareous Brown Floodplain Soils, Noncalcareous Dark Grey Floodplain Soils, Acid basin Clays, Acid Sulphate Soils, Peat, Deep Red-Brown Terrace Soils and Made-land. A correlation between these soil types and major international soil units is provided in Table 7.11. The physical and chemical properties of these soil types are given in Table 7.12.

Water Resources

Limited amounts of surface water exist in perennial rivers and are used partially for HYV boro rice cultivation. Ground water supplies in valleys are erratic: artesian supplies exist locally, elsewhere, there are no accessible aquifers. More detailed groundwater investigation is needed to locate aquifers which could be used to irrigate valley soils, tea, and other tree crops.

Land Use

The hill area is mainly under scrub thicket, grassland or bamboos. A small area is under forest. Crops grown in this AEZ mainly include aus, transplanted aman, sesame, pulses, potato, spices and vegetables. Cultivation is rainfed. Aus is the main crop which is partly followed by transplanted aman. Aus includes both local and HYVs. Irrigated HYV boro is grown in small areas. Tea is grown on deep soils on low hills in parts of Sylhet, Moulvibazar and Habiganj districts. Pineapple is extensively cultivated in Sylhet and Moulvibazar districts. Small areas are used for orange production in these districts. Tribal people in the northern part of Mymensingh district grow cassava. Different forms of agro-forestry are practised, especially in home gardens and boundary planting.

Existing Projects

AEZ 29 includes Sari-Goyain project which provides flood control and drainage to a net area of 4,210 ha. It also occupies part of a flood control and drainage project in adjoining AEZ 22.

Agricultural Development Constraints

Most hill soils are unsuitable for terracing because of very steep slopes, heavy rainfall, and the risk of landslip erosion. The soil is shallow and underlain by hard rocks which affects plant rooting. The condition is further aggravated by the low moisture level in the dry season. In early or mid-monsoon, rice crops are damaged by spills from the river banks.

Agricultural Development Opportunities

Development efforts should be concentrated on the hilly lands because of limited area of valleys and floodplains. The HYV area can be expanded in the aus and transplanted aman seasons if groundwater irrigation is available. Dryland kharif crops and early rabi crops can be grown on the tops of some low and level hills, and on terraced slopes. Fruit trees can be grown on gently to moderately steep slopes. Improved soil and crop management practices are needed for soil conservation and the development of field drains. These will reduce run-off on sloping soils and protect dryland kharif and rabi crops against waterlogging after heavy rainfalls. Existing irrigation facilities could be expanded by improved distribution and additional LLP, tube wells and cross dams where surface/groundwater supplies are known to be adequate. Identification of local schemes are needed for flood protection. Development of tree crops and forestry are needed in hill areas as an appropriate form of land use and in order to reduce the frequency and severity of flash floods on adjoining valleys and floodplain land.

Ecological Hazards

Degradation of the vegetation and soils on the hills would increase the rate of soil erosion. This would increase the frequency and severity of flash floods in neighbouring AEZs. There could be an increase in the sedimentation rate. Inappropriate or poorly maintained soil conservation works could themselves cause accelerated erosion. For example, construction of terraces on steep slopes might induce land slips during heavy rainfall.

Agriculture Research Needs

Soil surveys are needed to identify areas suitable for specific kinds of land use including the production of field crops without terracing and plantation of tree crops on step terraces. Agronomic trials are needed for improved field and tree crops, efficient use of fertilizers, and soil conservation practices.

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Table 7.11: Correlation between General Soil Types of Bangladesh and International Soil Units

General Soil Type	FAO-UNESCO Soil Unit	USDA Soil Taxonomy
Calcareous Alluvium	Mainly Calcaric Fluvisol, Some Cambic Arenosol	Mainly Fluvaquent; Some Psammaquent, Ustipsamment and Udifluvent
Noncalcareous Alluvium	Mainly Eutric Fluvisol, Some Cambic Arenosol	Mainly Fluvaquent; Some Hydraquent, Psammaquent, Haplaquent, Ustipsamment and Udifluvent
Calcareous Brown Floodplain	Mainly Calcaric Gleysol; Some Calcaric, Eutric and Gleyic Cambisol	Mainly Eutrochrept, Some Ustochrept and Haplaquept
Noncalcareous Brown Floodplain	Mainly Eutric Gleysol; Some Dystric, Gleyic and Eutric Cambisol; Dystric Gleysol; Cambic Arenosol; and Haplic Alisol	Mainly Eutrochrept; Some Ustochrept, Ustipsamment, Dystrochrept and Haplustult
Calcareous Dark Grey Floodplain	Calcaric Gleysol and Cambisol	Mainly Haplaquept, Some Eutrochrept
Noncalcareous Grey Floodplain	Mainly Eutric Gleysol, Some Dystric Gleysol	Haplaquept
Noncalcareous Dark Grey Floodplain	Mainly Eutric Gleysol; Some Dystric, Mollic and Umbric Gleysol; and Umbric Cambisol	Mainly Haplaquept; Some Fluvaquent, Eutrochrept and Haplaquoll
Acid Basin Clays	Eutric Gleysol, Dystric and Mollic Gleysol	Mainly Haplaquept; Some Fluvaquent and Humaquept
Acid Sulphate	Thionic Gleysol, Thionic Fluvisol	Mainly Haplaquept, Some Sulfaquent and Fluvaquent
Grey Piedmont	Eutric, Dystric and Albic Gleysol	Haplaquept
Shallow Red-Brown Terrace	Calcaric, Dystric, Regic and Eutric Gleysol; and Gleyic and Haplic Alisol	Ustochrept, Haplaquept, Haplaquent, Haplustult and Paleustult
Shallow Grey Terrace	Eutric Planosol and Gleysol	Haplaquept, Haplaquent and Albaquept
Deep Grey Terrace	Albic Gleysol, Eutric Planosol	Albaquept, Haplaquent and Haplaquept
Deep Red-Brown Terrace	Ferric Alisol, Dystric Gleysol	Paleustult, Haplustalf, Dystrochrept
Brown Mottled Terrace	Ferric Luvisol, Gleyic Alisol	Paleustult
Grey Valley	Albic and Eutric Gleysol	Albaquept and Haplaquept
Brown Hills	Dystric Cambisol, Ferric Alisol, Dystric Leptosol, Haplic Luvisol	Haplustult, Ustochrept, Dystrochrept, Eutrochrept, Ustorthent, Haplaquept
Peat	Dystric Histosol	Histosol, Haplaquept, Madisaprist
Made-land	Fimic Anthrosol	Arent

Source: Agro-ecological Regions of Bangladesh, UNDP/FAO, 1988.

Table 7.12: Physical and Chemical Properties of General Soil Types

General Soil Type	Texture	pH	C%	Top soil N%	P_2O_5 ppm	S ppm	Zn ppm	Exchangeable Cations (me/100g)				
								CEC	Ca	Mg	K	Na
Calcareous Alluvium	SiL	8.02	0.71	0.08	25.0	7.0	0.8	12.09	51.6	5.28	0.43	0.26
Noncalcareous Alluvium	SL	6.52	0.38	0.05	72.0	1.1	2.1	7.36	3.13	1.10	0.14	0.11
Calcareous Brown FP	SiCL	7.50	1.24	0.12	196.0	20.7	1.1	17.30	28.4	3.91	0.45	0.57
Noncalcareous Brown FP	SL	5.30	0.61	0.06	54.0	13.8	1.9	6.59	1.52	0.44	0.21	0.35
Calcareous Dark Grey FP	C	7.12	1.80	0.20	31.0	29.6	3.3	29.41	27.2	6.37	1.01	0.42
Grey FP	SiL	5.35	0.86	0.09	61.0	10.3	7.4	4.57	1.31	0.28	0.21	0.20
Noncalcareous Dark Grey FP	SiCL	5.22	2.29	0.22	36.0	45.7	1.0	15.27	10.3	2.19	0.32	0.37
Acid Basin Clays	C	4.50	2.41	0.23	32.0	32.2	6.4	31.91	8.52	3.39	0.51	0.26
Acid Sulphate	C	4.62	1.39	0.14	39.0	361.0	1.7	10.24	1.26	4.09	0.37	3.39
Grey Piedmont	L	4.95	1.21	0.14	77.0	4.1	1.7	4.49	1.91	0.37	0.13	0.05
Shallow Red-Brown Terrace	SiCL	4.90	1.28	0.11	19.0	4.5	1.4	9.67	3.72	1.36	0.25	0.40
Grey Terrace (and Valley)	SiL	5.80	1.15	0.13	54.0	1.0	2.6	7.36	4.44	0.99	0.19	0.75
Deep Red-Brown Terrace	SL	5.62	0.82	0.08	16.0	5.8	1.4	8.04	1.89	0.51	0.14	0.23
Brown Mottled Terrace	L	5.25	0.75	0.08	14.0	5.2	2.3	11.39	3.15	0.85	0.20	0.31
Brown Hills	SL	4.35	0.76	0.09	30.0	1.8	1.2	9.29	0.52	0.21	0.16	0.02
Peat	SiC	6.18	2.48	0.22	45.0	283.0	4.1	31.2	16.6	3.52	0.3	1.00

* SL: Sandy Loam, C: Clay, L: Loam, SiCL: Silty Clay Loam, SiL: Silt Loam, SiC: Silty Clay.
Source: Soil Of Bangladesh, CERDI, 1983.

8. FOOD SITUATION

Agricultural production in the Northeast Region has increased over the last ten to fifteen years. There has been an increase in rice production which accounts for 98% of the total cereal production. The major reasons for this increase include: expansion of irrigated area, increasing yields per unit area of land due to introduction of HYVs, increasing HYV yields through improved cultivation practices and input use, availability of inputs, and improvement in agricultural extension services. There has been a slight increase in annual per person production of pulses and oilseeds. However, agriculture production in the Region is vulnerable to flood damage. Livestock production has increased.

In the early 1980's, the Region produced 3.01 million tons of cereals for its 14.1 million people. In the early 1990's production reached 3.36 million tons while the population increased to 17.5 million. Therefore, per capita per year production of cereal crops is estimated to have declined from about 213 kg per annum in the early 1980's to about 192 kg per annum in the early 1990's.

In the light of these changes, the current food situation in the Northeast Region is summarized below. While this assessment does not cover all food items, the food groups that are discussed represent the bulk of the diet of the population in the Region.

8.1 Cereals

Total cereal production in the Region increased at an average annual rate of 1.9%, from 1.88 million tons in 1959/60 to about 3.38 million tons in 1991/92, passing the two million mark during the early years of the *green revolution* in the country. Although the absolute level of cereal output has been increasing in the Region, it's rate of growth has declined from 2.7% a year in the 1960s to about 1.0% in the 1980s.

The average cereal production during 1989/90 to 1991/92 appears to be slightly more than the food grain requirements. Data in Table 8.1 shows that the Northeast Region produced adequate cereals to meet the regional food grain needs during the same period. Availability of food grain in the Region, however, is heavily dependent on nature which is very unpredictable.

In the national context, food grain production during the years from 1989/90 to 1991/92 in Bangladesh reached record levels, with the aggregate cereal output averaging 19.044 million tons a year. However, based on the 1991 Census population of 109.88 million, the figure suggests that domestic production of cereals has lagged behind growth demands.

8.2 Livestock

The latest data available on livestock production (1983-84 Livestock Census) indicates that the output of livestock products has grown, but not as fast as population. The rate of livestock increase has been slower than that of cereal production. The Region increased poultry meat output faster than goat meat. The reported increase in the number of cattle is well below that of demand.

8.3 Role of Cereals on Diet

According to the 1988-89 household expenditure survey, cereals provide about 80% of the calorie intake. Vegetables, oilseeds and pulses, the next largest contributors to calorie intake, account for 5.8%, 4.0% and 3.5% of the average calorie supply, respectively. Fish contributes 2.3% to calorie intake, and meat, milk and eggs only 1.9%.

2 80.

Table 8.1: Population, Cereal Production and Net Availability of Foodgrain

Country/ Region	Population (1991)		Cereal Production[a]		Foodgrain (million tons)	
	Million	Percent	Million tons	Percent	Net Availability[b]	Requirement[c]
Bangladesh	109.88	100.00	19.04	100.00	17.14	18.19
NE Region	17.53	15.95	3.32	17.43	2.99	2.90

a: Average for 1989/90-1991/92 all cereal production, BBS 1993.
b: Total cereal production minus 10% for seeds, feed, wastage, etc.
c: Calculating 16 ounces per capita per day for the total population in 1991.

Cereals provide more than 62% of the protein intake. The contribution of fish to protein supply is about 12%, pulses nine percent, vegetables seven percent, and animal food five percent.

The considerable share of cereals in the calorie and protein intake of the people in the Region demonstrate the significant role that these food items assume in the Region's food and poverty problems.

In the household expenditure survey it was found that the poorest decile of the population spends 75 to 80% of its income on food. Based on this level of expenditure, this group is considered to be at severe nutritional risk and is likely consuming less than 80% of the minimum calorie requirements. The average household was found to spend about 60% of its income on food, a level associated with being faced with deprivation and chronic or seasonal under nutrition. These circumstances demand that the Region should not only strive to fill the gap between demand and supply of food but also ensure an increasing level of nutrition for its growing population.

8.4 Demand for Rice

The growing population and expansion of industries in the Region and in the country continuously demand more food and commercial crops. Although production of major food crops has improved in recent years, the gains have not kept pace with increasing demand. As a result, the country is an importer of foods causing a heavy drain on its economy. In 1991-92 the cereals import was 1.56 million tons. In 1992-93, the initial target of cereal import was fixed at 1.8 million tons which was about 10% of the national cereal requirements.

The production of major staple food crops would need to expand at relatively faster rates than has been achieved in the past if the projected food gaps are to be filled by the Region itself. The 1988-89 household expenditure survey found that average per day intake of food is 869 g, of which rice provides 51%. In the rural area, the intake is 6 g less than the average, but rice provides 52% of the total intake. In the same survey the income elasticities for rice were found to be high (over 0.8) for the lower decile, reflecting the poverty that exists and the fact that a large share of any additions to income of the poor goes for rice consumption. The price elasticities for rice were also high for the lower decile (again over 0.8).

The people of Bangladesh eat rice as the staple of choice, and shifting of taste to other cereals is a gradual process, particularly amongst the poor. This was evident in the household expenditure survey by a low substitution factor between rice and wheat by the lower income groups.

There are advocates of decreasing the price of rice by up to 15% as a means of addressing the nutritional needs of the poor. There are indications that this would increase demand for rice by up to 12%, and a significant part of increased consumption would be by the poor. This will require continuous efforts in increasing rice production, together with improved methods for getting food to the poor.

8.5 Rice Production Constraints

There are a number of constraints impeding the rapid increase of the country's food grain production. The most serious is the ever present risk of floods. The Northeast Region suffers from this natural hazard almost every second year. During the past decade 2,000 to more than one million tons of cereal production were lost each year by floods, heavy rainfall, hailstorms, and cyclones. More than 99% of the cereal production lost was rice. Damage of the crop by frequent floods were the major causes of the loss. The floods of 1987 and 1988 were very severe. Almost the entire floodplain went under water. Flooding creates a precarious food situation in the Region. Food grain deficit can reach as high as 0.34 million tons a year (Table 8.2) based on the 1991 population and foodgrain requirements of Table 8.1.

There are other constraints which limit foodgrain production. These include: a highly skewed pattern of land ownership, lack of high-yielding crop varieties suitable for specific land types, lack of quality seeds, draught power shortages, inadequate credit and market facilities, and an inadequate research programme and extension service.

8.6 Rice Production Prospects

While it may not be possible to quickly overcome some of the constraints discussed above, there is ample scope to increase rice production in the Region. Average rice yields are 1.6 ton/ha. Fertilizer consumption has reached only 83 to 98 kg per ha per year. The HYVs cover only about 42% of the total rice cropped area.

The goals of the agricultural development policy in Bangladesh are to increase the output per unit area of land. Self-sufficiency in rice production is a long standing policy of the Government. The rice production plan of the Government places major emphasis on development, control and efficient utilization of water resources. This includes both structural and non-structural measures. Increases in HYV areas by replacing low-yielding traditional varieties and increasing the cropping intensity would also contribute to the goals.

During the Fourth Five Year Plan, emphasis was given to the expansion of HYV area and irrigation. Expansion of irrigation will bring a substantial increase in yields per unit area of land during the dry season. It will also contribute to higher cropping intensities and diversification of cropping patterns.

Table 8.2: Net Availability of Foodgrains in Flooding Years

Year	Net Availability (million tons)
1983-84	2.66
1984-85	2.77
1987-88	2.79
1988-89	2.56

Source: BBS 1987, 1989 and 1993.

The World Bank forecasts that Bangladesh's population will be 181 million in 2015. This suggests that the country's rice production will have to grow to at least 33 million tons to feed the projected population. Moreover, the Bangladesh population is forecast to continue to grow for at least the next 50 years, by which time there will be perhaps 240 million people. To feed this population the country's rice production would have to increase further to 44 million tons a year.

It is recognized that without the introduction of HYVs, rice production could not have increased substantially. At present the HYVs occupy about one-half of the rice cultivated area and produce two-thirds of the total rice production in Bangladesh. Under the present agro-ecological environment, HYVs could be used to increase rice production by 20 to 25% by increasing yield levels, input use, and expanding irrigation. IRRI is experimenting with new breeds and is reportedly developing a new variety using advanced bio-technology. The new variety is designed to produce a hefty panicle with vigorous roots and genetic resistance to a multitude of diseases and insects. Its yield is reportedly about 40% higher than present maximum HYV outputs. However, under the present agro-ecological environment in the country, where about two-thirds of the total cultivated land is seasonally flooded, the new variety alone may not be able to produce the future rice requirements. Thus, to feed the growing population advances in agriculture must proceed on several fronts in Bangladesh and the Northeast Region.

9. REGIONAL ISSUES

The Northeast Region accounts for 17% of the Bangladesh's area, 16% of the population, and 12% of agricultural households. Per capita income of the farmers in the region is below the national level. The region contributes about 15% of the GNP. Total cropped area is 2.3 million ha of which 1.9 million ha is allocated to rice. The rice is mostly rainfed (about 70% of the total rice cropped area).

Two-thirds of the total cultivated land in the Region is medium to deeply flooded for more than six months of each year. With a cultivated area of 16,000 sq km and an estimated population of 17.5 million, this indicates a population density of 11 people per hectare, or about 0.09 ha of land available per person for food production. In some areas, the population/land equation is far in excess of the average. The high population/land pressure and a primary dependence on unpredictable crop harvests pose significant physical constraints to crop production. These and other considerations are summarized below.

9.1 Floods

Deep flooding together with early floods and flash floods restrict crop production in many areas. Crops are extensively damaged by floods in the pre-monsoon season when boro is in the reproductive or ripening stage, and aus and deepwater aman are in the early vegetative growth stage. Floods damage transplanted aman extensively in the monsoon season when the plants are at the tillering stage. Late floods prevent the cultivation of rice in the transplanted aman season in many areas. Farmers can not use, or are reluctant to use, HYVs, fertilizers and other inputs because of the ever present risk of floods. Thus, unstable food production and low crop yields are common in many parts of the Region.

9.2 Slow Drainage

Slow drainage delays the transplanting of rice in the aman and boro seasons. It also delays the sowing of dryland rabi crops and may prevent these crops from being grown at all in low-lying depressions during years when late floods keep the soils wet until late December and January.

9.3 Draught Power Shortage

Many areas suffer a shortage of draught power for land preparation. Small and marginal farmers and share-croppers are most affected by draught power shortages. Peak shortages are reported in the short period of transplanted aman land preparation after the aus harvest. Timely tillage, and proper tillage depths are not achieved. Traditional land preparation in transplanted rice cultivation involves ploughing and puddling, requiring substantial draught power as power-tillers are not used for puddling.

9.4 Availability of HYVs

Present crop varieties and cultural practices are not ideal for rainfed lands. This is most noticeable in the case of rice. The new technology was tailored to a "congenial" production condition, i.e. irrigated areas. But only 30% of the rice area in the Region is irrigated. Most fields, including both upland and lowland areas, are only rainfed. The HYVs that have been developed up to now have not given the desired range of acceptability for the variety of adverse agro-climatic conditions found in the Region. The lack of a short duration HYV to replace the short duration local aus, photoperiod sensitive local transplanted aman, and cold tolerant local boro varieties is the major constraint to expanding the HYV area in the Region. Neither is a short duration HYV available to replace local deepwater varieties. Introduction of HYVs with the present growth duration in low-lying areas is difficult due to late drainage and early flooding. Some farmers cultivate HYVs in the boro season by adjusting the planting date, but this is risky due to the unpredictability of flooding. No short duration HYV is available to replace local boro grown under wetland conditions.

HYVs are not preferred by all farmers. Important considerations for choosing rice varieties include agronomic characteristics, yield, size and shape of grain, and cooking and eating quality. Where HYV can be produced, local varieties may be preferred for their fine quality, even though yield is low.

9.5 Cultural Practices

Soil and crop management are poor. Puddled top soil and strong ploughpans in soils used for transplanted aman cultivation, prevent or restrict rabi crop cultivation in a large area. Green manure and farmyard manure (mixture of animal excreta and crop residues) are rarely applied to the fields. After the rice harvest, some farmers leave straw or stubble with varying lengths. Long stubble is usually left in the big farmers' fields. Small farmers collect as much rice stubble as possible for thatching or other purposes. Few farmers know that rice stubble provides NPK to the fields. Cultivation of crops which fix the nitrogen in the soil is limited. The importance of dhaincha (*Sesbania* sp.), sun-hemp, cow pea, black gram, mung bean, soy bean and other green manuring and leguminous crops in maintaining productivity and fertility of soil is not well known. There is no strategy to encourage farmers to use technologies that increase productivity while conserving the soil. Farmers are poorly educated about the need for good soil management and effective crop management for maintaining soil fertility and achieving reasonable yields. Crop rotation, and mixed farming are not practised to control pests. Large-scale participation of rural communities is needed for integrated pest management, rather than the widespread use of pesticides. The use of old and unhealthy seedlings is common. Seedlings are usually raised a good distance from the main fields and are damaged during transportation. Excess seedlings, which become old and unhealthy, are frequently sold to other growers. The low price attracts small farmers. Old and unhealthy seedlings increased the growing time.

9.6 Monoculture

Rice production has increased substantially but the production of non-rice crops such as vegetables, potato, pulses and oilseeds has not increased proportionately. Many areas, where dryland rabi crops were grown after the harvest of aus or deepwater rice, have been converted to single HYV boro lands. If one crop is grown continuously on the same land, the soil becomes depleted of certain nutrients and crop yield decreases. Moreover, converting production sites for one crop means that planting and harvesting are no longer staggered throughout the year. Employment opportunities are therefore limited to the cycle of one crop.

9.7 Decrease in Deepwater Rice Culture

Wherever irrigation can be provided farmers are converting marginal lands from deepwater aman production to HYV production in the winter season. Before this conversion, farmers would grow deepwater aman varieties in the monsoon season and dryland rabi crops in the winter season. Though higher rice yields can be obtained, the disadvantages of the new system are: (1) there are difficulties in providing capital intensive irrigation facilities to such areas, (2) crops such as pulses, oilseeds and wheat which can be cultivated during the dry season with residual moisture are eliminated, and (3) crop intensity is reduced because the land will remain completely fallow during the monsoon season. Emphasis should be given to the technology needed to improve the production of deepwater aman. A thorough understanding of current practices and problems in deepwater rice areas is necessary. Deepwater rice followed by winter crops using residual moisture can provide high returns, and triple cropping is possible where soil and environmental conditions are favourable.

9.8 Weed Infestation

In the local boro areas where perennial grasses are present, poor land preparation or zero tillage treatment increases the incidence of weeds. Weeds cause two types of rice losses. The more important one is the direct loss resulting from competition. Second is the loss due to reduced rice quality. The farmers also suffer losses because of the relatively high cost of weeding before land preparation.

9.9 Preservation and Management of Seeds

Lack of knowledge on simple storage and preservation techniques results in a loss of seed stock. The importance of drying seeds for storage to less than 14% moisture content is not sufficiently stressed in the extension programs. Moreover, very heavy rainfall, persistent cloudiness in the monsoon season, and a lack of space, hampers drying ability.

9.10 Inadequacy of Research Program

Improvement of crop varieties has received more attention than improved cultivation practices in Bangladesh. Farming systems research is still in its infancy. On-farm testing was initiated only a few years ago. Soil and water conservation, utilization, and management research is yet to be initiated. Variety improvement has been directed towards increasing yields and resisting pests; breeding of varieties for specific local conditions remains secondary. Farmers' need of appropriate technologies for all aspects of the agricultural production system has not been considered. Labour intensive farming is needed so that the increasing farm labour force can be employed. More research is needed for the development of farm level technologies on production, harvesting, handling, storage and processing. This would help rural people to develop small-scale workshops and factories and has the potential to absorb more workers.

9.11 Inadequate Extension Service

There has been a bias in the extension service towards the affluent farmers. However, small farmers are in the majority and without their active participation full improvement in farm productivity is not possible. Similarly, the extension services have not paid much attention to the rural women who actively participate in agricultural works. There is no arrangement for extension work to communicate the improved methods and practices to them. Lack of an effective linkage between extension service and agricultural research is also noticeable. Extension field workers are not familiar with the latest recommended farm practices. The lack of sufficient extension workers also results in poor motivation among the farmers.

9.12 Infrastructure

In many areas farmers are not able to adopt new technologies due to a lack infrastructure. Many of the rural areas of the Northeast do not have proper access to good road and rail networks, electricity, communication networks, rural credit facilities, large scale fertilizer and pesticide distribution facilities, marketing systems for crops, and agricultural research and training networks. The lack of good road communications in the interior of the Region, especially in the pre-monsoon and monsoon seasons, make it difficult to provide government and commercial services.

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9.13 Land Ownership

Uncertain land ownership and dominance of big and absentee land owners are constraints to crop production in many areas. Big land owners and absentee land owners are generally uninterested in intensifying agricultural production. The 1985 BIDS and IFPRI studies suggest that the yield per unit area is low for land owned by larger farmers. Often they leave considerable land unplanted. These studies demonstrate that larger land owners are often inefficient farmers.

9.14 Conflict

Conflicts between fishing and agricultural interests for use of water in the rabi season restricts crop production in low-lying areas. This can be a major problem for boro cultivation in *haors* and flood basins.

9.15 Credit

Increase in the HYV rice cropped area indicates the farmers' willingness to use modern agricultural inputs and credit. There are several credit institutions that finance loans to farmers, the most important being the agricultural and commercial banks. However, these credit institutions are not receptive to farmers needing larger loans. Bureaucratic formalities complicate the loan applications and farmers cannot get loans at the right times or in adequate amounts. Two or three months are required to get loans, and few farmers can submit all the documents the banks require. The eligibility criteria are not appropriate for illiterate farmers. Many small and marginal farmers, including share croppers, borrow from moneylenders, with exorbitant rates of interest. At harvest time, when rice prices are at their lowest, many farmers are forced to sell much of what they produce in order to pay back the moneylender.

Comprehensive credit programmes are also needed for the development of agro-based, small-scale workshops and factories. Some of the increasing farm population can be absorbed by developing small factories and workshops in the rural areas to make farm implements and basic consumer goods.

10. STRATEGY

Agriculture remains the largest sector of the economy, occupying 70% of the employed labour force, and producing nearly half of the Northeast Region's economic output. Accelerating the growth rate of agricultural production is essential to supply food for the population, provide raw materials for emerging industries, and create employment opportunities.

An analysis of the agricultural performance and issues in the Northeast Region reveals strong complimenters between land use and water control. This implies that there are opportunities and potentials for increasing agricultural productivity through controlled supply of water i.e., flood control, drainage and irrigation.

The government has initiated a shift in its approach towards more scientific and sustainable agricultural production. This includes improved availability of inputs, long- and short-term credits and irrigation equipment. In view of these steps, the prospects are now encouraging for rapid agricultural development in the Northeast Region through appropriate water control and management.

The agriculture in the Northeast Region has a special characteristic; most of the farms are small and mainly produce rice. The agriculture process here needs to be directed for the increased production of non-rice crops, livestock products, fodder, fuel and other commodities. Water control and management has an important role to ensure maximum agricultural land use, diversified production, and higher output per unit area in order to raise the level of well-being of the entire community - of farmers, the rural landless who depend on them for employment, and of the urban customers who rely on them for food. It is expected that the diversification of agriculture and improvement of the present farming systems in the Region will be accompanied by the adoption of modern agricultural technology, and a more intensive use of labour. This will increase employment, generate higher incomes, and ultimately bring an overall improvement in the quality of life of the people. However, it is assumed that advances in agriculture will also be accompanied by other Government of Bangladesh programmes, including population control and poverty alleviation which are priority activities of the Government. In consideration with the physiography and agro-ecological characteristics in the Region, these objectives can be achieved by the following strategic thrusts (Figure 7).

Intensive Agriculture

The agro-climatic conditions in the western part of the Region are favourable for intensive agriculture. The area is close to Dhaka mega-urban city. The market forces in the city can create an agriculture intensive zone in this area. A potential for intensive agriculture also exists in Sylhet Region. The private and public initiation and investment in agriculture, therefore, should focus on these areas where much higher returns on investment are possible through market gardening and intensive livestock production. However, drainage, and in some cases flood protection (in seasonally flooded areas) is needed in support of this activity.

High Risk Agriculture—Integrated Farming in Deeply Flooded Areas

In deeply flooded areas agricultural production is high risk. Here the crops are threatened by flooding in most years. Present farming systems need to be improved and diversified to increase agricultural production. Currently rice production is the primary focus in this area and the potential for livestock, forestry and fishery has been largely ignored. To take advantage of the aquatic environment prevailing in the deeply flooded area, closer integration of crops, livestock, fish and multi-purpose trees is needed for the present farming system to increase productivity. Livestock production needs to be enhanced through the study and improvement of locally available feeds, fodder, and supplements. Information-based technologies are required to raise farm productivity, perennial trees and mixed cropping or crop-livestock systems. It would provide a sustainable alternative which would produce higher incomes from much smaller areas. Applied and adaptive research are needed to design integrated farming systems. These studies should include understanding of the present farming systems, on-station research, testing, and pilot production programme.

Low Risk Agriculture—Diversified Farming in Western and Eastern Seasonally Flooded Areas
Increased rice production in all the crop seasons is desirable. Higher output in the wet season may relieve the pressure for growing rice in the dry season. This may lead farmers to shift from rice-only production to higher value non-rice crops which require small investments, low management, and a reduced share of irrigation water. The most promising areas for this type of diversified farming are the seasonally flooded lands in eastern and western parts of the Region where agro-climatic conditions in the monsoon season are favourable for growing HYV rice, and crop production is only moderately exposed to flooding. However, full or partial flood protection needs to be provided in some areas. There is also need for increased surface water and ground water irrigation. These interventions would assist in the diversification from rice to crops, such as vegetables, pulses, oilseeds, food and forage crops, quick growing fodder crops, and perennial shrubs/trees. By-products of crops (rice straw, non-rice crops residue, bran and oilcakes) and more fodder and forage production would increase resources for cattle, goats, and poultry. Promotional work on post-harvest matters such as processing and preservation, storage and marketing would be needed to increase the non-rice cropped area and livestock production.

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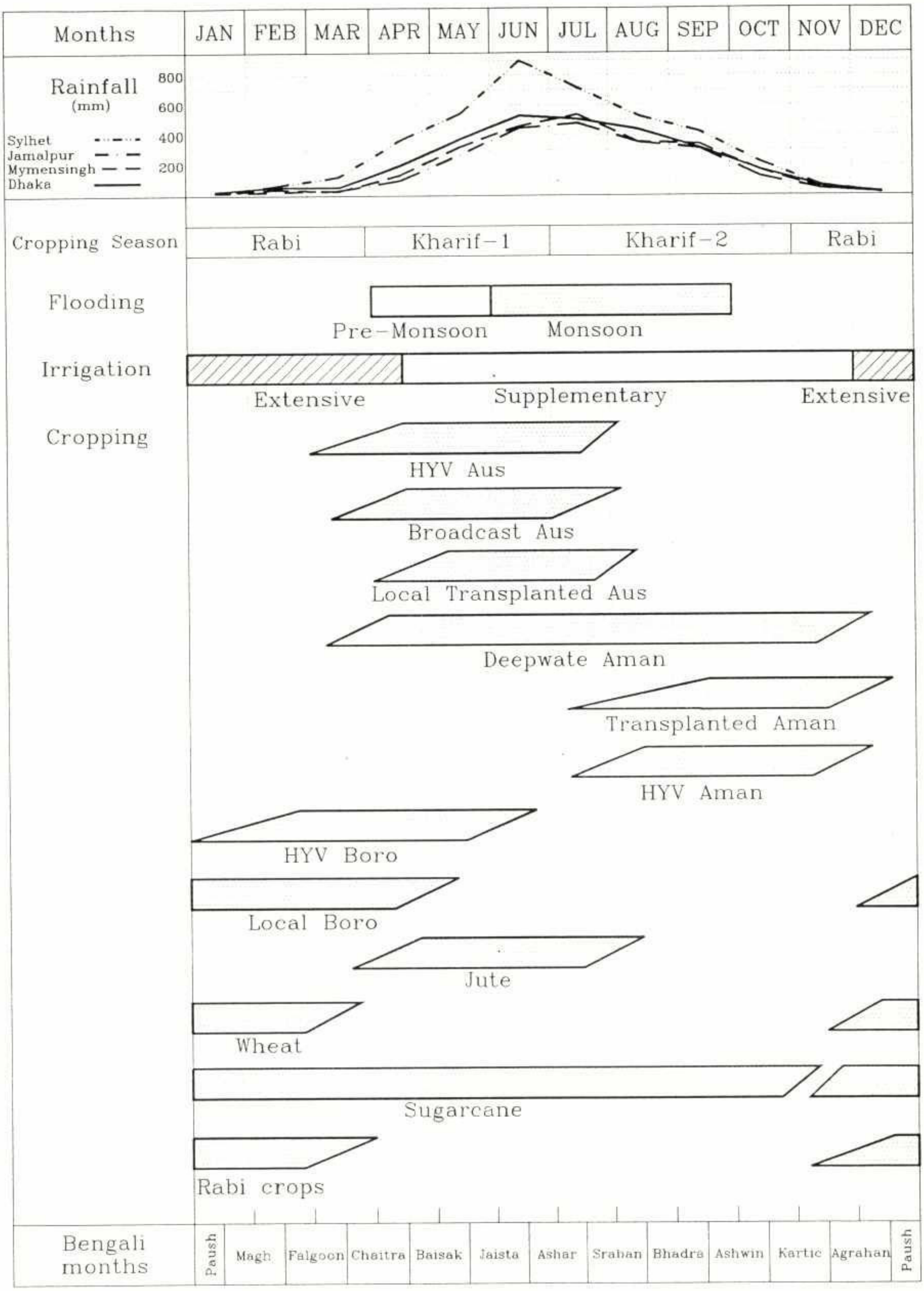
ANNEX A

FIGURES

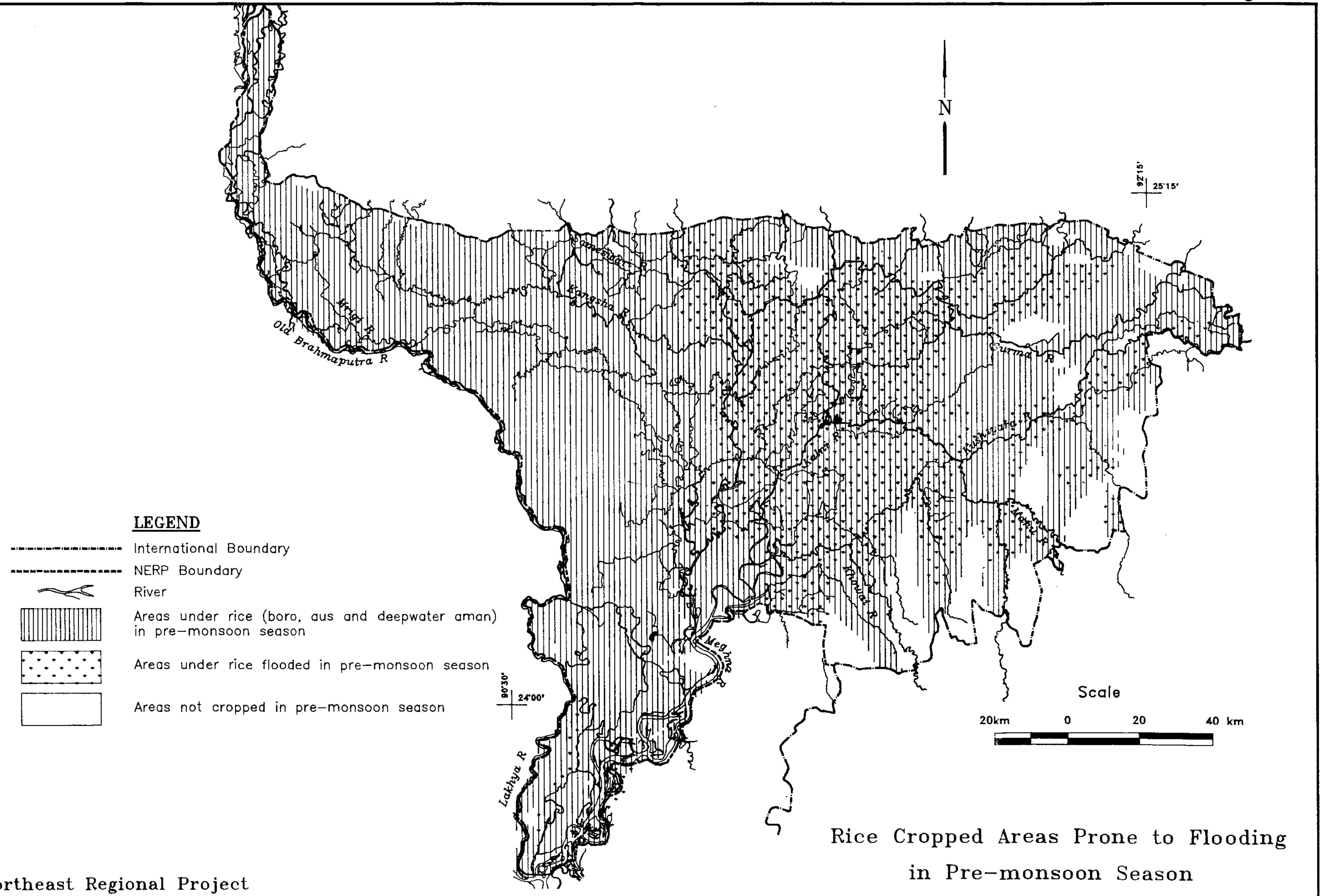
Figure 1



Major Cropping Pattern and Crop Calendar Showing Relationship between Rainfall, Flooding and Irrigation

Northeast Regional Project

Figure 2a

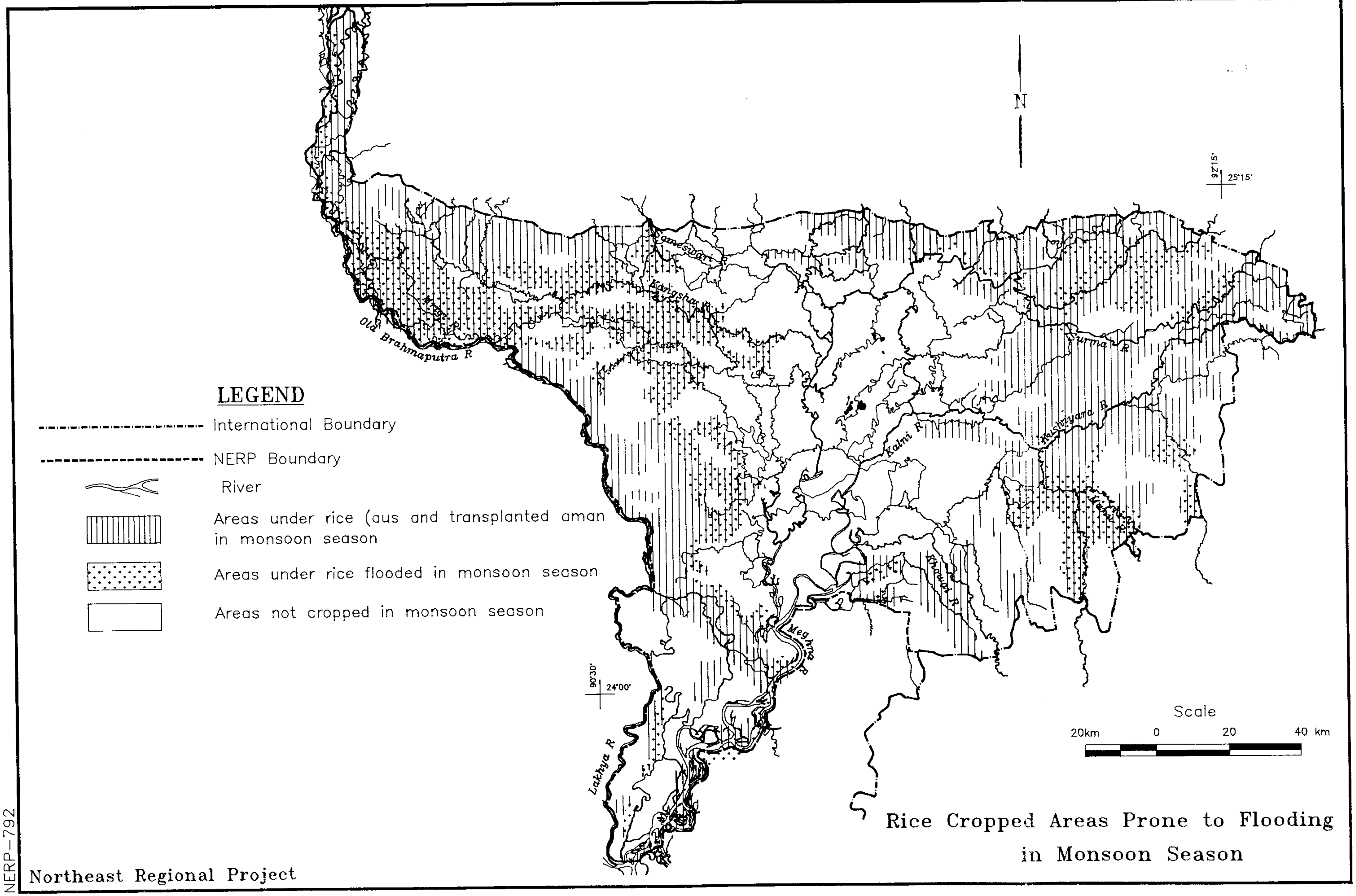


Rice Cropped Areas Prone to Flooding in Pre-monsoon Season

NERP-791

Northeast Regional Project

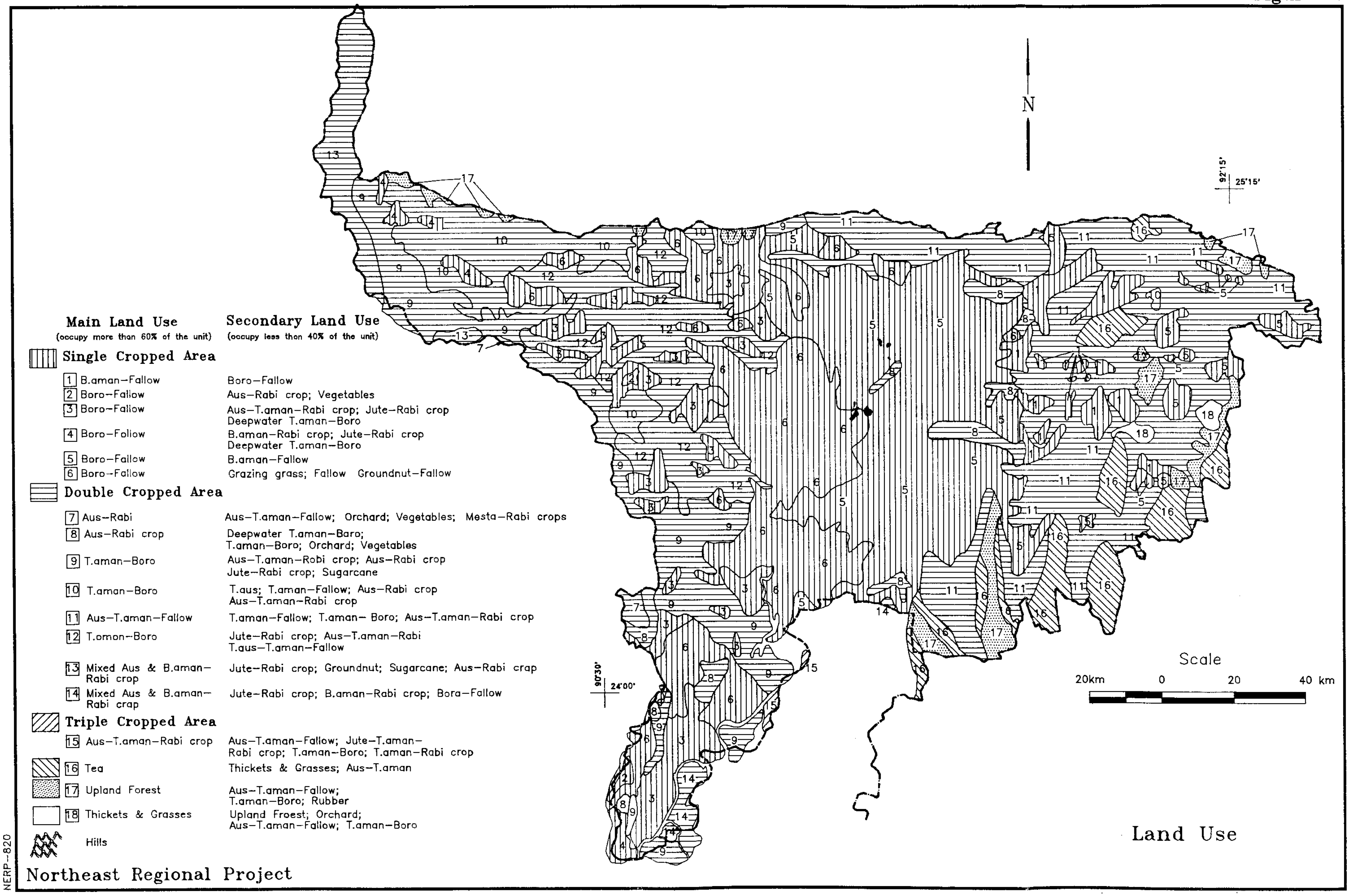
Figure 2b



Rice Cropped Areas Prone to Flooding in Monsoon Season

NERP-792

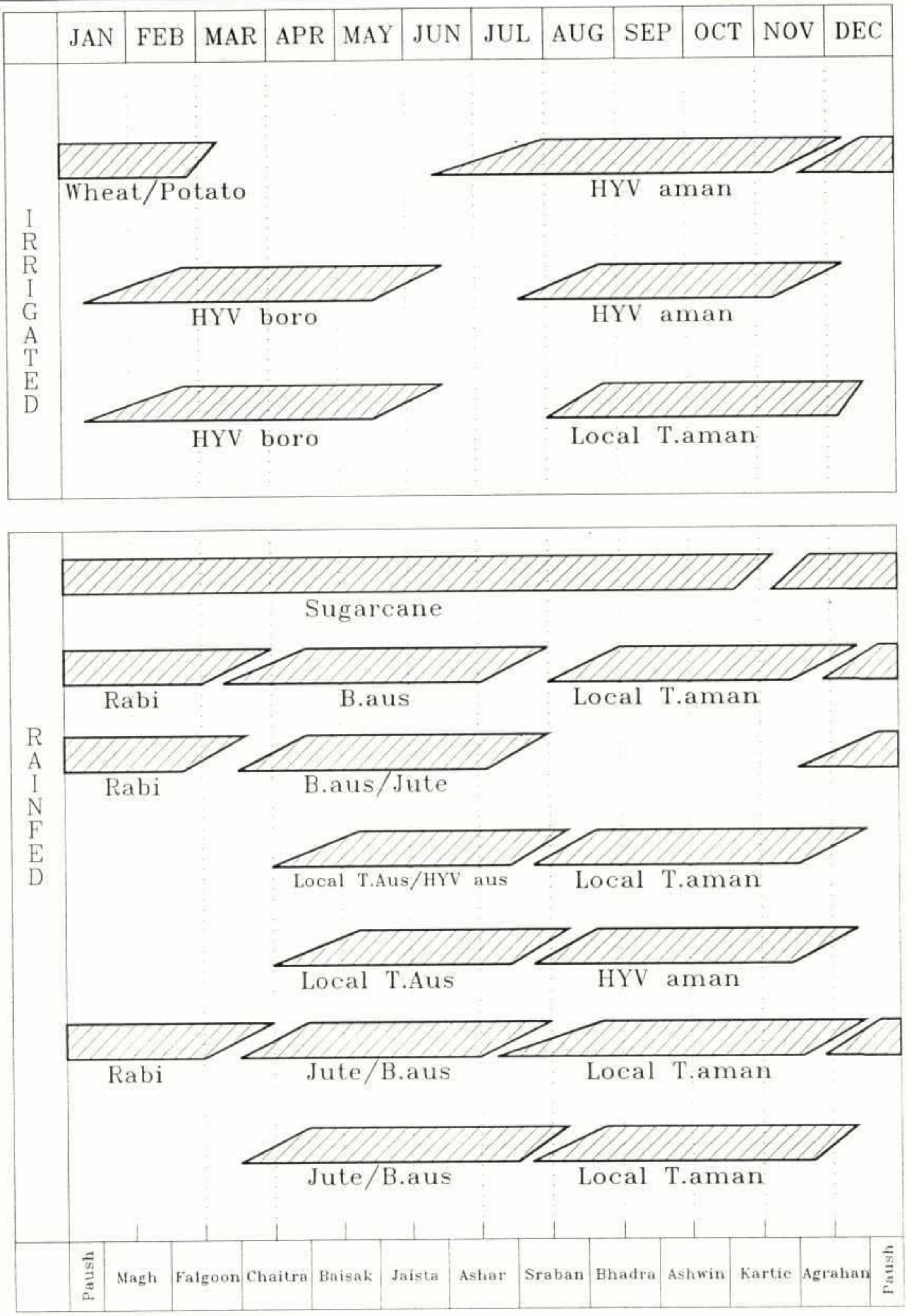
Figure 3



Land Use

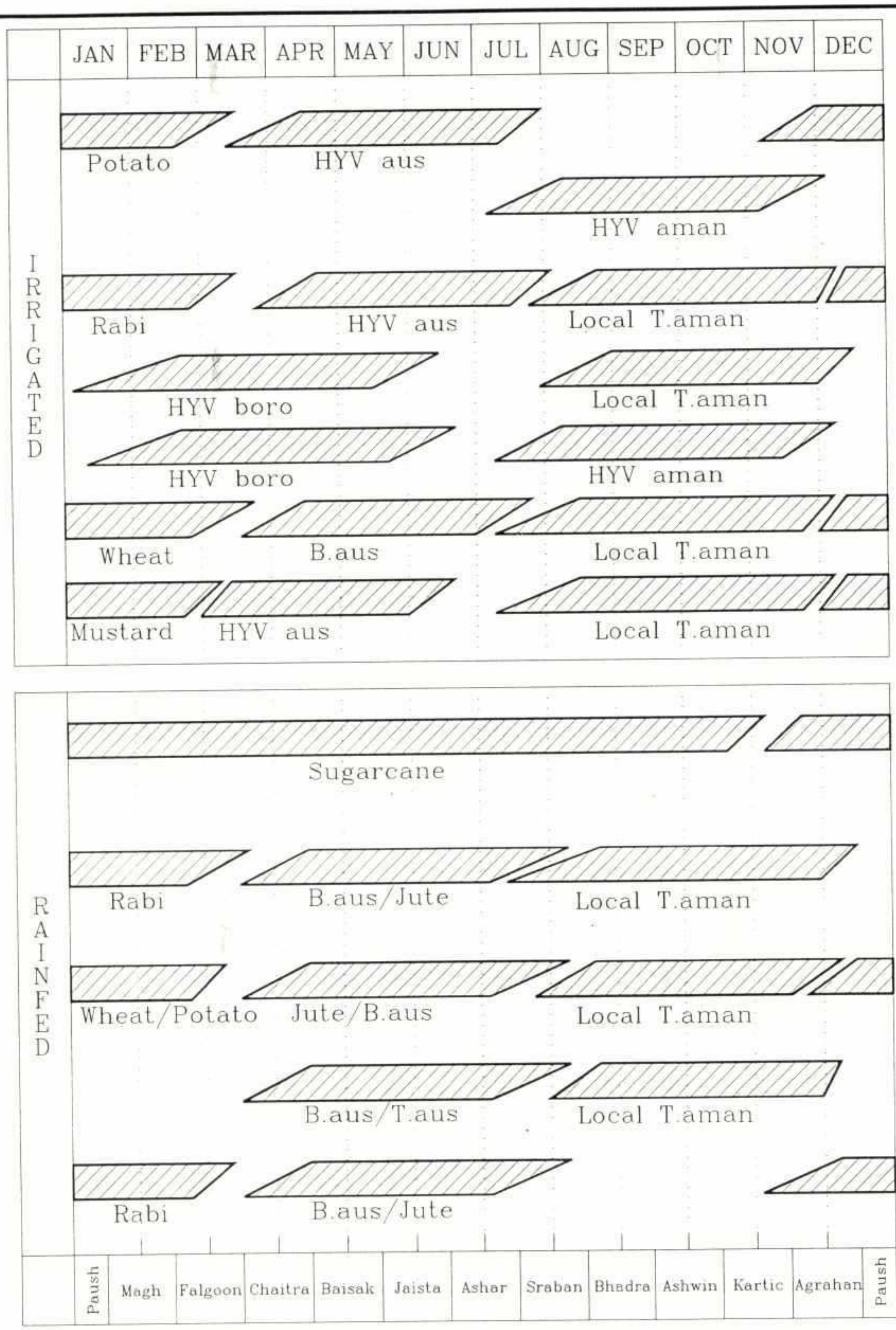
Northeast Regional Project

NERP–820



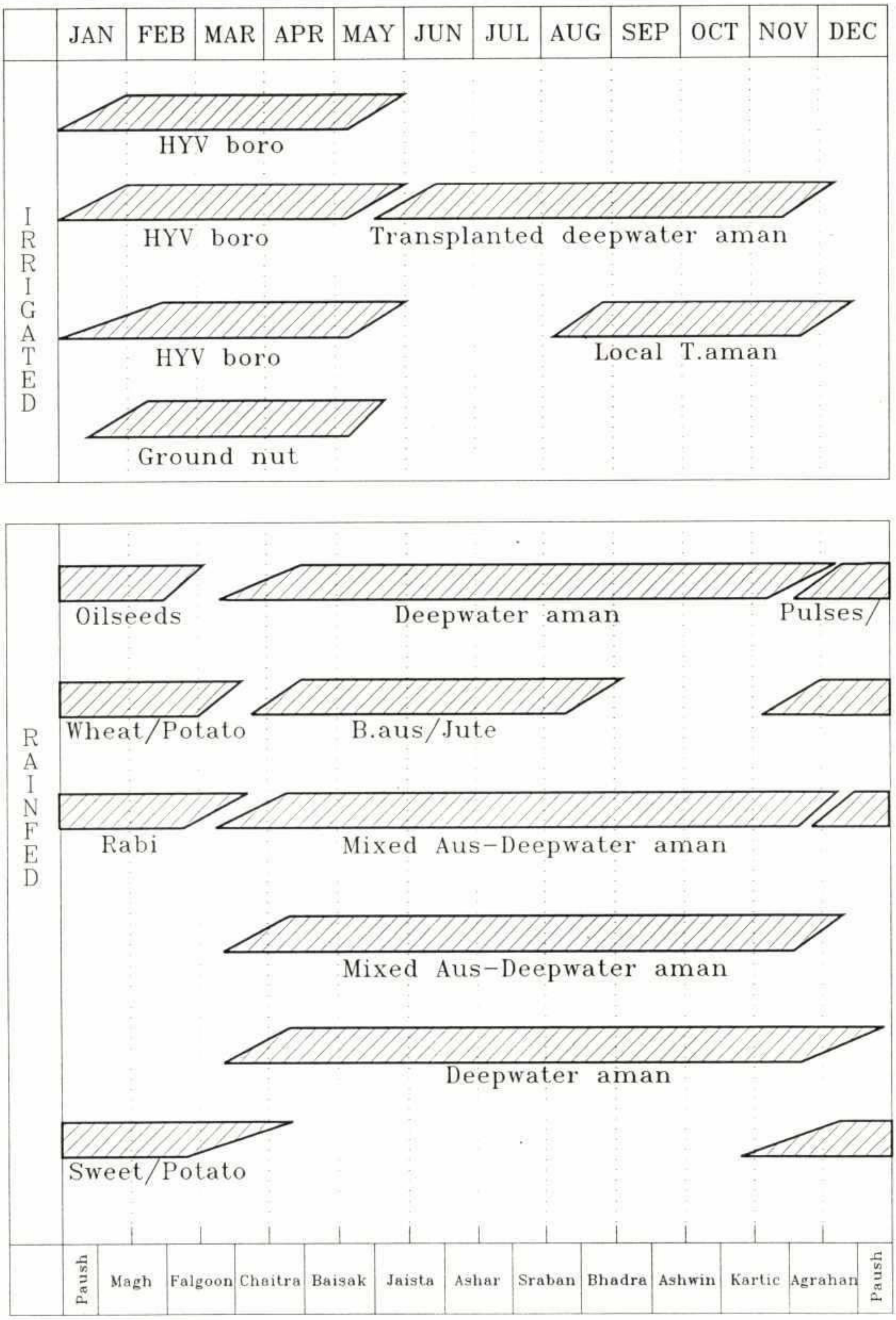
Major Cropping Patterns and Crop Calendar High Land (F0)

Northeast Regional Project

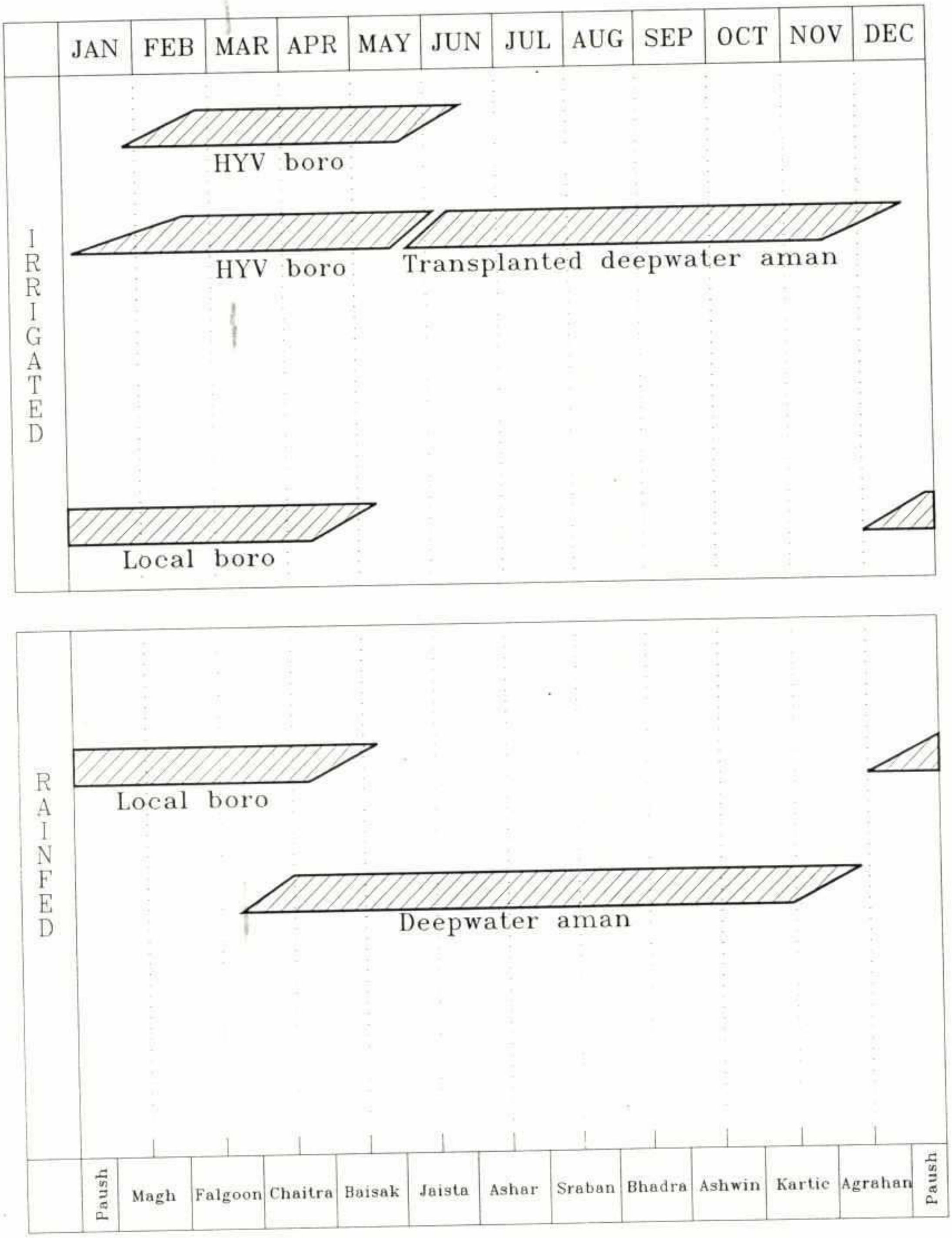


Major Cropping Patterns
and Crop Calendar
Medium Highland (F1)

Figure 4c.

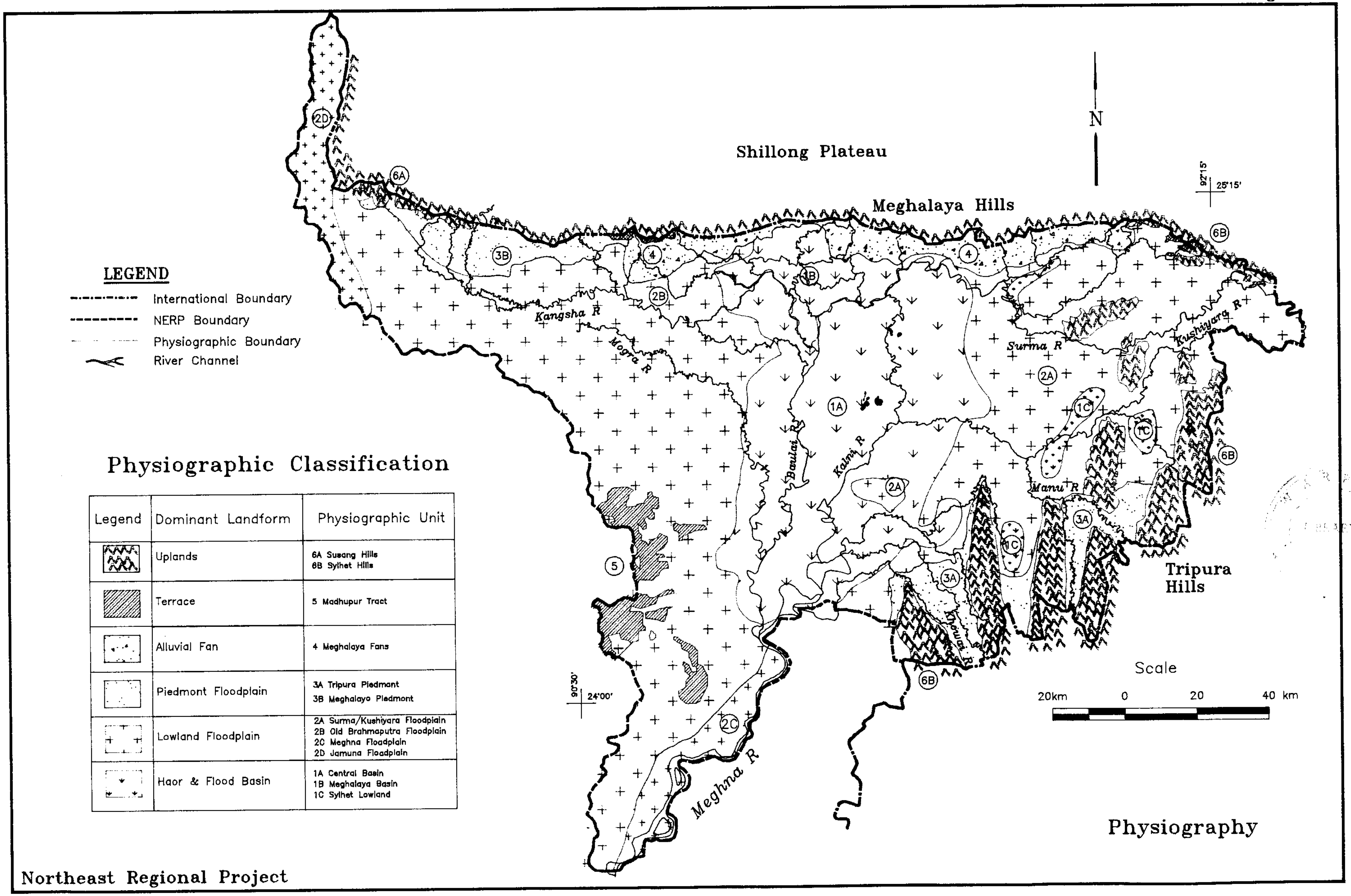


Major Cropping Patterns
and Crop Calendar
Medium Lowland (F2)



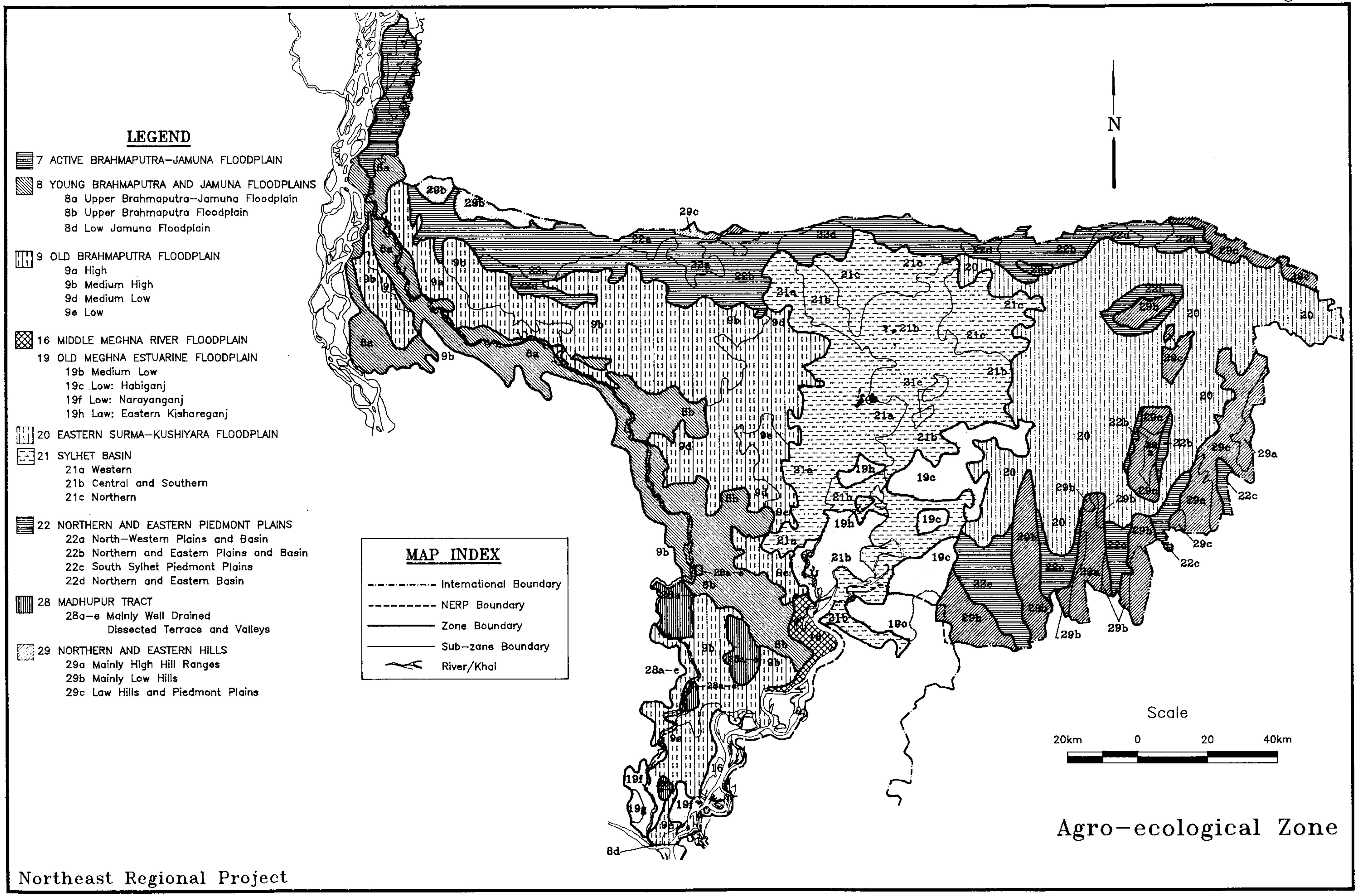
Major Cropping Patterns
and Crop Calendar
Low Land (F3)

Figure 5



Legend	Dominant Landform	Physiographic Unit
	Uplands	6A Susang Hills 6B Sylhet Hills
	Terrace	5 Madhupur Tract
	Alluvial Fan	4 Meghalaya Fans
	Piedmont Floodplain	3A Tripura Piedmont 3B Meghalaya Piedmont
	Lowland Floodplain	2A Surma/Kushiyara Floodplain 2B Old Brahmaputra Floodplain 2C Meghna Floodplain 2D Jamuna Floodplain
	Haor & Flood Basin	1A Central Basin 1B Meghalaya Basin 1C Sylhet Lowland

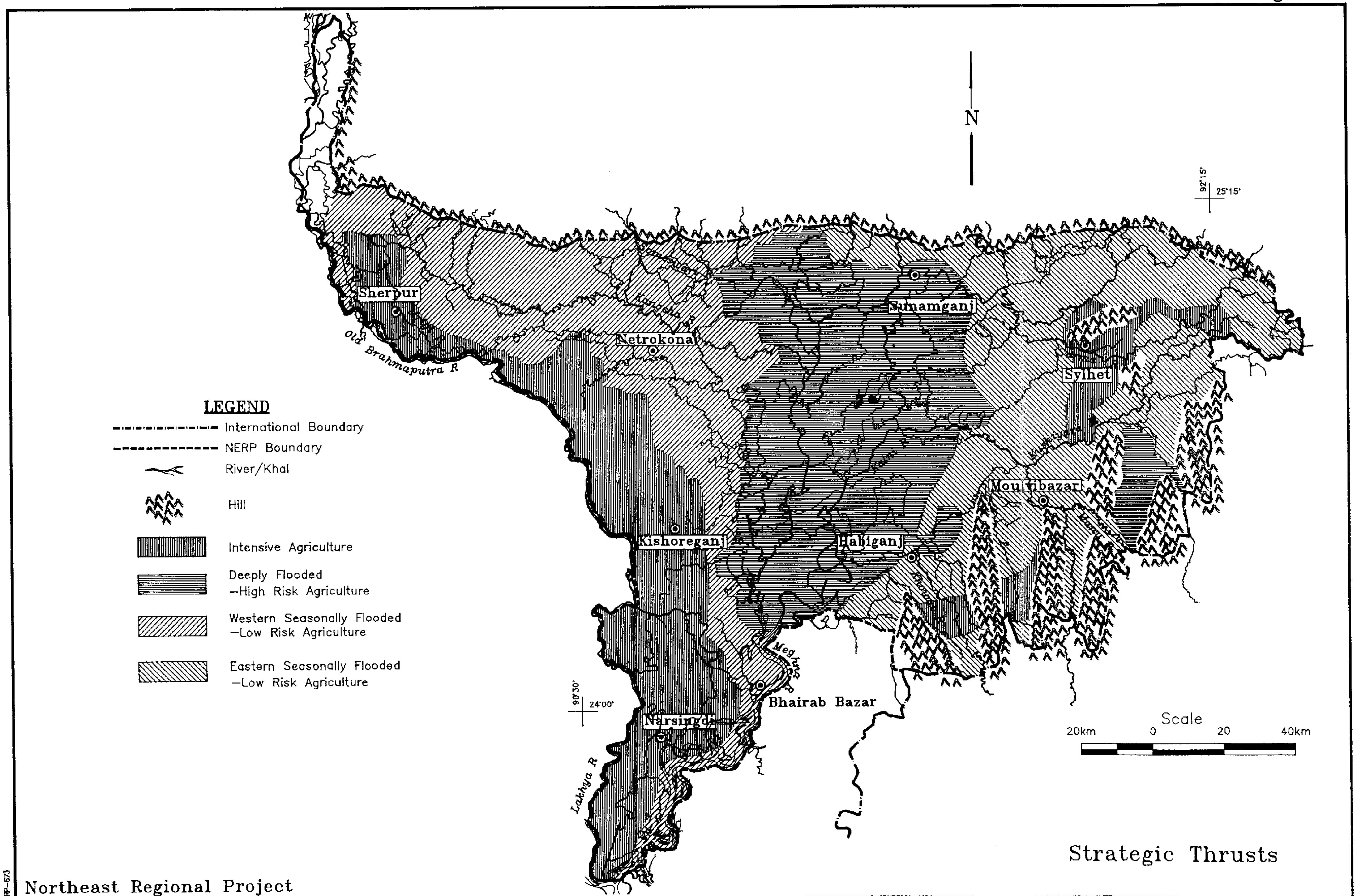
Figure 6



Agro–ecological Zone

Northeast Regional Project

Figure 7



Strategic Thrusts

NERP-673

Northeast Regional Project

ANNEX B
RICE AREA, PRODUCTION AND YIELDS

The regional statistics depict only the part of the region (old district) located in the study area of the Northeast Region.

Table B.1: Total Rice Cropped Area (ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	903019	903481	888816	799452	864503	866655	778587	765135	875750	886492	789678
Dhaka	138740	134126	136420	131940	116863	131242	122707	115589	119773	122832	118594
Jamalpur	212458	213922	204303	210632	198001	193515	191291	168138	172834	173282	177058
Mymensingh	823690	843263	830662	850023	803733	817041	814137	723010	771720	773311	764776
Rangpur	28384	28944	27836	28302	29217	27808	27988	26854	26748	27817	28270
NE Region	**2106291**	**2123736**	2088037	2020349	2012317	2036261	1934710	1798726	1966825	1983734	1878376

Source: Yearbook of Agriculture, BBS.

Table B.2: Total Rice Production (ton)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	1144883	1135893	1158210	1103552	1105196	1150023	1088594	1014416	1211982	1340280	1276332
Dhaka	206997	220035	201068	191454	175753	198970	175930	173467	217378	232054	227259
Jamalpur	257308	288343	263564	296751	289501	298733	296410	266511	289418	297599	319368
Mymensingh	1230270	1268835	1206583	1338564	1261332	1292748	1408657	1253543	1390619	1338735	1409664
Rangpur	37283	38341	37996	39939	44148	43352	44324	44125	49575	50541	51558
NE Region	**2876741**	**2951447**	2867421	2970260	2875930	2983826	3013915	2752062	3158972	3259209	3284181

Source: Yearbook of Agriculture, BBS.

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Table B.3: All Types Rice Yield (t/ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	1.3	1.3	1.3	1.4	1.3	1.3	1.4	1.3	1.4	1.5	1.6
Dhaka	1.5	1.6	1.5	1.5	1.5	1.5	1.4	1.5	1.8	1.9	1.9
Jamalpur	1.2	1.3	1.3	1.4	1.5	1.5	1.5	1.6	1.7	1.7	1.8
Mymensingh	1.5	1.5	1.5	1.6	1.6	1.6	1.7	1.7	1.8	1.7	1.8
Rangpur	1.3	1.3	1.4	1.4	1.5	1.6	1.6	1.6	1.9	1.8	1.8
NE Region	**1.4**	**1.4**	1.4	**1.5**	1.4	1.5	1.6	1.5	**1.6**	**1.6**	1.7

Source: Yearbook of Agriculture, BBS.

Table B.4: Aus Rice Cropped Area (ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	202561	199659	188910	156409	166113	188531	140461	167510	209687	190588	132246
Dhaka	43222	41340	42721	39279	28857	33638	28925	33156	26730	22954	19226
Jamalpur	68362	70855	65279	67510	63345	52046	45595	38457	34657	35774	33637
Mymensingh	244824	255904	247112	241974	224541	215672	233157	175420	164596	153452	154140
Rangpur	10647	11091	9837	10015	9428	7331	6855	5830	4248	4438	4434
NE Region	**569616**	**578849**	553859	515187	**492284**	497218	454993	420373	**439918**	**407206**	**343683**

Source: Yearbook of Agriculture, BBS.

Table B.5: Aus Rice Production (ton)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	247065	199552	171539	155134	160408	226313	174390	222154	258277	264127	179621
Dhaka	45388	48536	45177	40259	31181	36266	27481	27373	27479	22689	18446
Jamalpur	65653	77646	65588	67534	66212	59700	48067	38885	33151	32045	30421
Mymensingh	295323	284305	291248	279848	270272	260185	288399	199035	200609	180618	190326
Rangpur	9584	9434	8181	8114	8550	7226	7277	6380	4602	4557	4488
NE Region	**663013**	**619473**	**581733**	**550889**	**536623**	**589690**	**545614**	**493827**	**524118**	**504036**	423302

Source: Yearbook of Agriculture, BBS.

Table B.6: Aus Rice Yield (t/ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	1.2	1.0	0.9	1.0	1.0	1.2	1.2	1.3	1.2	1.4	1.4
Dhaka	1.1	1.2	1.1	1.0	1.1	1.1	1.0	0.8	1.0	1.0	1.0
Jamalpur	1.0	1.1	1.0	1.0	1.0	1.1	1.1	1.0	1.0	0.9	0.9
Mymensingh	1.2	1.1	1.2	1.2	1.2	1.2	1.2	1.1	1.2	1.2	1.2
Rangpur	0.9	0.9	0.8	0.8	0.9	1.0	1.1	1.1	1.1	1.0	1.0
NE Region	**1.2**	**1.1**	**1.1**	**1.1**	**1.1**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**	**1.2**

Source: Yearbook of Agriculture, BBS.

Table B.7: Local Aus Rice Cropped Area (ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	170761	169380	160169	122911	132669	124300	87378	89922	158359	137669	102026
Dhaka	37408	34912	36888	33074	22698	27766	24851	31116	24281	20812	16099
Jamalpur	59848	60503	57466	59308	55143	45021	40236	35774	34433	33985	32081
Mymensingh	185170	190706	180582	170916	158427	143107	159263	138171	125755	108244	95134
Rangpur	9755	10324	9002	8994	8399	6369	5257	4771	3486	3914	3751
NE Region	**462942**	**465825**	**444107**	395203	**377336**	346563	316985	299754	**346314**	**304624**	**249091**

Source: Yearbook of Agriculture, BBS.

Table B.8: Local Aus Rice Production (ton)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	161122	142910	118195	92431	97912	115673	77447	92421	170094	155346	118859
Dhaka	30416	30524	34877	28809	19792	27197	20675	24454	23950	19160	13394
Jamalpur	46043	51789	50094	47863	46543	48498	39857	34808	32598	29835	28200
Mymensingh	147746	149055	165404	143872	142389	133326	159637	136886	129019	99124	85703
Rangpur	7932	7998	6767	6263	6685	5669	4848	4704	3381	3675	3343
NE Region	**393259**	**382276**	375337	319238	**313321**	330363	302464	293273	**359042**	**307140**	**249499**

Source: Yearbook of Agriculture, BBS.

Table B.9: Local Aus Rice Yield (t/ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	0.9	0.8	0.7	0.8	0.7	0.9	0.9	1.0	1.1	1.1	1.2
Dhaka	0.8	0.9	0.9	0.9	0.9	1.0	0.8	0.8	1.0	0.9	0.8
Jamalpur	0.8	0.9	0.9	0.8	0.8	1.1	1.0	1.0	0.9	0.9	0.9
Mymensingh	0.8	0.8	0.9	0.8	0.9	0.9	1.0	1.0	1.0	0.9	0.9
Rangpur	0.8	0.8	0.8	0.7	0.8	0.9	0.9	1.0	1.0	0.9	0.9
NE Region	**0.8**	**0.8**	**0.8**	**0.8**	**0.8**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**	**1.0**

Source: Yearbook of Agriculture, BBS.

Table B.10: HYV Aus Rice Cropped Area (ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	31800	30279	28741	33498	33444	64231	53083	77588	51328	52919	30220
Dhaka	5814	6428	5833	6205	6159	5872	4074	2040	2449	2142	3127
Jamalpur	8514	10352	7813	8202	8202	7025	5359	2683	224	1789	1556
Mymensingh	59654	65198	66530	71058	66114	72565	73894	37249	38841	45209	59006
Rangpur	892	767	835	1021	1029	962	1598	1059	762	525	683
NE Region	**106674**	**113024**	**109752**	**119984**	**114948**	**150655**	**138008**	**120619**	**93604**	**102584**	**94592**

Source: Yearbook of Agriculture, BBS.

Table B.11: HYV Aus Rice Production (ton)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	85943	56642	53344	62703	62496	110640	96943	129733	88183	108781	60762
Dhaka	14972	18012	10300	11450	11389	9069	6806	2919	3529	3529	5052
Jamalpur	19610	25857	15494	19671	19669	11202	8210	4077	553	2210	2221
Mymensingh	147577	135250	125844	135976	127883	126859	128762	62149	71590	81494	104623
Rangpur	1652	1436	1414	1851	1865	1557	2429	1676	1221	882	1145
NE Region	**269754**	**237197**	**206396**	**231651**	**223302**	**259327**	**243150**	**200554**	**165076**	**196896**	**173803**

Source: Yearbook of Agriculture, BBS.

Table B.12: HYV Aus Rice Yield (t/ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	2.7	1.9	1.9	1.9	1.9	1.7	1.8	1.7	1.7	2.1	2.0
Dhaka	2.6	2.8	1.8	1.8	1.8	1.5	1.7	1.4	1.4	1.6	1.6
Jamalpur	2.3	2.5	2.0	2.4	2.4	1.6	1.5	1.5	2.5	1.2	1.4
Mymensingh	2.5	2.1	1.9	1.9	1.9	1.7	1.7	1.7	1.8	1.8	1.8
Rangpur	1.9	1.9	1.7	1.8	1.8	1.6	1.5	1.6	1.6	1.7	1.7
NE Region	**2.5**	**2.1**	1.9	**1.9**	**1.9**	1.7	**1.8**	1.7	**1.8**	**1.9**	**1.8**

Source: Yearbook of Agriculture, BBS.

Table B.13: Transplated Aman Rice Cropped Area (ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	282376	281943	294706	268144	299347	279210	278187	253454	284490	278521	279559
Dhaka	23875	24165	26468	25222	24768	34186	24502	14895	20404	21730	24587
Jamalpur	101239	99752	95265	89938	88962	91345	85366	70430	80715	81834	87159
Mymensingh	352052	355327	357811	371731	373428	379644	318901	283346	327599	340015	320563
Rangpur	15862	15867	15942	15992	16408	16233	16246	15503	17276	17882	18320
NE Region	**775404**	**777054**	**790192**	**771027**	**802913**	**800618**	**723202**	**637628**	**730484**	**739982**	**730188**

Source: Yearbook of Agriculture, BBS.

Table B.14: Transplanted Aman Rice Production (ton)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	333540	343860	382638	359389	411755	373984	423774	292010	423759	451918	473352
Dhaka	29801	33552	35644	35026	35605	44403	35839	22878	36622	37130	43261
Jamalpur	108535	119910	119653	120505	131319	129879	116806	95776	119644	120290	135131
Mymensingh	456197	502049	461354	521054	568895	533804	521995	411319	541249	514501	510010
Rangpur	23674	24491	25398	26773	26941	25703	25296	24757	31268	32418	32936
NE Region	**951747**	**1023862**	**1024687**	**1062747**	**1174515**	**1107773**	**1123710**	**846740**	**1152542**	**1156257**	**1194690**

Source: Yearbook of Agriculture, BBS.

Table B.15: Transplanted Aman Rice Yield (t/ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	1.2	1.2	1.3	1.3	1.4	1.3	1.5	1.2	1.5	1.6	1.7
Dhaka	1.2	1.4	1.3	1.4	1.4	1.3	1.5	1.5	1.8	1.7	1.8
Jamalpur	1.1	1.2	1.3	1.3	1.5	1.4	1.4	1.4	1.5	1.5	1.6
Mymensingh	1.3	1.4	1.3	1.4	1.5	1.4	1.6	1.5	1.7	1.5	1.6
Rangpur	1.5	1.5	1.6	1.7	1.6	1.6	1.6	1.6	1.8	1.8	1.8
NE Region	**1.2**	**1.3**	**1.3**	**1.4**	**1.5**	**1.4**	**1.6**	**1.3**	**1.6**	**1.6**	**1.6**

Source: Yearbook of Agriculture, BBS.

Table B.16: Local Transplanted Aman Rice Cropped Area (ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	253450	244064	258243	230178	245628	219005	203569	190588	222419	194169	201812
Dhaka	14755	14269	17344	15652	15146	24768	16931	8162	9692	8264	11857
Jamalpur	85892	80376	73250	72106	69548	69921	64814	48966	60816	64841	69042
Mymensingh	215691	204534	233853	234389	234835	235285	189496	182742	216171	226995	191367
Rangpur	13684	13253	13121	13135	12904	12564	12930	11160	11053	10327	9949
NE Region	**583472**	**556496**	**595811**	**565460**	**578061**	**561543**	**487740**	**441618**	**520151**	**504596**	**484027**

Source: Yearbook of Agriculture, BBS.

Table B.17: Local Transplanted Aman Rice Production (ton)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	280520	279122	315629	290477	312186	264599	268620	190741	299876	279229	295599
Dhaka	16562	16716	21038	19079	19099	28530	22006	9580	13109	11597	15923
Jamalpur	88332	88955	85809	87535	91453	87121	76076	60223	78455	85085	95461
Mymensingh	203351	205501	243255	265621	284337	273701	255866	224210	301306	292652	251768
Rangpur	18932	18348	19062	20096	19330	17822	18180	16258	17480	15288	14683
NE Region	**607697**	**608642**	**684793**	**682808**	**726405**	**671773**	**640748**	**501012**	**710226**	**683851**	**673434**

Source: Yearbook of Agriculture, BBS.

Table B.18: Local Transplanted Aman Rice Yield (ton/ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	1.1	1.1	1.2	1.3	1.3	1.2	1.3	1.0	1.3	1.4	1.5
Dhaka	1.1	1.2	1.2	1.2	1.3	1.2	1.3	1.2	1.4	1.4	1.3
Jamalpur	1.0	1.1	1.2	1.2	1.3	1.2	1.2	1.2	1.3	1.3	1.4
Mymensingh	0.9	1.0	1.0	1.1	1.2	1.2	1.4	1.2	1.4	1.3	1.3
Rangpur	1.4	1.4	1.5	1.5	1.5	1.4	1.4	1.5	1.6	1.5	1.5
NE Region	**1.0**	**1.1**	**1.1**	**1.2**	**1.3**	**1.2**	**1.3**	**1.1**	**1.4**	**1.4**	**1.4**

Source: Yearbook of Agriculture, BBS.

Table B.19: HYV Transplanted Aman Rice Cropped Area (ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	28926	37879	36463	37966	53719	60205	74618	62866	62071	84352	77747
Dhaka	9120	9896	9124	9570	9622	9418	7571	6733	10712	13466	12730
Jamalpur	15347	19376	22015	17832	19414	21424	20552	21464	19899	16993	18117
Mymensingh	136361	150793	123958	137342	138593	144359	129405	100604	111428	113020	129196
Rangpur	2178	2614	2821	2857	3504	3669	3316	4343	6223	7555	8371
NE Region	**191932**	**220558**	**194381**	**205567**	**224852**	**239075**	**235462**	**196010**	**210333**	**235386**	**246161**

Source: Yearbook of Agriculture, BBS.

Table B.20: HYV Transplanted Aman Rice Production (ton)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	53020	64738	67009	68912	99569	109385	155154	101269	123883	172689	177753
Dhaka	13239	16836	14606	15947	16506	15873	13833	13298	23513	25533	27338
Jamalpur	20203	30955	33844	32970	39866	42758	40730	35553	41189	35205	39670
Mymensingh	252846	296548	218099	255433	284558	260103	266129	187109	239943	221849	258242
Rangpur	4742	6143	6336	6677	7611	7881	7116	8499	13788	17130	18253
NE Region	**344050**	**415220**	**339894**	**379939**	**448110**	**436000**	**482962**	**345728**	**442316**	**472406**	**521256**

Source: Yearbook of Agriculture, BBS.

Table B.21: HYV Transplanted Aman Rice Yield (ton/ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	1.8	1.7	1.8	1.8	1.9	1.8	2.1	1.6	2.0	2.0	2.3
Dhaka	1.5	1.7	1.6	1.7	1.7	1.7	1.8	2.0	2.2	1.9	2.1
Jamalpur	1.3	1.6	1.5	1.8	2.1	2.0	2.0	1.7	2.1	2.1	2.2
Mymensingh	1.9	2.0	1.8	1.9	2.1	1.8	2.1	1.9	2.2	2.0	2.0
Rangpur	2.2	2.4	2.2	2.3	2.2	2.1	2.1	2.0	2.2	2.3	2.2
NE Region	**1.8**	**1.9**	1.7	**1.8**	**2.0**	**1.8**	**2.1**	**1.8**	**2.1**	**2.0**	**2.1**

Source: Yearbook of Agriculture, BBS.

Table B.22: (Broadcast Aman) Rice Cropped Area (ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	167908	172484	165795	126667	150664	157850	139040	66447	105440	135679	79999
Dhaka	42706	36054	39691	39505	38643	36740	33983	22547	23465	27240	25206
Jamalpur	18424	16613	15908	14589	14069	13439	11292	2683	894	671	700
Mymensingh	37467	35474	34102	26986	22722	21744	18403	1273	6686	3184	2426
Rangpur	667	567	545	480	351	325	197	71	83	226	241
NE Region	**267172**	**261192**	256041	**208227**	**226449**	**230098**	**202915**	93021	**136568**	**167000**	**108572**

Source: Yearbook of Agriculture, BBS.

Table B.23: Deepwater Aman (Broadcast Aman) Rice Production (ton)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	174990	181335	181229	137687	161205	169312	145332	76690	141581	165178	97032
Dhaka	50924	47089	44300	40902	42468	40187	29223	14622	23950	25714	22621
Jamalpur	19512	18147	13207	13451	14266	15492	8680	1525	707	553	829
Mymensingh	30813	38270	38034	28325	26417	24372	23101	1164	7600	3147	2659
Rangpur	865	685	648	509	403	400	233	72	93	268	262
NE Region	**277104**	**285526**	**277418**	**220874**	**244759**	**249763**	**206569**	**94073**	**173931**	**194860**	**123403**

Source: Yearbook of Agriculture, BBS.

Table B.24: Deepwater Aman (Broadcast Aman) Rice Yield (ton/ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	1.0	1.1	1.1	1.1	1.1	1.1	1.0	1.2	1.3	1.2	1.2
Dhaka	1.2	1.3	1.1	1.0	1.1	1.1	0.9	0.6	1.0	0.9	0.9
Jamalpur	1.1	1.1	0.8	0.9	1.0	1.2	0.8	0.6	0.8	0.8	1.2
Mymensingh	0.8	1.1	1.1	1.0	1.2	1.1	1.3	0.9	1.1	1.0	1.1
Rangpur	1.3	1.2	1.2	1.1	1.1	1.2	1.2	1.0	1.1	1.2	1.1
Total	**1.0**	**1.1**	**1.1**	**1.1**	**1.1**	**1.1**	**1.0**	**1.0**	**1.3**	**1.2**	**1.1**

Source: Yearbook of Agriculture, BBS.

Table B.25: Boro Rice Cropped Area (ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	250174	249395	239405	248232	248379	241064	220899	277724	276133	281704	297874
Dhaka	28937	32567	27540	27934	24595	26678	35297	44991	49174	50908	49574
Jamalpur	24433	26702	27851	38595	31625	36685	49038	56568	56568	55003	55562
Mymensingh	189347	196558	191637	209332	183042	199981	243676	262971	272839	276660	287647
Rangpur	1208	1419	1512	1815	3030	3919	4690	5450	5141	5271	5275
NE Region	**494099**	**506641**	**487945**	**525908**	**490671**	**508327**	**553600**	**647704**	**659855**	**669546**	**695932**

Source: Yearbook of Agriculture, BBS.

Table B.26: Boro Rice Production (ton)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	389288	411146	422804	451342	371828	380414	345098	423562	388365	459057	526327
Dhaka	80884	90858	75947	75267	66499	78114	83387	108594	129327	146521	142931
Jamalpur	63608	72640	65116	95261	77704	93662	122857	130325	135916	144711	152987
Mymensingh	447937	444211	415947	509337	395748	474387	575162	642025	641161	640469	706669
Rangpur	3160	3731	3769	4543	8254	10023	11518	12916	13612	13298	13872
NE Region	**984877**	**1022586**	**983583**	**1135750**	**920033**	**1036600**	**1138022**	**1317422**	**1308381**	**1404056**	**1542786**

Source: Yearbook of Agriculture, BBS.

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Table B.27: Boro Rice Yield (t/ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	1.6	1.6	1.8	1.8	1.5	1.6	1.6	1.5	1.4	1.6	1.8
Dhaka	2.8	2.8	2.8	2.7	2.7	2.9	2.4	2.4	2.6	2.9	2.9
Jamalpur	2.6	2.7	2.3	2.5	2.5	2.6	2.5	2.3	2.4	2.6	2.8
Mymensingh	2.4	2.3	2.2	2.4	2.2	2.4	2.4	2.4	2.3	2.3	2.5
Rangpur	2.6	2.6	2.5	2.5	2.7	2.6	2.5	2.4	2.6	2.5	2.6
NE Region	**2.0**	**2.0**	2.0	**2.2**	**1.9**	**2.0**	**2.1**	**2.0**	**2.0**	**2.1**	**2.2**

Source: Yearbook of Agriculture, BBS.

Table B.28: Local Boro Rice Cropped Area (ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	190051	170908	161614	163844	153427	158787	137414	167112	161144	150799	158228
Dhaka	4281	3639	4538	2703	3194	3425	3764	4387	3877	1836	1651
Jamalpur	7970	6775	7977	8476	7158	5821	5899	3801	4919	5590	2323
Mymensingh	75913	64526	61793	64399	52438	47443	54279	30563	36930	38522	47679
Rangpur	130	110	142	112	132	150	168	48	48	12	17
NE Region	**278345**	**245958**	**236064**	**239534**	**216349**	**215626**	**201524**	**205911**	**206918**	**196759**	**209897**

Source: Yearbook of Agriculture, BBS.

Table B.29: Local Boro Rice Production (ton)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	263463	222577	240012	253449	189361	194919	177809	216304	179926	215321	226923
Dhaka	7459	4856	6870	4254	4425	4296	4177	5798	5294	2521	2211
Jamalpur	14275	12265	14636	15511	12382	9851	9918	4973	7735	8840	3718
Mymensingh	145187	108331	103378	124653	96484	84869	97906	46415	50349	59003	76648
Rangpur	172	172	212	188	221	218	251	68	88	19	26
NE Region	**430556**	**348201**	**365108**	**398055**	**302873**	**294153**	**290061**	**273558**	**243392**	**285704**	**309526**

Source: Yearbook of Agriculture, BBS.

Table B.30: Local Boro Rice Yield (ton/ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	1.4	1.3	1.5	1.5	1.2	1.2	1.3	1.3	1.1	1.4	1.4
Dhaka	1.7	1.3	1.5	1.6	1.4	1.3	1.1	1.3	1.4	1.4	1.3
Jamalpur	1.8	1.8	1.8	1.8	1.7	1.7	1.7	1.3	1.6	1.6	1.6
Mymensingh	1.9	1.7	1.7	1.9	1.8	1.8	1.8	1.5	1.4	1.5	1.6
Rangpur	1.3	1.6	1.5	1.7	1.7	1.5	1.5	1.4	1.8	1.6	1.6
NE Region	**1.5**	**1.4**	**1.5**	**1.7**	**1.4**	**1.4**	**1.4**	**1.3**	**1.2**	**1.5**	**1.5**

Source: Yearbook of Agriculture, BBS.

Table B.31: HYV Boro Rice Cropped Area (ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	60123	78487	77791	84388	94952	82277	83485	110612	114989	130905	139646
Dhaka	24656	28928	23002	25231	21401	23253	31533	40604	45297	49072	47923
Jamalpur	16463	19927	19874	30119	24467	30864	43139	52767	51649	49413	53239
Mymensingh	113434	132032	129844	144933	130604	152538	189397	232408	235909	238138	239969
Rangpur	1078	1309	1370	1703	2898	3769	4522	5402	5093	5259	5259
NE Region	**215754**	**260683**	**251881**	**286374**	**274322**	**292701**	**352076**	**441793**	**452937**	**472787**	**486036**

Source: Yearbook of Agriculture, BBS.

Table B.32: HYV Boro Rice Production (ton)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	125825	188569	182792	197893	182467	185495	167289	207258	208439	243736	299404
Dhaka	73425	86002	69077	71013	62074	73818	79210	102796	124033	144000	140720
Jamalpur	49333	60375	50480	79750	65322	83811	112939	125352	128181	135871	149269
Mymensingh	302750	335880	312569	384684	299264	389518	477256	595610	590812	581466	630021
Rangpur	2988	3559	3557	4355	8033	9805	11267	12848	13524	13279	13846
NE Region	**554321**	**674385**	**618475**	**737695**	**617160**	**742447**	**847961**	**1043864**	**1064989**	**1118352**	**1233260**

Source: Yearbook of Agriculture, BBS.

Table B.33: HYV Boro Rice Yield (ton/ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	2.1	2.4	2.3	2.3	1.9	2.3	2.0	1.9	1.8	1.9	2.1
Dhaka	3.0	3.0	3.0	2.8	2.9	3.2	2.5	2.5	2.7	2.9	2.9
Jamalpur	3.0	3.0	2.5	2.6	2.7	2.7	2.6	2.4	2.5	2.7	2.8
Mymensingh	2.7	2.5	2.4	2.7	2.3	2.6	2.5	2.6	2.5	2.4	2.6
Rangpur	2.8	2.7	2.6	2.6	2.8	2.6	2.5	2.4	2.7	2.5	2.6
NE Region	2.6	2.6	2.5	2.6	2.2	2.5	2.4	2.4	2.4	2.4	**2.5**

Source: Yearbook of Agriculture, BBS.

ANNEX C
NONRICE AREA, PRODUCTION AND YIELDS

The regional statistics depict only the part of the region (old district) located in the study area of the Northeast Region.

Table C.1: Wheat Cropped Area (ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	4080	6237	3925	6989	5364	8051	6509	5968	6764	8356	7385
Dhaka	5795	6090	6116	9477	10021	9611	9377	7754	8162	8162	7800
Jamalpur	3081	4322	7720	12606	9348	12227	11747	10509	11850	12745	12948
Mymensingh	11748	12685	12528	16791	18994	19318	18373	17829	17829	18465	18061
Rangpur	1963	2306	2327	2802	1551	2210	2222	2058	1927	2046	1951
NE Region	**26667**	**31640**	**32616**	**48665**	**45278**	**51417**	**48228**	**44118**	**46532**	**49774**	**48145**

Source: Yearbook of Agriculture, BBS.

Table C.2: Wheat Production (ton)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	8121	13615	8691	15535	9114	11302	10348	10815	8357	11798	10658
Dhaka	9620	11890	12726	19649	19027	12997	16155	13109	12302	11697	15451
Jamalpur	5827	9579	16907	25686	17614	21945	20630	20443	18448	18896	23238
Mymensingh	17333	25245	31610	37592	33954	32388	30870	33828	28195	29108	34088
Rangpur	3745	4995	5104	5767	3188	4861	3855	3910	3440	3439	3960
NE Region	**44646**	**65324**	**75038**	**104229**	**82897**	**83493**	**81858**	**82105**	**70742**	**74938**	**87395**

Source: Yearbook of Agriculture, BBS.

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Table C.3: Wheat Yield (ton/ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	2.0	2.2	2.2	2.2	1.7	1.4	1.6	1.8	1.2	1.4	1.4
Dhaka	1.7	2.0	2.1	2.1	1.9	1.4	1.7	1.7	1.5	1.4	2.0
Jamalpur	1.9	2.2	2.2	2.0	1.9	1.8	1.8	1.9	1.6	1.5	1.8
Mymensingh	1.5	2.0	2.5	2.2	1.8	1.7	1.7	1.9	1.6	1.6	1.9
Rangpur	1.9	2.2	2.2	2.1	2.1	2.2	1.7	1.9	1.8	1.7	2.0
NE Region	**1.7**	**2.1**	**2.3**	**2.1**	**1.8**	**1.6**	**1.7**	**1.9**	**1.5**	**1.5**	**1.8**

Source: Yearbook of Agriculture, BBS.

Table C.4: Sugar Cane Cropped Area (ha)

Region	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91
Sylhet	2439	2308	2232	2326	1894	1864	1462	1524	1592	1592	1518
Dhaka	1678	1731	1767	2161	2262	2274	2250	2090	2449	2674	2802
Jamalpur	3362	3306	3274	3497	3478	3513	3545	3884	3801	4219	4278
Mymensingh	3960	4089	4290	4217	4210	4105	4268	4054	3820	4075	3766
Rangpur	405	462	450	444	423	401	347	451	375	416	436
NE Region	**11844**	**11896**	**12013**	**12645**	**12267**	**12157**	**11872**	**12003**	**12037**	**12976**	**12800**

Source: Yearbook of Agriculture, BBS.

Table C.5: Sugar Cane Production (ton)

Region	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91
Sylhet	100989	95779	87871	97386	76950	74876	51736	57335	27923	30637	30971
Dhaka	61725	63879	65636	81909	89347	85979	86241	77460	54817	51681	53833
Jamalpur	154940	152692	150992	145136	142111	153672	155360	169910	162772	179010	186364
Mymensingh	159921	165001	171814	176201	171575	160585	166552	159492	131599	152620	140721
Rangpur	17081	20491	19092	18411	17359	15377	15034	20329	16984	19551	21671
NE Region	**494656**	**497842**	**495405**	**519043**	**497342**	**490489**	**474923**	**484526**	**394095**	**433499**	**433560**

Source: Yearbook of Agriculture, BBS.

Table C.6: Sugar Cane Yield (ton/ha)

Region	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91
Sylhet	41.4	41.5	39.4	41.9	40.6	40.2	35.4	37.6	17.5	19.2	20.4
Dhaka	36.8	36.9	37.1	37.9	39.5	37.8	38.3	37.1	22.4	19.3	19.2
Jamalpur	46.1	46.2	46.1	41.5	40.9	43.7	43.8	43.7	42.8	42.4	43.6
Mymensingh	40.4	40.4	40.0	41.8	40.8	39.1	39.0	39.3	34.5	37.5	37.4
Rangpur	42.2	44.4	42.4	41.5	41.0	38.3	43.3	45.1	45.3	47.0	49.7
NE Region	**41.8**	**41.8**	**41.2**	**41.0**	**40.5**	**40.3**	**40.0**	**40.4**	**32.7**	**33.4**	**33.9**

Source: Yearbook of Agriculture, BBS.

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Table C.7: Potato Cropped Area (ha)

Region	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91
Sylhet	4530	4540	4707	4222	4534	4273	3672	4116	4775	4775	5111
Dhaka	4962	4978	4980	4928	4843	4666	4642	6220	3775	4081	4218
Jamalpur	964	1052	1084	1143	1158	1173	1183	1327	1342	1342	1519
Mymensingh	5976	6089	6224	7354	7470	6839	6350	6474	6367	6686	7295
Rangpur	288	289	289	251	238	251	245	338	262	274	278
NE Region	**16720**	**16948**	**17284**	**17898**	**18243**	**17202**	**16092**	**18475**	**16521**	**17158**	**18421**

Source: Yearbook of Agriculture, BBS.

Table C.8: Potato Production (ton)

Region	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91
Sylhet	64695	64837	58430	51069	53813	47779	32637	37996	41294	41294	45635
Dhaka	72358	73328	74821	72627	64147	61599	64413	87999	62521	49664	67423
Jamalpur	5997	8694	8474	9391	9909	10273	10688	12130	12155	12708	14959
Mymensingh	37404	37962	41657	60262	53709	47303	45019	45684	40122	40122	52969
Rangpur	2436	2478	2506	2230	2113	1985	1823	2454	1117	1882	2332
NE Region	**182890**	**187299**	**185888**	**195579**	**183691**	**168939**	**154580**	**186263**	**157209**	**145670**	**183318**

Source: Yearbook of Agriculture, BBS.

Table C.9: Potato Yield (ton/ha)

Region	1980-81	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91
Sylhet	14.3	14.3	12.4	12.1	11.9	11.2	8.9	9.2	8.6	8.6	8.9
Dhaka	14.6	14.7	15.0	14.7	13.2	13.2	13.9	14.1	16.6	12.2	16.0
Jamalpur	6.2	8.3	7.8	8.2	8.6	8.8	9.0	9.1	9.1	9.5	9.8
Mymensingh	6.3	6.2	6.7	8.2	7.2	6.9	7.1	7.1	6.3	6.0	7.3
Rangpur	8.5	8.6	8.7	8.9	8.9	7.9	7.4	7.3	4.3	6.9	8.4
NE Region	**10.9**	**11.1**	**10.8**	**10.9**	**10.1**	**9.8**	**9.6**	**10.1**	9.5	8.5	**10.0**

Source: Yearbook of Agriculture, BBS.

Table C.10: Jute Cropped Area (ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	3535	2819	2141	1914	6931	3352	1126	398	1194	796	398
Dhaka	12959	12226	12892	13134	23377	16961	11131	12039	10304	10916	10712
Jamalpur	17354	16183	16505	14780	20318	13621	10629	15204	17887	18558	16322
Mymensingh	68481	62944	60601	60109	118564	79740	41999	40114	33428	39159	36612
Rangpur	3185	3137	3888	4213	6173	4797	3050	3129	3379	3807	3855
NE Region	**105514**	**97309**	**96027**	**94150**	**175363**	**118471**	**67935**	**70884**	**66192**	**73236**	**67899**

Source: Yearbook of Agriculture, BBS.

Table C.11: Jute Production (bale)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	28390	16518	11322	9930	45906	23361	8569	2950	7866	7866	3933
Dhaka	112716	105706	105801	108726	204492	147109	95439	87227	81428	97059	85462
Jamalpur	141940	139893	145669	116873	161659	122854	115832	142545	162988	178458	145860
Mymensingh	556984	529213	580695	483710	949598	702574	421093	296586	296586	350868	306026
Rangpur	27546	28678	29832	32271	48050	42556	26977	26372	25813	34868	33104
NE Region	**867576**	**820008**	**873319**	**751510**	**1409705**	**1038454**	**667910**	**555680**	**574681**	**669119**	**574385**

Source: Yearbook of Agriculture, BBS.

Table C.12: Jute Yield (bale/ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91	1991-92
Sylhet	8.0	5.9	5.3	5.2	6.6	7.0	7.6	7.4	6.6	8.0	8.3
Dhaka	8.7	8.6	8.2	8.3	8.7	8.7	8.6	7.2	7.9	8.9	8.0
Jamalpur	8.2	8.6	8.8	7.9	8.0	9.0	10.9	9.4	9.1	9.2	8.9
Mymensingh	8.1	8.4	9.6	8.0	8.0	8.8	10.0	7.4	8.9	9.0	8.4
Rangpur	8.6	9.1	7.7	7.7	7.8	8.9	8.8	8.4	7.6	9.0	8.6
NE Region	**8.2**	**8.4**	**9.1**	**8.0**	**8.0**	**8.8**	**9.8**	**9.3**	**8.7**	**8.9**	**8.5**

Source: Yearbook of Agriculture, BBS.

Table C.13: Pulse Cropped Area (ha)

Region	1981-82	1991-92
Sylhet	1082	1337
Dhaka	4405	12168
Jamalpur	4324	2956
Mymensingh	8582	12989
Rangpur	343	335
NE Region	**18736**	**29785**

Source: Yearbook of Agriculture, BBS.

Table C.14: Pulse Production (ton)

Region	1981-82	1991-92
Sylhet	709	862
Dhaka	3126	8859
Jamalpur	3443	2232
Mymensingh	5992	9940
Rangpur	266	301
NE Region	**13536**	**22194**

Source: Yearbook of Agriculture, BBS.

Table C.15: Pulse Yield (t/ha)

Region	1981-82	1991-92
Sylhet	0.7	0.6
Dhaka	0.7	0.7
Jamalpur	0.8	0.8
Mymensingh	0.7	0.8
Rangpur	0.8	0.9
NE Region	**0.7**	**0.8**

Source: Yearbook of Agriculture, BBS.

Table C.16: Oilseed Cropped Area (ha)

Region	1981-82	1991-92
Sylhet	6426	11401
Dhaka	7105	4351
Jamalpur	2653	8085
Mymensingh	16015	19317
Rangpur	411	473
NE Region	**32610**	**43627**

Source: Yearbook of Agriculture, BBS.

Table C.17: Oilseed Production (ton)

Region	1981-82	1991-92
Sylhet	5819	8495
Dhaka	5331	3691
Jamalpur	1359	5732
Mymensingh	11139	16623
Rangpur	319	408
NE Region	**23967**	**34949**

Source: Yearbook of Agriculture, BBS.

Table C.18: Oilseed Yield (t/ha)

Region	1981-82	1991-92
Sylhet	0.9	0.8
Dhaka	0.8	0.9
Jamalpur	0.5	0.7
Mymensingh	0.7	0.9
Rangpur	0.8	0.9
NE Region	**0.7**	**0.8**

Source: Yearbook of Agriculture, BBS.

Table C.19: Tobacco Cropped Area (ha)

Region	981-82	1990-91
Sylhet	2085	456
Dhaka	874	532
Jamalpur	736	548
Mymensingh	1741	904
Rangpur	694	656
NE Region	**6130**	**3096**

Source: Yearbook of Agriculture, BBS.

Table C.20: Tobacco Production (ton)

Region	1981-82	1990-91
Sylhet	1313	310
Dhaka	635	528
Jamalpur	566	420
Mymensingh	826	653
Rangpur	727	613
NE Region	**4067**	**2524**

Source: Yearbook of Agriculture, BBS.

Table C.21: Tobacco Yield (t/ha)

Region	1981-82	1990-91
Sylhet	0.6	0.7
Dhaka	0.7	1.0
Jamalpur	0.8	0.8
Mymensingh	0.5	0.7
Rangpur	1.0	0.9
NE Region	**0.7**	**0.8**

Source: Yearbook of Agriculture, BBS.

Table C.22: Cotton Cropped Area (ha)

Region	1981-82	1990-91
Sylhet	-	-
Dhaka	51	115
Jamalpur	2	1
Mymensingh*	20	127
Rangpur	23	4
NE Region	**95**	**247**

**: Mymensingh district.*
Source: Yearbook of Agriculture, BBS.

Table C.23 Cotton Production (bale)

Region	1981-82	1990-91
Sylhet	-	-
Dhaka	63	376
Jamalpur	1	1
Mymensingh*	14	439
Rangpur	130	10
NE Region	**207**	**825**

**: Mymensingh district.*
Source: Yearbook of Agriculture, BBS.

Table C.24: Cotton Yield (bale/ha)

Region	1981-82	1990-91
Sylhet	-	-
Dhaka	1.2	3.3
Jamalpur	0.5	1.0
Mymensingh*	0.7	3.5
Rangpur	5.7	2.5
NE Region	**2.2**	**3.3**

**: Mymensingh district.*
Source: Yearbook of Agriculture, BBS.

Table C.25: Spices and Condiments Cropped Area, 1990-91 (ha)

Region	Chili		Onion	Garlic	Ginger	Turmeric	Coriander	Other	Total
	Kharif	Rabi							
Sylhet	149	1393	442	241	286	300	408	16	3235
Dhaka	67	514	715	212	79	157	96	8	1848
Jamalpur	94	1163	693	233	110	239	103	37	2672
Mymensingh	436	2264	1208	576	390	879	283	6	6042
Rangpur	14	61	48	19	58	58	7	1	266
NE Region	**760**	**5395**	**3106**	**1281**	**923**	**1633**	**897**	**68**	**14063**

Source: Yearbook of Agriculture, BBS.

Table C.26: Spice and Condiments Production, 1990-91 (ton)

Region	Chili		Onion	Garlic	Ginger	Turmeric	Coriander	Other	Total
	Kharif	Rabi							
Sylhet	118	1701	934	526	1465	560	206	5	5516
Dhaka	34	454	3867	677	203	192	62	4	5492
Jamalpur	58	953	3243	691	738	367	61	66	6177
Mymensingh	271	1971	4225	1636	2895	1770	153	8	12929
Rangpur	12	49	208	56	396	396	4	1	1122
NE Region	**493**	**5128**	**12477**	**3586**	**5697**	**3285**	**486**	**84**	**31236**

Source: Yearbook of Agriculture, BBS.

Table C.27: Spices and Condiments Yield, 90-91 (t/ha)

Region	Chili		Onion	Garlic	Ginger	Turmeric	Coriander	Other
	Kharif	Rabi						
Sylhet	0.79	1.22	2.11	2.19	5.11	1.87	0.51	0.31
Dhaka	0.51	0.88	5.41	3.20	2.58	1.22	0.64	0.46
Jamalpur	0.62	0.82	4.68	2.97	6.73	1.54	0.59	1.80
Mymensingh	0.62	0.87	3.50	2.84	7.42	2.01	0.54	1.24
Rangpur	0.84	0.79	4.33	2.94	6.88	6.88	0.58	1.65
NE Region	**0.65**	**0.95**	**4.02**	**2.80**	**6.18**	**2.01**	**0.54**	**1.23**

Source: Yearbook of Agriculture, BBS.

Table C.28: Vegetables Cropped Area, 1990-91 (ha)

A. Kharif

Region	Brinjal	Pumpkin	Patal	Lady's Finger	Jhinga	Karala	Arum	Chal-kumra	Cucum-ber	Barbati	Puishak	Chich-inga	Danta	Other	Total
Sylhet	227	243	0	205	306	159	790	336	197	153	24	111	207	302	3260
Dhaka	160	85	54	65	110	143	148	101	71	48	27	31	40	28	1111
Jamalpur	87	57	38	34	47	56	155	84	61	23	28	22	60	85	837
Mymensingh	293	188	21	143	197	161	479	207	178	43	118	94	294	207	2623
Rangpur	20	11	14	6	13	14	20	11	7	5	5	5	8	6	145
NE Region	**787**	**584**	**127**	**453**	**673**	**533**	**1592**	**739**	**514**	**272**	**202**	**263**	**609**	**628**	**7976**

B. Rabi

Region	Brinjal	Pumpkin	Cauli-flower	Cabbage	Water Gourd	Tomato	Radish	Beans	Palong	Other	Total	TOTAL (A+B)
Sylhet	702	438	368	340	830	895	1450	456	86	350	5915	9175
Dhaka	324	100	186	123	219	372	335	188	57	342	2246	3357
Jamalpur	472	102	104	97	131	150	312	92	58	197	1715	2552
Mymensingh	1129	170	250	256	310	465	1172	511	51	274	4588	7211
Rangpur	39	11	26	22	15	13	39	7	9	19	200	345
NE Region	**2666**	**821**	**934**	**838**	**1505**	**1895**	**3308**	**1254**	**261**	**1182**	**14664**	**22640**

Source: Yearbook of Agriculture, BBS.

Table C.29: Vegetables Production, 1990-91 (ton)

A. Kharif.

Region	Brinjal	Pumpkin	Patal	Lady's Finger	Jhinga	Karala	Arum	Chal-kumra	Cucum-ber	Barbati	Puishak	Chich-inga	Danta	Other	Total
Sylhet	1077	1593	0	492	1067	516	4375	2384	678	216	93	442	806	1435	15174
Dhaka	526	503	243	154	411	604	1079	594	255	110	102	116	153	116	4966
Jamalpur	461	409	144	97	127	221	1080	608	279	19	133	88	265	276	4207
Mymensingh	1530	1117	59	437	641	665	3827	1404	968	55	586	421	1428	673	13811
Rangpur	146	78	87	21	83	56	148	71	47	20	33	31	34	24	879
NE Region	**3740**	**3700**	**533**	**1201**	**2329**	**2062**	**10509**	**5061**	**2227**	**420**	**947**	**1098**	**2686**	**2524**	**39037**

B. Rabi.

Region	Brinjal	Pumpkin	Cauliflower	Cabbage	Water Gourd	Tomato	Radish	Beans	Palong	Other	Total	TOTAL (A+B)
Sylhet	5653	3323	3146	3382	7418	5978	13961	1952	275	2016	47104	62278
Dhaka	2101	580	1395	1056	1366	2816	2977	955	171	1292	14709	19675
Jamalpur	3263	948	837	912	1279	1699	3138	967	191	881	14115	18322
Mymensingh	8618	1192	2199	2352	2576	4118	13327	2293	130	1078	37883	51694
Rangpur	286	68	268	209	122	106	317	33	21	166	1596	2475
NE Region	**19921**	**6111**	**7845**	**7911**	**12761**	**14717**	**33720**	**6200**	**788**	**5433**	**115407**	**154444**

Source: Yearbook of Agriculture, BBS.

Table C30: Vegetables Yield, 1990-91 (t/ha)

A. Kharif

Region	Brinjal	Pumpkin	Patal	Lady's Finger	Jhinga	Karala	Arum	Chal-kumra	Cu-cumber	Barbati	Puishak	Chich-inga	Danta	Other	Total
Sylhet	4.7	6.6		2.4	3.5	3.2	5.5	7.1	3.4	1.4	3.9	4.0	3.9	4.8	4.7
Dhaka	3.3	5.9	4.5	2.4	3.7	4.2	7.3	5.9	3.6	2.3	3.8	3.7	3.8	4.1	4.5
Jamalpur	5.3	7.2	3.8	2.9	2.7	3.9	7.0	7.2	4.6	0.8	4.8	4.0	4.4	3.2	5.0
Mymensingh	5.2	5.9	2.8	3.1	3.3	4.1	8.0	6.8	5.4	1.3	5.0	4.5	4.9	3.3	5.3
Rangpur	7.3	7.1	6.2	3.5	6.4	4.0	7.4	6.5	6.7	4.0	6.6	6.2	4.3	4.0	6.1
NE Region	**4.8**	**6.3**	**4.2**	**2.7**	**3.5**	**3.9**	**6.6**	**6.8**	**4.3**	**1.5**	**4.7**	**4.2**	**4.4**	**4.0**	**4.9**

B. Rabi

Region	Brinjal	Pumpkin	Cauliflower	Cabbage	Water Gourd	Tomato	Radish	Beans	Palong	Other	Total	TOTAL (A+B)
Sylhet	8.1	7.6	8.5	9.9	8.9	6.7	9.6	4.3	3.2	5.8	8.0	6.8
Dhaka	6.5	5.8	7.5	8.6	6.2	7.6	8.9	5.1	3.0	3.8	6.5	5.9
Jamalpur	6.9	9.3	8.0	9.4	9.8	11.3	10.1	10.5	3.3	4.5	8.2	7.2
Mymensingh	7.6	7.0	8.8	9.2	8.3	8.9	11.4	4.5	2.5	3.9	8.3	7.2
Rangpur	7.3	6.2	10.3	9.5	8.1	8.2	8.1	4.7	2.3	8.7	8.0	7.2
NE Region	**7.5**	**7.4**	**8.4**	**9.4**	**8.5**	**7.8**	**10.2**	**4.9**	**3.0**	**4.6**	**7.9**	**6.8**

Source: Yearbook of Agriculture, BBS.

Table C.31: Fruits Cropped Area, 1990-91 (ha)

Region	Banana	Coco-nut	Jack-fruit	Litchi	Mango	Pineapple	Papaya	Melon	Guava	Ber	Pomelo	Lime and Lemon	Orange	Other	Total
Sylhet	1074	310	1790	239	1767	3541	169	286	406	213	320	386	205	555	11261
Dhaka	455	89	632	46	761	248	80	144	90	33	57	44		130	2809
Jamalpur	482	55	126	51	719	46	50	67	60	57	28	27		153	1921
Mymensingh	710	376	1189	220	1689	344	138	143	204	142	146	131		337	5769
Rangpur	62	33	61	10	94	7	6	5	9	5	5	6		17	320
NE Region	**2783**	**863**	**3798**	**566**	**5030**	**4186**	**443**	**645**	**769**	**450**	**556**	**594**	**205**	**1192**	**22080**

Source: Yearbook of Agriculture, BBS.

Table C.32: Fruits Production, 1990-91 (ton)

Region	Banana	Coconut	Jack-fruit	Litchi	Mango	Pine-apple	Papaya	Melon	Guava	Ber	Pomelo	Lime and Lemon	Orange	Other	Total
Sylhet	16931	708	23764	688	12064	51775	2143	1195	2551	1278	1298	1254	462	2217	118328
Dhaka	7484	245	10276	66	2592	2858	821	1728	460	88	136	100		384	27238
Jamalpur	7066	64	1287	138	2354	370	417	696	213	108	52	19		464	13248
Mymensingh	15179	952	9547	586	7741	2163	1070	972	1160	437	307	181		979	41274
Rangpur	848	59	554	26	358	33	41	32	39	13	8	16		74	2101
NE Region	**47508**	**2028**	**45428**	**1504**	**25109**	**57199**	**4492**	**4623**	**4423**	**1924**	**1801**	**1570**	**462**	**4118**	**202189**

ource: Yearbook of Agriculture, BBS.

Table C.33: Fruits Yield, 1990-91 (t/ha)

Region	Banana	Coconut	Jack-fruit	Litchi	Mango	Pine-apple	Papaya	Melon	Guava	Ber	Pomelo	Lime and Lemon	Orange	Other
Sylhet	15.8	2.3	13.3	2.9	6.8	14.6	12.7	4.2	6.3	6.0	4.1	3.2	2.3	4.0
Dhaka	16.4	2.8	16.3	1.4	3.4	11.5	10.3	12.0	5.1	2.7	2.4	2.3		3.0
Jamalpur	14.7	1.2	10.2	2.7	3.3	8.0	8.3	10.4	3.6	1.9	1.9	0.7		3.0
Mymensingh	21.4	2.5	8.0	2.7	4.6	6.3	7.8	6.8	5.7	3.1	2.1	1.4		2.9
Rangpur	13.7	1.8	9.1	2.6	3.8	4.7	6.8	6.4	4.3	2.6	1.6	2.7		4.4
NE Region	**17.1**	**2.3**	**12.0**	**2.7**	**5.0**	**13.7**	**10.1**	**7.2**	**5.8**	**4.3**	**3.2**	**2.6**	**2.3**	**3.5**

Source: Yearbook of Agriculture, BBS.

Table C.34: Other Crops Area, 1990-91 (ha)

Region	Barly	Joar	Bajra	Maize	Cheenaand Kaon	Other Cereals	Date Palm	Palmyra Palm	Sunhemp	Other Fibre	Tea	Betel Leaf	Sweet Potato	Fodder	Mulberry
Sylhet					86		30	56			43648	1072	1321	40	
Dhaka				20	1165	86	77	42	2	23		52	1458	73	
Jamalpur	262	6		11	910	3904	12	13	2	17		44	1472	37	4
Mymensingh				19	65	799	67	57	8	83		275	3887	5	5
Rangpur	1	8	3	1	32	726	3	2		3		9	48		1
NE Region	**263**	**14**	**3**	**51**	**2258**	**5515**	**189**	**170**	**12**	**126**	**43648**	**1452**	**8186**	**155**	**10**

Source: Yearbook of Agriculture, BBS.

Table C.35: Other Crops Production, 1990-91 (ton)

Region	Barley	Joar	Bajra	Maize	Cheena and Kaon	Other Cereals	Date Palm	Palmyra Palm	Sunhemp	Other Fibres	Tea	Betel Leaf	Sweet Potato	Fodder	Mul-berry
Sylhet					44		310	501			43143	2704	13234	256	
Dhaka				18	1036	59	3197	875	9	89		332	16802	450	
Jamalpur	180	6		14	917	3716	367	486	11	69		307	21570	348	3
Mymensingh				8	39	389	2250	1054	39	354		1550	47430	20	4
Rangpur		7	1	1	25	483	98	71		14		26	390	1	
NE Region	**180**	**13**	**1**	**41**	**2061**	**4647**	**6222**	**2987**	**59**	**526**	**43143**	**4919**	**99426**	**1075**	**7**

Source: Yearbook of Agriculture, BBS.

Table C.36 : Other Crops Yield, 1990-91 (t/ha)

Region	Barley	Joar	Bajra	Maize	Cheena and Kaon	Other Cereals	Date Palm	Palmyra Palm	Sunhemp	Other Fibre	Tea	Betel Leaf	Sweet Potato	Fodder	Mulberry
Sylhet					0.5		10.3	8.9			1.0	2.5	10.0	6.4	
Dhaka				0.9	0.9	0.7	41.5	20.8	4.5	3.9		6.4	11.5	6.2	
Jamalpur	0.7	1.0		1.3	1.0	1.0	30.6	37.4	5.5	4.1		7.0	14.7	9.4	0.8
Mymensingh				0.4	0.6	0.5	33.6	18.5	4.9	4.3		5.6	12.2	4.0	0.8
Rangpur		0.9	0.3	1.0	0.8	0.7	32.7	35.5		4.7		2.9	8.1		0.0
NE Region	**0.7**	**0.9**	**0.3**	**0.8**	**0.9**	**0.8**	**32.9**	**17.6**	**4.9**	**4.2**	**1.0**	**3.4**	**12.1**	**6.9**	**0.7**

Source: Yearbook of Agriculture, BBS.

ANNEX D
INPUT USE

The regional statistics depict only the part of the region (old district) located in the study area of the Northeast Region.

Table D.1: Distribution of Chemical Fertilizer (ton)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88
Sylhet	25725	28703	36684	45779	34187	42618	54164
Dhaka	22433	22656	26809	28709	34480	27211	35752
Jamalpur	13945	16271	20829	23273	23382	26236	29419
Mymensingh	56548	67480	72570	85207	78237	96102	103627
Rangpur	1511	1834	2473	2475	2412	2905	2725
NE Region	**120162**	**136944**	**159365**	**185443**	**172698**	**195072**	**225687**

Source: Annual Report, BADC; and Yearbook of Agriculture, BBS.

Table D.2: Distribution of Urea (ton)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88
Sylhet	16969	20714	26718	33370	22968	28635	32991
Dhaka	13413	14611	16778	18333	23873	19795	25208
Jamalpur	9767	12032	14594	16669	17474	19366	22222
Mymensingh	43307	53171	53427	67106	60402	74376	77211
Rangpur	917	1149	1424	1523	1684	2077	1714
NE Region	**84373**	**101677**	**112941**	**137001**	**126401**	**144249**	**159346**

Source: Annual Report, BADC; and Yearbook of Agriculture,BBS.

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Table D.3: Distribution of TSP (ton)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88
Sylhet	7226	6713	8267	9730	8374	9510	11569
Dhaka	7395	6772	8791	8615	8750	6607	8356
Jamalpur	3196	3543	5206	5736	4984	5607	6191
Mymensingh	11496	12575	17151	15498	15048	17355	22658
Rangpur	263	215	376	776	580	655	811
NE Region	**29576**	**29818**	**39791**	**40355**	**37736**	**39734**	**49585**

Source: Annual Report, BADC; and Yearbook of Agriculture, BBS.

Table D.4: Distribution of MP (ton)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88
Sylhet	1117	1248	1698	2655	2815	4435	3487
Dhaka	1091	928	1183	1412	1798	751	2130
Jamalpur	569	677	949	803	843	1183	969
Mymensingh	1319	1684	1946	2399	2402	4066	3621
Rangpur	111	132	158	163	135	163	192
NE Region	**4207**	**4669**	**5934**	**7432**	**7993**	**10598**	**10399**

Source: Annual Report, BADC; and Yearbook of Agriculture,BBS.

Table D.5: Distribution of ASP, SSP, DAP, SOP and Zinc and Gypsum (ton)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88
Sylhet	413	28	1	24	30	38	6117
Dhaka	534	345	57	349	59	58	58
Jamalpur	413	19	80	65	81	80	37
Mymensingh	426	50	46	204	385	305	137
Rangpur	220	338	515	13	13	10	8
NE Region	**2006**	**780**	**699**	**655**	**568**	**491**	**6357**

Source: Annual Report, BADC; and Yearbook of Agriculture,BBS.

Table D.6: Distribution of Pesticides (ton)

Region	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89
Sylhet	58	53	126	82	141	113	162
Dhaka	45	44	61	50	55	59	75
Mymensingh	197	211	173	251	286	266	285
Rangpur	4	5	6	6	6	7	9
NE Region	**304**	**313**	**366**	**389**	**488**	**445**	**531**

Source: Annual Report, BADC; and Yearbook of Agriculture,BBS.

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Table D.7: Distribution of Pesticides by Types, 1988-89 (ton)

Region	Granular	Conventional Pest Complex	Soil Insecticide	Acari-cide	Fungi-cide	Roden-ticide	Weedi-cide	Total
Sylhet	55.8	13.8	5.9	11.8	4.9	0.5	68.8	161.5
Dhaka	56.7	9.6	1.3	0.8	6.3	0.1	0	74.7
Mymensingh	220.3	45.6	6.3	4.7	7.9	0.4	0	285.2
Rangpur	6.9	1.1	0.4	0.1	0.1	0.0	0	8.5
NE Region	**339.7**	**70.1**	**13.9**	**17.4**	**19.2**	**1.0**	**68.8**	**529.9**

Source: Annual Report, BADC; and Yearbook of Agriculture, BBS.

Table D.8: Distribution of Improved Seeds, 1990-91 (ton)

Region	Aus	Aman	Boro	Wheat	Potato
Sylhet	52	212	231	304	195
Dhaka	16	43	18	184	156
Jamalpur	38	50	52	430	160
Mymensingh	104	69	98	1956	133
Rangpur	6	2	4	108	19
NE Region	**216**	**376**	**403**	**2982**	**663**

Source: Annual Report, BADC.

Table D.9: Irrigated Area (ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91
Sylhet	213639	201729	192201	178566	184775	189852	166317	198943	212561	214519
Dhaka	29746	31154	34082	36623	33311	34668	39788	37850	43415	45470
Jamalpur	23437	24710	38338	49518	45729	45645	49860	57686	68411	66332
Mymensingh	187468	198812	208944	201741	198613	206693	219991	233681	241473	238572
Rangpur	3694	3812	4483	5644	5684	6157	6306	8209	8280	9106
NE Region	**457984**	**460217**	**478048**	**472092**	**468112**	**483015**	**482262**	**536369**	**574140**	**573989**

Source: Yearbook of Agriculture, BBS.

Table D.10: Area Irrigated by LLP (ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91
Sylhet	68516	62468	68709	73856	78318	80196	61672	66049	70576	77132
Dhaka	16073	15418	16101	15589	13312	14660	10814	12549	13772	13627
Jamalpur	5159	5710	7523	8809	7847	8044	5590	8273	6799	5514
Mymensingh	83390	87489	77005	75039	72108	73530	77363	82457	74965	72188
Rangpur	1267	1291	792	673	579	530	624	581	573	579
NE Region	**174405**	**172376**	**170130**	**173966**	**172165**	**176960**	**156063**	**169908**	**166685**	**169040**

Source: Yearbook of Agriculture, BBS.

Table D.11: Area Irrigated by Tube Wells (ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91
Sylhet	5222	1552	4677	6141	8344	8984	9947	12334	15063	15152
Dhaka	2450	7292	12289	16234	15890	16088	28056	19996	24551	26703
Jamalpur	11893	12542	27951	37835	35334	35058	38904	46506	55933	55733
Mymensingh	21380	52753	71831	82697	83598	91640	128302	111110	121591	120116
Rangpur	686	769	1970	3031	3576	3607	4766	5853	5904	7063
NE Region	**41631**	**74908**	**118718**	**145938**	**146742**	**155376**	**209975**	**195799**	**223042**	**224767**

Source: Yearbook of Agriculture,BBS.

Table D.12: Area Irrigated by Canals (ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91
Sylhet	8893	8097	11575	14348	18904	12428	15915	31433	30834	31735
Dhaka	2093	2023	1384	1409	1041	1064	510	1122	1108	2288
Jamalpur	15	15	1285	1232	1046		1789	671	1596	1208
Mymensingh	9834	5261	4207	3069	2814	3378	318	6049	5132	5237
Rangpur	278	278	251	266	206	185	87	141	146	106
NE Region	**21113**	**15674**	**18701**	**20324**	**24012**	**17055**	**18619**	**39416**	**38817**	**40574**

Source: Yearbook of Agriculture,BBS.

Table D.13: Area Irrigated by Traditional Methods (ha)

Region	1981-82	1982-83	1983-84	1984-85	1985-86	1986-87	1987-88	1988-89	1989-90	1990-91
Sylhet	131008	129612	107240	84221	79209	88243	78782	89127	96088	90499
Dhaka	9130	6422	4308	3391	3068	2856	408	4183	3984	2851
Jamalpur	6370	6443	1580	1642	1503	2543	3577	2236	4082	3867
Mymensingh	72864	53309	55900	40936	40092	38145	14008	34065	39785	41031
Rangpur	1462	1474	1470	1674	1322	1836	829	1635	1657	1359
NE Region	**220835**	**197259**	**170498**	**131864**	**125194**	**133624**	**97604**	**131245**	**145596**	**139607**

Source: Yearbook of Agriculture, BBS.

Table D.14: Area Irrigated by Different Means, 1990-91 (ha)

Region	LLP	DTW	STW	HTW	Canals	Traditional	Total
Sylhet	77132	7612	5958	1582	31735	90499	214518
Dhaka	13627	12555	13619	528	2288	2851	45468
Jamalpur	5514	18110	34843	2780	1208	3867	66322
Mymensingh	72188	61451	58398	267	5237	41031	238572
Rangpur	579	1620	5202	241	106	1359	9107
NE Region	**169040**	**101348**	**118020**	**5398**	**40574**	**139607**	**573987**

Source: Yearbook of Agriculture, BBS.

Table D.15: Area Irrigated under Different Crops, 1989-90 (ha)

Region	Rice			Wheat	Other Cereals	Pulses and Oilseeds	Potato	Vegetables	Sugar cane	Other
	Aus	Aman	Boro							
Sylhet	2781	4074	188101	7739	117		3106	6505	103	1991
Dhaka	701	2762	36248	1274	24	108	2388	1287	27	628
Jamalpur	1761	1991	55054	3566	6	135	1149	873	298	1489
Mymensingh	2124	4148	220516	5173	64	272	1315	3050	433	1501
Rangpur	552	324	4653	2051	36	25	256	146	5	1059
NE Region	7919	13299	504572	19803	247	540	8214	11861	866	6668

Source: Yearbook of Agriculture, BBS.

ANNEX E
LIVESTOCK

The regional statistics depict only the part of the region (old district) located in the study area of the Northeast Region.

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Table E.1: Distribution of Livestock, 1983-84 ('000)

Region	Cattle	Buffaloes	Goats	Sheep	Chickens	Ducks
Sylhet	1451	52	278	45	2812	658
Dhaka	454	2	109	13	1237	187
Jamalpur	355	11	165	7	1804	25
Mymensingh	1434	12	392	4	3660	819
Rangpur	59	1	36	2	185	25
NE Region	**3753**	**78**	**980**	**71**	**9698**	**1714**

Source: Census of Agriculture and Livestock: 1983-84, BBS.

Table D.2: Distribution of Livestock, 1977 ('000)

Region	Cattle	Buffaloes	Goats	Sheep	Chickens	Ducks
Sylhet	1608	35	256	34	2067	752
Dhaka	379	1	131	12	785	159
Jamalpur	284	7	141	5	797	80
Mymensingh	1346	10	368	7	2531	652
Rangpur	60	1	35	1	104	26
NE Region	**3677**	**54**	**931**	**59**	**6284**	**1669**

Source: Agricultural Census: 1977, BBS.

Table D.3: Distribution of Working Animals, 1983-84 ('000)

Region	Total Working Cattle	Cattle Used for Cultivation	Total Working Buffaloes	Buffaloes Used for Cultivation	Total Working Bovine	Bovine Used for Cultivation	Draft Animal Unit
Sylhet	844	761	38	35	882	796	813
Dhaka	182	160	1	1	183	161	166
Jamalpur	257	252	10	8	267	260	229
Mymensingh	849	827	9	5	858	832	699
Rangpur	31	31	1	1	32	32	27
NE Region	**2163**	**2031**	**59**	**50**	**2222**	**2081**	**1934**

Source: Census of Agriculture and Livestock: 1983-84, BBS.

Table D.4: Ownership of Livestock by Households, 1983-84

Region	No. of Total Households ('000)	Percentage of Total Households		
		Bovines	Sheep/Goat	Poultry
Sylhet	894	52.0	24.3	67.9
Dhaka	297	48.0	34.6	71.4
Jamalpur	239	48.1	42.6	76.4
Mymensingh	918	52.8	34.0	72.2
Rangpur	34	54.4	53.7	73.9
NE Region	**1701**	**51.5**	**31.4**	**70.9**

Source: Census of Agriculture and Livestock: 1983-84, BBS.

Table D.5: Ownership of Bovines by Farm Size, 1983-84

Region	No. of Total Bovines ('000)	Percentage of Total Bovines				
		Non-farms	Farms	Small Farms	Medium Farms	Large Farms
Sylhet	1669	3.7	96.3	36.2	39.5	20.6
Dhaka	384	7.6	92.4	51.0	34.1	7.3
Jamalpur	328	3.7	96.3	39.9	42.7	13.7
Mymensingh	1363	3.4	96.6	40.5	40.5	15.6
Rangpur	60	4.5	95.5	37.3	43.2	15.0
NE Region	**3804**	**4.0**	**96.0**	**39.6**	**39.6**	**16.8**

Source: Census of Agriculture and Livestock: 1983-84, BBS.

Table D.6: Changes in Per Capita Bovines in Farm Households

Region	1983-84	1977
Sylhet	0.29	0.32
Dhaka	0.21	0.24
Jamalpur	0.24	0.23
Mymensingh	0.26	0.29
Rangpur	0.31	0.35
NE Region	**0.26**	**0.29**

Source: Census of Agriculture and Livestock: 1983-84; and Agricultural Census 1977, BBS.

Table D.7: Changes in Number of Bovines Per Hectare of Land by Farm Size

Region	All Farms		Small Farm		Medium Farm		Large Farm	
	1983-84	1977	1983-84	1977	1983-84	1977	1983-84	1977
Sylhet	2.57	2.77	4.30	4.50	2.47	2.77	1.56	1.73
Dhaka	2.97	3.14	4.05	4.25	2.45	2.55	1.66	1.78
Jamalpur	2.40	2.10	3.43	3.01	2.17	2.05	1.53	1.48
Mymensingh	2.42	2.57	3.56	3.81	2.20	2.42	1.56	1.75
Rangpur	2.94	4.13	4.13	4.10	2.72	2.87	1.98	2.20
NE Region	**2.67**	**2.99**	**3.95**	**4.03**	**2.42**	**2.59**	**1.66**	**1.83**

Source: Census of Agriculture and Livestock: 1983-84; and Agricultural Census 1977, BBS.

Table D.8: Ownership of Sheep/Goat by Farm Size, 1983-84

Region	No. of Total Goat/Sheep ('000)	Percentage of Total Goat/Sheep				
		Non-farms	Farms	Small Farms	Medium Farms	Large Farms
Sylhet	547	14.39	85.79	50.00	25.36	10.43
Dhaka	243	16.68	83.32	56.48	22.59	4.25
Jamalpur	257	16.13	83.87	48.17	28.17	7.53
Mymensingh	731	13.46	86.54	49.95	28.74	7.85
Rangpur	47	15.43	84.57	45.23	30.73	8.61
NE Region	**1825**	**14.58**	**85.48**	**50.41**	**27.02**	**8.05**

Source: Census of Agriculture and Livestock: 1983-84, BBS.

Table D.9: Ownership of Poultry by Farm Size, 1983-84.

Region	No. of Total Poultry ('000)	Percentage of Total Poultry				
		Non-farms	Farms	Small Farms	Medium Farms	Large Farms
Sylhet	3765	15.36	84.64	46.46	27.08	11.10
Dhaka	1350	20.12	79.88	55.58	20.56	3.74
Jamalpur	1076	15.91	84.09	46.41	29.67	8.01
Mymensingh	4229	13.58	86.42	48.43	29.54	8.45
Rangpur	170	15.27	84.73	44.38	31.30	9.05
NE Region	**10590**	**15.30**	**84.68**	**48.36**	**27.56**	**8.75**

Source: Census of Agriculture and Livestock: 1983-84, BBS.

Table D.10: Changes in Per Capita Availability of Goat/Sheep and Poultry in Farm and Non-farm Households

Region	Goat/Sheep		Poultry	
	1983-84	1977	1983-84	1977
Sylhet	0.10	0.06	0.67	0.50
Dhaka	0.15	0.09	0.80	0.53
Jamalpur	0.19	0.12	0.81	0.67
Mymensingh	0.14	0.08	0.82	0.65
Rangpur	0.25	0.21	0.91	0.70
NE Region	**0.21**	**0.13**	**0.77**	**0.60**

Source: Census of Agriculture and Livestock: 1983-84; and Agricultural Census 1977, BBS.

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ANNEX F
LAND USE AND TENURE

The regional statistics depict only the part of the region (old district) located in the study area of the Northeast Region.

Table F.1: Land Utilization, 1990-91 (ha)

Land Use	Sylhet	Dhaka	Jamalpur	Mymensingh	Rangpur	NE Region
Net Cropped	673623	96614	120291	507794	18989	1417311
Single	398285	29892	22582	165550	3569	619878
Double	235947	52949	79598	291942	12183	672619
Triple	39391	13773	18111	50302	3236	124813
Total Cropped	988352	177109	236110	900340	37643	2339554
Current Fallow	90320	11222	17216	41069	2225	162052
Cultivable Waste	56898	26628	6260	34384	524	124694
Forest	74405	6631	6708	13053	71	100868
Not Available for Cultivation	343376	46420	37116	186244	6472	619628
Total	**1238622**	**187515**	**187591**	**782544**	**28281**	**2424553**

Source: Yearbook of Agriculture, BBS.

Table F.2: Net Cropped Area, 1969-70 to 1989-90 (ha)

Region	1969-70	1974-75	1979-80	1984-85	1989-90
Sylhet	747686	696304	619488	651137	621100
Dhaka	134449	127433	127425	128548	98553
Jamalpur*			142974	148624	120068
Mymensingh	777568	728224	529427	560817	501746
Rangpur	19124	19578	20193	20380	18358
NE Region	**1678827**	**1571539**	**1439507**	**1509506**	**1359825**

**: Jamalpur is included in Mymensingh in 1969-70 and 1974-75.*
Source: Yearbook of Agriculture, BBS.

Table F.3: Single Cropped Area, 1969-70 to 1989-90 (ha)

Region	1969-70	1974-75	1979-80	1984-85	1989-90
Sylhet	517253	519243	366631	435085	311147
Dhaka	75814	79424	80291	83634	40911
Jamalpur*			56859	50238	26384
Mymensingh	280024	302529	182189	179659	151861
Rangpur	6113	6295	5352	4912	4021
NE Region	**879204**	**907491**	**691322**	**753528**	**534324**

**: Jamalpur is included in Mymensingh in 1969-70 and 1974-75.*
Source: Yearbook of Agriculture, BBS.

Table F.4: Double Cropped Area, 1969-70 to 1989-90 (ha)

Region	1969-70	1974-75	1979-80	1984-85	1989-90
Sylhet	208121	161901	228984	200137	265788
Dhaka	44570	37966	38462	38997	40298
Jamalpur*			73773	84964	72219
Mymensingh	476721	383975	309489	335823	308497
Rangpur	11565	11547	12483	12850	10946
NE Region	**740977**	**595389**	**663191**	**672771**	**697748**

**: Jamalpur is included in Mymensingh in 1969-70 and 1974-75.*
Source: Yearbook of Agriculture, BBS.

Table F.5: Triple Cropped Area, 1969-70 to 1989-90 (ha)

Region	1969-70	1974-75	1979-80	1984-85	1989-90
Sylhet	22312	15160	23873	15915	44165
Dhaka	14065	10043	8672	5917	17344
Jamalpur*			12342	13422	21465
Mymensingh	20823	41720	37749	45335	41388
Rangpur	1446	1736	2358	2618	3391
NE Region	**58646**	**68659**	**84994**	**83207**	**127753**

**: Jamalpur is included in Mymensingh in 1969-70 and 1974-75.*
Source: Yearbook of Agriculture, BBS.

Table F.6: Total Cropped Area, 1969-70 to 1989-90 (ha)

Region	1969-70	1974-75	1979-80	1984-85	1989-90
Sylhet	1000431	888525	896218	883104	975619
Dhaka	207149	185485	183231	179379	173538
Jamalpur*			241431	260432	234545
Mymensingh	1295935	1195639	914414	987310	893017
Rangpur	33581	34597	37392	38466	36086
NE Region	**2537096**	**2304246**	**2272686**	**2348691**	**2312804**

**: Jamalpur is included in Mymensingh in 1969-70 and 1974-75.*
Source: Yearbook of Agriculture, BBS.

Table F.7: Current Fallow Land, 1969-70 to 1989-90 (ha)

Region	1969-70	1974-75	1979-80	1984-85	1989-90
Sylhet	4774	60228	135182	103356	107429
Dhaka	5823	12679	12612	7796	33667
Jamalpur*			8510	2124	23030
Mymensingh	13897	72324	56140	26045	70996
Rangpur	1783	1363	784	668	3070
NE Region	**26277**	**146594**	**213228**	**139989**	**238192**

**: Jamalpur is included in Mymensingh in 1969-70 and 1974-75.*
Source: Yearbook of Agriculture, BBS.

Table F.8: Not Available for Cultivation, 1969-70 to 1989-90 (ha)

Region	1969-70	1974-75	1979-80	1984-85	1989-90
Sylhet	328273	328356	330246	339372	374810
Dhaka	40380	40554	41140	43489	43461
Jamalpur*			27747	29481	35327
Mymensingh	173303	188187	149234	152009	169052
Rangpur	6188	6193	6224	6388	6258
NE Region	**548144**	**563290**	**554591**	**570739**	**628908**

*: *Jamalpur is included in Mymensingh in 1969-70 and 1974-75.*
Source: Yearbook of Agriculture, BBS.

Table F.9: Culturable Waste Area, 1969-70 to 1989-90 (ha)

Region	1969-70	1974-75	1979-80	1984-85	1989-90
Sylhet	56046	55247	53715	90718	60479
Dhaka	916	903	878	1428	5305
Jamalpur*			1764	3650	2683
Mymensingh	30360	20774	17031	12521	17828
Rangpur	1059	1015	947	714	523
NE Region	**88381**	**77939**	**74335**	**109031**	**86818**

*: *Jamalpur is included in Mymensingh in 1969-70 and 1974-75.*
Source: Yearbook of Agriculture, BBS.

Table F.10: Forest Area, 1969-70 to 1989-90 (ha)

Region	1969-70	1974-75	1979-80	1984-85	1989-90
Sylhet	81710	78356	79857	65990	74405
Dhaka	6608	6608	6121	6915	6631
Jamalpur*			6748	3864	6708
Mymensingh	35870	21488	11839	12280	13053
Rangpur	50	56	56	55	71
NE Region	**124238**	**106508**	**104621**	**89104**	**100868**

*: *Jamalpur is included in Mymensingh in 1969-70 and 1974-75.*
Source: Yearbook of Agriculture, BBS.

Table F.11: Number of Farm Households, 1977 ('000)

Region	Small Farm	Medium Farm	Large Farm	Total
Sylhet	182	179	51	412
Dhaka	76	42	6	124
Jamalpur	47	47	10	104
Mymensingh	230	179	36	445
Rangpur	8	7	1	16
NE Region	**543**	**454**	**104**	**1101**

Source: Agriculture Census 1977.

Table F.12: Cultivated Land by Farm Types, 1977 ('000 ha)

Region	Small Farm	Medium Farm	Large Farm	Total
Sylhet	103	304	267	673
Dhaka	39	70	28	137
Jamalpur	27	80	47	154
Mymensingh	123	299	170	592
Rangpur	4	12	7	23
NE Region	**296**	**765**	**519**	**1580**

Source: Agriculture Census 1977.

Table F.13: Number of Farm Households, 1983-84 ('000)

Region	Small Farm	Medium Farm	Large Farm	Total
Sylhet	443	170	47	660
Dhaka	155	37	5	197
Jamalpur	115	43	7	165
Mymensingh	457	166	31	654
Rangpur	16	6	1	23
NE Region	**1186**	**422**	**91**	**1699**

Source: Agriculture Census 1983-84.

Table F.14: Cultivated land by Farm Types, 1983-84 ('000 ha)

Region	Small Farm	Medium Farm	Large Farm	Total
Sylhet	179	262	229	670
Dhaka	58	55	19	132
Jamalpur	102	130	69	301
Mymensingh	184	263	150	597
Rangpur	6	10	6	22
NE Region	**529**	**720**	**473**	**1722**

Source: Agriculture Census 1983-84.

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