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The Spatial Interconnection between Agro-Ecological Dissimilarities and Poverty in Bangladesh: A Case Study

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ABSTRACT

The study explores spatial deviation of agro-ecology and its interconnection with poverty. Agro-ecology provides more than the resources need for material welfare and livelihoods, in addition to alleviating poverty. Bangladesh, especially the northwest region, remains high intensity of poverty with divergence of agro-environment. Heterogeneous agro-ecological features were found which affect poverty dissimilarity. Incidence of poverty seems to have linkage with agro-ecological variations. The areas having low productivity have higher incidence of poverty. Both the field and printed documents have been exploited to put in writing this manuscript.

Keywords: Agro-ecology, poverty, Rajshahi, variations

INTRODUCTION

In the Asian and Pacific region, land and water resource management has been acknowledged as one of the priority sectors for reaching sustainable food security throughout, increasing land productivity, reducing land degradation and water failure, and increasing biodiversity as well as improving the quality of environment. In particular, the Asian countries have also committed themselves to manage their natural resources. In the last three decades, the Land and Water Development Division of FAO has made considerable progress on the appraisal of land use planning and management, land degradation assessment, and land use mapping as well as the potential utilizations of land resources for better food and agriculture (FAO, 2005). This is particularly because the ecosystem provides more than the resources needed for material welfare and livelihood. In addition to supporting all life and regulating natural systems, they specifically provide health and cultural benefits to people (UNEP and IISD, 2005). Both the status and trend of the ecosystems, ecosystem services, and their linkages to poverty reduction in Uganda have been explored in the report by the Centre for Resource Analysis Limited (CRA). The report serves as a tool for raising awareness among policy makers and the general public about the linkages between the ecosystems and poverty reduction (CRA, 2006).

Agro-ecosystem is a medium for growing food crops for human beings. The cultivation of plants for food is dependent on natural factors, such as fertile soil, adequate soil moisture, suitable climatic conditions, and a rich source of plant and animal species (CRA, 2006). Thus, the agricultural sector is a significant means for

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feeding the additional growing population, which also provides an important role for economic growth in a sustainable manner. Globally, 2.8 billion people earn not more than US$2 per day, whereas 1.2 billion of them receive just a single US$ per day (World Bank, 2001) and 70% of these poor people are living in rural areas. In a developing country like Bangladesh, where poverty is a great problem, around half of its total population (140 million) are deprived of the living standard, where agriculture is a fundamental sector.

Bangladesh is a predominantly agricultural country. For their living, more than half of the country's population are directly or indirectly related to agriculture (Alam and Moral, 1997). Agriculture occupies almost 9.6 million hectares of about 14.5 million hectares of the country's total area. Meanwhile, around 70 percent of the total land areas are developed primarily for agricultural purposes or activities with regional variations. In other words, the agricultural productivity varies from one region to another because of the bio-physical, socio-economic and operational factors which have linkages with poverty (*Fig. 2*).

AGRO-ECOLOGY

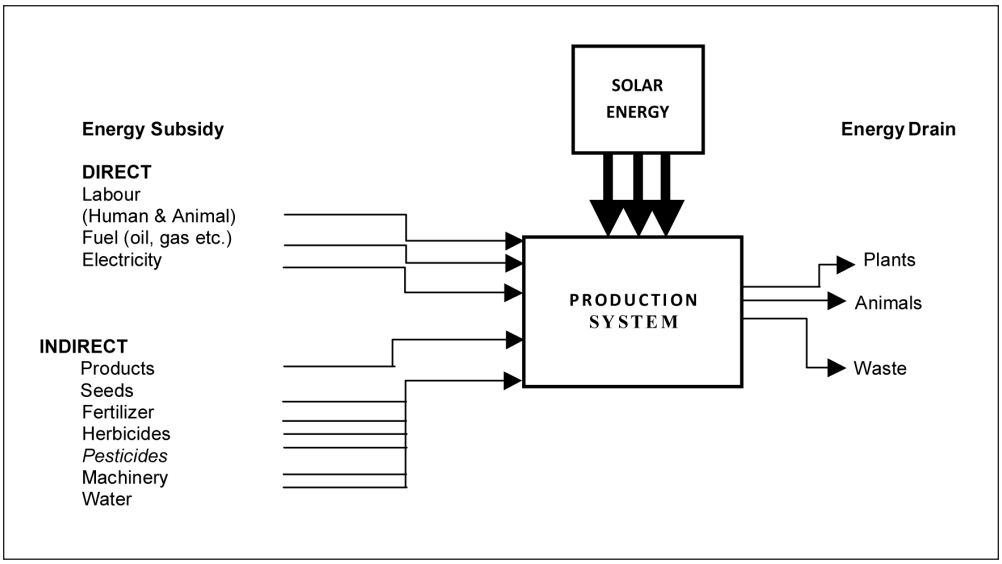
In the context of natural and social parameters, the system of agro-ecology is wide and diverse. The agro-ecology involves the interaction between agriculturally associated organisms and their physical habitats. The productions of food-grains, livestock, energy flow and nutrient cycle, etc. are therefore the fundamental elements of the agro-ecosystem. In addition, the system comprises communities of plants and animals which are interacting with their physical and chemical environments that are modified by people to produce their food, fire, fuel, and other products for human consumption and processing. Direct energy subsidy includes labour, fuel and electricity, whereas indirect energy subsidy includes seeds, fertilizer, herbicides, pesticides, machinery, and water (*Fig. 1*). By using solar energy, the energy subsidies produce various types of agricultural products and waste products in the system (Tivy, 1992).

THEORETICAL STRUCTURE

Poverty refers to not only the lack of income but also being short of resources. It also includes other dimensions of deprivation like physical weakness, isolation, vulnerability and powerlessness. In Bangladesh, poverty is not only a sense of deprivation but it also interconnected with vulnerability. Most frequently, regular vulnerability generates critical problems of income generation (BIDS, 1988). The risk of entitlement failure determines the level of vulnerability of a household to food insecurity. In more specific, the greater the share of resources denoted to food acquisition, the higher the vulnerability of the household to food insecurity. The routine vulnerability in food security leads to income erosion and perpetuates the problems of poverty. Food production and availability at the household level is one of the major dimensions of poverty and the exploration need to identify and analyze the biophysical and socioeconomic factors of food production and availability and their linkages to poverty. One approach to examine the pattern of food production is to understand the control of agricultural production that has both spatial and temporal dimensions. The productive capacity of land is set by the agro-ecological conditions of the area concerned. Agricultural, socio-economic and operational factors, together determine agricultural productions and their inter-linkage is known as agro-ecological system (*Fig. 2*).

AGRO-ECOLOGY AND POVERTY

Ahmad and Zaman (1997) stated that there is a close relationship between poverty, high population growth and agro-ecology with positive feedback, and they feed upon one another to generate a vicious circle (*Fig. 3*). Nonetheless, the nature and strength of this interrelation vary from one situation to another.



(*Source*: Tivy, 1992)

Fig. 1: A diagram of an agro-ecosystem

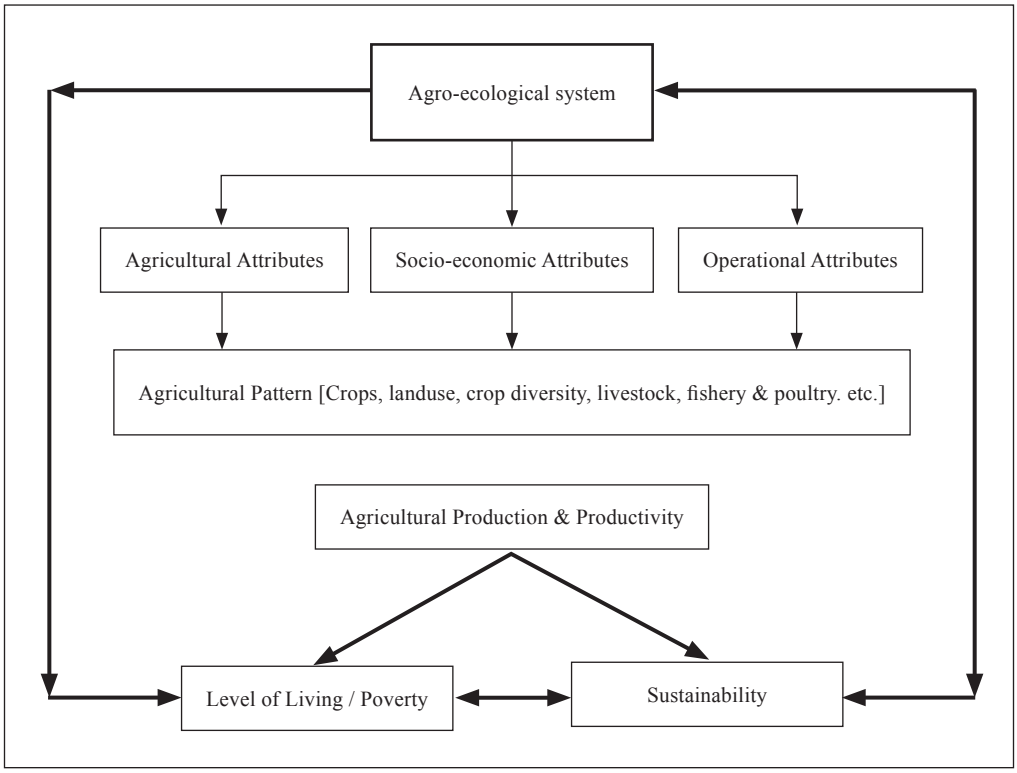
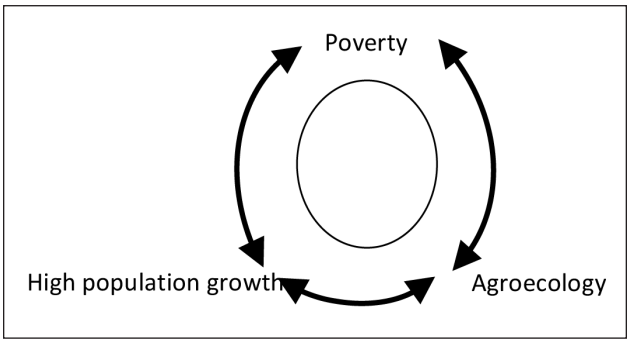


Fig. 2: Agricultural systems and poverty



(*Source*: Ahmad and Zaman, 1997)

Fig. 3: The interconnection between poverty and agro-ecology

The vicious circle of the population, poverty, and environmental poor quality can be extended to explicitly incorporate with the linkages of agro-ecology.

METHODOLOGY

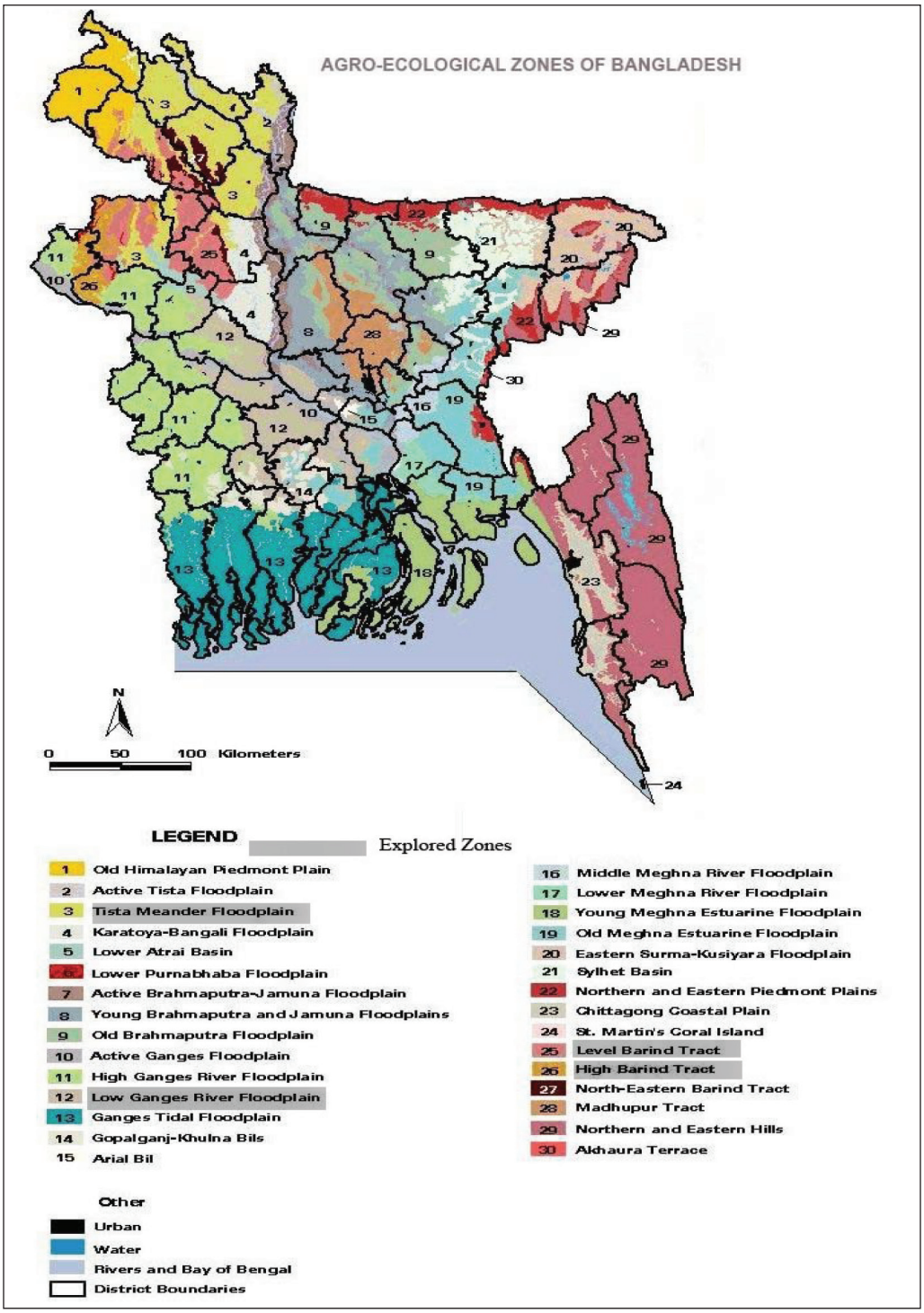
Both the primary and secondary data, which were respectively gathered from the field survey and published documents, were used in this study. Meanwhile, a structured questionnaire was used to acquire information from the fields of selected villages. In particular, the BARC/ FAO (Bangladesh Agriculture Research Project/ Food and Agricultural Organization) and AEZ (Agro-Ecological Zones) project reports were used as the key sources of the secondary data. The northwest region of Bangladesh comprises eleven agro-ecological zones, as illustrated in Map 1. Four zones out of eleven, known as Tista Meandering Floodplain, High Barind Region, Level Barind Region and Low Ganges Floodplains, were investigated. It is important to note that the studied regions also have wide agro-ecological variations and diverse poverty. In order to finding the micro-level ecological characteristics, four villages named Uttar Dhumitary, Uttar Chandipur, Krisna Pur, and Vhabanipur from each of the four investigated zones were studied. The total numbers of households (HHs) for those villages were 85, 190, 522 and 361, respectively. A structured questionnaire was used to collect the field data. Meanwhile, a stratified random sampling comprising of 30% of the samples of HHs were searched out, at 0.05 significant level.

STUDY REGIONS

The whole Bangladesh can be divided into 30 agro-ecological zones, and each of these zones has distinct characteristics (*see* Map 1). Eleven zones are located in the northwestern region of Bangladesh. Land types, such as low, high and other types, can be found in the northwest part of Bangladesh. Out of these, one is high piedmont plain, three terraced to level barind tract, three active, 3 low, 1 high and 2 other types of floodplains (UNDP/FAO, 1988). For the purpose of area selection, the different agro-ecological regions were grouped into three categories based on more or less similar physiographic characteristics, which include:

- High Barind
- Level Barind and Old Himalayan Piedmont Plain
- Floodplains

Among these regions, floodplains occupy a major proportion of the area. Four case studies have been investigated, which include two from the floodplain zones, one from a high barind region, and another one from the level barind tract (*see* Maps 1-5).



(*Source*: BARC/FAO/UNDP GIS Project: BGD/95/006, based on UNDP/GOB/FAO Project BGD/81/035)

Map 1: Agro-ecological zones in Bangladesh

Agro-ecology and Poverty in the Northwest of Bangladesh

UNDP/FAO identified 11 main agro-ecological zones in the northwest region of Bangladesh. Each zone indicates a wide range of agro-ecological variation. The main characteristics of each zone have been highlighted into subsequent Boxes 1-4.

The High Barind Region (HBR)

The High Barind Region is one of the fundamental agro-ecological zones in the northwest region. The total area occupies around 1600 km^2, whereby there are a wide range of ecological variations along with significant differences in physiography, soil, and slope. These diverse and complex physical conditions provide both the opportunities and limitations for land use and development. Land level of the region increasingly rises to the western side but gradually lowers to the level barind tract. Most of the land is free from flood with prevailing uniform climate all over the region and a mean annual rainfall of 1300-1400 mm. The soil is of grey, silty, puddle topsoil, and plough-pan. The topsoil, which has small moisture holding capacities with slow permeability, contains high acid with low organic matter. Limited surface waters are available in tanks. Groundwater is available in the eastern region. Transplanted Aman is a major crop. Meanwhile, Broad Cast Aus is cultivated before Aman through irrigation. HYV Boro is also farmed there. Rabi crops are cultivated by hand irrigation from the adjoining water tanks in field. The main constraints of agriculture include terrace soil and shortage of soil moisture during the dry season. The development strategies may exercise the ways of widespread irrigation facilities from deep tube wells to improve the crops.

The Level Barind Region (LBR)

Just like the HBR, the Level Barind Region (LBR) has also been developed over Madhupur clay which has ecological variations and great opportunities for development. The total area is around 5049 km^2, with flat landscape increasingly rises to the high barind region (HBR). In the relatively higher parts, rainwater is reserved in ponds for paddy cultivation. In lower sites, rainwater is accumulated up to about 60 cm deep in the rainy season. Flood occurs occasionally due to heavy rainfalls. In addition, the climatic condition is not uniform. The mean annual rainfall is 2000 mm in the northeast region and this is around 1300-1500 mm in the southwest region. The soil is strongly acidic with low organic matter, and there is limited surface water that can be used for irrigation during the dry season. Groundwater is available within 100 m depth from the surface but varies from one place to another. A higher proportion of the land is used for mixed Aus and Aman, deepwater Aman, capsularis jute and irrigated HYV Boro. Meanwhile, a lower proportion is devoted to transplanted Aman and cash crops, such as tobacco, cotton, potatoes, bananas, and spices.

Low Ganges Floodplain Region (LGFR)

The region comprises eastern half of the Ganges River with broad landscape of smooth ridges and basins (7968 km^2). Moderate to deep flash floods occur respectively during rainy and dry seasons. The mean annual rainfall increases from about 1600 mm in the northwest to about 2000 mm in the southwest. Soils are olive-brown, silt loams, and silty clay loams on the upper parts of floodplain ridges and soil are dark grey, with mottled brown clay soil on the lower ridge sites. Most of the ridge soil is calcareous and non-calcareous in the upper layers. Meanwhile, non-calcareous upper layers are slightly acidic or neutral. Ample groundwater apparently exists throughout the region with limited amounts of surface water. Aus is the main crop, while early Rabi cash crops (tobacco, potato, vegetables, and spices) are cultivated by hand irrigation.

Meandering Tista Floodplain Region (MTFR)

This region is one of the major parts of Tista Floodplain (9468 km^2) with broad almost level floodplain ridges. The ridge in the northwest

BOX 1
Agro- ecology and poverty of the HBR

Location
Rajshahi,
Chapinawabganj
Naogaon Districts
Physiography
Highest and most steeply sloping areas
Terraced valley sides
Deep valley to the south and west
Long valleys to the eastward
Shallower towards level Barind
Drainage
Well drained
Rapid run-off
Proportion of landscape
High land 93%
Medium high land 1%
Medium lowland<1%
Low land <1%
Very low land 0%
Homesteads, water 6%
Climate
High deviation of climate from year to year
Both winter and summer are the longest
Mean annual rainfall of 1300-1400
Soil
Poorly drained soils
Soil types and total percentage
Acid basin clays---<1%
Shallow red brown terrace soils-3%
Shallow grey terrace soils-----3%
Deep grey terrace soils-------72%
Gray valley soils---16%
Soil texture
Loamy---13%
Clayey--87%
Water resources
Limited surface water
Ground water poor in western region
but rich in eastern region
Present land use
Transplanted Aman grown dominantly
Development constraints
Uncertain rainfall
Inadequate surface and ground water
Low soil Fertility
Sloping relief
puddle silty topsoil
Big land ownership
Development possibilities
Crop production by increasing irrigation, soil and crop management
Poverty (%) *73*

(*Source*: UNDP/FAO, 1988 and field survey)

BOX 2
Agro-ecology and poverty of the LBR

Location
Denajpur, Gaibandha, Jaipurhat, Naogaon, Natore, & Sirajgang Districts
Physiography
Almost level, gradually elevated in the west side
Drainage
Seasonally flooded by heavy rainfalls
Proportion of the landscape
High land -30%
Medium high la--55%
Medium lowland--4%
Low land -2%
Very low land --0%
Homesteads, water --9%
Climate
High standard deviation of climate
Mean annual rainfall of -2000 mm in the north east region & 1300-1500 in the southwest
Soil
The maximum soils are Grey, Silty, puddle topsoil and plough pan
General soil types
Non-calcareous alluvium--<1%
Non-calcareous brown floodplain soil-----<1%
Non-calcareous dark Grey floodplain soil-----<1%
Acid basin clay----1%
Shallow red brown floodplain soil--<1%
Deep red brown floodplain soil--1%
Brown mottled terrace soil--1%
Shallow Grey terrace soil---46%
Deep Grey terrace soil-34%
Grey valley soil--6%
Made land-----<1%
Urban ----<1%
Homesteads + water----9%
Soil texture
Sandy---------<1
Loamy---------3%
Clayey--------97%
Water resources
Limited surface water i.e. rivers & tanks during dry season
Groundwater resources are good except for the border of High Barind Region
Present land use
T. Aman
HYV Aus
Aman varieties
Development constraints
Drought
Flood
Low soil fertility
Uncertain groundwater
Poor communication
Big land ownership
Development possibilities
Great possibilities for food-grain productivity
Poverty *64%*

(*Source*: UNDP/FAO, 1988 and field survey)

BOX 3
Agro-ecology and poverty of the LGFR

Location
Natore, Pabna, Goalundo, Faridpur, Madaripur, Gopalgong, And so on.
Physiography
Meandering floodplain landscape of broad ridges and basins
Drainage
Most of region flood except high region
Proportion of the landscape
High land ---13%
Medium high land 29%
Medium lowland 31%
Low land ----14%
Very low land -2%
Homesteads, water11%
Climate
Mean annual rainfall of 1600 mm in the north east region & 2000 mm in the southeast
Soil
General soil types
Calcarious alluvium--.-3%
Noncalcarious alluvium----<1%
Calcarious brown floodplain soil-----14%
Calcarious Grey floodplain soil....1%
Calcarious dark Grey floodplain soil--64%
Noncalcarious dark Grey floodplain soil<1%
General soil types
Peat------<1%
Made land-<1%
River-------2%
Urban -------<1%
Homesteads + water-.... 10%
Soil texture
Organic(peat) ---<1%
Sandy--------<1
Loamy-------48%
Clayey-------52%
Water resources
Limited surface water
Groundwater find within 100 m from the surface
Present land use
Aus
Aman
Deepwater Aman
HYV Boro
Development constraints
Widespread deep flooding
Doughtiness in north region
Heavy clay basin
Poor internal road communication
Big land ownership
Development possibilities
Large food-grain production
Poverty *53%*

(*Source*: UNDP/FAO, 1988 and field survey)

region is relatively higher other than elsewhere. Flash flood occurs in the Basin of Tista River. Deep floods hit in the south and south-east regions. Most of the soil is silty. Patches of grey sandy soil occurs erratically amongst the silty basin soil in several areas. Meanwhile, great climatic differences, with a mean annual rainfall of about 1500 mm in the southwest

BOX 4
Agro-ecology and poverty of the MTFR

Location
Rangpur, Nilphamari, Kurigram & Gaibandha District
Physiography
Low land with ridges and cut-off channels
Drainage
Well drained
Rapid run-off
Proportion of landscape
High land, 93%
Medium high land, 1%
Medium lowland, <1%
Low land, <1%
Very low land, 0%
Homesteads, water, 6%
Climate
High deviation of climate from year to year
Both winter and summer are longest
Mean annual rain fall of 1300-1400mm
Soil
Poorly drained soil
Soil types and percentage of total
Acid basin clay---<1%
Shallow red brown terrace soil----3%
Shallow grey terrace soil---3%
Deep grey terrace soil---72%
Gray valley soil---16%
Soil texture
Loamy--13%
Clayey--87%
Water resources
Limited surface water
Ground water poor in western region but rich in eastern region
Present land use
Transplanted Aman grown dominantly
Other varieties grown scarcely but poor yield
Development constraints
Uncertain rainfall
Inadequate surface and ground water
Low soil Fertility
Sloping relief
puddle silty topsoil
Big land ownership
Development possibilities
Crop production by increasing irrigation, soil and crop management
Poverty *85%*

(*Source*: UNDP/FAO, 1988 and field survey)

and about 2300 mm in the extreme north, are seen. Olive-brown soil with rapidly permeable and loamy soils are seen into the upper parts of high floodplain ridges, and grey or dark grey with slowly permeable and heavy silt loam or silty clayey loam soil can be found into the lower land. Clay soil is seen in limited basin areas. Silty Tista floodplain soil possesses a very high moisture holding capacity with low organic matter. Slight to strong acid of cultivated topsoil can also be seen there. The predominant soil is grey with puddled topsoil and ploughpan. During the dry season, surface water is unavailable in most of the rivers and tanks. Meanwhile, groundwater is available all over the region other than that adjacent to the HBR. During the rainy season, however, groundwater is close to the surface. T. Aman is the major crop, whereas HYV. Aus and Aman varieties are also widely cultivated. No irrigated land generally stays crop-free during the dry season.

Micro-level Agro-ecology and Poverty

Agro-ecology influences productivity of agriculture and it also leads to alleviation of poverty. The productivity varies from one region to another because of agro-environment disparity.

Uttar Chandipur

High intensity of poverty and wide variation of agro-environment are found in the investigated village of Uttar Chandipur. Most of the lands are owned by very few landlords. The rest of the people have limited lands and they live below

TABLE 1
Agro-ecological constraints and intensity of poverty

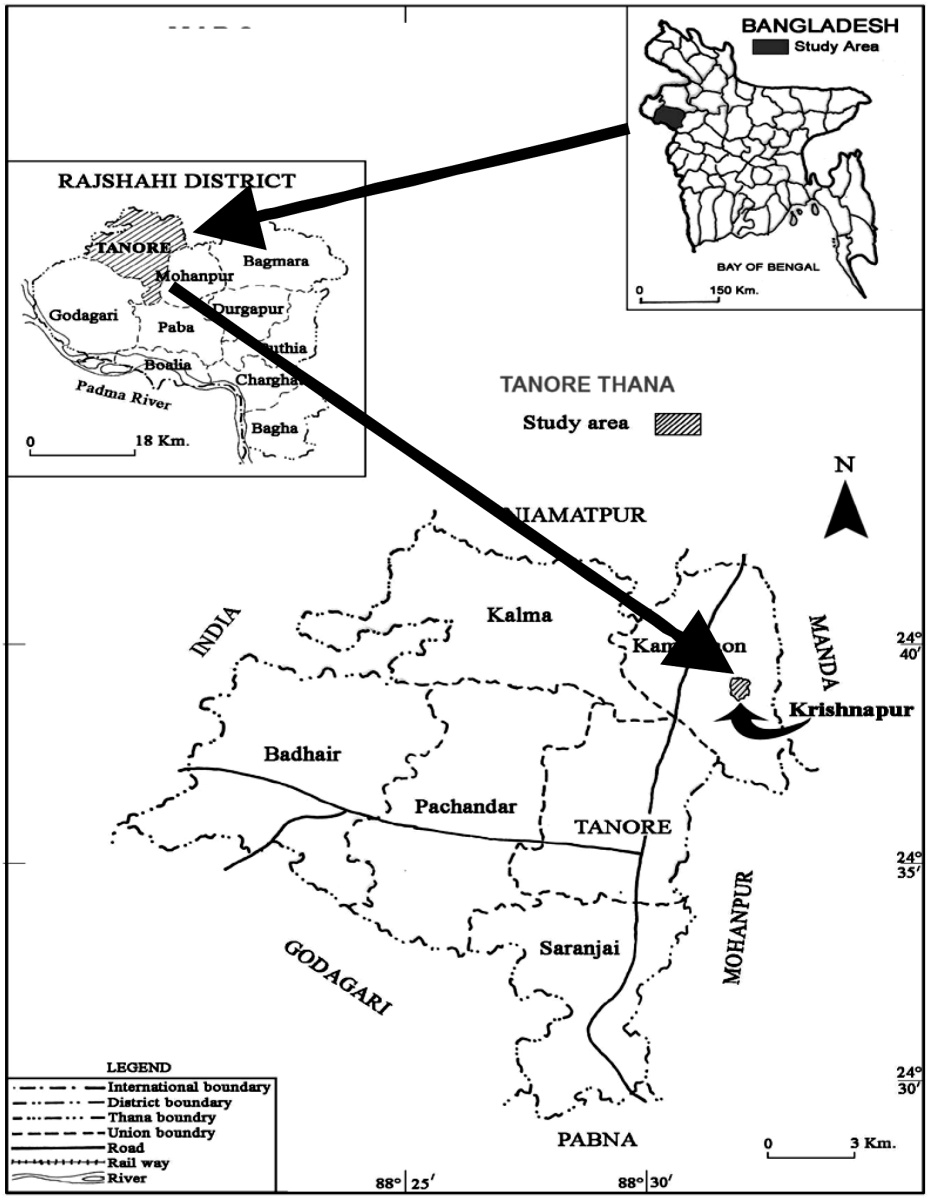
AEZ	Ecological constraints	Intensity of poverty (%)
HRB	• steep slope • terrace valley • high erosion, • rapid run-off • high land 93% • high deviation of climate • clayey soil texture • limited surface water	73
LBR	• plain land • low erosion, • medium land 55% • high standard deviation of climate • clayey soil texture (97%) • limited surface water	64
LGFR	• floodplain • seasonally flooded • less deviation of climate • loamy (48%) and clayey (52%) soil texture • limited surface water within 100m find ground water	53
MTFR	• floodplain • seasonally flooded • loamy soil texture • limited surface water and ample ground water	85

(*Source*: UNDP/FAO, 1988 and field survey)

the poverty line. Agriculture is the main sector of employment, where most of the poor work. Deep grey terrace soil and grey silty soil in the subsoil, with medium to strong acid, are the main features of the soil.

Krishnapur

This place has an almost homogeneous flat environment, where more than 50% of the households are poor. It has deep grey terrace soil with poorly drained and silty soil, where medium to strong acid soil can also be found.

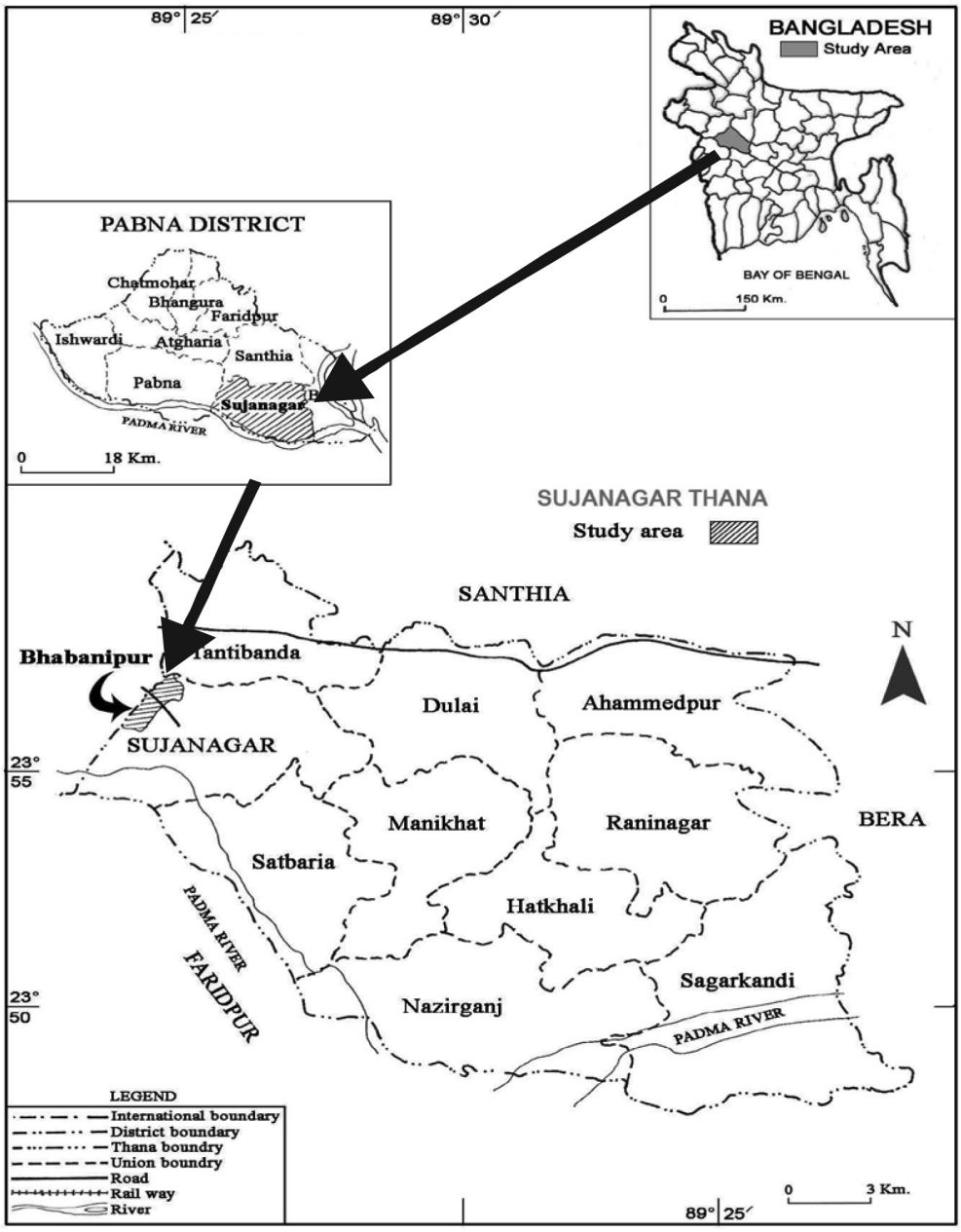


Source: BARC/FAO/UNDP GIS Project: BGD/95/006, based on UNDP/GOB/FAO Project BGD/81/035)

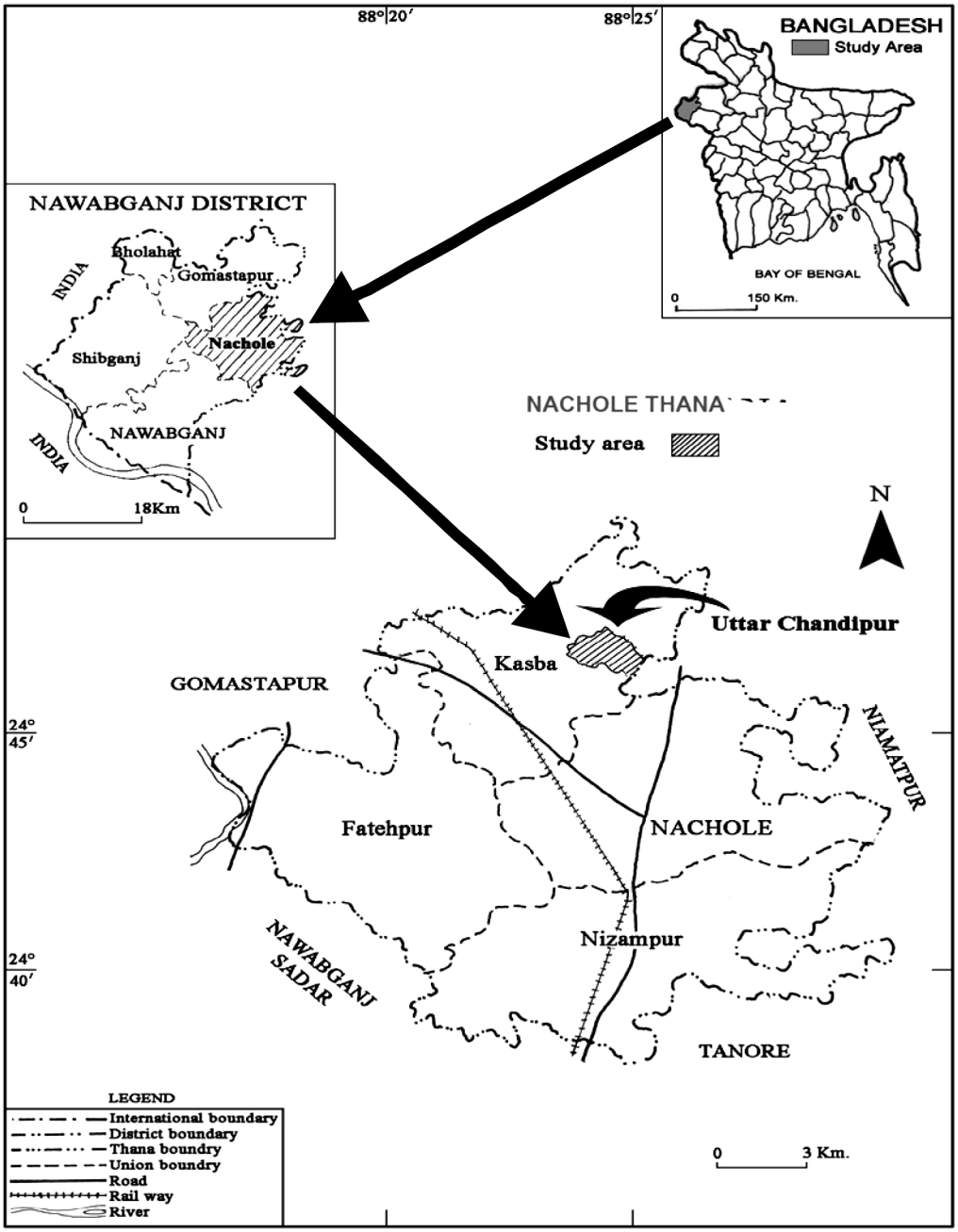
Map 2: Shows the location of Krishnapur

Vhabanipur

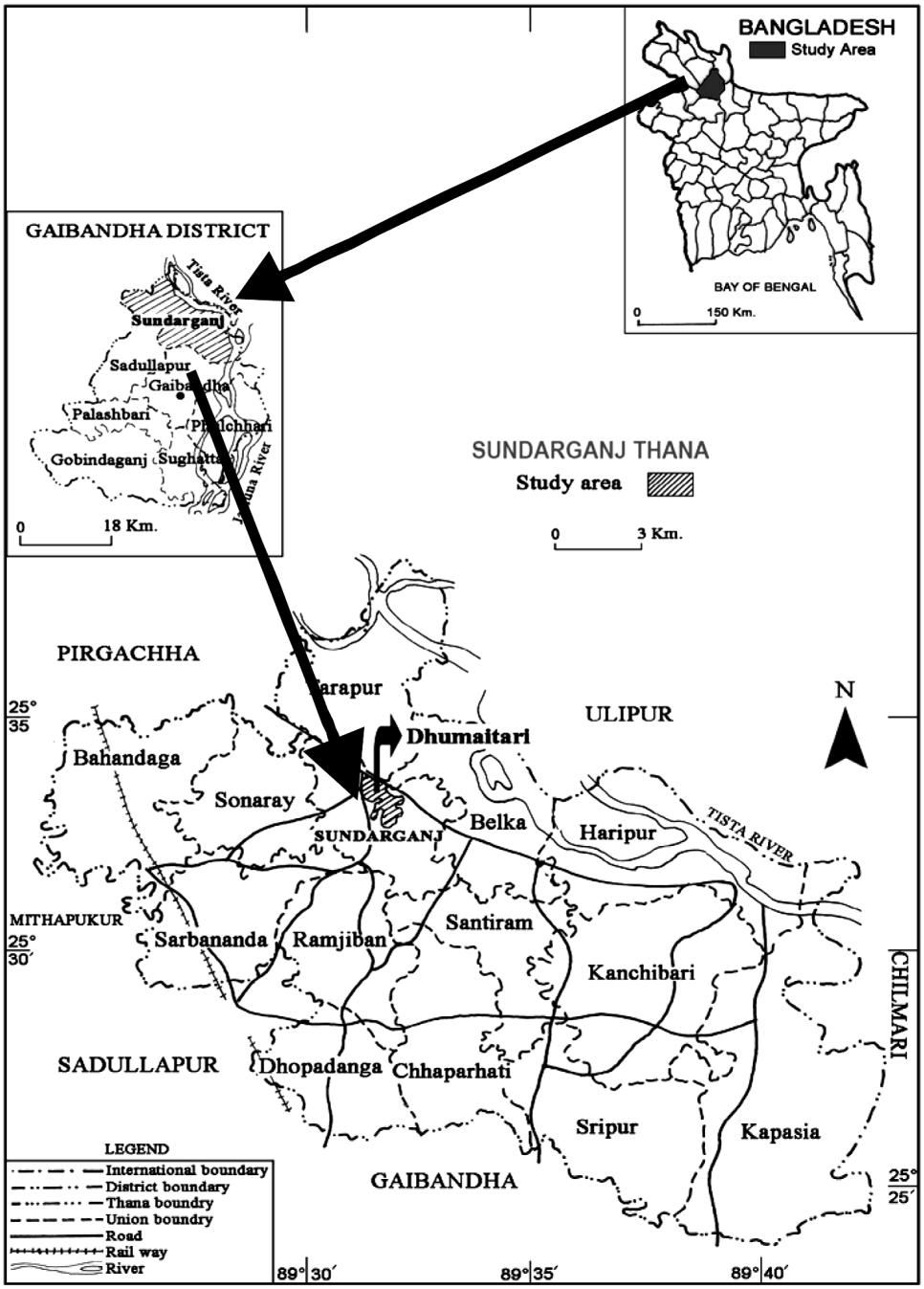
The environmental uniqueness includes calcareous dark grey floodplain soil, seasonally flooded soils with a cambic B horizon which is either dominantly dark grey or has a prominent dark grey or pressure faces, and calcareous within 125 cm from surface. Much of the basin soil has a neutral to acid topsoil and near-neutral subsoil over a calcareous substratum at 40-60 cm.



Map 3: The location of Bhabanipur



Map 4: The location of Uttar Chandipur



Map 5: The location of Uttar Dhumaitri

Uttar Dhumitury

The high intensity of poverty is seen at the village. Most of the poor live in floodplain basin, where frequent floods and river bank erosion are major disasters. Divergent agro-environment was also observed there. Meanwhile, non-calcareous dark grey floodplain soil, with a dark grey cambic B horizon, is also found at this place.

CONCLUSIONS

The heterogeneous agro-environment, which influences food-grain production and income of rural poor, was found in the investigated areas. In addition, the production systems, which are primarily influenced by physical, biological, climatologically and socio-economic factors, are highly complex and diverse. The present ranges of technologies are not uniformly distributed all over the agro-ecological zones. Instead, a wide gap of technologies could be seen at the sites. The environmental heterogeneities, which influence cropping intensity and productivity, are directly interconnected with poverty. The main causes of poverty found at the study areas include unequal landownership distributions of the respondents together with agro-ecological variations. Meanwhile, individual components of agro-environment, like climate and soil, and its interconnection with poverty, are suggested for further study.

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