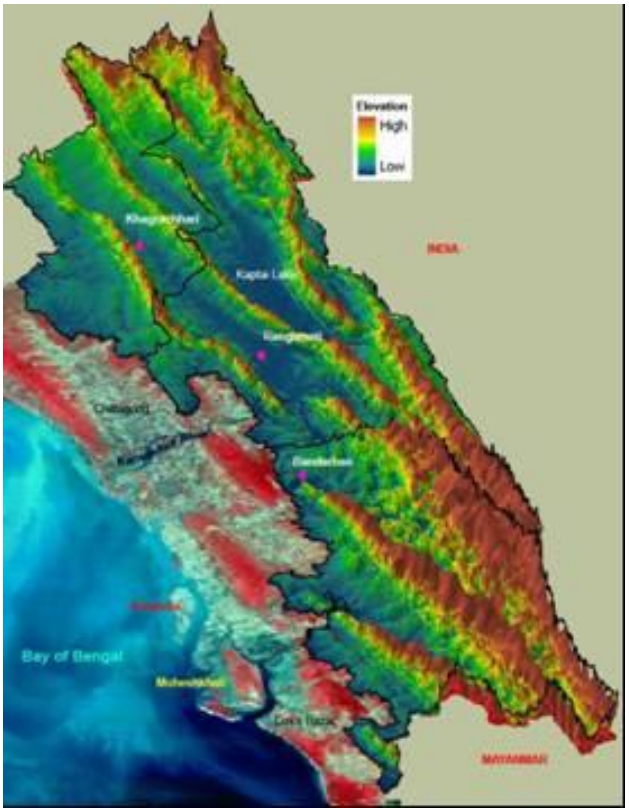
Technical Report



Support to Preparation of an Integrated Project for Environment Friendly Agriculture in the Chittagong Hill Tracts

Ministry of Agriculture
Ministry of Chittagong Hill Tract Affairs
Government of the People's Republic of Bangladesh
&
Food and Agriculture Organization of the United Nations

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Acronym

AD	Additional Director
ADB	Asian Development Bank
AI	Artificial Insemination
BADC	Bangladesh Agricultural Development Corporation
BARI	Bangladesh Agricultural Research Institute
B.Aus	Broadcast Aus
BBS	Bangladesh Bureau of Statistics
BD	Bangladesh
BDHS	Bangladesh Demographic and Health Survey
BFDC	Bangladesh Fisheries Development Corporation
BFRI	Bangladesh Fisheries Research Institute
BLRI	Bangladesh Livestock Research Institute
BMD	Bangladesh Meteorological Department
BRRI	Bangladesh Rice Research Institute
BSCIC	Bangladesh Small & Cottage Industries Corporation
BSRI	Bangladesh Sugarcane Research Institute
BSTI	Bangladesh Standard Testing Institute
BWDB	Bangladesh Water Development Board
C	Centigrade
CA	Conservation Agriculture
CBO	Community Based Organization
CDB	Cotton Development Board
CEGIS	Center for Environment & Geographic Information System
CEGIS	Center for Environmental & Geographic Information Services
CHARM	Chittagong Hill Tracts Improved Natural Resources Management
CHT	Chittagong Hill Tracts
CHTDB	Chittagong Hill Tracts Development Board
CHTDF	Chittagong Hill Tracts Development Facility
CHTRC	Chittagong Hill Tracts Regional Council
CHTRDP	Chittagong Hill Tracts Rural Development Project
CLW	Community Livestock Worker
CPW	Community Poultry Worker
DAE	Department of Agricultural Extension
DAM	Department of Agricultural Marketing
DEM	Digital Elevation Model
DLS	Department of Livestock Services
DoF	Department of Fisheries
DP	Development Partner
ECD	Early Childhood Development
EH	Eastern Hills
ERD	External Resources Division
ET	Evapo-Transpiration
FAO	Food and Agriculture Organization
FD	Forest Department
FFS	Farmers' Field School

FGD	Focused Group Discussion
GDP	Gross Domestic Product
GED	General Economic Division (of the Planning Commission)
GIS	Geographic Information System
GoB	Government of Bangladesh
GSB	Geological Survey of Bangladesh
GW	Groundwater
ha	Hectare
HDC	Hill District Council
HDRC	Human Development Research Centre
HH	Household
HIES	Household Income & Expenditure Survey
HKI	Helen Keller International
HYV	High Yielding Variety
ICIMOD	International Center for Integrated Mountain Development
ISRIC	International Soil Reference and Information Centre, the Netherlands
IUCN	International Union for Conservation of Nature
km	Kilometer
kpd	Knot per day
kph	Kilometer per hour
LGD	Local Government Division
LGED	Local Government Engineering Department
LGI	Local Government Institution
LLP	Low Lift Pump
m	Meter
MDG	Millennium Development Goal
MICS	Multiple Indicator Cluster Survey
MoA	Ministry of Agriculture
MoCHTA	Ministry of Chittagong Hill Tract Affairs
MoEF	Ministry of Environment & Forest
MoFL	Ministry of Fisheries & Livestock
MSL	Mean Sea Level
NARS	National Agricultural Research System
NGO	Non Government Organization
NIPORT	National Institute of Population Research and Training
NTFP	Non Timber Forest products
PDC	Para Development Committee
PNDG	Para Nari Development Group
PWD	Public Works Datum
RC	Regional Council
REDD	Reducing Emission from Deforestation and Degradation
R&D	Research and Development
RF	Reserve Forest
RS	Remote Sensing
SAAO	Sub Assistant Agriculture Officer
SEC	Small Ethnic Community

SoB	Survey of Bangladesh
SOTER	Soil and Terrain Digital Database
SRDI	Soil Resource Development Institute
SRTM	Shuttle Radar Topography Mission (NASA Satellite)
t	Tonne (metric ton)
T.Aman	Transplanted Aman
T.Aus	Transplanted Aus
Tk	Taka
UNDP	United Nations Development Programme
UNICEF	United Nations Children's Fund
UP	Union Parishad
USF	Unclassed State Forest
USGS	United States Geological Survey
UZP	Upazila Parishad
VCF	Village Common Forest
WFP	World Food Programme
VGF	Vulnerable Group Feeding
WL	Water Level
WS	Watershed

Glossary

Beari/bepari	Trader
Bilati-suta	British cotton yarn
Chang	Chakma language
Chhara	Hilly stream
Circle	Traditional kingdoms in CHT
Dao	Hill knife
District	Administrative unit comprising several upazila; 64 districts in Bangladesh
Ghona	Gorge between hills
Gur	Molasses
Headman	Traditional chief of a mouza
Jum	Swidden agriculture
Jumia	Jum farmer
Jumma	Hill dweller; members of small ethnic communities in the CHT
Kamla	Farm laborer
Karbari	Traditional chief of a village
Khal	Canal
Kharif	Mid-March to October
Mohajan	Moneylender
Mouza	Unit of revenue administration; may include more than one village
Nari	Woman
Para	Village
Paiker	Wholesaler
Pourashava	Municipality
Rabi	Mid-October to mid-March

Taka	Bangladesh currency
Union	Lowest level administrative unit comprising several villages
Union Parishad	Local government at the union level
Upazila	Administrative unit under a district comprising several unions
Upazila Parishad	Local government at the upazila level

Conversion

1 decimal	= 0.001 acre, 0.0004 ha
1 ha	= 2.471 acres
1 meter	= 39.37 inches
1 kg	= 2.2046 pounds
1 US$	= 78.64 taka (as of 18 March 2013)

Executive Summary

Introduction

The Government of Bangladesh (GoB) is committed to the socio-economic development of the Chittagong Hill Tracts (CHT). Through the Ministry of Agriculture (MoA) it has initiated a program to develop agriculture in the region. The declared objectives are:

- Assessment of current farming practices, market chain and the state of natural resources management; and
- Sustainable economic growth, food and nutrition security, with enhanced livelihoods and reduced poverty.

The project is envisaged is in conformity with the existing GoB plans and policies. Particular mention is made in the ***Chittagong Hill Tracts Treaty 1997*** that the government shall allot additional fund, on priority basis, with an aim to implement more projects in CHT. The ***Perspective Plan of Bangladesh 2010-2021***aims to create a more inclusive and equitable society through the inclusion of ethnic, religious, and cultural minorities into a national and social force. Finally, the ***Sixth Five Year Plan 2011-2015*** cites that the government will ensure community involvement in the adoption of technologies without competing with their traditional food production systems.

This technical report has been prepared by the Food and Agriculture Organization (FAO) of the United Nations based on a request from the MoA. FAO set up a field office for the CHT in Rangamati in July 2012 and mobilized a team of experts to undertake a background assessment of socio-economic factors, natural resources, current farming systems and practices in the region, identifying challenges and exploring options for future development. Necessary data have been obtained from consultation with farmers, focused group discussions (FGD), consultation with officials of GoB departments, NARS institutes, local government representatives, community leaders, NGOs and the private sector. Two rounds of regional/district level stakeholder consultations were held to share the methodology, generate ideas and communicate findings.

Socio-Economic Profile

The CHT region has a total area of 13,295 km^2, 342,390 households and about 1.7 million people. It accounts for 9 percent of the area and 1 percent of the population of the country. CHT is the home to a large number of small ethnic communities with their distinct cultures, livelihoods and identities. The average operated area per household is 0.93 ha (2.30 acres) and that of homestead area is 0.04 ha (0.11 acre). The extent of landlessness is 36 percent. Top five percent households (large farmers) operate 35 percent of the land, while the bottom 25 percent of households operate on only one percent.

The extent of poverty is high in the CHT. About half of the population or more are poor. Coping strategies for managing deficits and crises include working as wage laborer, distress sale of household assets, eating less and fewer meals, exhausting savings and fresh borrowing.

Food Security and Nutrition

In the CHT, people generally take three meals a day when they can afford. Rice is universally consumed, and so also are vegetables. Consumption of meat is very low, while more people eat

dry fish than fresh fish. Families usually do not drink milk and do not use oil in cooking vegetables. June-August is the period of relative scarcity across communities. Current level of rice production in the region falls short of the demand to the extent of 13 percent.

The prevalence of stunting, underweight and wasting among children below five years is 42.2, 34.1 and 7.3 percent respectively. The poor water and sanitation conditions compound the vulnerability of children to morbidity and mortality from diarrhea and other preventable diseases. Certain sections of the population are considered most vulnerable in terms of food and nutrition. They are:

- Female-headed households
- Marginal farmers and casual laborers with limited or no access to land
- Households with many children
- The elderly

Livelihood Practices

Farmers and farm laborers are major livelihood groups. Agriculture is broadly of two types; hill agriculture (*jum*) and plain land agriculture (plow agriculture). The number of *jum* farmers is estimated at 22,413, constituting about 13.4 percent of farm households dependent on agriculture for their livelihoods.

Thirty percent of households live on wage labor. Among other agricultural occupational groups are fishers, herdsmen, and dairy farmers and poultry keepers. Among non-agricultural activities are weaving, making household utilities, trading, hunting, extracting forest resources, money lending and various salaried jobs.

Agricultural activities are either self-financed and/or financed through borrowing. About a quarter of the households borrow from different sources. The highest proportion of them borrows for cultivation of crops. NGOs are a dominant source of credit.

Gender and the Role of Women

Households are overwhelmingly male-headed. Women in poor households more often manage their families, which indicate their strength, as well as vulnerability.

Women are primarily responsible for household food security. Gender dynamics clearly manifest that women and girls suffer most profoundly during periods of food shortage. Women participate in agriculture at various stages and have more roles and a greater labor burden than men. Women farmers in particular play a critical role in the production and storage of seed and maintaining genetic diversity. Their indigenous knowledge and techniques for seed preservation are transmitted through an intergenerational learning exchange process.

Jum is more than an occupation. It is a way of life and women have a central role in it. Apart from *jum,* women participate in indigenous forest management practices in the village common forest to retain forest cover within the village for long-term use.

Women in the CHT have relatively higher social mobility, but they are subject to wage discriminations. They are also the main sellers of *jum* products in the local market.

Except in the *Marma* community, women in other ethnic communities do not inherit any property. They are severely under-represented in both the traditional and formalized regional and local government bodies.

Institutions

Different formations belonging to the national government, local government, private sector and a wide range of civil society organizations including NGOs have emerged with complementary roles in agricultural development. Additionally, there are formal and informal functional groups and coalitions of the people at the community level who are increasingly being acknowledged as focus of development efforts. All these social and institutional entities operate within a network of power relations and linkages, which frame the overall institutional environment.

The traditional administrative system runs parallel to the formal government administrative system. It centers round the *Raja* (Circle chief), *Headman* (*mouza* chief) and the *Karbari* (village chief). *Headmen* and *Karbari* look after law and order, conflict management, allocation of land for *jum* in respective jurisdictions and collect revenue from *jum* farmers.

The *Union Parishad* (UP) is the lowest level elected local government in the administrative structure of the country. At the district level, there is the Hill District Council (HDC), while at the regional level there is a CHT Regional Council (CHTRC).

Public agencies are major service providers in various fields of agriculture. Among these are different extension departments and NARS institutes. Some of these have district level offices, while some have offices up to the upazila level and below.

Private sector is expanding in almost all spheres. Each hill district has a Chamber of Commerce and Industries with individual membership.

NGOs are active in all the hill districts. There are 17 national and 267 local NGOs in the CHT registered with different authorities. Some of them have programs for agricultural development.

Local NGOs have helped in setting up community based organizations (CBOs) at the *para* (village) level including 690 *Farmers' Field Schools* (FFS), 3257 *Para Development Committees* (PDC) and 1685 *Para Nari Development Groups* (PNDG) within the framework of the Chittagong Hill Tracts Development Facility (CHTDF) implemented by the HDCs. Presently CHTDF has 13 NGO partners under its Community Empowerment Project (CEP).

Natural Resources

Six major landforms are identified in the CHT. These are: medium-gradient mountains, high-gradient hills, medium-gradient hills, dissected plains, plains and valleys. The maximum elevation is 1,027m PWD; 79 percent lies between the elevations of 0m to 200m.

Land cover includes forest, herb/shrubs, fallow/agricultural land, river and water bodies, settlements, hill shades etc. The maximum area (44.9%) is covered with medium dense forest in 2003 which was reduced to 17.4% in 2010. Similarly, the area of dense forest was about 15.2% in 2003 which declined to 5.9% in 2008.

In the high hill ranges, soils are very shallow to deep, pale brown, slightly to strongly acid, sandy loams to clays, usually overlying decomposing bedrocks at variable depths. They are usually Eutrochrepts, Dystrochrepts and Lithosols. In the low hills, soils developed in soft rock materials are usually deep, brown to red brown, strongly to very strongly acidic, sandy loams to clay loams, locally overlying plinthite or hard lateritic substrata. Soil patterns generally are complex due to local differences in sand, silt clay contents of the underlying sedimentary rocks and in the amount of erosion that has occurred. Brown Hill soils are the predominant general soil type of the area. Organic matter content and general fertility level is low

The mean total annual rainfall in the CHT varies from 2400 to 3000mm. Monsoon rainfall is approximately 70-80 percent of the annual rainfall. Rainfall intensity is gradually increasing from North to South.

Drought originates from a deficiency of precipitation over an extended period of time resulting in a water stress. The total number of non-rainy days per year is generally increasing.

Probability of flood in terms of water congestion is very low due to topography of the region. Rivers are faster and speedier than other parts of Bangladesh and the region is flash flood prone. Affected areas usually remain waterlogged for a few days after every flood and suffer severe damage. Landslides are common during the monsoon.

Main sources of water are the surface water of rivers, lakes, canals and springs, and groundwater from shallow and deep aquifers. Rainwater is an alternative source of water in areas where rainfall is comparatively high. Most of the rivers flow in a north-south direction. About 1,400 km of rivers flow through the CHT region include mainly five rivers, named the *Chengi, Myani, Karnafuli, Matamuhuri and Sangu*. All these rivers contribute to the Kaptai reservoir.

Total length of *chharas* connected to the rivers and spreading over the CHT is more than 7,200 km. The *Kaptai Lake* stores about 43 percent of water of all perennial water bodies in the CHT.

In the context of groundwater, the CHT is less suitable than most parts of the country. The primary source of natural groundwater recharge is direct rainfall. No declining trend of groundwater level has been observed. Except for some areas of Khagrachhari district, the region has a very low ground water table.

A good tradition of water management is rarely visible in these areas. Drinking water largely comes from perennial water sources such as streams, springs, and rock channels. Water rights are rather undefined compared to land and forest rights. Sustainability of technologies installed for producing water is questionable due to many challenges in this area.

The CHT is very rich in biodiversity, though the situation is worsening with increasing human interventions and encroachments. The negligence of the customary use and management rights of forests has accelerated deforestation.

Assessment of Watersheds

In the CHT, 659 watersheds have been delineated. Most of the rivers, *chharas* and *khals* dry up in the winter. Only 156,936 ha (3.1%) of the total land area are valley and suitable for intensive cropping. One-fifth of the valley land has been brought under irrigation and 80 percent of the area is under rainfed agriculture.

Vast majority of the land in the region is hilly and undulated. During the monsoon, some of the rain infiltrates and recharges the ground water table, but most of it actually runs off. Ground water table varies rapidly in this region in comparison to the plain lands due to its topography.

Commonly used methods for water retention for irrigation purposes are indigenous cross-dams and retention ponds. Two rubber dams are under construction in the region.

Farming Systems

Subsistence farming, small land holdings and short growing season prevail in the region. Most of the farmers grow some fruits and vegetables.

Livestock and poultry play an important role in the farming system by supplying meat, milk and egg for nutrition and manure for crop production. Livestock and poultry freely graze. *Jumia* farmers keep native variety of pigs in their homesteads. Pisciculture is done by those who possess pond or other water body**.**

The majority of farms are of small size. Among all field crops, tobacco is predominant, while among cereal crops; HYV Aman is dominant, followed by HYV Boro and Local Aus (mostly *jum* variety). Among non-cereal crops other than tobacco, vegetables (both summer and winter), cotton and sugarcane cover substantial areas of the region, as do fruit orchards. Most of the cultivable land (62%) is single cropped. Different farming systems include

- Floodplain and valley land irrigated farming system
- Floodplain and valley land rainfed farming system
- Upland mono crop based farming system
- Mixed crop based farming system
- Upland *jum* cultivation
- Horticulture based farming system in hill slopes

Jum is a traditional farming system in the uplands, which is practiced by local communities and accounts for 10 percent of the net cropped area in the CHT. Cultivating multiple agricultural crops in the cleared patch of hill slopes for one or two seasons and then shifting to another place is a major trait of this land use.

Agro forestry is an alternative land use system characterized by cultivating different woody perennials along with agricultural crops.

Value Chain

Farmers store food and seed generally for three major objectives, (a) food for future consumption before the next harvest, (b) seed for next sowing/plantation season and (c) sale at a better price. Most of the farmers face various problems of storing and marketing their products. Major problems include small space for storage at the household level, absence of storage facilities for perishable commodities and different microbial spoilage of the produces, which compel farmers to sell their products immediately after the harvest at a very low price.

As agricultural commodities are transported from the farmyard to local, district and metropolitan city markets, prices soar. Incremental prices are mainly due to loss in storage and transportation, visible and hidden transport costs and profit of the actors in the market chain.

Depending on the location of the village and the bazaar, farmers have to travel anywhere between 0-25km to sell their produce, with most farmers reporting a distance of 5km to the local market and average distance to the major township market reported at 20km. Farmers in remote areas find it difficult or almost impossible to market their products, as they carry commodities manually over large distances. Carrying costs are thus very high often offsetting sales proceeds.

There are multiple actors, such as, the primary producer, broker, *aaratdar* and the wholesaler, in a value chain. The higher the number of actors, larger is the gap between the farm gate price and the ultimate price paid by the consumer. At each stage, actors are to incur costs of transportation, packaging, storage and various kinds of tolls and taxes. Costs are often multiplied because of product loss due to transportation and storage.

Fruit processing at the household level is practiced very little. Some traditional processing and preservation practices are found, especially for seeds.

Challenges

The report identifies major challenges that currently impinge on economic productivity and agricultural development in CHT, thereby negatively affecting the livelihood and food and nutrition security of the CHT populations. They are:

Population pressure

During 2001-2011, the population of the CHT increased by 19.5 percent, thus reducing the per capita availability of land. Concomitantly, the demand for food, water, housing, energy and recreational facilities have increased. In this scenario, population is still increasing, which implies increased food insecurity and malnutrition and more degradation of land and water quality.

Degradation of the natural resource base

Natural resources are degrading due to deforestation, reduction of *jum* rotation period, declining water resources, soil loss and decreasing soil fertility. Deforestation is a serious environmental concern because of resulting biodiversity loss, soil degradation and significant contribution to climate change.

Agro processing and value chain

Post-harvest losses of many agricultural products are quite high because of the perishable nature of the products, lack of processing facilities, improper harvesting and lack of facilities for storing, packaging and transportation. Post-harvest loss can be as high as 33 percent for many products. Market infrastructure is also very weak. In fact, storage, processing and quality grading activities do not exist.

Products are almost entirely sold as unprocessed raw materials. Large agro-processing companies that exist in other parts of the country do not have any processing/ collection point in the CHT.

Input management

Access to key production inputs is limited. For example

- access to good quality seeds, particularly those of recently developed improved varieties at affordable price, which is essential for productivity enhancement, is negligible;
- use of fertilizers and pesticides by farmers is done haphazardly and arbitrarily due to lack of knowledge on appropriate combination, dose and timing;
- access to institutional credit is severely constrained; farmers who have only customary rights to land and do not possess any official title cannot access bank credit.

Low productivity of Kaptai lake fisheries

The annual production of fish from Kaptai Lake is 130 kg/ha, far below its potential. Lack of modern and innovative techniques and poor management are serious constraints to productivity enhancement.

Agricultural research and development not focused on CHT needs

R&D systems addressing the special geo-physical nature and needs of the CHT are largely absent. In addition, many of the relevant institutions are poorly equipped with technical staff; it is difficult for them to deliver the required services.

Options for Development

On the basis of the identified challenges, a number of development options were identified which will constitute the priorities to be tackled in an integrated development project. Main development options to be considered are:

- Increasing agricultural productivity
  - *Enhanced productivity of HYV rice*
  - *Year round vegetable cultivation*
  - *Promotion of hybrid cotton*
  - *Zoning of sugarcane with intercrop*
- Creation of crop suitability zones based on land and water availability as well as socio-economic considerations
- Promotion of conservation agriculture in *jum* farming system
  - *Selection of suitable crop combinations*
  - *Selection of suitable crops and varieties*
- Upscaling of sustainable production practices of fruits and high value crops
  - *Adaptation trial of exotic fruits and high value crops at different elevations*
  - *Establishment of genetic resource conservation center*
- Sustainable orchard management
  - *Promotion of mixed orchards with pineapple cultivation*
  - *Popularization of mushroom cultivation in homesteads*
- Ensuring supply of improved seeds and planting materials
  - *Improving existing nurseries and establishing new ones*
- Promotion of agro forestry in sloping lands
  - *Assessment of carbon stock to benefit from REDD and REDD+ packages*
- Livestock development
  - *Improving community based animal health care*
  - *Establishing and strengthening AI service for cattle, goat and sheep*
  - *Improving homestead based pig rearing*
  - *Improved fodder production*
- Development of fisheries
  - *Establishment of fish culture in hill creeks*
  - *Improving management and productivity of Kaptai Lake resources*
  - *Establishment of cage and pen culture in the Kaptai Lake*
- Water management
  - *Use of seasonally available water for intensive cropping*
  - *Augmentation of water for irrigation over varied watersheds*

- Improved household agro-processing and value chain
  - *capacity building in post-harvest processing and value chain development*
  - *production zoning based on transport facility*
  - *upgrading of household level agro processing ventures*
  - *investment in production packaging*
  - *improving market access*
- Alternate income generation through integrated homestead farming
  - *improving livelihoods through apiculture*
  - *nutrition improvement through homestead and cooking demonstration*
- Adaptive research, participatory extension and demonstration
  - *expansion and strengthening of on-farm research*
  - *setting demonstration of advanced technologies*
- Human resource development
  - *filling human resources gap*
  - *capacity development of service providers*

Implementation Modalities

Implementation of a development project in the CHT needs a multi-agency framework where interventions will be addressed by all relevant stakeholders, such as, the local government (both under MoCHTA and LGD), GoB departments, private sector, CBOs and NGOs.

While addressing the management system, it is important to take two aspects into consideration. These are:

- Involvement of all stakeholders in the system that are relevant and able to contribute to accomplishing project objectives; and
- Delineation and devolution of responsibilities horizontally and vertically to make the system inclusive and functional.

A three tier management system has been envisaged to steer the process of implementation and coordination.

National level: At this level, there will be an Inter-Ministerial Steering Committee (IMSC).

District level: Districts would be the focal points for project planning, implementation, coordination and monitoring. The HDC will be the point of anchorage.

Upazila level: Upazilas will be organically linked with the districts for project planning, implementation, coordination and monitoring. The *Upazila Parishad* will look after activities at the upazila level and below.

Chapter 1

Introduction

1.1 Context

The Chittagong Hill Tracts (CHT) is located in the south-eastern part of Bangladesh bordering India and Myanmar. The British occupied the region in 1860, named it as Chittagong Hill Tracts and brought it as a district under the Province of Bengal (van Schendel *et al*, 2001). It presently includes three hill districts, Bandarban, Rangamati and Khagrachhari. The CHT has 5,811 villages under a total of 25 upazilas across the three districts (Table 1.1).

Table 1.1: Distribution of administrative units in the CHT

Administrative unit	Number			
	Bandarban	Khagrachhari	Rangamati	Total
Upazila	7	8	10	25
Union	30	38	49	117
Mouza	96	120	162	378
Village	1,554	1,702	1,555	4,811

Source: BBS (2012)

The region coincides with three traditional administrative Circles. These are the *Mong* (Khagrachhari), *Chakma* (Rangamati) and *Bohmong* (Bandarban), each with a traditional Chief (Figure 1.1).[1]

The CHT accounts for nine percent of the area and one percent of the population of the country. Large tracts of the region are covered by hills, which have made it unique in terms of agricultural practices and livelihood patterns. The majority of the people depends on agriculture for their livelihoods, and is facing mounting insecurity in the face of persistent environment and social challenges. The current situation is largely characterized by increasing population, water scarcity in the dry season, land degradation and weak market linkage.

1.2 Objectives

At the moment, a host of government and non-government agencies are implementing various projects for socio-economic development of the people of the CHT. The Ministry of Agriculture (MoA) of the Government of Bangladesh (GoB) has pledged to initiate a program to develop agriculture in the region in harmony with nature. Declared objectives are

- Assessment of current farming practices, market chain and the state of natural resources management; and
- Sustainable economic growth, food and nutrition security, with enhanced livelihoods and reduced poverty.

[1] Some parts of Khagrachhari district (Dighinala, Lakshmichhari) are under the *Chakma* Circle, while some parts of Rangamati district (Kaptai, Rajasthali) are under the *Bohmong* Circle.

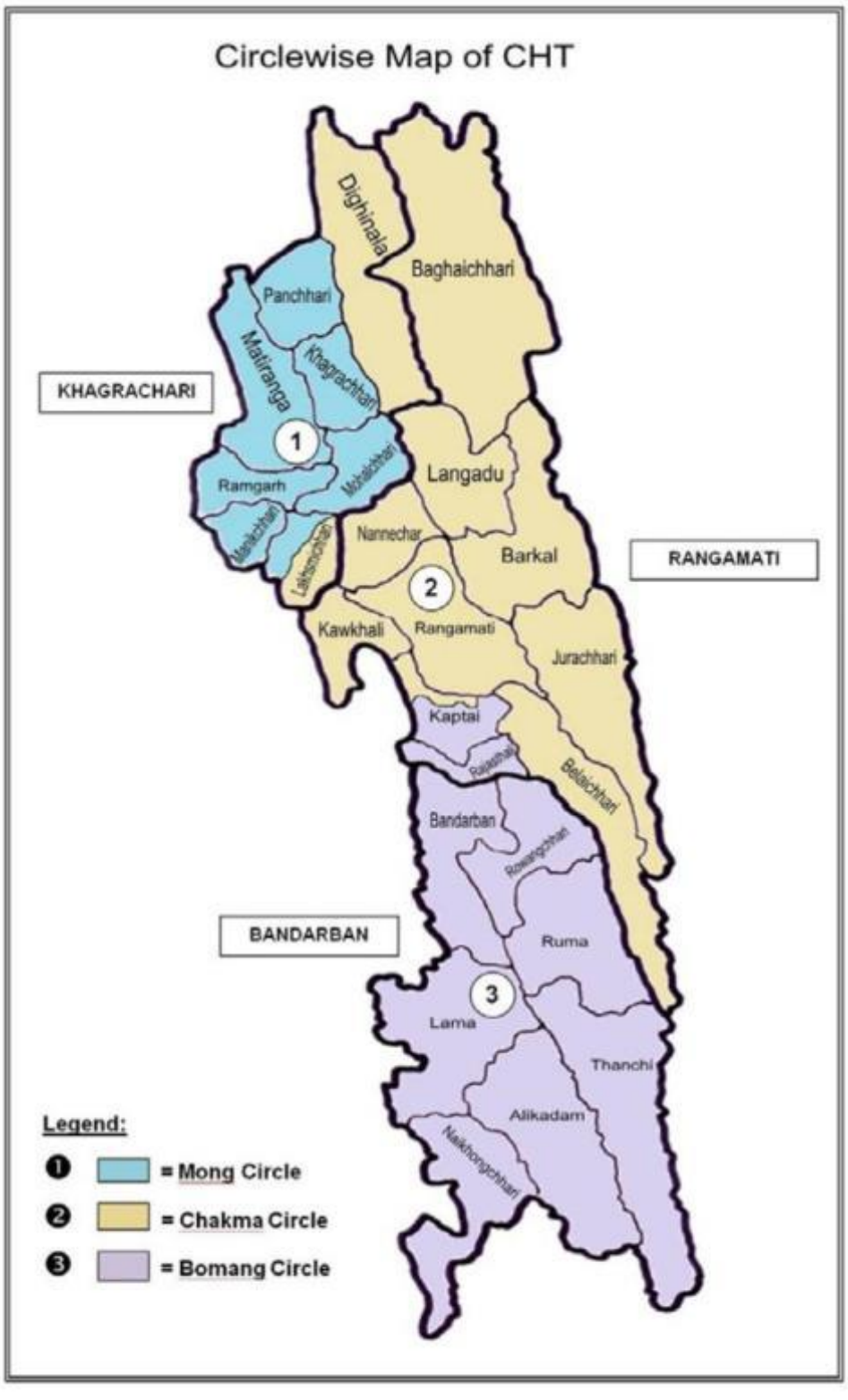

Figure 1.1: Map of the CHT showing upazila, district and circle
Source: ANZDEC Ltd (2011)

1.3 Strategic Thrusts in National Plans and Policies

The project is envisaged as an effort to improve livelihoods through the development of agriculture in the region. This is in conformity with the following GoB plans and policies.

Chittagong Hill Tracts Treaty 1997

The Chittagong Hill Tracts treaty was signed on December 2, 1997 in Dhaka at the Prime Minister's office between the government and the *Parbatya Chattagram Jana Sanghati Samity* (PCJSS) "with an objective to elevate political, social, cultural, educational and financial rights and to expedite socio-economic development process of all citizens in CHT". The treaty created conditions for the establishment of Hill District Councils, whose functions, among others, would be:

- Land and land management
- Environment preservation and development
- Proper utilization of water resources of rivulets, canals, ponds except *Kaptai Lake*, and irrigation
- *Jum* cultivation.

It has been particularly mentioned that "the government shall allot additional fund, on priority basis, with an aim to implement more number of projects in CHT. New projects are to be formulated with an aim of making necessary superstructures for development in the area, shall be implemented on priority basis and the government shall provide fund for these purposes" (www.mochta.gov.bd).

Perspective Plan of Bangladesh 2010-2021

The Perspective Plan aims to create a more inclusive and equitable society through the inclusion of ethnic, religious, and cultural minorities into a national and social force. The full implementation of the 1997 Chittagong Hill Tracts treaty will be a move in this direction. In addition, the Plan puts major emphasis on environmental issues and sustainability, mentioning that "ecological balance and bio-diversity conservation are in critical state. In hill forests, the most common problems are erosion, over-exploitation and loss of soil fertility" (GED, 2010).

Sixth Five Year Plan 2011-2015

The Plan cites that Bangladesh has around forty-five different small ethnic communities and some of the "hardcore poor' of Bangladesh are found among these communities. For the people belonging to these ethnic groups, the vision is to ensure their access to education, healthcare, food and nutrition, employment and protection of rights to land and other resources." The Plan identifies major challenges as, among others, low food production resulting in food insecurity and inadequate institutional mechanism to establish linkage and coordination with the private sector to address issues related to ethnic communities in a comprehensive manner. It emphasized the following activities pertaining to their socio-economic development:

- Empowering ethnic communities: The government will ensure community involvement in the adoption of technologies without competing with their traditional food production system.

- Rural development and non-farm economic activities: In the hill districts, income generating activities through small and cottage industries, trading, and poultry and livestock rearing will be expanded. The income of poor people will be enhanced through social forestry in hilly areas and cultivation of fruits and medicinal plants.
- Expansion of micro credit: Micro credit activities for the poor people will be expanded and vocational training will be provided to the poor. The development of rural roads, hats, and bazaars for marketing of agricultural products will continue. Action will be taken to eliminate barriers so that agriculture and local products have easy access to national and international markets (Planning Commission, 2011).

1.4 Methodology

This technical report has been prepared by the Food and Agriculture Organization (FAO) based on a request from the MoA. FAO set up a field office for the CHT in Rangamati and mobilized a team of experts to undertake necessary assessment of socio-economic characteristics, natural resources, current farming systems and practices in the region, identifying challenges and exploring options for future development. The process sequenced as follows.

- 28 December 2010: MoA initiated integrated program for environment friendly cultivation in hilly areas (based on opinions of the DAE, DAM, BADC, SRDI, BRRI, BARI)
- 19-21 April 2011: MoA formed a sub-committee to advise on project development
- October 2011: Field visits/consultations by the sub-committee in three hill districts
- 22 January, 2012: MoA decided to formulate an integrated project
- 26 February 2012: MoA decided to develop a TA project
- 25 March 2012: MoA sent a letter to ERD
- 25 April 2012: ERD sent a request letter to FAO Bangladesh for technical and financial assistance for formulating a comprehensive plan for the CHT
- 1 July 2012: Mobilization of FAO team of experts in CHT
- 9 July 2012: Initial briefing to MoA by the FAO team
- 27 August 2012: MoCHTA nominated Focal Points of the CHTRC and three HDCs for liaison & coordination with FAO
- Submission of the preliminary draft report to MoA on 11 January 2013
- Presentation of the preliminary draft report to MoA on 29 January 2013
- Submission of a revised draft to MoA on

Necessary data have been obtained from consultation with farmers, focused group discussions (FGD), consultation with officials of GoB departments, NARS institutes, local government leaders, community leaders (*Headman*, *Karbari*, etc), NGOs, field level workshops and other secondary sources.

In addition, FAO contracted CEGIS to do an assessment of watershed resources in the CHT. CEGIS used available land elevations to prepare the Digital Elevation Model (DEM) of this area.

This DEM provided a terrain representation using GIS technology from which the watersheds were derived. The cell size in the DEM was 30m by 30m. The GIS analysis of flow accumulation defines the watershed boundaries.

CEGIS team of professionals made field visits several times since October 2012 to

a) Verify river and *chhara* (hill stream) systems with satellite images

b) Collect local information on water availability in *chharas* during the year

c) Verify preliminary delineated watersheds

d) Understand the existing scenario in terms of project requirements

e) Collect related documents (i.e., soil erosion data from SRDI field office)

f) Collect local people's perceptions in terms of need

Prior to field visits, desk work has been done focusing on some sample areas. In the field, CEGIS professionals met officials of relevant line agencies and the local people. They collected 358 GPS points for their field verification and tried to obtain information from local people on the spot.

1.5 Work Plan

The study for developing the aforementioned project started in July 2012. Data collection continued up to November. Two rounds of regional/district level stakeholder consultations were held. In the first round, one regional (held in Rangamati) and two district level (held in Khagrachhari and Bandarban), were organized in October-November 2012. Among the participants were farmers, leaders of traditional institutions (*Headman*, *Karbari*), representatives of the Regional Council and Hill District Councils, officials of GoB Departments, NARS institutes, development partners and projects, private sector and NGOs (Table 1.2). These consultations were aimed at sharing the methodology, process and preliminary findings, as well as to generate ideas and information around pertinent issues. Participants had interactive group exercises and their opinions were recorded for further research and analysis.

The next round of consultations was held in January 2013 to share the draft report with representatives of the HDC, Upazila Parishad, GoB Departments, NARS institutes, private sector and NGOs (Table 1.2). Comments received from the participants were duly addressed in revising and updating the draft report.

Table 1.2: List of stakeholder consultations

Location	Date	No. of participants
First round: Sharing methodology and generating ideas		
Rangamati	4 Oct 2012	49
Khagrachhari	8 Nov 2012	42
Bandarban	27 Nov 2012	43
Second round: Sharing draft report and generating comments		
Bandarban	23 Jan 2013	19
Rangamati	24 Jan 2013	24

The preliminary draft report was presented to the MoA on 29 January, which was attended by officials of MoA, MoCHTA and relevant departments and institutes of the MoA, MoFL, Planning Commission, ERD and so forth. Their comments on the report have also been addressed in the finalization process.

Chapter 2

Socio-Economic Profile

2.1 Demographic Features

According to the Population & Housing Census 2011, the CHT region has a total area of 13,295 km^2, encompassing 342,390 households and about 1.7 million people (Table 2.1). Population density per km^2 is much lower in the CHT (120) compared to Bangladesh as a whole (1015). Though per capita land endowment is seemingly very high compared to rest of the country, it is, in fact, the lowest in terms of available plain land.

The average number of persons per household in the CHT is 4.7, which is higher than the national average (4.4). There are more men than women. Indeed the sex ratio is quite high in CHT (108.1). Possible reasons are high female mortality and/or high degree of male in-migration. About 30 percent people in the CHT are urban dwellers.

Table 2.1: Demographic characteristics

District	Area km^2	Household	Population			HH size	Sex ratio	Population per km^2
			Male	Female	Total			
Bandarban	4,479	80,102	211,628	192,465	404,093	4.75	110.0	87
Khagrachhari	2,700	133,792	326,621	312,346	638,967	4.59	104.6	227
Rangamati	6,116	128,496	325,823	294,391	620,214	4.53	110.7	97
CHT	13,295	342,390	864,072	799,202	1,663,274	4.67	108.1	120
Bangladesh	147,570	32,173,630	74,980,386	74,791,978	149,772,364	4.44	100.3	1,015

Data source: BBS (2012)

The CHT experienced massive population growth in recent decades (Figure 2.1). While overall country population increased by 96 percent during the period from 1974 to 2011, CHT population increased by 227 percent during the corresponding period.

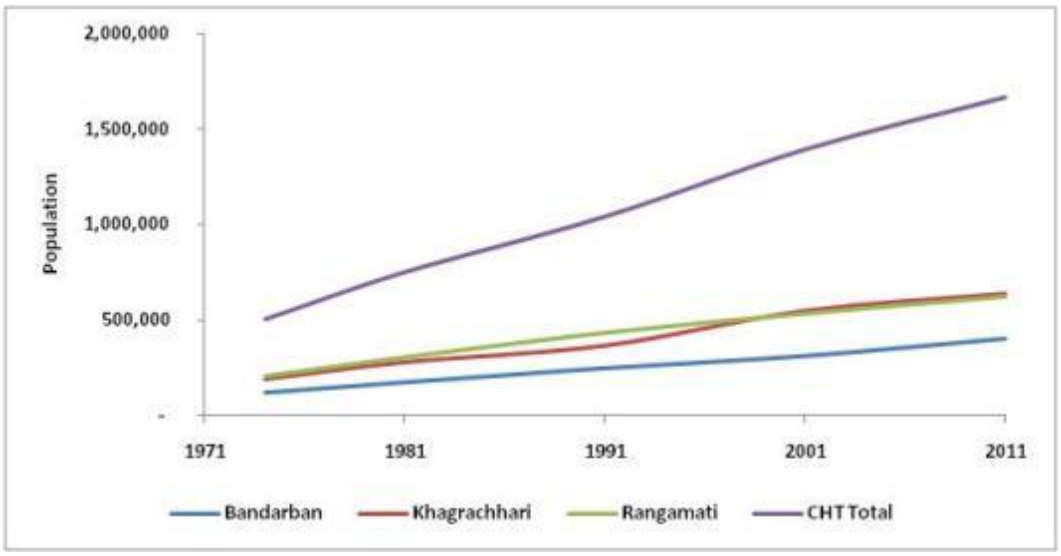

Figure 2.1: Population growth

CHT population was 124,762 (0.43% of the total population of Bangladesh) in 1901, which increased to 508,199 (0.67% of Bangladesh) in 1974 and to 1,663,274 (1.11% of Bangladesh) in 2011 (Establishment Division, 1971; BBS, 2007; BBS, 2012).

2.2 Ethnicity

CHT is home to a large number of *khudro nri-goshthi* (small ethnic communities).[2] These small ethnic communities (SEC) are broadly categorized into two groups based on their origin and level of exposure to 'modernity'. One group is the *Toungtha* (children of the hill, also called the *Kuki* Group). Among them are *Kuki, Khumi, Mro, Lushai, Khyang, Banjogi* and *Pankh*. The other group is the *Khyoungtha* (children of the river, also called the *Tipra* group). This includes *Chakma, Marma, Tipra, Tangchangya* and *Riang*. The *Toungthas* are the 'ancient tribes', while the *Khyoungthas* are the 'domiciled tribes' (Lewin, 1869). Based on BBS data, SECs accounted for 44 percent of CHT population in 2001. Among the SECs, *Chakma* tops the list in terms of population, followed by *Marma* and *Tripura* (ANZDEC Ltd, 2011).

There are different claims about the number of SECs in the CHT. Thirteen SECs have been mentioned by Larma (2008). They are *Chakma* (*Changma*), *Marma* (*Magh*), *Tripura* (*Tippera*), *Bawm* (*Banjogi*), *Chak* (*Asak*), *Khyang, Khumi, Lushai* (*Kuki*), *Mro* (*Murang*), *Pangkhua* (*Pankho*), *Tanchangya, Nepalese* (*Gorkha*) and Assamese. They collectively identify themselves as the *Jumma* people (High Landers) (Larma, 2008).[3] The UNDP-CHTDF baseline survey identified 11 communities as indigenous to the CHT, which excluded the *Nepalese* and the *Assamese* (HDRC, 2009)[4]. *Ushui* and *Riang* have been mentioned as separate ethnicities in some literature (Establishment Division, 1971; Khisha, 1996, van Schendel, 2001).[5] The *Santal* has also been mentioned as a community presently living in the region (Tripura, 2012). There are at least two *Santal* villages in Khagrachhari district confirmed by FAO field visits: one is Santalpara at Panchhari union of Panchhari upazila and another is Pukurpar Bainyachola Santalpara at Lakshmichhari union of Lakshmichhari upazila. Another community named *Khaeo* has been identified in Thanchi upazila of Bandarban district during FAO field visits and consultations. In addition to local ethnic groups, there are many *Bangalee* now living in the CHT.

Plain land dwellers call the *Jumma* people as *Pahari* (hill people). Among the three hill districts, Bandarban (Ruma upazila) and Rangamati (Sadar upazila) are home to the highest number of ethnic communities.

Each SEC is divided into several *goja* (clan) and each clan has several *gutthhi* (kinship group). A *goja* may have different customs and rituals and its members usually live in close proximity (Tripura, 1994).

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[2] Ethnic communities, hitherto been termed as *upajati* (tribal) or *adibashi* (indigenous people) are now mentioned as *khudro nri-goshthi* in the official literature of Bangladesh. The CHT Manual of 1900 described them as "indigenous hillmen" or "indigenous tribe" (Roy, 2008).

[3] Larma is the Chairman of the CHTRC and the chief of the PCJSS, the main political party of the region that signed the treaty with the government in December 1997.

[4] Population of some communities is very small and live in one or few villages, which might have been excluded by the CHTDF sample survey that covered only 29 unions (out of 117) of 14 upazilas (out of 25) in the CHT.

[5] Many *Chakmas* claim *Tanchangya* and *Chak* as part their community and *Tripuras* consider *Ushui* and *Riang* as part of them. Lewin (1869) mentioned that the *Bawm* and the *Pankhua* are the same.

2.3 Access to Land

According to popular perception, land is abundant in the CHT. Because of the predominance of hilly terrains with steep slopes, most of the land is not suitable for 'plough agriculture'. Another feature unique in the region is that land has been a common access resource for SECs, who operate on land for agricultural purposes through a system of customary rights inherited by an age-old traditional system.

The average operated area per household is 0.33 ha (0.82 acre) in Bangladesh, while in the CHT one household operates on 0.93 ha (2.30 acres). In terms of homestead area, each household possesses 0.04 ha (0.11 acre) in CHT, compared to 0.03 ha (0.08 acre) in the country (BBS, 2010)[6]. Households are broadly categorized into four major groups in the BBS literature. These are

- *non-farm* holdings, possessing no or less than 0.02 ha (0.05 acre) of land;
- *small farmer,* farm size of 0.02-1.00 ha (0.05 to 2.49) acres of land;
- *medium farmer,* farm size of 1.00 to 3.00 ha (2.50 to 7.49 acres) of land; and
- *large farmer,* farm size of 3.00 ha (7.50 acres) or more.

Non-farm households, who are mostly landless, are one quarter of total households in the CHT. Another 11 percent operate on less than 0.02 ha (0.5 acre) each and are considered as "functionally landless". Hence the extent of landlessness is 36 percent compared to 62 percent in Bangladesh. Land is highly concentrated in few hands. Top five percent households (large farmers) operate in 35 percent land, while the bottom 25 percent households operate in only one percent land in the CHT (Table 2.2, Figure 2.2).

Table 2.2: Land endowment by farm size

Farm strata	Percentage		Cumulative percentage	
	Holding	Operated area	Holding	Operated area
Non-farm	25	1	25	1
Small	42	23	68	24
Medium	27	40	95	65
Large	5	35	100	100

Data source: BBS (2010)

The highly unequal distribution of land is reflected in Figure 2.2 through a land endowment curve. If all households had equal access to land, then the curve would have taken the shape of the diagonal. More away the curve is from the diagonal, higher is the degree of inequality.

[6] Operated area includes homestead area. The UNDP baseline survey 2009 shows that average operated area and homestead area in CHT are 2.30 acres and 0.36 acre respectively.

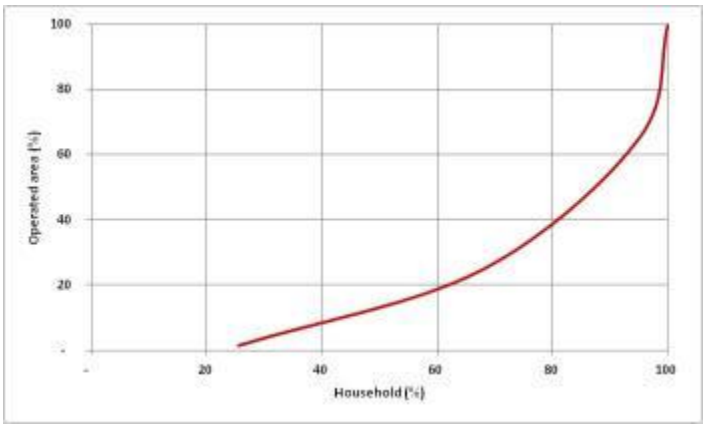


Figure 2.2: Land endowment

According to the UNDP-CHTDF baseline survey, average amount of land possessed by households is highest in the *Tanchangya* community, followed by *Mro*, *Khumi* and *Khyang*. The *Bangalees* are endowed with the lowest amount of land, followed by *Pankhua*, *Lushai* and *Tripura*. *Jum* (upland) farms are relatively bigger among members of the *Khumi* community, followed by *Mro*, *Pankhua* and *Lushai*, while the amount is very low among the *Chak*, *Bangalee* and *Khyang*. Average holding for plough agriculture (plain land) is the highest among the *Chak*. Plantations (fruits and trees) are more prevalent among the *Khyang*, *Chak*, *Bawm* and *Marma* (Table 2.3).

Table 2.3: Holding size by community and type of land

Type of land	Amount of land (decimal)[7]													
	All SEC	Bawm	Chak	Chakma	Khyang	Khumi	Lushai	Marma	Mro	Pankhua	Tanchangya	Tripura	Bangalee	All CHT
Homestead	40	14	20	69	15	12	12	21	7	10	29	24	31	36
Pond/water body	3	6	9	1	0	0	0	8	1	0	5	1	3	3
Plough agriculture	45	5	123	48	35	0	0	60	21	0	37	26	33	40
Jum agriculture	90	150	3	62	26	310	171	78	249	173	140	95	11	54
Plantation	94	111	126	92	274	38	22	100	65	0	87	59	37	69
Fringe land	18	9	0	42	0	0	0	1	0	0	0	0	17	17
Grazing & others	29	4	0	0	0	0	0	1	0	0	842	0	1	16
Total	318	298	280	314	351	361	204	270	342	183	1140	205	134	235

HDRC (2009)

2.4 Poverty

The concept of poverty has undergone radical changes in recent decades. Once it was indicative of food deficiency only. The narrow definition of poverty as lack of calories, food and income may not suffice, as it overlooks socio-cultural aspects. Also it is important to understand households and communities in terms of their culture and way of life. A broader definition based on the human development index (HDI) to measure poverty has been developed encompassing access to basic necessities of life including clothing, health, education, housing, water and sanitation, recreation and right to participation in decision making.

[7] 1 decimal = 0.001 acre (0.0004 ha)

Perceptions of poverty in the CHT have been mixed. According to some observations, life is simple; people are easy-going and happy. Some other observations indicate abject poverty among the people (Table 2.4).

Table 2.4: Poverty assessment in a historical context

Source	Narrative
W.W. Hunter, A Statistical Account of Bengal, 1876	With the exception of the Chiefs and a few headmen, the people are generally poor. They cultivate their patches of jungle until the soil within easy reach of their village is exhausted, and then they move away to a fresh spot. In the case of a bad harvest they borrow from Bengali traders and moneylenders.
R.H. Hutchinson, Chittagong Hill Tracts District Gazetteer, Calcutta, 1909	Taken as a whole, the hill people are exceedingly well off. They get three rice meals a day and seldom have a meal without some sort of relish; while fish, flesh of goat, pig and fowl are frequent additions to the daily meal. There are occasions of scarcity. They are well clothed and surround themselves with articles of luxury.
Commissioner, Chittagong Division, 1917	The economic condition of the hillman is deplorable, and is said to be getting worse every year. The first thing that strikes a visitor is the awful destitution of the people. Since 1891 there has been repeated distress every year.
F.D. Ascoli, Report on the Administration of the Chittagong Hill Tracts, 1918	The standard of comfort and living have increased to a phenomenal extent within the past fifty years; the ordinary homespun thread is now despised, and I have found even the poorest families able to afford to expense of *bilati-suta* (British cotton yarn) for their home-woven clothes. The adult Hillman consumes the large amount of three-fourths of a *seer* of rice per day flavored with dried fish imported from Chittagong; he frequently eats meat, and constantly vegetables, while his rice-brew is seldom absent. Tobacco is his constant companion and his meals are eaten thrice a day.
The Population Census, 1951	The economic condition of this district is very unsatisfactory. Trade is entirely in the hands of outsiders. There are 66 bazaars in the district and only a few shops in them belong to men of the district.
The Pakistan Census of Agriculture, 1960	Out of 42,400 farms, 14,050 farms or 33 percent of the total number of farms are in debt. The highest number of indebted farmers has farm size up to 2.5 acres and the amount of individual debt for majority farmers ranges from Rs 1 to Rs 99.
BBS, World Bank & WFP, Updating Poverty Maps of Bangladesh, 2009	Extent of poverty is high, particularly in Bandarban district (Sadar, Rowangchhari, Ruma, Thanchi, Alikadam) and in Rangamati (Baghaichhari, Langadu).
Chakma saying	A good harvest in the *jum* brings prosperity and keeps away poverty; as the local saying goes: *jei jei jei rainna bera jei, sudo goichha tulibam, tenga khamabam* (let's go to *jum*, collect cotton and sesame and make money).

Source: Establishment Division (1971), FGD (2013)

Recent findings show that the extent of poverty is still high in the CHT.[8] About half of the population or more are poor (Figure 2.3). The proportion of poor people is relatively higher in Bandarban, while that of hardcore poor is higher in Khagrachhari (SMEC, 2008).[9] Bandarban is one of the three poorest districts in the country (GED, 2008).

[8] According to the CHTRDP rural social survey, households who cannot afford two meals a day are 'hardcore poor', while who somehow have three meals a day with no savings are 'poor'.

[9] SMEC data are of 2008, while latest country level data are from Household Income and Expenditure Survey 2010 (HIES), BBS. Disaggregate data at the district level or below is not available from the HIES. The Poverty Map (2009), which was based on 2001 population census and 2005 HIES data, has not been updated yet.

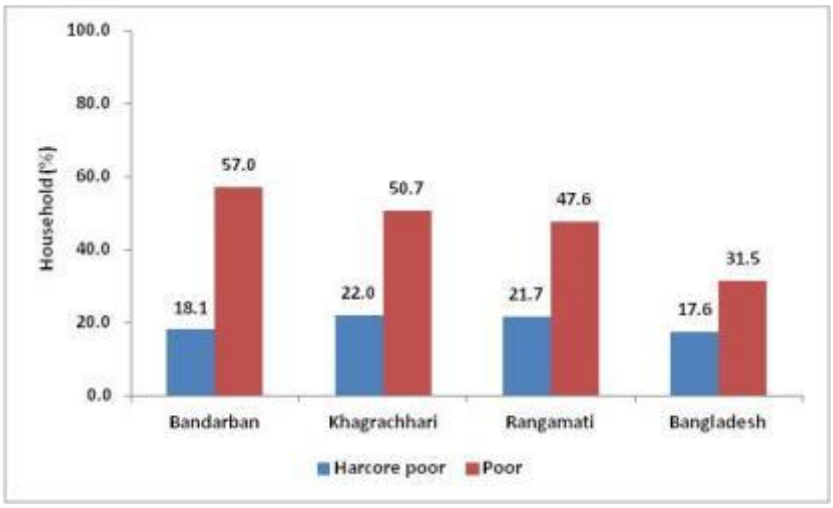


Figure 2.3: Extent of poverty

As there is poverty, crisis management practices also prevail. A dominant form of coping with deficit situations is working as wage laborers. However, the opportunity is limited as the demand for wage labor is low. Another coping mechanism is the distress sale of household assets. Exhausting savings and fresh borrowing are also important strategies for survival (Alam *at el*, 2010) (Figure 2.4).

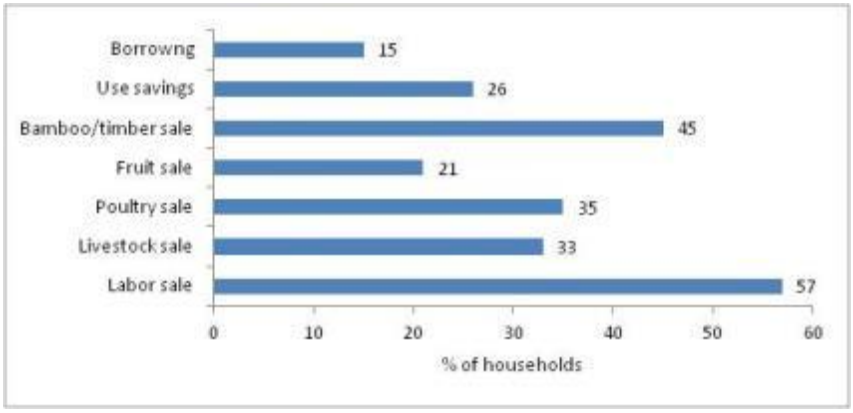


Figure 2.4: Coping strategies in times of stress

2.5 Food Security

Food security at the household level is largely determined by individual farm level production in a subsistence economy. In the CHT, households cannot meet both ends with their farm level production. For example, they have to buy rice, the main staple, from the market during certain lean periods of the year.

The diversity of households' and children's diets, adequate frequency of intake of meals, improved access to and coverage of health care and hygiene services markedly influence food security and nutritional status. In the CHT, people generally take three meals a day when they can afford it. Rice is universally consumed in the CHT, as are vegetables. Consumption of meat is very low, while more people eat dry fish than fresh fish (SMEC, 2008).

Access to food in terms of affordability and dietary pattern does not vary significantly among different communities. A comparative analysis of six communities in three districts shows little or no variation with respect to consumption of main food items like rice, vegetables and dry fish irrespective of their socio-economic status (Table 2.5).[10]

Farmers and casual laborers living far from main roads have a comparatively poorer diet. They consume rice, seasonal vegetables and small quantities of meat and fish depending on income and availability. Usually the poor and the non-poor both consume *chidol* or *nappi* (dry fish paste). *Jum* does not require plowing and hence farmers do not keep cattle. These families usually do not drink milk and do not use oil in cooking vegetables.

Table 2.5: Food consumption by selected communities

Food	Consumption (number of days)													
	Khagrachhari		Bandarban								Rangamati			
	Chakma		Tangchangya		Mro		Bawm		Marma		Pangkhua		Chakma	
	Poor	Non poor	Poor	Non poor	Poor	Non poor	Poor	Non poor	Poor	Non poor	Poor	Non poor	Poor	Non Poor
Rice	365	365	365	365	365	365	365	365	356	356	365	365	365	365
Flour	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Vegetables	365	365	365	365	365	365	365	365	365	365	365	365	365	365
Meat	24	48	22	48	24	45	10	125	36	12	36	60	36	48
Fresh fish	48	84	77	120	15	14	12	145	48	24	36	48	48	60
Dry fish	300	365	8		65	97	300	365	300	365	300	300	300	300
Milk	-	-	8	24	-	-	-	200	-	48	-	-	-	-
Fruits	115	200	120	200	250	285	85	300	365	365	365	365	365	365

Source: FGD

June-August is the period of scarcity across communities (Table 2.6). This coincides with the pre-harvest period of *jum* rice.[11] The period of food insecurity is more prolonged among the *Chakma*, *Khyang* and *Tripura* communities, while the *Pankhua* community is relatively secured (HDRC, 2009).

[10] The poor are mainly landless and live on wage labor, while the non poor have access to land.

[11] *Jum* rice season overlaps with the pre-kharif *Aus* rice.

Table 2.6: Status of food security

Month	Community													
	All SEC	Bawm	Chak	Chakma	Khyang	Khumi	Lushai	Marma	Mro	Pankhua	Tanchangya	Tripura	Bangalee	All CHT
Magh/MAGH (Jan-Feb)														
Fagun/FALGUN (Feb-Mar)														
Choud/CHOITRA (Mar-Apr)														
Boizag/BOISHAKH (Apr-May)														
Jeth/JOISHTHA (May-Jun)														
Azar/ASHAR (Jun-Jul)														
Shagan/SRAVAN (Jul-Aug)														
Bado/BHADRA (Aug-Sep)														
Azin/ASHWIN (Sep-Oct)														
Kadi/KARTIK (Oct-Nov)														
Agun/AGRAHAYAN (Nov-Dec)														
Poz/POUSH (Dec-Jan)														

Note: Green=Secured; Yellow=More or less secured; Red=Unsecured;
Months in *italic* are in *Chang* and in block letter are in *Bangla* language.
Source: HDRC (2009), field visits

Current level of rice production in the CHT falls short of the demand to the extent of 13 percent. This analysis was done comparing the 2011 population and 2011-12 production level.[12] While Khagrachhari district is surplus in terms of rice production, Rangamati suffers from huge deficit. This deficit is generally met by net imports from outside the CHT and suppressed consumption (Table 2.7, Figure 2.4).

Table 2.7: Food balance in the CHT

District	Population	Rice (tonne)			
		Demand	Supply	Balance	Deficit/surplus (%)
Bandarban	404,093	70,355	69,384	- 971	-1.4
Khagrachhari	638,967	111,247	120,027	8,779	7.9
Rangamati	620,214	107,982	62,814	- 45,169	- 41.8
CHT Total	1,663,274	289,584	252,224	- 37,360	- 12.9

Food "self-sufficiency" or "surplus" at the macro (district) level does not necessarily imply that everybody will have access to food. At the micro (household) level, many people may remain underfed or even starve, as they have low purchasing power and cannot buy food from the market all the time.

[12] Estimates are based on urban-rural differentials, as per capita per day requirement for rice in rural areas is 477 grams and for urban areas is 389 grams (Planning Commission, 2011); 70 % rural and 30% urban population assumed.

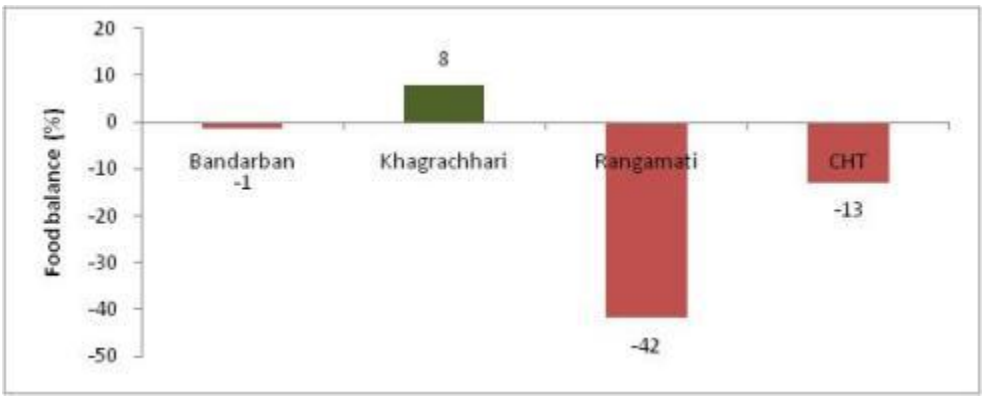


Figure 2.4: Food balance in CHT

An innovative practice for food crisis management has been observed. Under the CHTDF, "rice banks" have been set up at the *para* level consisting of a common storage system where each household contributes a certain quantity of rice (say, two *ari*)[13] after the harvest. At times of crises, they borrow rice from this 'bank' and later repay in double quantity. The bank is managed by the Para Development Committee (PDC). There are now 1,228 rice banks in the region, 334 in Bandarban, 371 in Khagrachhari and 523 in Rangamati (source, CHTDF).

2.6 Nutrition Status

Malnutrition and food insecurity are serious public health problems throughout Bangladesh. Poor nutritional status is noted particularly among women of reproductive age who are vulnerable to nutritional deficits and micronutrient deficiencies. Nutrition directly affects height and weight of children. The prevalence of stunting, underweight and wasting among children below five years in the CHT is 42.2, 34.1 and 7.3 percent respectively.

The poor water and sanitation conditions compound the vulnerability of children to morbidity and mortality from diarrhea and other preventable diseases (HKI, 2008).[14] Unsafe child birth practices are another indicator of poor situation with respect to health, as well as gender. The situation of Bandarban district is precarious in terms of child and infant mortality, while all hill districts are ranked in the lower end with regard to child delivery services and access to improved sanitation (Table 2.8). In vast areas of Baghaichhari upazila (Rangamati) and Thanchi upazila (Bandarban), access to safe water is negligible. These are areas with high prevalence of diarrhea. Women have to walk long distances to fetch water from *chharas* and rivers.

Certain sections of the population are considered most vulnerable in terms of food and nutrition. They are:

- Female-headed households
- Marginal farmers and casual laborers with limited or no access to land
- Households with many children
- The elderly
- Remote area dwellers

[13] *Ari* is a basket made of bamboo which is used for keeping food grain, as well as used as unit of measurement; one *ari* contains about10 kg of rice.

[14] Incidence of stunting greater than 40 percent, combined with underweight prevalence higher than 30 percent and wasting prevalence higher than 15 percent are "very high" as indicated by WHO classifications.

Table 2.8: Health and nutrition situation

District	Indicator									
	<5 mortality		Infant mortality		Child delivery attended by skilled personnel		Access to improved sanitation		Timely initiation of breastfeeding	
	Live birth /1000	Rank*	Live birth /1000	Rank	%	Rank	%	Rank	%	Rank
Bandarban	85	59	63	59	7.6	64	30.6	56	44.0	48
Khagrachhari	63	37	49	35	9.1	62	19.6	63	36.6	61
Rangamati	45	2	36	1	11.5	57	34.9	53	49.2	38
National	64		49		24.4		51.5		50.2	

*Ranking among 64 districts from the worst (64) to the best (1)
Source: Multiple Indicator Cluster Survey (MICS) 2009, BBS & UNICEF

Some communities, such as *Khumi*, *Tanchangya* and *Marma*, follow some food restrictions during pregnancy and lactation, which affect the health and nutrition status of mothers and young children. Lactating mothers are given only plain rice for two weeks after childbirth and then rice with salt and vegetables without oil. For three months, they do not take meat or fish.

During crisis periods, people eat less or eat fewer meals. According to a survey of 2008, at least one household member in 80 percent households was forced to eat smaller meals than usual, while at least one member in 45 percent households skipped one meal a day. This happened during the time of rodent infestation, as per capita rice consumption fell from 456 grams to 373 grams (HKI, 2008).

The problem of under nutrition is particularly high among children aged 6 to 23 months due to inappropriate infant and young child feeding practices. According to MICS 2009, only 36.6 percent of children in Khagrachhari start breastfeeding within one hour of birth compared to national average of 50.2 percent. Lakshmichhari, Panchhari and Khagrachhari Sadar (Khagrachhari), Belaichhari (Rangamati), Thanchi and Lama (Bandarban) are the upazilas with "worst performance" in this respect. In Khagrachhari Sadar upazila, the proportion of such children is only 8.5 percent.

The indigenous diet in the CHT is predominantly vegetarian and includes many roots, shoots and leaves harvested from the jungle. Oil is not commonly used in the rural areas, but is being slowly introduced in wealthier families. Traditionally, food is either steamed in bamboo or boiled.

There are some poverty pockets in the CHT characterized by physical isolation, absence of physical infrastructure and services and water scarcity. The nutrition situation worsens if there is a crop failure or a disaster, as that of the rodent infestation in 2007. According to the latest poverty map of Bangladesh (based on 2005 HIES and updated in 2009), Rowangchhari, Ruma, Thanchi and Naikhangchhari upazilas in Bandarban district have the highest proportion of ultra poor people (people below the lower poverty line), followed by Baghaichhari, Belaichhari, Rajasthali and Kaptai upazilas in Rangamati (BBS, WFP and World Bank, 2009).

Chapter 3

Livelihood Practices

3.1 Major Activities

Certain livelihood activities are common everywhere and some are typical of the CHT. Specific activities are those which stem from geo-physical specialty of the region conditioned by its unique systems, opportunities available in the area and cultural practices of the communities.

Occupations vary from each other in terms of production relations. Among agriculture related activities, some work independently as owner/manager-farmer; some work as lessee or sharecropper and some are wage laborer. Others are self-employed in traditional activities, living for instance on exploitation of natural resources (collecting fire wood) or on skill-based activities (weaving, house construction).

Agriculture is the predominant source of livelihood, particularly for the ethnic communities. In the CHT, 49 percent of the households live on agriculture (HDRC, 2009), compared to 46 percent in rural Bangladesh overall (BBS, 2011). It is more dominant among the *Tanchangya* (72%), *Khumi* (69%), *Marma* (68%), *Mro* and *Bawm* (67% each). Business activities are more prevalent among the *Pankhua* and *Lushai* (30% each). Wage earners (non-farm wages and salaries) are more concentrated among the *Chak* and the *Bangalee*. The *Khyang*, *Mro* and *Tripura* are more engaged in traditional activities (Table 3.1).

Table 3.1: Distribution of population by livelihood source

Livelihood source	Percentage of annual net income													
	All SEC	Bawm	Chak	Chakma	Khyang	Khumi	Lushai	Marma	Mro	Pankhua	Tanchangya	Tripura	Bangalee	All CHT
Agriculture related	62.9	66.6	56.1	56.9	62.2	68.9	60.5	68.2	67.0	62.9	71.9	66.3	49.0	56.0
Business	8.1	10.0	7.8	9.6	7.6	2.6	29.6	6.1	7.1	29.9	6.5	2.1	18.4	13.1
Wages (non-farm)	9.5	9.4	29.0	10.1	0.0	2.5	0.0	10.8	2.3	7.2	7.1	9.7	20.1	14.6
Traditional	11.8	11.4	7.2	11.3	25.8	0.0	9.8	9.6	22.5	0.0	8.5	17.6	4.8	8.4
Others	7.9	2.6	0.0	12.0	4.4	26.0	0.0	5.3	1.1	0.0	6.0	4.3	7.6	7.8
Total	100	100	100	100	100	100	100	100	100	100	100	100	100	100

HDRC, 2009

3.2 Agriculture

In the CHT, farmers and farm laborers are major livelihood groups. Agriculture is broadly of two type, hill agriculture (swidden agriculture) and plain land agriculture (plow agriculture). In *Chakma* language, these two types are named as *jum* and *bhui* respectively. CHT is the only region in Bangladesh where *jum* is practiced. It has different names among different communities, such as *ya* (*Marma*), *hog* (*Tripura*), *lai* (*Khiyang*), *lao* (*Bawm*), *ua* (*Mro*) and *ippra* (*Chak*). In vast areas of Northeast India, this practice is known as *jum* (Khisha, 1995; JAC, 2000). In the CHT, more than four-fifths of the area is not suitable for plough agriculture and, hence, *jum* is widely practiced by communities living in the hills.

Plough agriculture in the CHT was not known until 1818 when the *Chakma* Chief, Dharam Bakhsh Khan, first took the initiative to introduce it by bringing some *Bangalee* farmers from

Chittagong. However, it was not attractive to the local people who preferred to rely on their traditional methods.

Jum is a unique system of hill agriculture. *Chakma* people often call *jum* farmers as *Jumowla* and plain land dwellers call them *Jumia*. The number of *jum* farmers was 7,832 in 1880, which is now estimated at 22,413 (Table 3.2, Figure 3.1). They are 13.4 percent of farm households in the CHT dependent on agriculture for their livelihoods.[15] A declining trend is observed since 1980s.

Table 3.2: Number of *jum* farmers over the period

Year	Household	*Jum* cycle (year)	Data source
1880	7,832		Khisha (1995)
1895	9,274		
1901	14,000	12-15	
1905	15,336		
1915	23,229		
1961	29,631	3-5	
2001	29,261	3-4	Tripura & Harun (2003)
2012	22,413	2-3	DAE (2012) & field visit

Bandarban district has the biggest proportion of *jum* land (57%), followed by Rangamati (32%) and Khagrachhari (11%).[16] Thanchi upazila of Bandarban district tops the list in terms of upazila-wise *jum* area (2,800ha), followed by Ruma upazila in the same district (1,780ha) and Belaichhari upazila of Rangamati district (1,398ha). The *jum* involves activities round the year (Table 3.3).

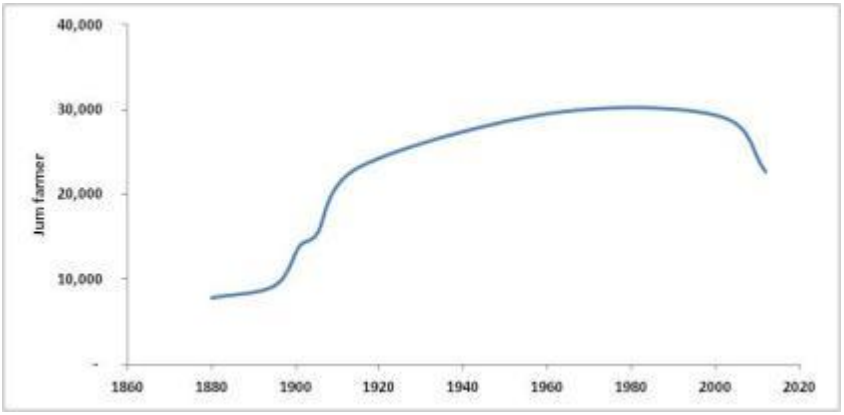


Figure 3.1: Number of *jum* farmers

An average *jum* cycle ranged from 12 to 15 years in the past to allow sufficient vegetation during the interval. In 1961, after the construction of the *Kaptai Dam*, the *jum* cycle was shortened to 3-5 years, as most of the cultivable plain land was lost under the reservoir and many farmers were

[15] 49% households in the CHT are dependent on agriculture for their livelihoods (HDRC, 2009).

[16] DAE reported 14,791ha of land under *jum* cultivation, while UNDP baseline survey estimated average *jum* land per household to be 0.65ha.

compelled to move to the hills. At present the cycle has further shortened to 2-3 years with serious implications on soil quality and yield.

Jum has a year-round cycle of activities and is considered as a food bank for the local people, as they are able to harvest a wide variety of products over a period of several months (Table 3.3).

Table 3.3: *Jum* calendar

Month	Activity
January	A convenient piece of forest land is selected on the hillside.
February-March	Shrubs and creepers are cleared and smaller trees are felled. Larger trees are denuded of their lower branches. The fallen jungle is left to dry in the sun.
April	The fallen jungle is fired to complete clearing; soil is burnt to the depth of an inch or two. They now set to work to build a *tong ghar* (temporary farm house) in respective *jum*.
May	With the advent of rain, farmers bind on the left heap a *kurum* (small basket) filled with mixed seeds; each takes a *tagol* (hill knife) in hand, and in a short time every hillside is bustling with activity. A dig with the blunt square end of the *tagol* makes a narrow hole, about three inches deep; into this is put a small handful of mixed seeds, such as, *dhan* (rice), *mokya* (maize), *goishya* (sesame), *tula* (cotton), *chindira* (melon) and some vegetables. *Morich* (chili), *kochu* (aroid), *ada* (ginger), *ohlot* (turmeric), *kola* (banana), etc are sown or planted separately.
July-September	Maize is ripen first in end-July; next comes *mamra* or *marfa* (cucumber-type vegetable) and *chindira*; afterwards vegetables and chili become fit for gathering. In September, rice ripens.
October	Harvest of rice is completed.
November	Cotton and ginger are harvested.
December	Harvest of turmeric starts.

Source: Lewin (1869), Establishment Division (1971), Sarker and Uddin (2009), field visit and consultation.
Words in *italic* are in *Chang* (*Chakma)* language.

3.3 Farm Labor

In agriculture, 30 percent of households live on wage labor. Their number is relatively higher in Khagrachhari district (33%) and lower in Rangamati (26%). Farmers of all strata work as wage laborer for certain period of the year (BBS, 2010).

Labor practices are of different types. In *Chakma* language, a farm laborer is called *gabur*. A gabur can be a male or a female. Those who are engaged on an annual basis are called *bojorlakya gabur*.

People give voluntary labor to neighbors' farms. This is a common practice and is reciprocated by all who work collectively when there is a need. This type of participatory engagement is called *malaiya*.

According to an estimate, wage employment in rural areas by a household is 139 days in a year on the average (Alam et al, 2010).[17] Wage employment, as well as demand for labor reaches its peak in *Boishakh* (Apr-May), which coincides with *Boro* harvesting, as well as *Aus* planting and *jum* sowing (Figure 3.2). Large and medium farmers are the main employers.

3.3 Fishing

Before the 1960s, none of the people lived solely by fishing. People could fish for their own consumption everywhere free, but not for commercial purpose. Often a whole river was auctioned to a headman or to some local people. In the mid-1963, fishing started in the *Kaptai*

[17] The study was undertaken in Sadar and Dighinala upazilas of Khagrachhari district.

Lake and the people gradually started fishing in the lake with long series of baited hooks. The use of improved gill-nets made of nylon twine gradually became widespread. The number of fishing units ranged from 88 in January 1964 to 674 in June 1966 (Establishment Division, 1971). Currently the lake is leased out by the district administration to BFDC at Tk 500,000 on an annual basis, and restrictions have been imposed on fishing by local people. There are an estimated 12,000-15,000 registered fishers including 3,000 hill men (Adnan, 2004). According to BFDC, about 10,150 VGF cards have been distributed to fisher families for subsistence during the period when fishing in the lake is prohibited. This number is another indication of the number of lake-dependent poor fishers.

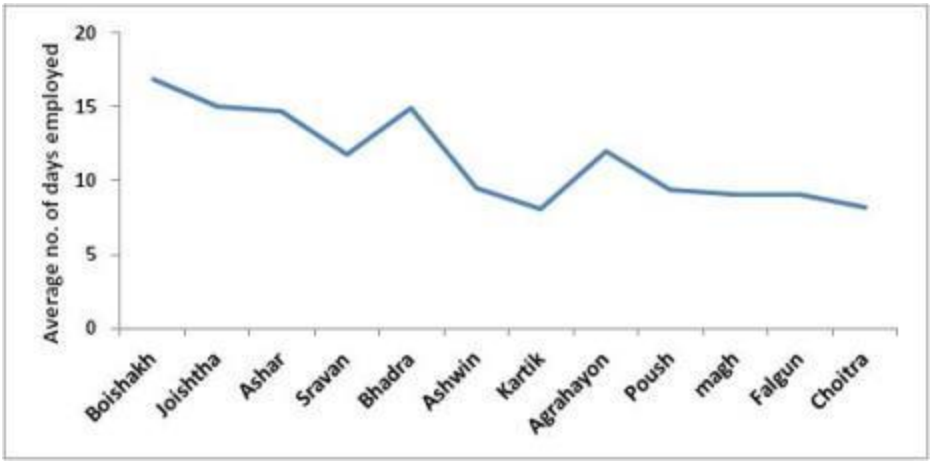


Figure 3.2: Wage employment in rural areas

3.4 Other Agricultural Occupations

Among the people engaged in other agricultural occupations are herdsmen, dairy farmers and poultry keepers. Apiculture is also practiced.

From April 2008 to September 2009, the International Center for Integrated Mountain Development (ICIMOD) initiated a project in the CHT to promote livelihoods through income and employment generation activities facilitated by the transfer of skill and technology funded by the UNDP-CHTDF. The approach for the projects was based on value chains and the use of cluster groups to link the income generating activities with markets. ICIMOD focused few IGAs in specific areas; apiculture is one of them. A total of 524 persons (157 women and 367 men) with almost equal numbers from the three hill districts were trained on beekeeping (Source: *ASHIKA*, Rangamati). The program was stalled because of the withdrawal of assistance from the CHTDF.

3.5 Cottage Industry

Ben buna (weaving with handloom) has been a major household based industrial activity. With the influx of textiles from urban areas, this activity has waned significantly. Still women weave their *pinon*/*thami* (sarong, skirt) and *khadi*/*anji* (tops, blouse) by themselves. Women also make household utilities using bamboo and cane, such as, *khallong* (basket for carrying goods), *fadi* (mat), *daba* (smoking tool, *hookka*), etc.

3.6 Others

Among other occupations is trading, hunting, extracting forest resources (fire wood), money lending, various salaried jobs, etc.

3.7 Financing and Credit

Agricultural activities are either self-financed and/or financed through borrowing. About a quarter of the households borrow from different sources. The highest proportion of them borrows for cultivation of crops (Figure 3.3). In the CHT, more households borrow for livestock and forestry activities and less number of households for pisciculture (BBS, 2010).

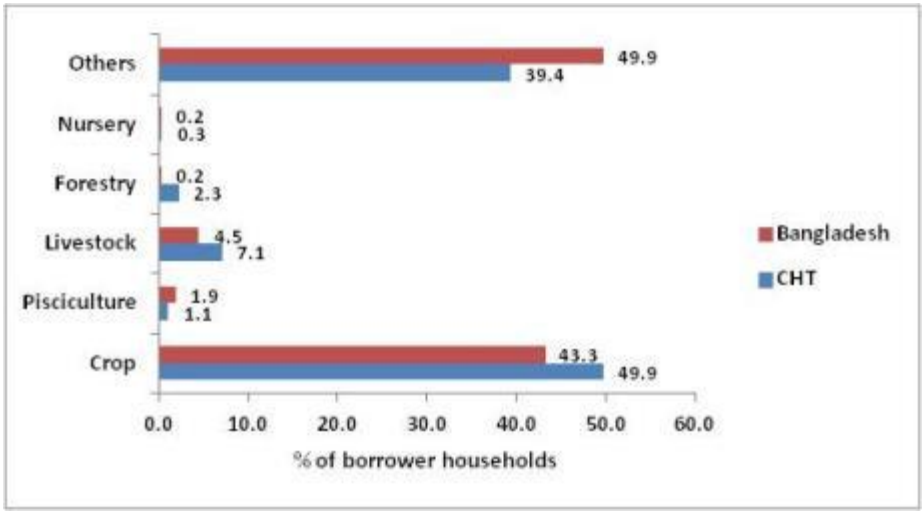


Figure 3.3: Distribution of borrower households by purpose

NGOs are the dominant source of credit. Public sector institutions including the *Krishi Bank* cater only 16 percent of SEC borrowers and 22 percent of *Bangalee* borrowers (HDRC, 2009). Banks require collateral (land mortgage) for credit. As many farmers do not have *de jure* land titles, they are not eligible for bank loans. A hidden 'processing fee' of up to 30 percent has been reported by farmers in accessing bank loans.

NGOs and the *Grameen Bank* offer credit which has to be repaid in weekly installment. The repayment system is a constraint for many farmers as their production cycle involves several months or even years (say, for cattle rearing, fruit orchard, etc) and do not produce any income before the end of the gestation period. Clearly, the lack of affordable and accessible credit opportunities is a serious concern.

Chapter 4

Gender and the Role of Women

4.1 Women in the Household

An elderly male person is perceived as the "head of the household", though most households are "woman-managed". Women in the villages perform all chores in addition to agricultural activities, yet they are categorized as "unpaid family helpers" in some official literature. In reality, however, women as well as men are full and active players in the agriculture sector, taking part in all activities from production to processing to marketing.

Households are overwhelmingly male-headed with only 7.7 percent being headed by women in the CHT and 6.2 percent in the country. However, an inverse correlation exists between socio-economic status and the number of female-headed households (BBS, 2010). In successive higher land-holding strata, lower is the proportion of female headed households (Figure 4.1). This means, women in poorer households (in terms of land endowment) more often manage their respective households on their own, which indicates their strength, as well as vulnerability.

While women are just as involved as men in agricultural life, as primary caretakers they are primarily responsible for household food security and the decisions they make have a profound effect on nutrition. Women engage in agriculture mainly to produce food for their households. Surplus produce is sold in the local market.

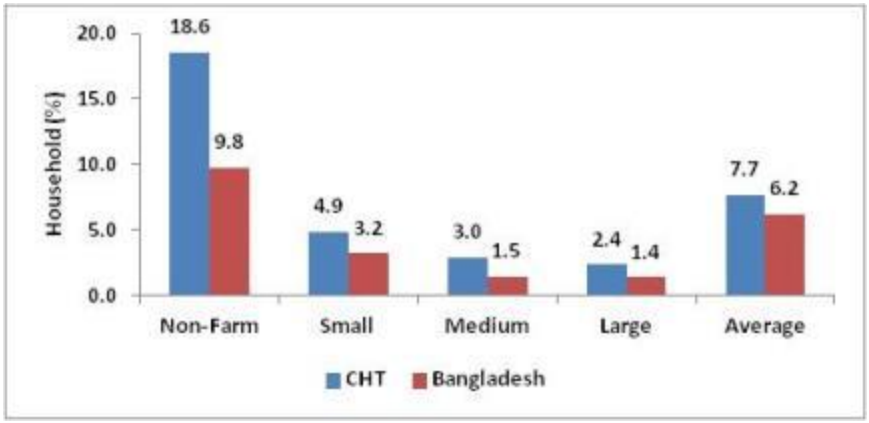


Figure 4.1: Female headed households by farm size

During the period of deficit, many women eat just one meal a day. Gender dynamics clearly manifests that women and girls suffer first and most profoundly during prolonged food shortage. With the shrinking of *jum* area, women are to spend more time and energy scavenging for wild foods, which raises their calorie demand. Due to marriage at early age, food shortages and micronutrient deficiencies have stark implications for nutrient-deficient adolescent mothers (HKI, 2008).

4.2 Women in Agriculture

In addition to household chores, women participate in agriculture at various stages. The jum cycle, in particular, includes a series of activities and processes. Both women and men perform these activities by playing multiple roles in different periods, though women have more roles and

a greater labor burden than men (Table 4.1). Any project or program that deals with agriculture must take this reality into consideration.

Table 4.1: Gender division of labor in agriculture

Month	Role in a farm households	
	Female	Male
Boishakh	Collecting firewood, *jum* cutting	Cutting *jum*, extracting bamboo and firewood
Joishtha	Collecting firewood, cleaning *jum*	Burning and cleaning *jum*
Ashar	Planning paddy, ginger, turmeric, chili, vegetables etc	Planning paddy, ginger, turmeric , chili, vegetables etc
Sravan	Cleaning weeds, selling wild vegetable	Cleaning weeds
Bhadra	Harvesting paddy, drying paddy, selling *jum* products	Repairing house, collecting materials for making house
Ashwin	Cleaning weeds in ginger and turmeric field	Cleaning weeds in horticulture and ginger and turmeric field
Kartik	Cleaning garden, assisting to transport banana, papaya, chili, potato, ginger, collecting and preserving various seeds	Cleaning garden, selling products such as chili, ginger, turmeric, papaya etc.
Agrahayan	Selling wild vegetables/ *jum* products	Repairing house, collecting materials for house construction
Poush	Weaving cloth, threading	Making basket from bamboo and cane
Magh	Collecting firewood, weaving cloth and threading	Cutting *jum*, making poultry house, planting papaya, preparing seed bed
Falgun	Harvesting/ boiling/ drying turmeric, weaving cloth, threading	do
Choitra	Collecting firewood, harvesting/ boiling/ drying turmeric	Burning *jum* field/ making *jum* house

Source: FGD

Women farmers in particular play a critical role in the production and storage of seed and maintaining genetic diversity. Their indigenous knowledge and techniques for seed preservation are transmitted through an intergenerational learning exchange process. They practice an underground seed-storage technique in which rice, ginger and turmeric are stored for one year. They preserve certain items like *mamra*, yam, *kumura*, ginger, turmeric, etc for six months to three years for future consumption using indigenous techniques. They preserve seeds of different varieties of rice, maize, bean, vegetables, etc. To preserve better quality seeds, women dry them in the sun using a *kula* (round-shaped carrier made of bamboo and used for winnowing rice) and *talai* (a spacious mat made from cane, mainly used for drying paddy, ginger, turmeric and arum) and put them in an airtight bottle sealed with a piece of cloth (Talukdar, 2012).

In the past, women grew numerous varieties of rice and many species of different plants. Recently, the number of indigenous varieties of rice and plants has reduced as these cannot compete with HYVs in the market in terms of price. Women still access a variety of crop seeds

through exchange. Before selecting the seeds for *jum* cultivation, women collect information about the availability of seeds in the village. Seeds, seed tubers, rootstocks, and various other genetic materials are exchanged with other households, together with the knowledge of their proper storage and cultivation. Women also grow marigold flowers, which act as an insecticide, and leguminous plants, which help to improve soil fertility in addition to contributing to dietary diversity.

Women and *jum* are inseparable. *Jum* is more than a source of livelihood. It is a way of life of the *jumma* people. Their work and passion, joy and sorrow, prosperity and poverty, hope and despair rotate round the *jum*, and women have a central role in it. This has been profoundly captured in the following *Chakma* verse.

> *Tanjhangor kaikure jummor jum a monghar*
> *Tanjhangor pani tule jummo milai,*
> *Benna no-oley belay, kalong pidhong, hum korod*
> *Mur dab bei bei ahdhe,*
> *Jumottun togei ane mamra chindira kuji*
> *Oleysiya togai chhara pare pare koju pada dhengishak*
> *Ija-kangara, olesiya shamuk, no-oley*
> *Chigon chigon mach* (Talukder, 2006).
>
> (Translation:
> *Jumia* has *jum* and *jum* house near the creek
> Jumia woman fetch water from the creek
> In the dawn or the dusk, vat on her back, jar on her waist
> Walks along the slope of the hill
> Reaps green *marpha* or *chinar* from the *jum*
> Maybe collects edible fern from the streamside
> Prawn-crab or shell or small fish)

4.3 Forest Management

Apart from *jum*, women participate in indigenous forest management practices in the "village common forest" (VCF). These practices are based on their indigenous knowledge of resource management in which they retain forest cover within the village for long-term use. There are an estimated 110 VCFs in the CHT, ranging from 20 to 122 ha each. These have good forest stocks and are a valuable habitat for wildlife. These forests also play an important role in maintaining watersheds. Farmers, with permission of the *Karbari* (traditional village chief), collect forest resources to meet their household needs. Commercial exploitation from the VCF is prohibited (Talukdar, 2012).

4.5 Social Mobility

Women in the CHT have relatively higher social mobility and access to local market. In the past, access to market was restricted by social barriers, long distances, remoteness, and very limited access to public transport. The situation is changing and women are now the main sellers of *jum* produce in the local market. As a result, women now have more cash income.

In the past, women used to weave their own clothes on a back-strap loom using cotton grown in the *jum*. They collected cotton and spun it on a spinning wheel at home. They dyed the yarn using natural dyes from sap, leaves, and bark. Nowadays, fewer households make their own clothes, preferring to buy readymade clothes from the markets.

4.5 Access to Resources

Food security is dependent on women's equal access to land and natural resources. When women secure property rights and access finance, they have a better chance of ensuring their own food security. Women are left to carry the full burdens of agricultural production, but often with no legal protection or rights to property (CHT Development News, 2011).

Except the *Marma*, women in other ethnic communities do not inherit any property. *Marma* women inherit only $1/16^{th}$ of the property. According to *Himawati* (local NGO working with hill women), property corresponds to rights to land; for women to be empowered, they must have formal inheritance to land. Women are concerned with the use and management of resources. Control of resources through customary rights may not be sufficient unless women have formal rights.

Women's livelihoods are inseparable from *jum*. As more and more jum fields are transformed into permanent orchards, women are at risk of losing their space.

Institutions are an important social capital. Women in the CHT are severely under-represented in both the traditional and formalized and elective regional and local government bodies, except in the case of *Union Parishads* and *Pourashavas*, where seats are reserved for them by law (Halim, 2002).

4.6 Wages

Women are subject to wage discriminations. In *Bawm* community of Bandarban District, a male worker gets a daily wage of 400 Taka for extracting tree, bamboo and doing earthwork and 300 Taka for harvesting ginger and turmeric, while a female worker gets 200 Tk. In Bandarban district, wage employment hardly exists in July-September. In Rangamati, paid work is minimal from mid-November to mid-February. In *Chakma* and *Tanchangya* communities, there is no seasonal variation in daily wage rates (Table 4.2).

Table 4.2: Daily wage rate

Community	Daily wage (Taka)	
	Female	Male
Chakma (Rangamati)	200	300
Chakma (Khagrachhari)	150	200-250
Marma (Bandarban)	150	200
Tangchangya (Bandarban)	170	300
Pangkhua (Rangamati)	150-200	200-300
Mro (Bandarban)	200	250
Bawm (Bandarban)	200	200-400

Source: FGD

Chapter 5

Institutions

The Government is composed of several Ministries/Divisions headed by the Minister. The Government mainly deals with public administration and development. With the passage of time, the role of the government has undergone significant changes and a host of other institutions have emerged to cater the needs of the people.

Under changed circumstances, different formations belonging to the national government, local government, private sector and a wide range of civil society organizations including NGOs have emerged with complementary roles in agricultural development. Besides, there are formal and informal functional groups and coalitions of the people at the community level who are increasingly being acknowledged as focus of development efforts. All these social and institutional entities operate within a network of power relations and linkages, which frame the overall institutional environment.

5.1 Traditional Institutions

The traditional administrative system runs parallel to the formal government administrative system. It centers round the *Raja* (Circle chief), *Headman* (*mouza* chief) and the *Karbari* (village chief). Several villages constitute a union. A village is widely known as *para* in CHT. A *para* is a social unit, while a *mouza* is a revenue unit. One *mouza* may include one or several *para*. *Headmen* and *Karbari* look after law and order, conflict management, allocation of land for *jum* in respective jurisdictions and collect revenue from *jum* farmers. The revenue is shared between the *Raja*, the *Headman* and the Government (represented by the Deputy Commissioner). *Headman* is appointed by the Deputy Commissioners on recommendation from the Circle Chief and *Karbari* is appointed by the Circle Chief. *Headman* and *Karbari* are considered 'learned persons' within the community.

The three administrative Circles, *Mong* (Khagrachhari), *Chakma* (Rangamati) and *Bohmong* (Bandarban) have respective Chiefs. This system was formalized in 1900 and still continues. Circle Chiefs are currently member of their relevant Hill District Council (HDC).

5.2 Local Government

Union Parishad (UP) is the lowest level elected local government in the administrative structure of the country. It is an elected body with designated administrative, development and extension roles. The next higher level local government is the *Upazila Parishad* (UZP) based in each upazila (Table 2.15). At the district level, there is Hill District Council (HDC). At the regional level, there is a CHT Regional Council (CHTRC). While CHTRC and HDC are under the MoCHTA, UZP and UP are under the Local Government Division (LGD).

The CHT Treaty of 1997 specifies that the HDC will have the key role of coordination among government department and implementation of their activities within its jurisdiction, while the CHTRC will coordinate all development activities in the region including activities of the CHT Development Board (CHTDB). The process of its implementation is still going on.

5.3 Public Sector Agricultural Institutions

Public institutions are major service providers in various fields of agriculture. Among these in the CHT are different extension departments and NARS institutes. Some of these have district level offices, while some have offices up to the upazila level and below.

5.3.1 Department of Agricultural Extension (DAE)

Crops and horticultural crop extension

The DAE is helping farmers in modern and sustainable agricultural production systems. It organizes training for farmers on the following:

- IPM in fruit and vegetable production;
- ICM in rice production;
- High value crop production;
- Soil conserving hill farming;
- Off-season vegetable production technology for hills;
- Year round pineapple production;
- Soil conservation practices in hill slope cultivation;
- Quality HYV rice seed production, preservation and exchange among farmers.

The DAE is currently implementing a mushroom development project in Sadar upazila of Rangamati district.

The Sub-Assistant Agriculture Officer (SAAO) provides day to day need based suggestions and advice and helps farmers in their respective jurisdictions (blocks). There are 438 agricultural blocks in the CHT with provision of 492 SAAOs, while 471 are currently available. Besides, the DAE is implementing an Integrated Quality Horticulture Development Project supported by its Food Crop Wing.

Horticulture centre

In three hill districts, 16 horticultural centers are operating for supplying quality sapling to farmers. The production of different fruit saplings and seeds of various kinds of improved varieties are inadequate. These centers also provide facilities for training in utilization of horticulture foods for improving diets and nutrition.

Agricultural information service

It provides agriculture related information to farmers and shows video documentaries on agricultural development activities to raise interest for adoption of new technologies.

Agricultural Training Institute (ATI)

There is one “Agricultural Training Institute” located at Sukarchari in Rangamati for grassroots level students who are interested to study “Diploma in Agriculture”. Generally DAE officials are engaged to run the ATI under the linkage with the Bangladesh Technical Education Board. The Board has developed courses and curriculum. However, it does not offer any specialized curriculum for hill agriculture.

5.3.2 Department of Livestock Services (DLS)

At present, the DLS in the CHT has serious shortage of staff. Some solar-driven refrigerators were distributed by the CHTDF for vaccine storage, which is useful in remote areas outside the power grid.

5.3.3 Department of Fisheries (DoF)

The DoF is mandated to develop fish culture in CHT. It has institutional network up to the upazila level and implement proven technologies developed by the BFRI.

During the mid 1990s the Government of Bangladesh encouraged aquaculture in creeks, ponds and the lake in the CHT. For aquaculture development and extension, 11.5 ha of nursery ponds and 92 ha of other water bodies were created by modifications of creek flows and construction of small earthen dams, and these were brought under aquaculture. At present, nurseries are not functioning well.

5.3.4 Bangladesh Agricultural Development Corporation (BADC)

BADC is responsible for supplying quality seeds, saplings and other inputs like fertilizers and pesticides to farmers for enhancing yields. In the CHT, there are four base nurseries and seed multiplication farms for supplying quality seeds and saplings to farmers. Besides, it is developing creeks for irrigating both the horticultural and field crops in the dry season.

5.3.5 Department of Forest

The forest is the most vital resource in the CHT. Most of the slopy agricultural lands are under unclassed state forest. In three hill districts five divisional offices are operating. Besides, a Conservator of Forest has an office in Rangamati. The Department is the custodian of Reserve Forests, which are outside the purview of this report, as these forests need a separate management system.

5.3.6 Bangladesh Agricultural Research Institute (BARI)

Four research stations were established in the CHT by the Bangladesh Agricultural Research Institute (BARI) for research activities specially addressing bio-physical characteristics of the region. Among these are three Hill Agricultural Research Stations, one each in Ramgarh, Khagrachhari and Raikhali, and one On-Farm Research Division (OFRD) in Bandarban. Thereafter, some improvements have been made to the development of soil and water conservation research and technology development. Planting in contour line in hill slope instead of up and down the slopes, zero tillage cultivation, mulching, furrow planting, contour hedgerow barrier system and cover crops along with rainwater harvesting by cross-dam at suitable sites, appropriate planting time, keeping crops free from weeds, proper plant spacing, using optimum doses of chemical fertilizers with application time and methods of application, etc are found to be effective soil and water conservation option for hilly areas in the CHT. These research stations have released some potential varieties of fruits, vegetables and species (Table 5.1).

5.3.7 Bangladesh Livestock Research Institute (BLRI)

Bangladesh Livestock Research Institute (BLRI) under the Ministry of Fisheries & Livestock (MoFL) has one research station at Naikhangchhari (Bandarban). Since the inception of the institute, scientists have developed 59 technologies on improved animal and poultry breeds, livestock production system, quality livestock feed /fodder production and preventive and curative measures for livestock disease.

5.3.8 Bangladesh Fisheries Research Institute (BFRI)

The BFRI has set-up 10 research stations and sub-stations in different agro-ecological locations of Bangladesh. Among these, the important ones are:

- Fresh water station, BFRI, Mymensingh
- Riverine station, BFRI, Chandpur
- Marine fisheries & technology station, BFRI, Cox's Bazaar
- Riverine sub-station, Rangamati

The BFRI has so far developed a number of technology packages for increasing quality fish production. In the mid-1990s, the Government encouraged aquaculture in creeks, ponds and lakes in the CHT. The Rangamati sub-station undertakes various adaptive researches. Priorities are given on continuous monitoring of biological productivity, stock assessment, natural spawning, and population dynamics of various commercially important fishes and major carps. Recently, it has introduced pen and cage aquaculture in the creeks and lagoons of the *Kaptai Lake* to culture fingerlings of major carps and thus to support BFDC for artificial stocking in the lake.

5.3.9 Bangladesh Fisheries Development Corporation (BFDC)

The BFDC looks after overall production of fish in the *Kaptai Lake* by selective stocking of major carps. BFRI-RSS and BFDC indicated that polyculture of *Indian carp* and *Chinese carp* in pens installed in creeks/coves might be a unique system to enhance fish production. Several *ghona* sites along the lake were identified for pen installation. The average retrieval rate of stocked carp was 24.4% (range 6.5–38.5%). The average yield from the creeks was 966 kg/ha, several times higher than the natural catch (± 110 kg/ha) from the reservoir. But the present fish production of the *Kaptai Lake* is far behind than the scientifically managed production system.

5.3.10 Soil Resource Development Institute (SRDI)

The SRDI has one research station in Bandarban, which recommended some component technologies for soil and water conservation farming system. Contour, trip, and hedgerow systems of cropping as suitable alternative to current practices of *jum* have been recommended; planting should be done across the hill slope; one row hedge crop in between ten rows of rice crops.

5.3.11 Bangladesh Sugarcane Research Institute (BSRI)

The BSRI has been implementing "A pilot project on sugarcane extension and research in CHT" since 2008-09 funded by the MoCHTA. Three project offices in three hill districts which have been conducting varietal selection trial in farmers' field with chewing and *gur* (molasses) varieties of sugarcane and found some encouraging results.

5.3.12 Bangladesh Sericulture Board (BSB)

Bangladesh Sericulture Board has one station at Kaptai (Rangamati), which is working for silk warm production.

5.3.13 Cotton Development Board (CDB)

Under the CDB, there is one Hill Cotton Research Station in Bandarban and one sub-station at Matiranga (Khagrachhari). It has conducted research work to develop suitable HYV cotton for

the CHT region and component technologies of crop management for higher yield. This station has developed some component technologies, such as row arrangement and row orientations for cotton and rice in *jum* production system in the form of five rows of rice + two rows of cotton.

5.4 Private Sector

Private sector is expanding in almost all spheres. They are contributing in the construction of road infrastructure (as contractors), production (agriculture, agro-processing) and services (sale of seed, fertilizers, pesticides, tools and implements, marketing and value chain management). Each hill district has a Chamber of Commerce and Industries with individual membership. Rangamati Chamber has 161 members.

5.5 NGOs

NGOs are active in all the hill districts. There are reportedly 17 national NGOs who have activities in the CHT (*chtarchive.com/index.php). Besides*, 267 local NGOs are registered with different authorities.[18] Number of NGOs in Bandarban and Khagrachhari are 26 and 48 respectively. Not all of them are functional. Some of them have programs for agricultural development.

Local NGOs so far helped in setting up community based organizations (CBOs) at the *para* (village) level including 690 *Farmers' Field Schools* (FFS), 3257 *Para Development Committees* (PDC) and 1685 *Para Nari Development Groups* (PNDG) within the framework of the CHTDF (Table 5.1). Presently CHTDF has 13 NGO partners under its Community Empowerment Project (CEP).

Table 5.1: Community-based organizations set up by NGOs

District	FFS	PDC	PNDG
Rangamati	250	1,242	628
Khagrachhari	215	971	480
Bandarban	225	1,044	577
CHT total	690	3,257	1,685

Source: UNDP-CHTDF

The proposed institutional setting in the CHT is presented in Figure 5.1.

[18] Data source: Department of Social Services, Rangamati.

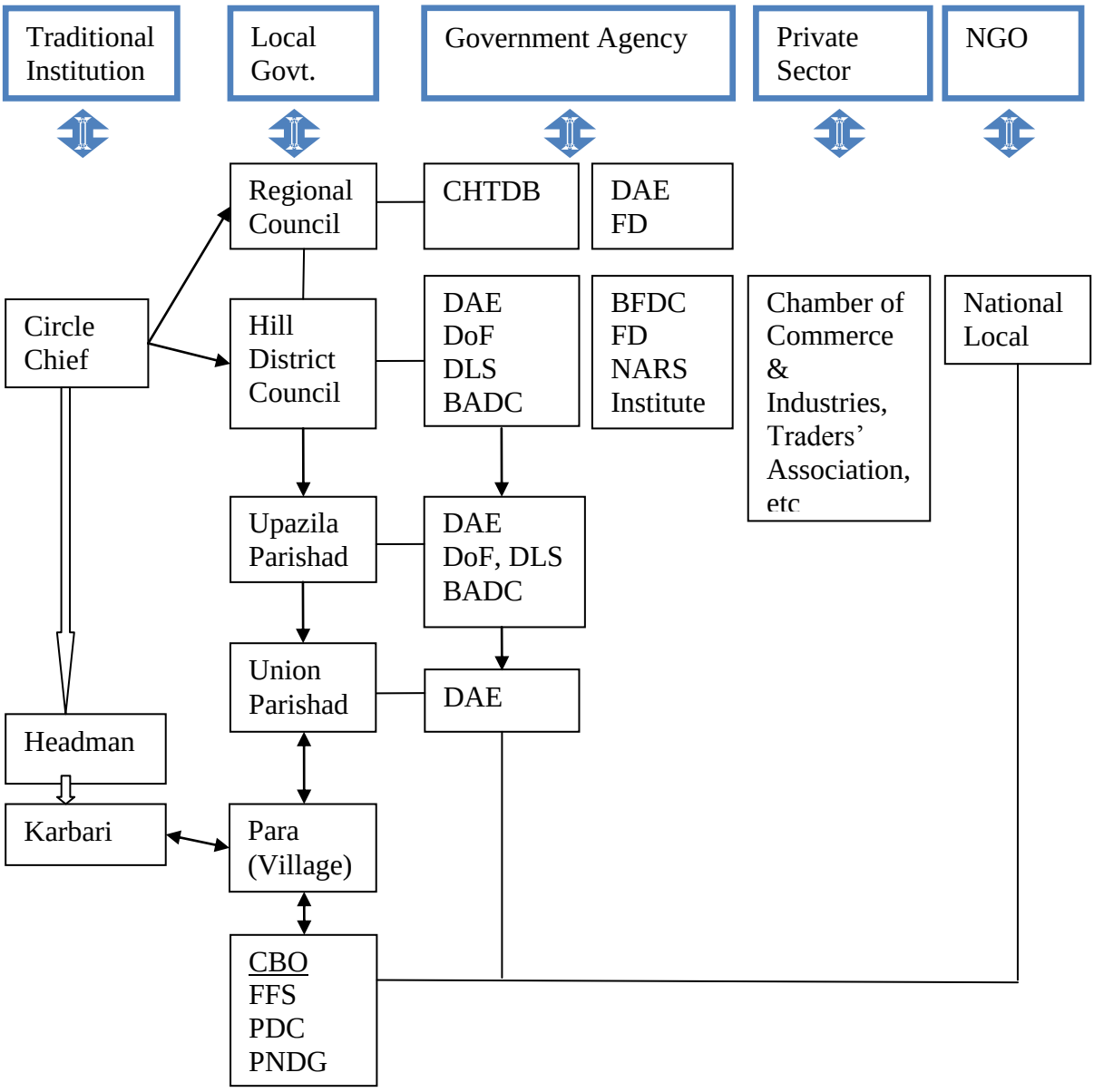


Figure 5.1: Institutions in the CHT

Chapter 6

Natural Resources

6.1 Land

6.1.1 Major landforms

Six major landforms are identified in the CHT (Figure 6.1). These are:

- Medium-gradient mountains
- High-gradient hills
- Medium-gradient hills
- Dissected plains
- Plains
- Valleys.

6.1.2 Land elevation and gradient

Primary elevation data of the CHT has been taken from available maps of the Survey of Bangladesh (SoB) and the Bangladesh Water Development Board (BWDB). Elevations are updated using SRTM (Shuttle Radar Terrain Model) datasets (90m digital elevation model developed by USGS in 2003). All the spot heights are converted in meter PWD datum. The maximum elevation of the CHT is 1,027m PWD. About 79 percent of the CHT lies between the elevations of 0m PWD to 200m PWD (Figure 6.2).

The gradient map shows areas with different slope ranges. Higher slope allows faster rainfall drainage, but is more vulnerable to soil erosion depending on the land cover and soil type.

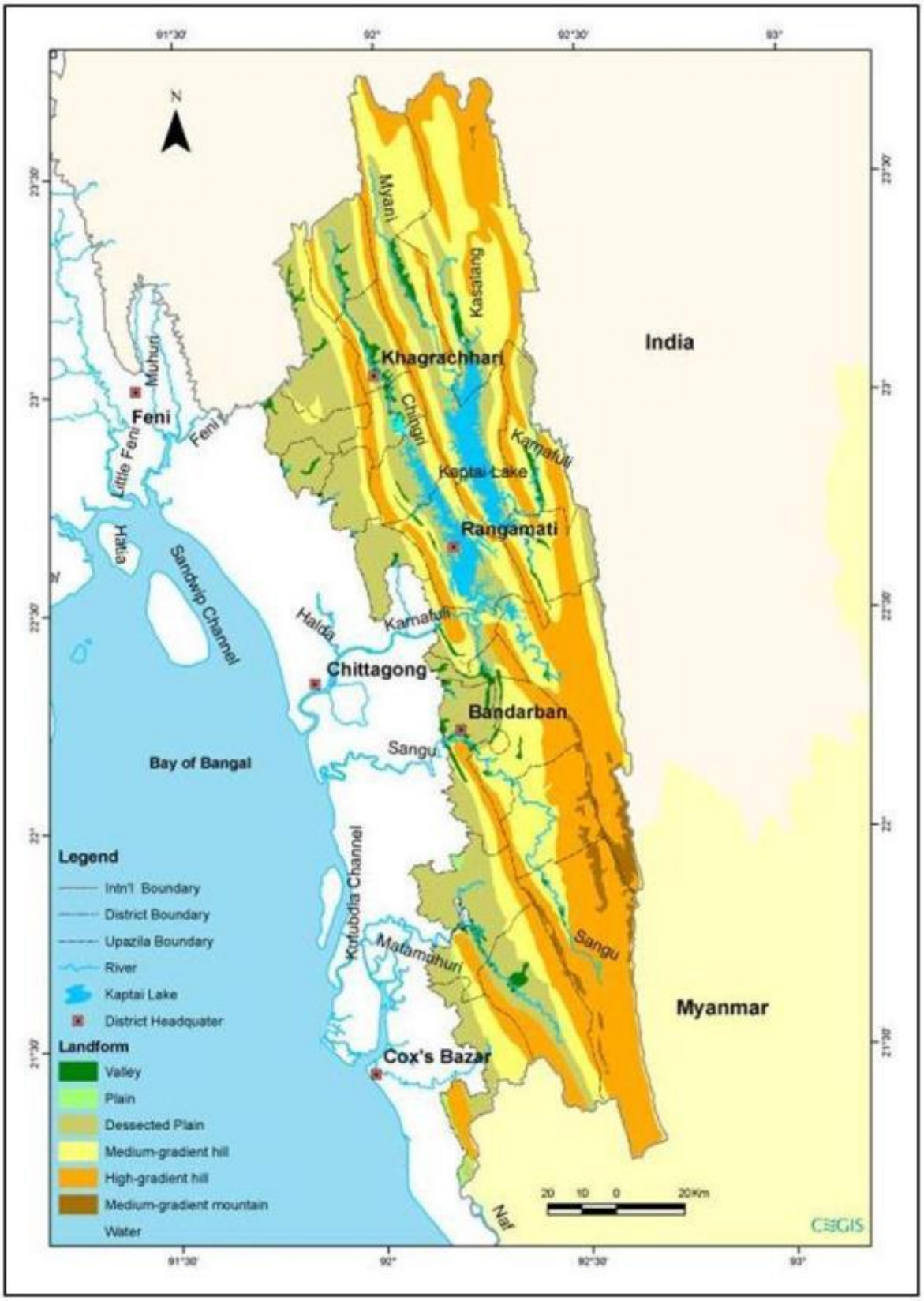


Figure 6.1: Major landforms

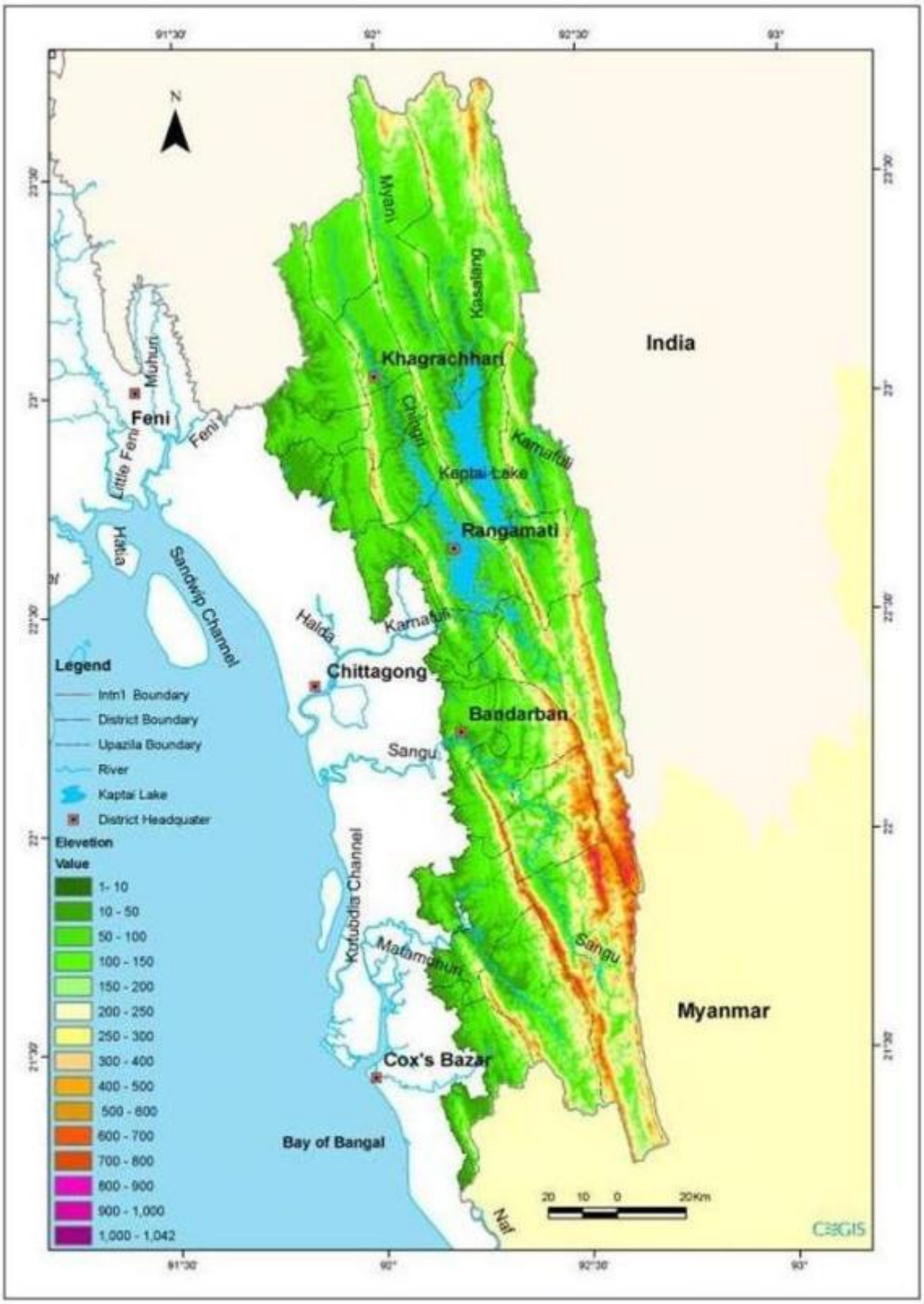


Figure 6.2: Land elevation (meter above MSL)

6.1.3 Land cover

Land cover includes forest, herb/shrubs, fallow/agricultural land, river and water bodies, settlements, hill shades etc.[19]The land use has been delineated by processing the satellite image of 2003 (LANDSAT ETM) and 2010 (TERRA ASTER) (Table 6.1). Detailed distribution of land cover has been estimated using processed satellite images for 2003 and 2010 respectively. It is observed that the maximum area (44.9%) was covered with medium dense forest in 2003 which was reduced to 17.4% in 2010. Similarly, the area of dense forest was about 15.2% in 2003 which declined to 5.9% in 2010. On the other hand, low dense forest, herbs/shrubs grass and fallow/agriculture land increased in 2010 than that of 2003. The area of water bodies including river, *chhara* etc more or less remained unchanged (Figures 6.3).

Table 6.1: Land cover in the CHT

Land cover	2003		2010		Change (2010-2003)	% Change (-/+) in 2010 over 2003
	Area (ha)	% of total Area	Area (ha)	% of total Area		
Dense forest	201,793	15.2	78,596	5.9	-123,197	-61.1
Medium dense forest	594,479	44.9	230,753	17.4	-363,726	-61.2
Low dense forest	282,530	21.3	413,869	31.2	131,338	46.5
Herb-shrub-grass	47,742	3.6	390,910	29.5	343,168	718.8
Fallow/agri. land	43,149	3.3	78,099	5.9	34,950	81
River & water	63,028	4.8	64,474	4.9	1,446	2.3
Settlement	63,939	4.8	55,162	4.2	-8,777	-13.7
Hill shades	26,875	2.0	12,181	0.9	-14,694	-54.7
Others	-		376	0.0	376	0
Total	1,323,535	100.0	1,324,420	100.0	885	0.1

Source: CEGIS Estimation (2013) using satellite images of two different years (2003 & 2010)

6.2 Soil

Bangladesh has a wide range of soils. In the high hill ranges, soils are very shallow to deep, pale brown, slightly to strongly acid, sandy loams to clays, usually overlying decomposing bedrocks at variable depths. They are usually Eutrochrepts, Dystrochrepts and Lithosols. In the low hills, soils developed in soft rock materials are usually deep, brown to red brown, strongly to very strongly acidic, sandy loams to clay loams, locally overlying plinthite or hard lateritic substrata. (Shaheed, 1995). Soil and terrain characteristics are summarized in Table 6.2.

The CHT has 20 mapping units in the SOTER database characterized by 16 soil components. The soil components are further characterized by 31 representative soil profiles. In Bangladesh, soil profiles that have a similar range of characteristics are grouped in the soil series. Sixteen soil series were identified by the reconnaissance soil survey (Brammer, 1986) and another five by survey work of the SRDI in the Chittagong coastal plain.

[19] Land cover is the presence of physical material at the surface of the earth.

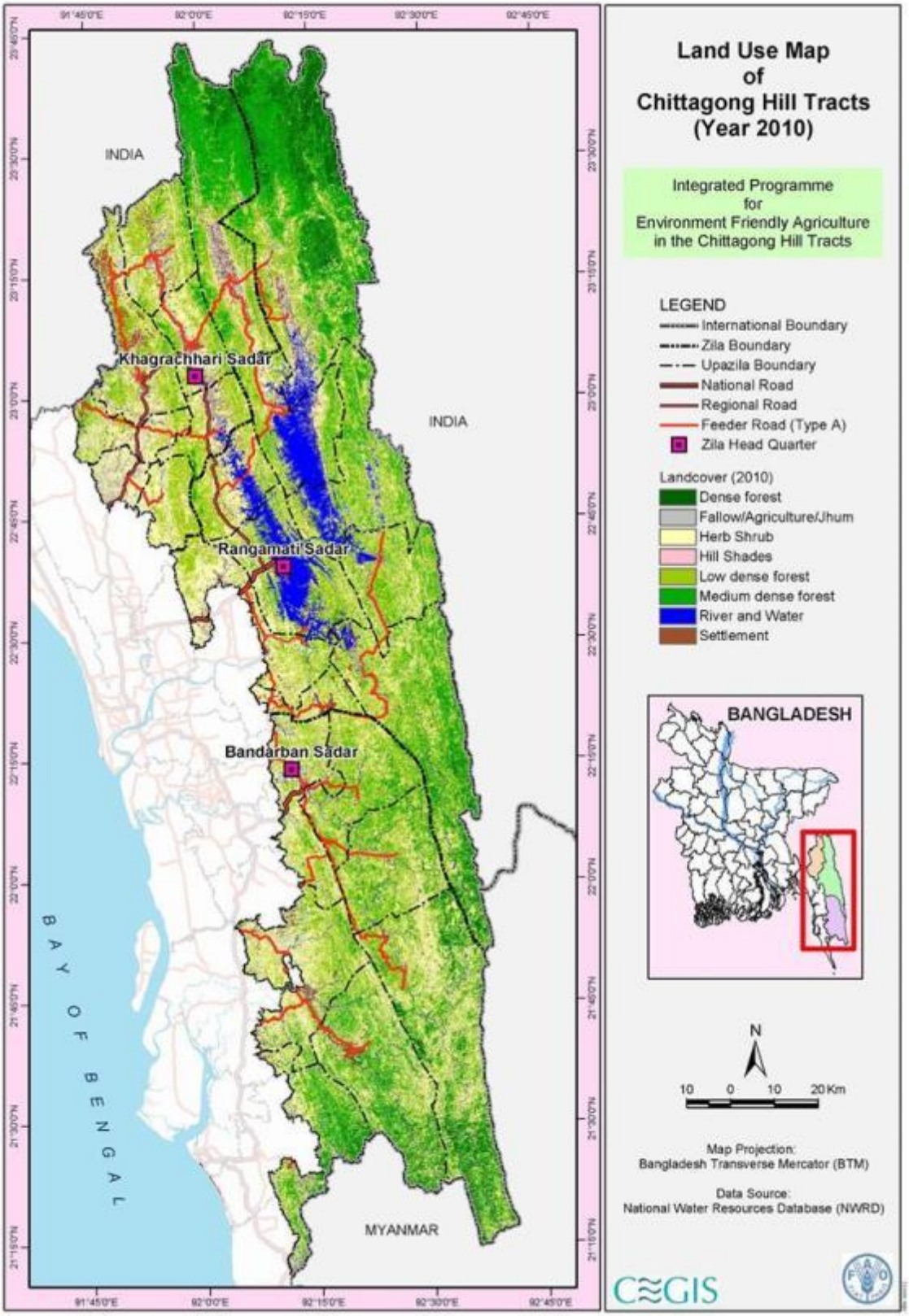


Figure 6.3: Land cover in the CHT

Table 6.2: Major characteristics of soil and terrain

SOTER unit	Lithology	Landform	Soils	%	Soil characteristics
1	Consolidated sandstones and siltstones	High-gradient hills (higher parts)	Kaptai (deep)	60	Deep, yellowish-brown to strong brown, silty clay loam, rock fragments in subsoil
			Kaptai (shallow)	25	Shallow, yellowish-brown to strong brown, silty clay loam, rock fragments in subsoil
			Belaichhari	15	Shallow, yellowish-brown, sandy loam, with pieces of rock over hard sandstone
2	Consolidated sandstones and siltstones	High-gradient hills (lower parts)	Kaptai (deep)	60	Deep, yellowish-brown to strong brown, silty clay loam, rock fragments in subsoil
			Rankhiang	15	Deep, yellowish-brown sandy loam
			Kankrachhari	25	Shallow to deep, light olive-brown with some mottles, silty clay loam to silty clay
3	Unconsolidated sandstones	Dissected plains	Teiabil	67	Deep, strong brown to yellowish red, sandy clay loam with many red mottles and iron concretions in the subsoil
			Hazaribak	33	Deep, yellowish brown sandy loam to loamy sand.
4	Alluvial deposits	Valley	Moghachhari	65	Very deep, poorly drained, mottled grey and brown silty clay loam and clay layers
			Karnaphuli	35	Very deep, moderately well drained, yellowish-brown, mottled, sandy loam with layers of silt loam, loamy sand or sand
5	Consolidated sandstones and siltstones	High-gradient hills (lower parts)	Kaptai (deep)	65	Deep, yellowish-brown to strong brown, silty clay loam, rock fragments in subsoil
			Kaptai (shallow)	35	Shallow, yellowish-brown to strong brown, silty clay loam, rock fragments in subsoil
6	Unconsolidated sandstones	Dissected plains	Hazaribak	61	Deep, yellowish brown sandy loam to loamy sand.
			Kaptai (deep)	34	Deep, yellowish-brown to strong brown, silty clay loam, rock fragments in subsoil
			Karnaphuli	5	Very deep yellowish-brown, mottled, sandy loam with layers of silt loam, loamy sand or sand
7	Consolidated sandstones	Medium-gradient hills	Kaptai (deep)	65	Deep, yellowish-brown to strong brown, silty clay loam, rock fragments in subsoil
			Rankhiang	35	Deep, yellowish-brown sandy loam
8	Unconsolidated sandstones	Dissected plains	Teiabil	55	Deep, strong brown to yellowish red, sandy clay loam with many red mottles and iron concretions in the subsoil
			Hazaribak	20	Deep, yellowish brown sandy loam to loamy sand.
			Kaptai (deep)	15	Deep, yellowish-brown to strong brown, silty clay loam, rock fragments in subsoil
			Moghachhari	5	Very deep, poorly drained, mottled grey and brown silty clay loam and clay layers
			Karnaphuli	5	Very deep, moderately well drained, yellowish-brown, mottled, sandy loam with layers of silt loam, loamy sand or sand
9	Unconsolidated sandstones	Dissected plains	Rankhiang	65	Deep, yellowish-brown sandy loam
			Kaptai (deep)	35	Deep, yellowish-brown to strong brown, silty clay loam, rock fragments in subsoil
10	Unconsolidated sandstones	Dissected plains	Rankhiang	100	Deep, yellowish-brown sandy loam
11	Alluvial deposit	Valley	Karnaphuli	50	Very deep, moderately well drained, yellowish-brown, mottled, sandy loam with layers of silt loam, loamy sand or sand

SOTER unit	Lithology	Landform	Soils	%	Soil characteristics
			Moghachhari	50	Very deep, poorly drained, mottled grey and brown silty clay loam and clay layers
12	Unconsolidated sandstones	Dissected plains	Hazaribak	55	Deep, yellowish brown sandy loam to loamy sand.
			Teiabil	25	Deep, strong brown to yellowish red, sandy clay loam with many red mottles and iron concretions in the subsoil
			Kaptai (deep)	20	Deep, yellowish-brown to strong brown, silty clay loam, rock fragments in subsoil
			Karnaphuli	5	Very deep, moderately well drained, yellowish-brown, mottled, sandy loam with layers of silt loam, loamy sand or sand
13	Consolidated sandstones and siltstones	High-gradient hills (lower parts)	Kaptai (deep)	55	Deep, yellowish-brown to strong brown, silty clay loam, rock fragments in subsoil
			Kankrachhari	24	Shallow to deep, light olive-brown with some mottles, silty clay loam to silty clay
			Belaichhari	14	Shallow, yellowish-brown, sandy loam, with pieces of rock over hard sandstone
			Karnaphuli	7	very deep yellowish-brown, mottled, sandy loam with layers of silt loam, loamy sand or sand
14	Consolidated sandstones and siltstones	Medium-gradient mountains	Kaptai (deep)	70	Deep, yellowish-brown to strong brown, silty clay loam, rock fragments in subsoil
			Belaichhari	30	Shallow, yellowish-brown, sandy loam, with pieces of rock over hard sandstone
15	Unconsolidated sandstones	Dissected plains	Hazaribak	60	Deep, yellowish brown sandy loam to loamy sand.
			Teiabil	25	Deep, strong brown to yellowish red, sandy clay loam with many red mottles and iron concretions in the subsoil
			Karnaphuli	15	Very deep, moderately well drained, yellowish-brown, mottled, sandy loam with layers of silt loam, loamy sand or sand
16	Alluvial deposits	Valley	Karnaphuli	65	Very deep, moderately well drained, yellowish-brown, mottled, sandy loam with layers of silt loam, loamy sand or sand
			Ruma	35	Very deep, moderately well drained, mottled, light olive brown, silt loam with layers of sandy loam or silty clay loam
17	Colluvial and alluvial deposits	Plain	Mirsarai	100	Deep, poorly drained, mottle, grey, silt loam
18	Colluvial and alluvial deposits	Plain	Rangamati	65	Deep, well drained, strong brown silty clay loam to silty clay
			Salban	35	Deep, moderately well drained, slightly mottled, yellowish brown silty loam
19	Unconsolidated sandstones and siltstones	Dissected plains	Hazaribak	60	Deep, yellowish brown sandy loam to loamy sand.
			Teiabil	25	Deep, strong brown to yellowish red, sandy clay loam with many red mottles and iron concretions in the subsoil
			Lama	15	Shallow, olive brown or yellowish brown, weakly mottled silt loam to silty clay loam over fragmented siltstone
20	Colluvial and alluvial deposits	Plain	Subalong	60	Deep, excessively well drained, yellowish brown, loam
			Jaldi	40	Deep, well drained, yellowish brown, silty clay

Soil patterns generally are complex due to local differences in sand, silt clay contents of the underlying sedimentary rocks and in the amount of erosion that has occurred. Brown Hill soils are the predominant general soil type of the area. Organic matter content and general fertility level is low (Table 6.3).

Table 6.3: Fertility status of Northern and Eastern Hills

Major land type	Soil pH	Soil O.M	Nutrient status of soil								
			N	P	K	S	Ca	Mg	Zn	B	Mo
High land (92%)	4.1-7.1	L-M	VL-L	L	L-M	L-M	L-M	L-M	L-M	L-M	L-M

Source: DAE

6.3 Land Use

6.3.2 Land capability

Land capability classification adopted for the CHT is based on the depth of soil and slope of the land. The land capability assessment for the CHT shows the proportion of different classes as follows (Source: Banglapedia):

- Class A: good agricultural land (3.2%);
- Class B: moderate agricultural land (2.8%);
- Class C: poor agricultural land (15.6%); and
- Class D: very poor non-agricultural land (78.4%).

Five classes of land are distinguished according to land capability (Forestal, 1966). Based on satellite images, lands are grouped in seven categories according to slope gradient (Table 6.4).

Table 6.4: Classification of land by crop suitability

Slope (%)	Area (ha)	Crop suitability	Area (%)
0-5	270,812 (plain to gentle slope)	All purpose agriculture	20.45
6 – 10	298,221 (gentle to moderate slope)	Contour planting of horticulture and spice crops	22.52
11 -20	369,892 (Moderate to steep slope)	Mostly horticulture and partly forest	27.93
21 -30	198,710(steep to moderate steep slope)	Mostly forest and horticulture	15.00
31 -50	150,506 (moderate to high steep slope)	Horticulture, spices and forest plants	11.32
51 -70	29,622 (high to very high steep slope)	Forest species and medicinal plants	2.24
>70	6,665 (very high steep slope)	Forest species	0.50
Total	1,324,428		100.00

CEGIS estimations (2012)

6.3.1 Factors influencing agricultural land use

Landforms, hydrology, climate and soil are major factors which determine agricultural land use. Hydrological and climatic conditions determine the choice of crops which can be grown in different seasons. Soil properties determine the crop yield, especially in valleys and adjoining piedmont plains with alluvial soils. In the hills, available soil moisture, organic matter content and nutrient status, gradient and length of slope are additional factors affecting growth and choice of plants. Two sub-regions of the hill areas, high hill ranges and low hill areas have following general patterns/types of land use.

The high hill *ranges* are mostly under scrub, high grass and scattered trees. About one-fifth of the area is under state forests, where a viable cover of trees and bamboos occurs. In the remaining unclassed state forest areas, *jum* cultivation is practiced annually covering 5-10 percent area. Locally plantation of pineapple, orange and rubber occupy small areas.

The low hills are mainly under scrubby thickets, grassland, bamboos and tree forest. *Jum* is practiced. Crops include early summer highland rice, ginger, banana, chilies, vegetables, etc. Tea is grown on some deep soils having steep to rolling topography. Rubber is grown on terraced very steep to rolling topography. Pineapple cultivation on hills by clearing the forest and planting mostly along the slopes is a faulty agricultural practice causing severe soil erosion. Vegetables, tobacco and wetland rice are major crops grown in the valleys and adjoining plains.

6.4 Climate

Climate includes rainfall, temperature, sunshine hours, evaporation, and humidity. Climate change affects systems significantly. Extreme climatic factors increase environmental hazards like floods, droughts, landslides and soil erosion.

6.4.1 Rainfall

The mean total annual rainfall in the CHT varies from 2400-3000mm.[20] Bandarban district experiences the highest rainfall and other two districts have similar rainfall distribution. Monsoon season rainfall is approximately 70-80 percent of the annual rainfall (Table 6.5, Figure 6.4).

Table 6.5: Season wise average rainfall distribution

District	Winter (Dec-Feb)		Pre monsoon (Mar-May)		Monsoon (Jun-Sep)		Post monsoon (Oct-Nov)		Annual rainfall (mm)
	Rainfall (mm)	(%)	Rainfall (mm)	(%)	Rainfall (mm)	(%)	Rainfall (mm)	(%)	
Khagrachhari	28	1.2	437	17.9	1761	72.4	207	8.5	2,433
Rangamati	28	1.1	435	17.1	1863	73.4	212	8.4	2,538
Bandarban	30	1.0	411	13.9	2270	76.5	256	8.6	2,966

CEGIS estimations (2013)

[20] Calculation was done for determining the seasonal average and annual total rainfall. For analysis, 12 months have been divided into four seasons. In order to obtain the trend (decreasing and/or increasing) and thereby to estimate the rate of decrease or increase, rainfall amount (mm) were plotted against time (years) for all the stations.

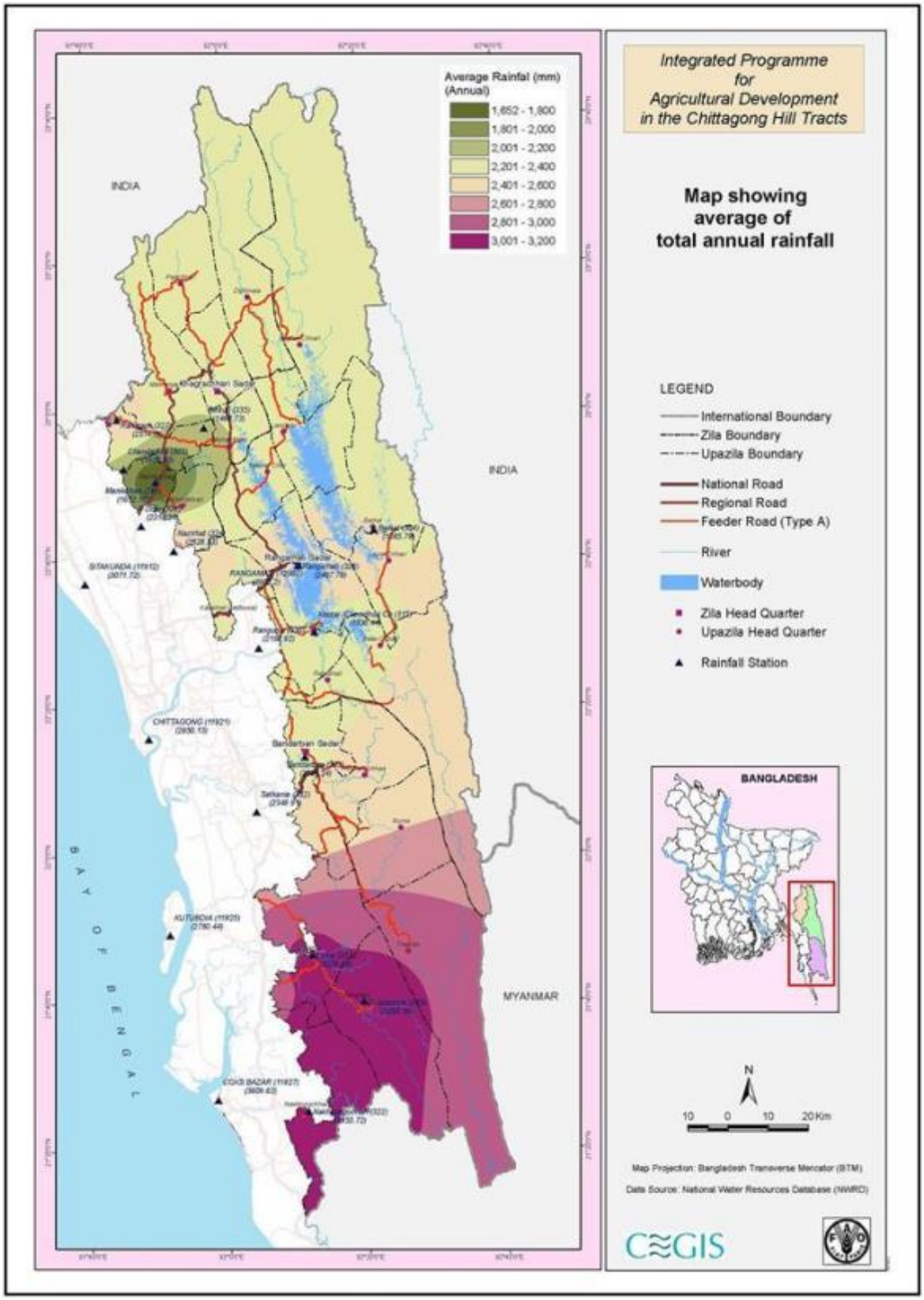


Figure 6.4: Annual rainfall

Annual total rainfall trend observed at all BWDB stations and is plotted in graph (Figure 6.5). From analysis it is observed that rainfall intensity is gradually increasing from North to South.

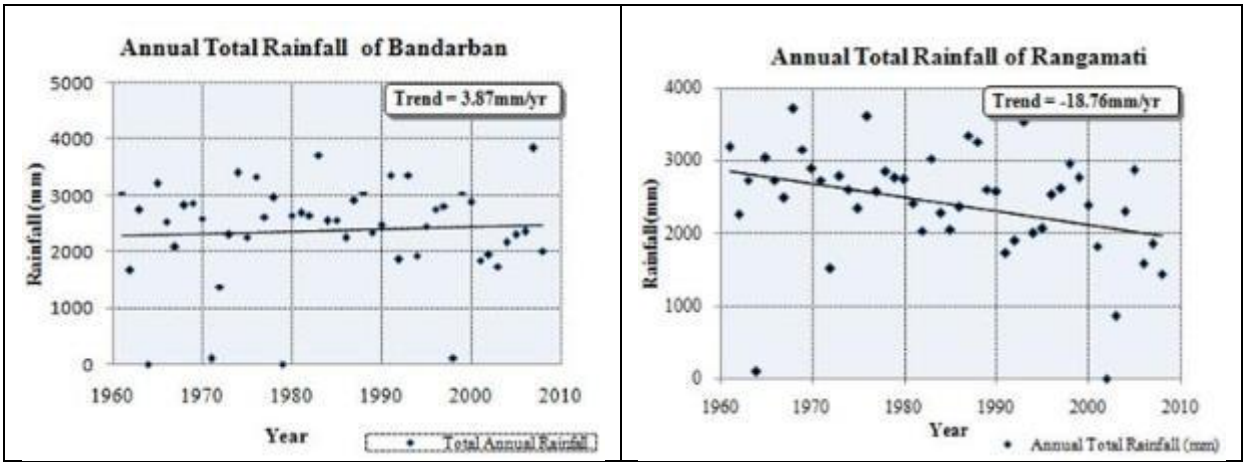


Figure 6.5: Annual total rainfall trend observed at Bandarban and Rangamati stations

6.4.2 Temperature

The mean annual temperature is approximately 24˚C. The mean minimum temperature varies from 9.5˚ to 22˚C and mean maximum temperature varies from 30˚ to 37˚C. High temperatures are observed between March to October and the lowest temperatures during December to February (Table 6.6). The maximum highest temperature was recorded at 43.30˚C in April 1966 and the lowest recorded minimum temperature was 5.5˚C in February 1961. Over the last few decades, the yearly maximum temperature has been increasing whereas the minimum temperature has remained almost stable. An increasing trend is observed from 1995 onwards.

Table 6.6: Seasonal variation of temperature

District Name	Winter (Dec-Feb)		Pre monsoon (Mar-May)		Monsoon (Jun-Sep)		Post monsoon (Oct-Nov)	
	Max	Min	Max	Min	Max	Min	Max	Min
Khagrachhari	30.35	9.50	36.50	14.95	35.40	21.80	34.15	15.45
Rangamati	30.15	10.00	36.75	15.25	35.50	21.75	34.16	16.02
Bandarban	30.00	11.00	35.75	16.25	34.75	21.86	33.92	16.50

6.4.3 Evaporation

The annual total evapo-transpiration (ET) in the CHT varies from 1,250 to 1,350mm. The highest ET is generally observed in the southern part, especially in Bandarban (Table 6.7).

Table 6.7: Evapo-transpiration in the CHT area (mm)

Districts	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Annual
Bandarban	87	100	136	148	152	114	107	113	113	112	92	82	1,356
Rangamati	70	86	126	138	142	114	106	113	106	103	80	68	1,251
Khagrachhari	71	86	126	136	142	115	110	113	109	105	82	68	1,262

Source: NWMP (2001)

6.4.4 Humidity

The mean humidity is approximately 78 percent in Bandarban and 76 percent in Khagrachhari and Rangamati. The maximum humidity is observed during July and August and the minimum in January and February.

6.4.5 Sunshine

The daily total sunshine hours range from four to eight hours in the CHT. In the monsoon season, the mean sunshine hours are around four to five hours. In the dry season, it varies from seven to eight hours.

6.4.6 Wind speed

High wind velocity is observed in the southern part. Mean wind speed is approximately 170 knots per day (kpd), or 315 km per hour (kph) in Bandarban and 103 kpd (190 kph) in Rangamati and Khagrachhari. High wind speed is generally observed in June, July and August and low wind speed in November and December.

6.4.7 Climate change variability

Drought

Drought originates from a deficiency of precipitation over an extended period of time resulting in a water stress, sometimes specifically on crops. Assessment of water stress condition on land can be done from rainfall and evaporation data. But there is only one BMD evaporation station (Rangamati) and a few BWDB stations in the study area. There is also considerable number of days where data was not collected.

First approach: Estimating the trends of non-rainy days

A trend analysis of rainfall using data of 1961-2010 shows that the annual total number of non-rainy days (i.e. dry days) per year is generally increasing. Also the consecutive maximum number of non-rainy days is increasing (Table 6.8). The average increase of consecutive non-rainy days in the CHT is 0.38 days/year and the annual total non-rainy days are 0.78 days/year. This indicates that dry days are increasing, which may worsen the drought situation.

Table 6.8: Trends of non-rainy days

Rainfall stations	Trend of consecutive max non-rainy days (days/year)	Trend of annual non-rainy days (days/year)
315	0.096	0.3547
319	0.5715	0.6232
322	1.0725	1.7051
324	0.3167	0.7686
327	0.227	0.322
328	0.3992	0.8833
330	0.3063	1.1001
332	0.0937	0.4744
Avg.	0.3853625	0.778925

Second approach: Estimating the trend of rainfall and evaporation

At a very coarse level, the balance of rainfall and evaporation gives an indication of water stress or surplus. This exercise has been done for all available stations in the study area. As an example, the rainfall and evaporation of station 327-Ramgarh (Khagrachhari) shows that the difference is always positive, meaning that moisture in soil is not in extreme deficit, i.e. not at stress (Table 6.19).

Table 6.9: Rainfall and evaporation difference in Station 327-Ramgarh

Year	Rainfall (mm)	Evaporation (mm)	Difference (mm)
1992	1465.6	1390.4	75.2
1993	3652.5	1263.4	2389.1
1994	1818.2	1349.6	468.6
1995	2385.4	1324.9	1060.5
1996	2420.9	1328.2	1092.7
1997	3282.6	1340.2	1942.4
1998	2719.8	1243.9	1475.9
1999	2329.9	1072	1257.9
2000	2525.2	1268.3	1256.9
2001	2216.5	1145	1071.5
2002	1896.4	1112.5	783.9
2003	1858.2	1036.3	821.9
2004	2180	1060.6	1119.4
2005	2165	1111.2	1053.8
2006	1871	1411.3	459.7
2007	3064	1209.4	1854.6
2008	1912	1303.4	608.6

The trend of balance of rainfall and evaporation is decreasing (Figure 6.6). On the other hand if the demand for water increases, which is expected with increase of population and agricultural coverage, then the region will face more drought.

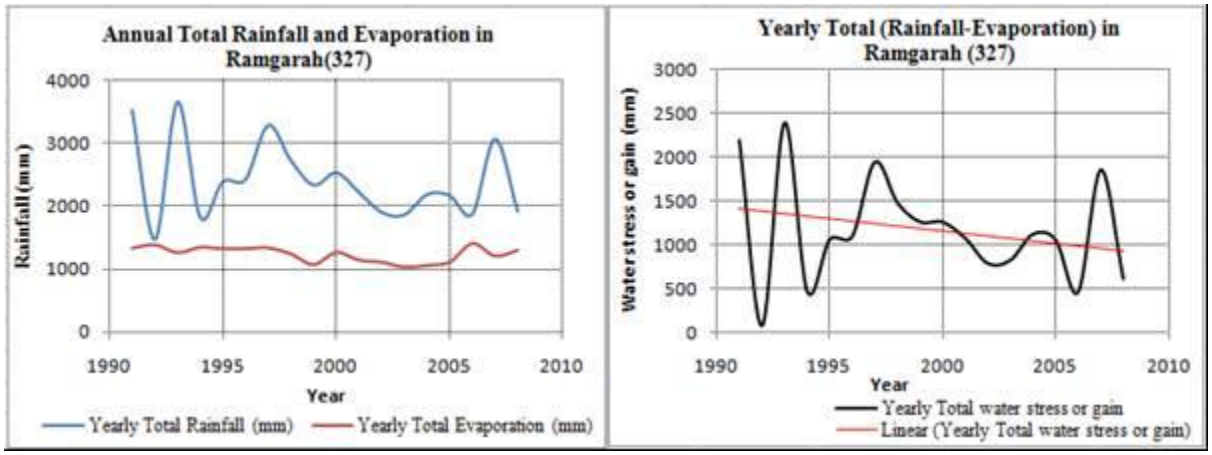


Figure: 6.6: Comparison of rainfall and evaporation

Flood

Probability of flood in terms of water congestion for few days like plain land is very low due to topography of the region (hilly). Rivers in the CHT are faster and speedier than other parts of Bangladesh and the region is flash flood prone. Sudden and short duration surge of water over an area due to heavy rainfall at higher altitude causes flash floods in valleys and damages a lot. This type of flood is characterized by rapid rise and fall of water levels. Flash flood occurs for a few minutes to few hours. Flash flood occurs during the monsoon.

It has been observed that hilly rivers passing through V-shaped gorges can inundate the banks. Thanchi and Lama bazaars are regularly flooded by flash floods from the *Sangu* and the *Matamuhuri* rivers. Panchhari and Khagrachhari are flooded by the *Chengi* River (Figure 6.7).

Affected areas usually remain waterlogged for a few days after every flood and suffer severe damage. The region is often lashed by cyclones. Landslides are common during the monsoon, caused by soil erosion, deforestation and faulty agricultural practices. Landslides also cause increased siltation in the rivers.

6.5 Water

In the CHT, main sources of water are the surface water of rivers, lakes, canals and springs, and groundwater from shallow and deep aquifers. Rainwater is an alternative source of water in areas where rainfall is comparatively high. Water is mainly used for drinking, domestic, irrigation and commercial purposes.

6.5.1 Surface water

Rivers with chhara system

The typical drainage patterns on hill slopes consist of a dense dendritic network of gullies fanning out into winding valleys. River system with *chhara* has been mapped in GIS system and presented in Figure 6.8.

Most of the rivers flow in a north-south direction. The northern catchments are drained by the *Karnafuli River* and its tributaries (*Chengi, Myani and Kassalong*); while in the south the *Sangu River* constitutes the main drainage system. These rivers have cut deep gorges in a southwest direction before entering the coastal plain and ultimately draining into the Bay of Bengal. In the Chittagong coastal plain, these rivers meander as a result of reduced flow and large quantities of sediment.

About 1,400 km of rivers that flow over the CHT region include mainly five rivers, named the *Chengi, Myani, Karnafuli, Matamuhuri and Sangu*. These rivers originate outside the country. The three major rivers in the north originate in Tripura and flow towards Bangladesh into the *Kaptai Lake*. Before the creation of the Kaptai reservoir, the *Chengi River* and the *Myani River* flew into the *Karnafuli River*. The *Matamuhuri* and the *Sangu* originate in the mountains of Myanmar. All these rivers contribute to the Kaptai reservoir.

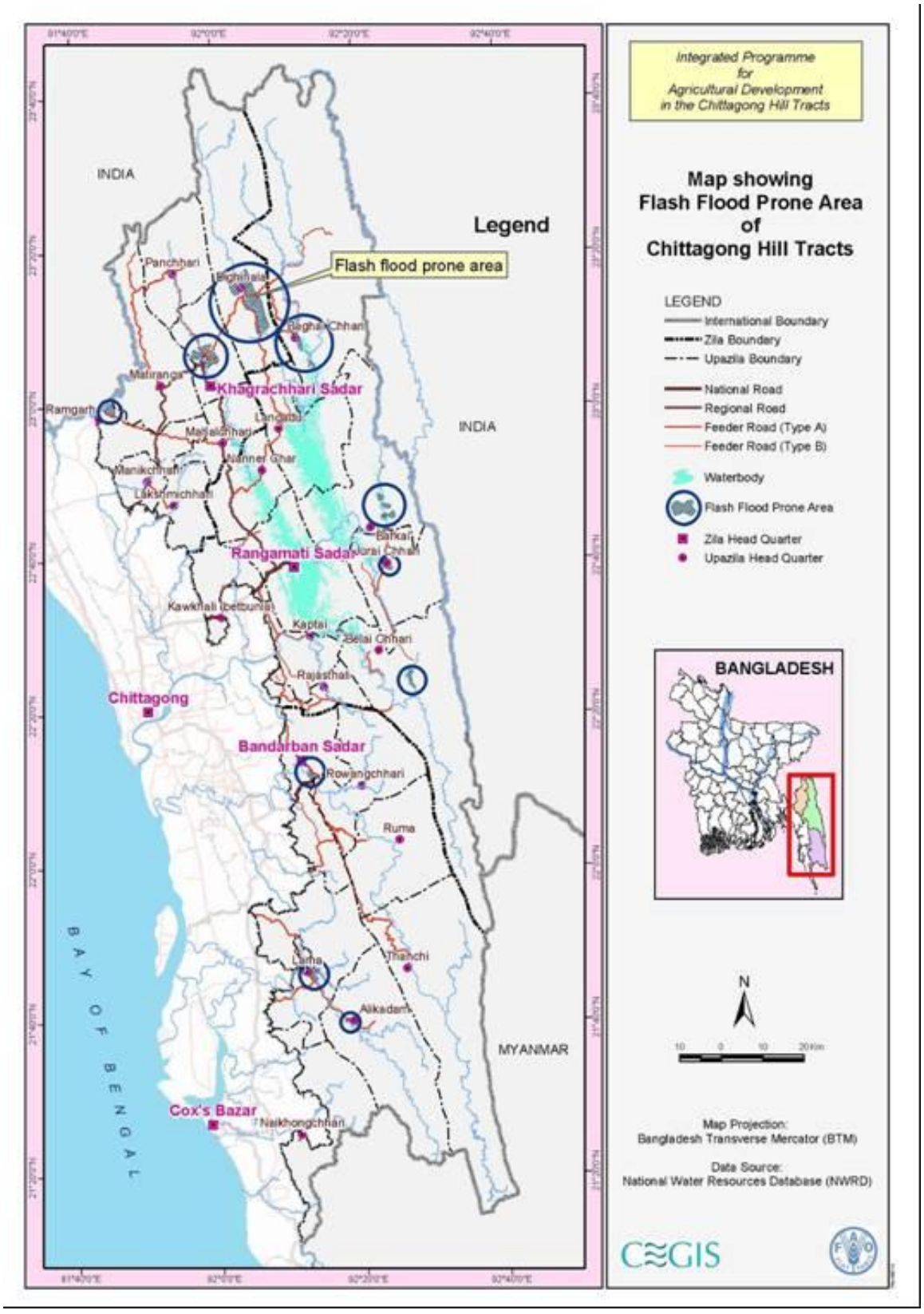


Figure 6.7: Indicative flash flood affected area

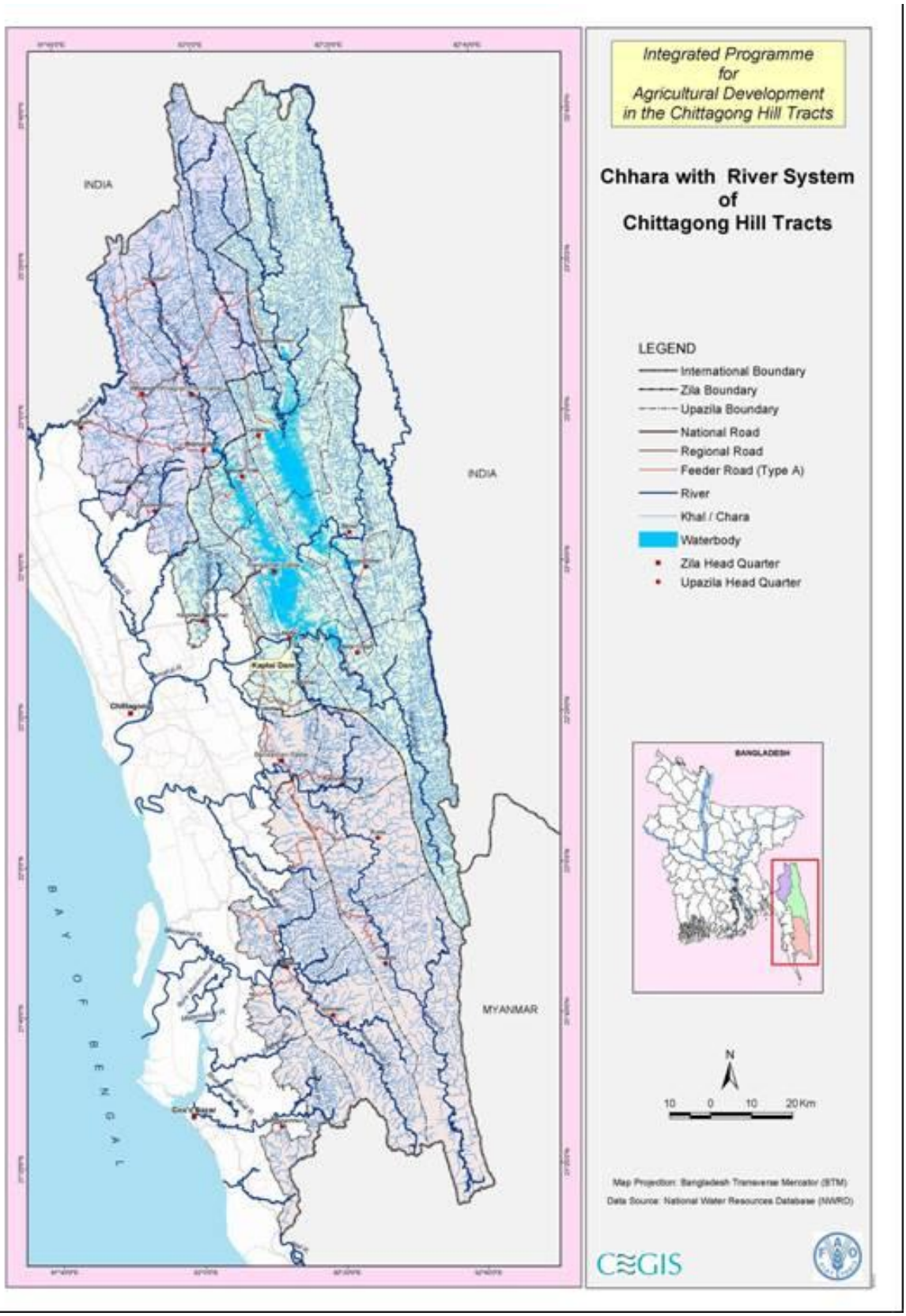


Figure 6.8: Rivers systems with *chhara*

Due to the construction of a hydroelectric dam on the river *Karnafuli* in the early 1960s, the *Kaptai Lake* was created. Because of seasonal variations, the reservoir area varies. Usually, the highest water coverage occurs in June and the lowest in November. The *Kassalong* and *Myani* tributaries of the *Karnafuli River* drain into the lake, which is intensively used for culture fisheries and river transport. The *Bagabili, Halda, Dighalchhari* and *Chatrachhara* rivers also spring back to life in the wet season.

The total length of *chharas* connected to the rivers and spreading over the CHT is more than 7,200 km. Among these, 40 percent flows over Rangamati and 30 percent each in Bandarban and Khagrachhari. These *chharas* are steep and cannot hold water for long. When the *chharas* meet rivers, they are flushed out. About 862 km of *khals* connected to *chharas* and rivers flow during the wet season.

The maximum average discharge in the *Sangu* and the *Matamuhuri* varies between 300 m^3/s in July and <25 m^3/s in the dry period (1965-2005). Particulars of the rivers of the CHT are presented in Table 6.10.

Table 6.10: Major rivers of the CHT

Sl.	River	Length (km)	Width (m)	Passing district	Originate from
1	Matamuhuri	97	Above 100	Bandarban	Myanmar
2	Karnafuli	90	Above 100	Rangamati	Mizoram
3	Rangkhaing	47	Above 100	Rangamati	Bangladesh
4	Sangu	177	50-100	Bandarban	Myanmar
5	Myani	65	50-100	Khagrachhari	Tripura
6	Chengi	86	25-50	Khagrachhari	Tripura
7	Feni	56	25-50	Khagrachhari	Tripura
8	Bakkhali	14	25-50	Bandarban	Bangladesh

Source: CEGIS, 2007

Perennial water bodies

The *Kaptai Lake* spreads over Rangamati, Langadu, Barkal, Naniarchar, Juraichhari, Kaptai and Belaichhari upazilas. On an average it stores about 43 percent of water of all perennial water bodies in the CHT.

According to the rule curve for water levels, the water level at the dam site should remain below 27.5m from April to August so that farmers can grow one crop (Aus or Boro) in the fringe valleys. Apparently this rule was not respected in last few years, resulting in the loss of rice crop in the valleys. Furthermore, the maximum water level in the rainy season also increased significantly (33.5m in September), leading to huge loss of land that used to be available for monsoon vegetable production.

The fringe valley area is estimated at 9,000 ha. It is not known how much of this is affected by the change in water level regulation. According to DAE-Rangamati estimates, it may be as much as 5,000 ha.

6.5.2 Groundwater

The availability and quality of groundwater in Bangladesh is greatly related to and controlled by major physiographic units of the country. The whole country is divided into three major physiographic units: the Holocene Plains, the Pleistocene Uplands, and the Tertiary Hills.

According to the simplified hydrogeological classification (Ahmed, 2003), this area belongs to the hydrogelogical province called 'Tertiary Hills'.

In the context of groundwater availability and the suitability of groundwater development, the CHT is less suitable than most parts of the country. The folds of the sedimentary strata developed from tectonics have made the geology of the area complex and consequently its hydrogeology as well. Thick beds of consolidated shale limits the vertical recharge of groundwater into the aquifer below. However, along the valley areas (synclines), deep groundwater is available within a depth range of 100-300 meter. Except some areas in Khagrachhari district, the groundwater table occurs at a greater depth below the ground surface. The primary source of natural groundwater recharge is direct rainfall.

The groundwater level fluctuates with season and abstraction of water from the system. Like many other places of the country, the aquifer of the region is not fully recharged during the wet season and in most places the groundwater level stands below the ground surface. No declining trend of groundwater level has been observed.

Except for some areas of Khagrachhari district, the whole of the CHT has a very low ground water table. The use of groundwater is comparatively low. The hard bedrock underlying much of the region makes tube well installation difficult. As a result, wells are not drilled deep enough and dry up quickly. Moreover, it is quite expensive to drill a hole and to install a well. The people of the CHT areas consume less water than people living in the plains.

A good tradition of water management is rarely visible in these areas. Drinking water largely comes from perennial water sources such as streams, springs, and rock channels. Water rights are rather undefined compared to land and forest rights. Sustainability of technologies installed for producing water is questionable due to many challenges in this area.

6.6 Biodiversity

The CHT is very rich in biodiversity, though the situation is worsening with increasing human interventions and encroachments.

The flora of the CHT resembles the flora of Arakan. The major species are *Garjan*, *Civit*, *Chandul* and *Champa*. It is a hub of numerous medicinal plants. There is lack of information on the floral diversity of the CHT.

Increase in population combined with forest degradation, unsustainable land use patterns and soil erosion threaten floral diversity (Table 6.11).

The CHT is considered a center of biocultural diversity because of its richness in natural resources and its cultural diversity (Halim *et al*, 2007). The negligence of the customary use and management rights of the forests has accelerated the deforestation (Thapa and Rasul, 2006).

Deforestation is caused by both natural and manmade factors. The forests, including high forest areas, have been disappearing. The timber type natural forest area of the *Kassalong Reserve* decreased, while plantation areas increased. Both mixed forest areas (timber-bamboo and bamboo-timber) and areas with bamboo trees have decreased. The *Sangu* and *Matamuhuri* reserve forest areas also underwent similar changes.

About 2,200 ha (ADB, 2001) of reserved forest area of Rangamati have been encroached. Encroachment occurs as there is no clear boundary demarcation supported by cadastral maps. No data is available on the encroachment of the forest areas of Khagrachhari and Bandarban.

Table 6.11: Threatened plant species of the CHT

Common name	Scientific name
Ban supari	*Areca trianda*
Kadam bet	*Calamus erectus*
Chhoto bet mara	*Calliowdra umbrosa*
Cycad	*Cycas pectinata*
Modon mosta	*Dehaasia kurzii*
Dholi garjan	*Dipterocarpus gracilis*
Bon jalpai	*Elacocarpus ganitus*
Dephal	*Garcinia scandens*
Homalina	*Homalium schlichii*
Kurud pata	*Licuala peltana*
Jangli am	*Mengifera longipes*
Uri am	*Mengifera sylratica*
Mon kata	*Pajanelia longifolia*
Ram supari	*Pinanelia gracilis*
Jigra	*Pithecellobium angulatum*
Bans pata	*Podocarpus neriifolia*
Joygga gola	*Prunus cylanica*
Chalmogra	*Hydrocarpus kurzii*
Chandul	*Tetrameles nudi flora*
Lasua garjan	*Valica lanceiflia*
Lota am	*Willugh beia edulies*
Han sak	*Xanthophyllum flavescens*
Biolam	*Anisoptera glabra*

Source: (ADB, 2001a)

As a habitat, the CHT supports many animals and plants, the diversity of which is threatened by increased human presence. The country supports a wealth of biodiversity including 113 species of mammals, 628 species of birds, 126 species of reptiles, 22 species of amphibians, 708 species of freshwater and marine fish, 400 species of mollusks and over 5, 000 species of vascular plants (IUCN, 2000). The CHT, as a large portion of Bangladesh's natural environment, contains many of these important species.

The government declared the natural forests of the hilly areas as protected areas, game sanctuaries and national parks in order to preserve biodiversity. The National Environment Policy 1992 has a clear mandate for the enhancement of biodiversity, but yet to be implemented fully.

Data gives evidence of the depletion of wildlife. However, there is little information on the actual status of wildlife in the CHT such as inventory, recruitment, or habitat ranges.

Chapter 7

Assessment of Watersheds

7.1 Watersheds

A watershed is the upslope area that contributes flow of water to a common outlet as concentrated drainage. It can be part of a larger watershed and can also contain smaller watersheds, called sub-basins. The outlet or pour point is the point on the surface at which water flows out of an area. This is usually the lowest point along the boundary of the drainage basin.

The area upon which water falls (i.e. rainfall) and the network through which it travels to an outlet are referred to as a drainage system. The flow of water through a drainage system is only a subset of what is commonly referred to as the hydrologic cycle, which also includes precipitation, evapo-transpiration, and groundwater. The development of watershed focuses on the movement of water across a surface.

In the CHT, the main source of surface water is rainfall and accumulated waters in streams, *chharas*, and lakes. Delineation of watersheds/catchments requires good quality of spot heights with very detailed topographic information, which are lacking. Spot heights available in the CHT are not precise and updated. Land elevation data has been used to prepare the Digital Elevation Model (DEM) for this region.

Using available DEM (cell size-30m x 30m) with the help of GIS technologies, available topographic maps and some field verification, 659 watersheds have been delineated in the CHT, 119 in Khagrachhari district (Figure 7.1.1), 273 in Rangamati district (Figure 7.1.2) and 267 in Bandarban district (Figure 7.1.3).

7.2 Water Availability

7.2.1 Rivers

Very limited surface water level stations are available in the CHT. Most of these are at the peripheral side of the region. No water level/discharge stations are available in the *Myani*, *Kassalong*, *Chengi*, *Rangkhaing* and *Bakkhali* rivers. Even upper portion of the *Sangu*, *Karnafuli* and *Matamuhuri* are without any station. Average seasonal mean water level (m, PWD) is presented in Table 7.1.

Table 7.1: Average seasonal mean water level

Station ID	River	Station	Average seasonal mean water level (meter, PWD)			
			Winter (Dec-Feb)	Pre-monsoon (Mar-May)	Monsoon (Jun-Sep)	Post-monsoon (Oct-Nov)
40	Bakkhali	Ramu	2.68	2.69	3.96	3.16
84	Feni	Ramgarh	12.00	12.08	13.08	12.45
124	Ichhamati (tributary)	Thandachhari	11.25	11.26	11.86	11.51
203	Matamuhuri	Lama	6.27	6.30	7.62	6.73
245	Sangu	Ruma	9.95	9.93	12.26	10.84
247	Sangu	Bandarban	4.99	5.01	7.41	5.92

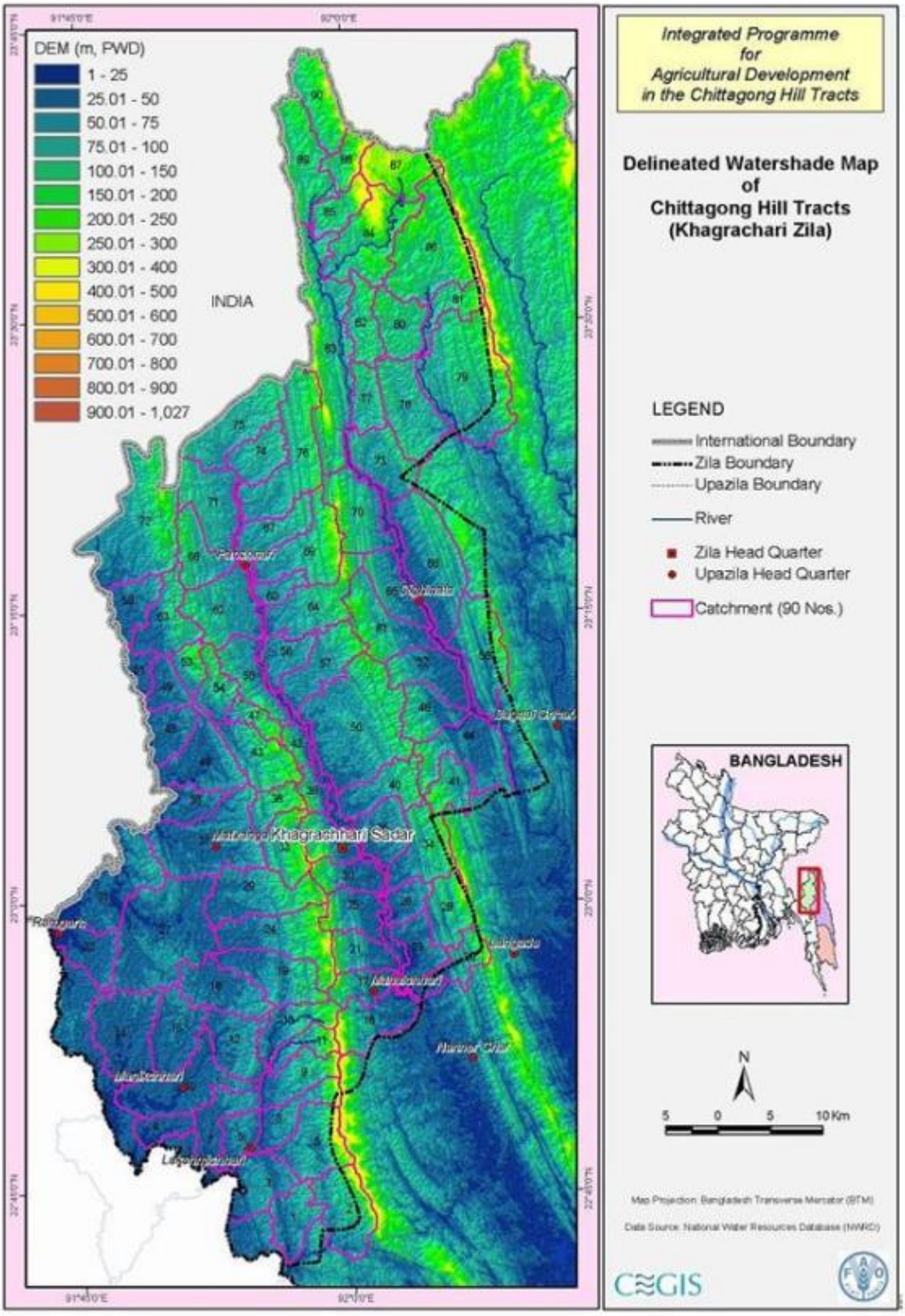


Figure 7.1.1: Watersheds of Khagrachhari

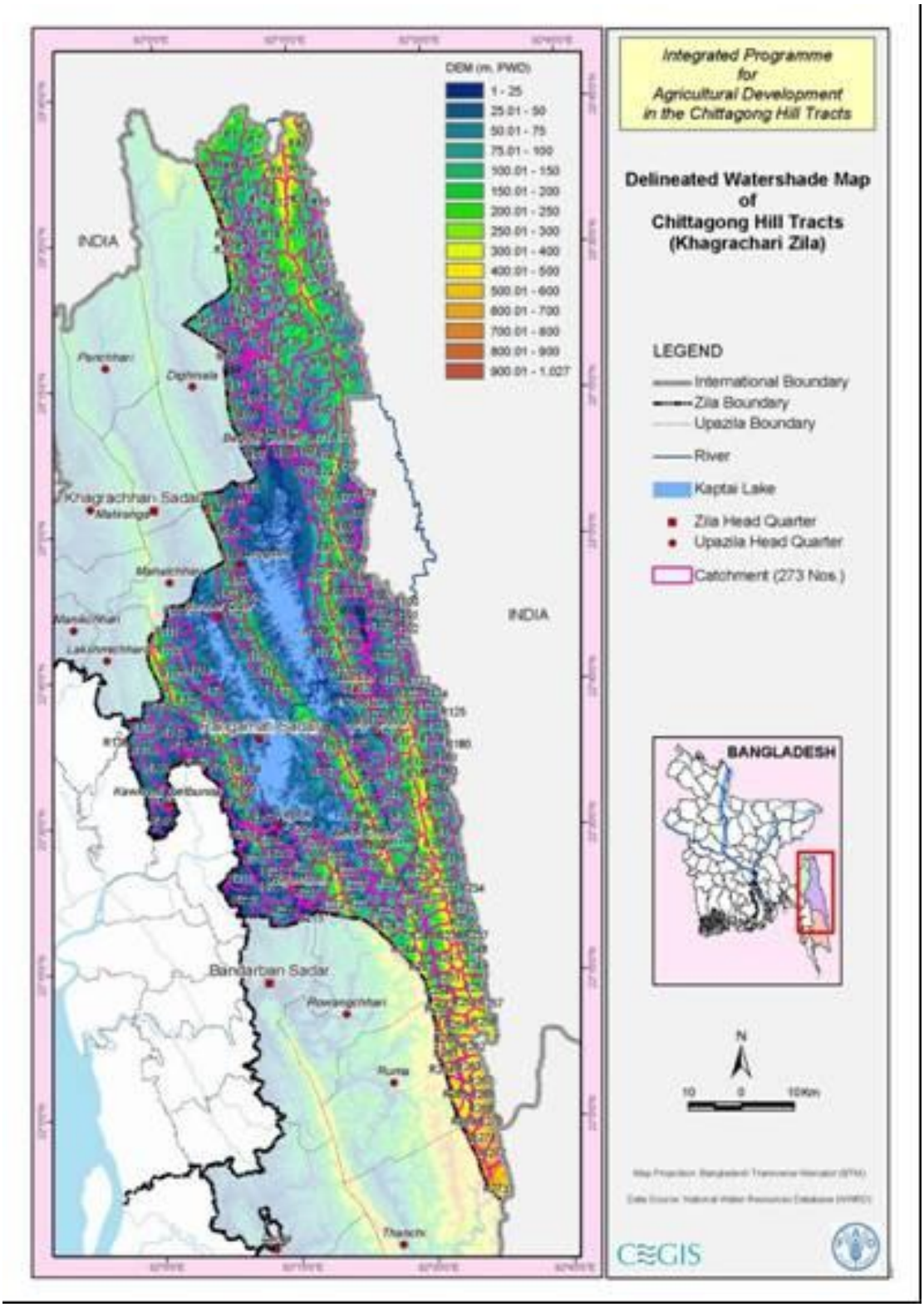


Figure 7.1.2: Watersheds of Rangamati

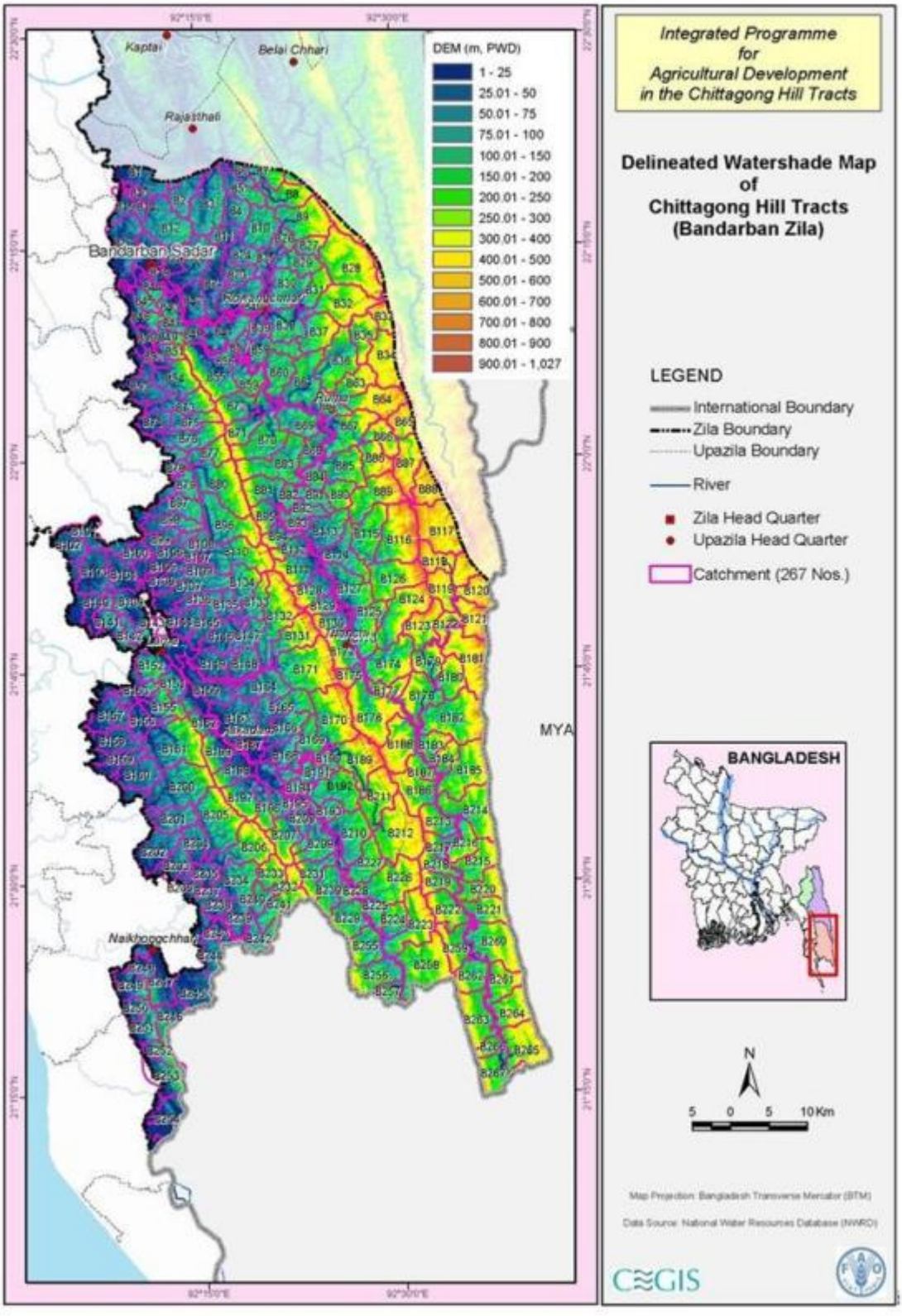


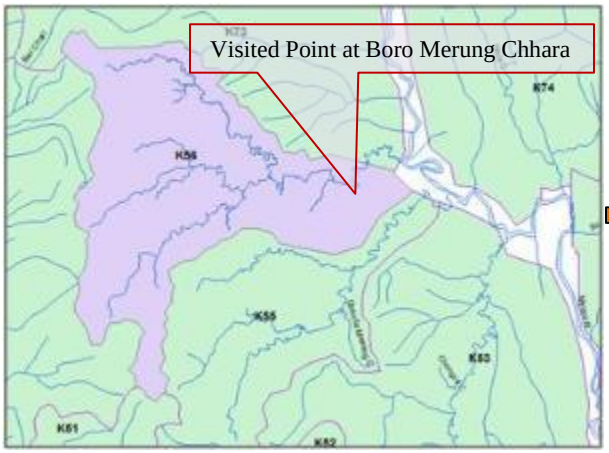
Figure 7.1.3 Watersheds of Bandarban

7.2.2 Watersheds

Most of the land is hilly and undulated. During the monsoon, most of the rainfall runoff runs away; some of those infiltrate and recharge the ground water table. Ground water table varies rapidly in this region in comparison to the plain lands due to its topography.

To assess water availability in different seasons, it is necessary to have the historical data. But ground and surface water level observation is very limited in the CHT; and in hills and valleys there are no measuring at all. Even to have a rough assessment, it is necessary to collect data for at least one year with close observation, which has not been possible at this stage.

However, a few watersheds (dry, medium and wet) have been selected at different locations for collecting data on water availability (discharge) from the field by measuring the flow and discussing with the local people in Rabi season (February), when precipitation is nearly nil. This is an indicative measure of water availability for base flow in the driest month (February) of the Rabi season. An attempt has thus been made to assess the gross water availability from rainfall without considering evaporation and other losses (Figure 7.2.1, 7.2.2 & 7.2.3). This assessment gives an indication of the temporal water availability throughout the year.



Information

Watershed No. K56 (A= 2068 ha) at Khagrachhari

Wetted Area, A =0.17 m^2
Surface velocity, v = 0.15 m/s (measured avg. height = 0.075m)
Discharge, Q = 0.026 m^3/s (Dry)
Date = 12-02-2013
Rainy season (July) avg. height. = 1.38m
(Source: Local people)

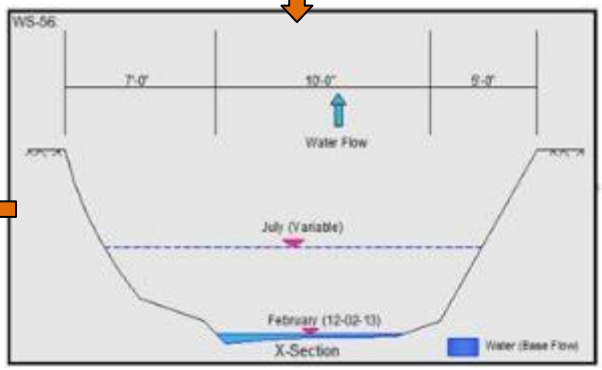
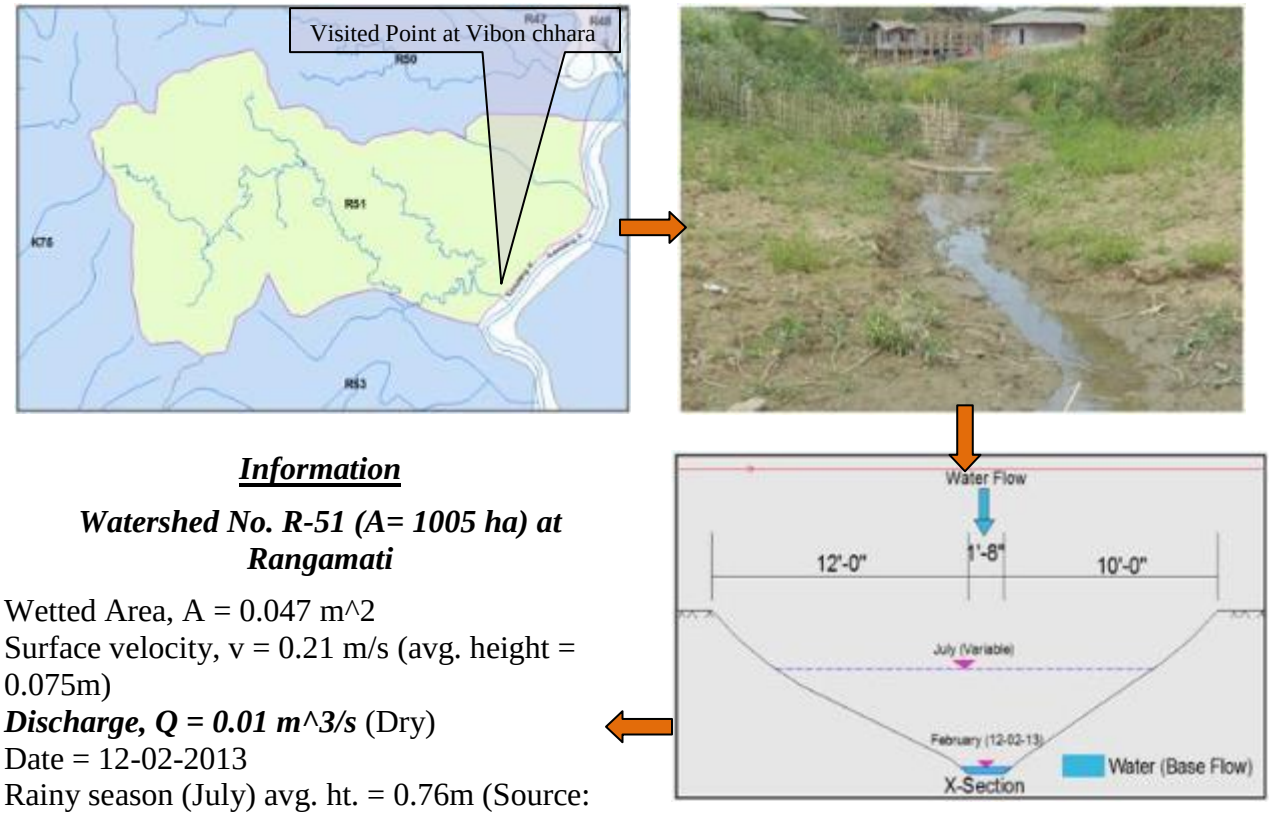


Figure 7.2.1: Water availability scenario in WS-K56 in mid-February (Rabi)

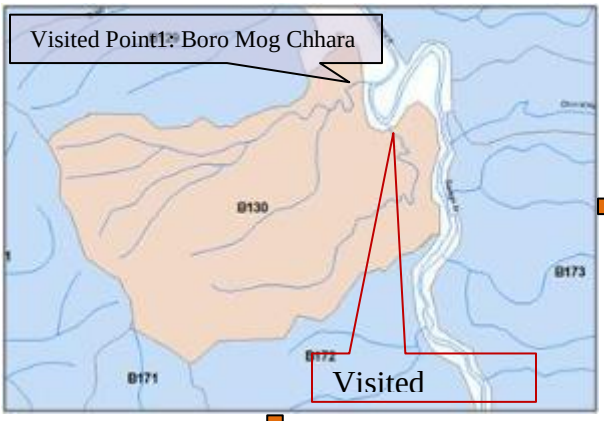


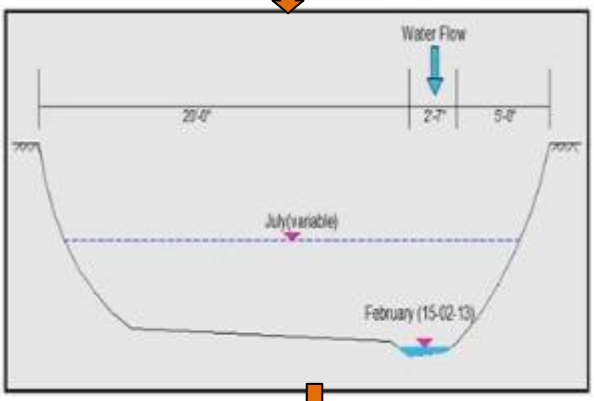
Information

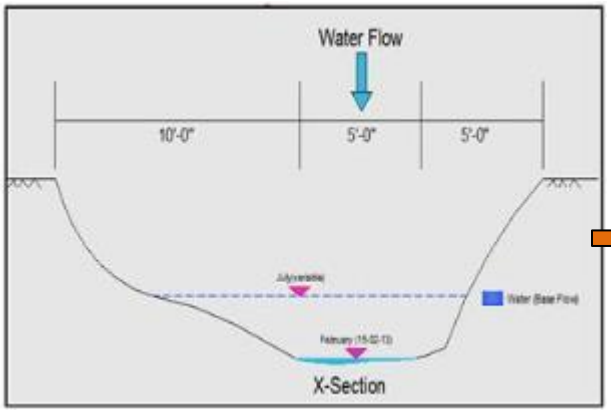
Watershed No. R-51 (A= 1005 ha) at Rangamati

Wetted Area, A = 0.047 m^2
Surface velocity, v = 0.21 m/s (avg. height = 0.075m)
Discharge, Q = 0.01 m^3/s (Dry)
Date = 12-02-2013
Rainy season (July) avg. ht. = 0.76m (Source: Local people)

Figure 7.2.2: Water availability scenario in WS- R51 in mid-February (Rabi)







Information

Watershed No. B-130 (A= 1244 ha) in Bandarban

*****Point 1 (Boro Mog Chhara):
Wetted Area, A = 0.06 m^2
Surface velocity, v = 0.27 m/s *(avg. height = 0.07 m)*
Discharge, Q = 0.016 m^3/s (Dry)
Date = 15-02-2013
Rainy season (July) avg. ht. = 1.22m (Source: Local people)
**Point2:*
Wetted Area, A = 0.045 m^2
Surface velocity, v = 0.2 m/s (avg. height = 0.038m)
Discharge, Q = 0.01 m^3/s (Dry)
Date = 15-02-2013
Rainy season (July) avg. ht. = 0.76 m (Source: Local people)

Figure 7.2.3 Water availability scenario in WS- B130 in mid-February (Rabi)

7.3 Water Management

7.3.1 Irrigation

In the CHT, only 156,936 ha (3.1%) of the total land area are valley and suitable for intensive cropping. Only 19.2 percent of the valley land is brought under irrigation and over 80 percent area is under rainfed agriculture (source: DAE). Extent of irrigation is relatively higher in Khagrachhari district (32%) and the lowest in Rangamati (12%). Most of the farmers are using low lift pumps (LLP) for irrigation and utilizing surface water. Only two deep tube wells (DTW) are operating, one in Dighinala upazila (Khagrachhari) and another in Baghaichhari upazila (Rangamati). Besides, two rubber dams are under construction, one in Panchhari (Khagrachhari) and the other in Rajvila (Bandarban).

7.3.2 Indigenous water retention practices

Commonly used methods for water retention for irrigation purposes are (a) indigenous cross-dam, (b) retention pond, (c) *Godha*, d) *Thelya-Thok*, and (e) LLP near the riverside. Indigenous earthen cross-dam, 4-6m wide and 2.5-5m high, is constructed across a perennial creek between two hills. The catchment area for the creek is 80-100 ha. People use stored water for fish culture and raising ducklings. A bamboo pipe of 5cm diameter that passes through the dam is used to maintain the water level. The pipe is kept closed with a wooden plug that can be removed to lower the water level in the pond or provide water for irrigation in downstream areas. Natural vegetation in the upstream hill slopes and along the banks of the creek is maintained to minimize soil erosion and siltation of the creek.

Godha is a kind of cross-dam that is constructed across a small hill creek to collect water for the dry season. The dam is made of earth, supported on both sides by bamboo and wooden poles pegged to the ground. Inclined support posts are also used. Water stored in the *godha* is used for household and irrigation purposes. Bamboo pipes are used to carry water to neighboring fields of lower elevation. *Godha* helps in transporting bamboo harvested in upstream areas. If long distance transport is necessary, a number of *godhas* are built in succession. Water is released by dismantling the upper *godha* and collected by a new *godha* built in the downstream. Harvested bamboo moves with the released water to the lower *godha*. This process is repeated to carry the harvested bamboo to the point of collection.

Thelya-Thok is similar to a *godha* and is used for same purposes. The dam may require a catchment area of 100 ha. Bamboo and wooden pegs are used to support the earthen body of the dam. The only difference with a *godha* is that a diversion drain beside the dam is used to release excess runoff.

Chapter 8

Farming Systems

Farming practices, in a broad sense, are land-based activities for food, fruits and cash including tree crop farming, livestock-poultry rearing and fish farming. Different farming practices largely depend on the size of the farm, intensity of technology use, and indigenous culture of the farming communities.

Topographical variations of flat lowland, gentle slope land and land having steep slopes along with varying soil characteristics and water availability dictate the pattern and the practices of agricultural crop production in the CHT. The pattern presently practiced in the *Chengi*, *Myani* and *Kassalong* valleys is typical subsistence production system modified to some extent by modern aids in the form of improved planting materials, irrigation facilities and use of chemical fertilizers and pesticides. Some fringe lands of *Kaptai Lake* in the dry season produce irrigated HYV Boro rice through plough agricultural practices. The other crop production practices are primitive, such as, *jum*. Subsistence farming, small land holdings and short growing season prevail in the region. Most of the farmers grow some fruits and vegetables.

Livestock and poultry play an important role in the farming system by supplying meat, milk and egg for nutrition and manure for crop production. Animals and birds are occasionally sold to meet cash requirements. Generally, livestock and poultry freely graze and the farmers do not provide any extra feed. *Jumia* farmers keep native variety of pigs in their homesteads. Pisciculture is done by those who possess pond or other water body**.**

8.1 Farm size

Majority of farms are of small size, less than one ha each. Only seven percent holdings are 'large', each being three ha or above. Small farms are more concentrated in Khagrachhari district, while medium and large farms are more prevalent in Bandarban and Rangamati (Table 8.1).

Table 8.1: Distribution of farm holdings by size of farm

Farm size (ha)	Number of holdings				
	Bandarban	Khagrachhari	Rangamati	CHT total	Percentage
Small (0.02->1.00)	24,669	57,016	39,594	121,279	56
Medium (1.00->3.00)	17,197	27,935	33,710	78,842	37
Large (3.00 +)	3,557	4,382	6,921	14,860	7
Total	45,423	89,333	80,225	214,981	100

Source: DAE

8.2 Agricultural Land Use Pattern

Among all field crops, tobacco is predominant, while among cereal crops; HYV Aman is dominant, followed by HYV Boro and Local Aus (mostly *jum* variety). Among non-cereal crops other than tobacco, vegetables (both summer and winter), cotton and sugarcane cover substantial areas. However, fruit orchards occupy vast areas of the region (Table 8.2).

Table 8.2: Distribution of crop area (ha), 2011-12

Crop	Variety	Rangamati	Khagrachhari	Bandarban	Total
Rice					
Boro	Hybrid	2,710	2,715	1,410	6,835
	HYV	6,040	8,645	5,155	19,840
	Local			43	43
	Total	8,750	11,360	6,608	26,718
Aman	HYV	9950	26,260	11,329	47,539
	Local	300	1,730	565	2,595
	Total	10,250	27,990	11,891	50,131
Aus	HYV	1,250	2,500	3,045	6,795
	Local	4,685	1,500	8,481	14,666
	Total	5,935	4,000	11,426	21,361
Maize		470	1,700	295	2,465
Pulses		364	770	525	1,659
Potato		360	475	716	1,551
Oilseeds		330	496	775	1,601
Spices		338	890	656	1,884
Sugarcane		3,510	4,090	3,330	10,930
Cotton		6,900	5,157	7,474	19,531
Tobacco		9,750	21,600	28,050	59,400
Orchards		18,130	22,000	29,125	69,255
Vegetables	Summer	2,850	5,635	1,690	10,175
	Winter	4,445	6,925	3,415	14,785

Source: DAE (2011-12)

Most of the cultivable land (62%) is single cropped. The proportion of triple cropped area is very small (6%). Intensity of cropping is 144 Percent in the CHT compared to 191 percent in the country (Table 8.3).

Table 8.3: Intensity of cropping

Agricultural land	Area (ha), 2011-12				
	Rangamati	Khagrachhari	Bandarban	Total	Percentage
Single cropped area	35,630	24,590	28,930	89,150	62
Double cropped area	11,738	18,098	15,478	45,314	32
Triple cropped area	1,878	3,870	3,172	8,920	6
Total cropped area	64,740	72,396	69,402	206,538	144
Net cropped area	49,246	46,558	47,580	143,384	100
Crop intensity (%)	131	155	146	144	

Source: DAE (2011-12)

8.3 Agricultural Land Utilization by Gradient

The landform as defined by the SOTER (SOil and TERrain Digital Database) methodology is determined by a combination of elevation, slope gradient and relief intensity.

Medium-gradient mountains and high-gradient hills

High-gradient hills are characterized by steep slopes - median slopes 21% with extremes of over 100% - and by a high relief intensity of about 180m km^{-2}. They stand out as elongated parallel ridges aligned almost north–northwest to south–southeast. Towards the east, the ridges get higher until they reach the highest mountain ranges - over 1000m - that mark the boundary between Bangladesh, Myanmar and India. The ridges are formed by the anticlines of consolidated rocks consisting of alternating beds of shales, siltstones and sandstones of the Bhuban formation.

The elevation of the high-gradient hills ranges from about 50m to 600m above the MSL. The medium-gradient mountains range from 600m to the highest summits. The cores of the higher anticlines consist of semi-consolidated to consolidated sedimentary rocks – mainly sandstones - that are strongly and deeply dissected. The mountains have very steep slopes and conical sharp peaks.

High-gradient hills

Medium-gradient hills

The lower hilly areas between high-gradient hills are formed by synclines mainly consisting of unconsolidated sandstone and siltstone of the late tertiary age. These sandstones mainly belong to the younger Tipam formation and the siltstones mainly comprise the Bokabil formation. Unconsolidated siltstones and sandstones of the Dihing and Dupi Tila formations occur in the western part of the CHT.

Hill summits are generally less than 300m above the MSL. Most of the areas are rolling to steep low hills, with rounded tops, with strongly dissected edges and very steep slopes. However, some have almost level relief.

Medium-gradient hill

Dissected plains

Within the plains, two groups are distinguished: those in the areas adjacent to the hills and those in the west of the CHT. The first group of hills is higher and steeper and has a higher relief while the latter have a subdued relief, lower elevation and gentler slopes. These units are classified as dissected plains; they show the remnants of a plain that is visible in the summits of the area. Valleys have cut the old surfaces resulting into an area of sloping landforms. Slopes are in general less than 10 percent with occasional extremes up to 30 percent.

Dissected plain

Plains

Only small areas in the southwest of the region are the parts of the Chittagong coastal plain. This part of the CHT is a relatively narrow strip of land sloping gently outward from adjoining hills. Sediments that are washed off the hills and/or deposited by small streams flowing out of the hills form this land. The relief is irregular. Deposits are mainly loamy and sandy in the elevated areas and clayey in depressions. Seasonal inundation is mainly intermittent and shallow that occurs from heavy rainfall in the adjoining hills.

Valley

Plain

Valleys

Valleys occur within the dissected hills. Most of the valleys, particularly those occurring between high-gradient hills, are very narrow with sharp gradient, and as a result have little accumulation of sediments. During the Pleistocene glacial periods, most of these hills were dissected at a deeper level than the present sea-level. The deep valleys were later filled up by sediments as the sea level rose. In the central and northern part of the CHT, the *Karnaphuli* and its major tributaries have substantial areas of alluvial deposits along their courses. In the south, only the *Sangu* and the *Matamuhuri* rivers have mapable fluvial sediments. Recent floodplains are subject to annual flooding; but the older sediments of the higher terraces are not.

8.3.1 Floodplain and valley land irrigated farming system

Floodplain and valley land in the CHT cover 270,812 ha, which is 3.2 percent of the total area of the region. Valley lands are intensively used for crop production. Most of the irrigated rice is cultivated in the northern valley and almost every suitable area of the valley floor throughout the region where irrigation facilities prevail. Rice is the main crop which is grown in this land area.

The seasonal fringed land area of the *Kaptai Lake* is utilized for Boro rice cultivation during the low water period. In irrigated areas, farmers are used high inputs as well as take intensive crop care for higher production (Table 8.4).

Table 8.4: Present status of irrigated crop cultivation area in CHT

Status	Area (ha)			
	Rangamati	Khagrachhari	Bandarban	Total
Under irrigation	6,610	13,500	6,457	26,467
Non- irrigation	40,913	28,333	41,123	110,369
Total land area	47,523	41,833	47,580	136,836
Irrigated area (%)	14	32	14	19

Source: DAE, CHT districts, 2012

Less than one-fifth of the total valley land area is currently under irrigation facilities. Khagrachhari district has relatively higher coverage (32%), while the other two districts have as low as 14 percent land area coverage (Figure 8.1). Yields vary depending on physiographic and management conditions of the region. Yield gaps are observed in all varieties of rice cultivated in

the valley. Current yield gaps can be substantially minimized through the use of better quality inputs and management practices (Table 8.5).

Table 8.5: Yield of different rice varieties

Rice variety	Yield (t/ha)		
	Current yield	Attainable yield	Yield gap
Pajam	2.79	3.80	1.01
BR-3	2.61	6.50	3.89
BR-10	2.74	6.50	3.76
BR-11	2.88	6.50	3.62
BR-22	2.28	5.00	2.72
BR-23	2.32	5.50	3.18
BR-25	3.20	4.50	1.30
BR-30	2.94	7.50	4.56
BR-31	2.80	5.00	2.20
BR-32	2.88	5.00	2.12
BR-34	2.73	3.50	0.77
BR-39	2.72	4.50	1.78
BR-40	2.97	4.50	1.53
BR-41	3.04	4.50	1.46
BR-44	3.00	5.50	2.50
BR-46	2.91	4.70	1.79
Burma IRRI	2.53	5.00	2.47
Hari dhan	2.65	4.50	1.85

Source: AD, DAE, Rangamati, 2012

Dominant cropping patterns are:

Boro rice – Fallow - T.Aman

Vegetables - T. Aus - T.Aman

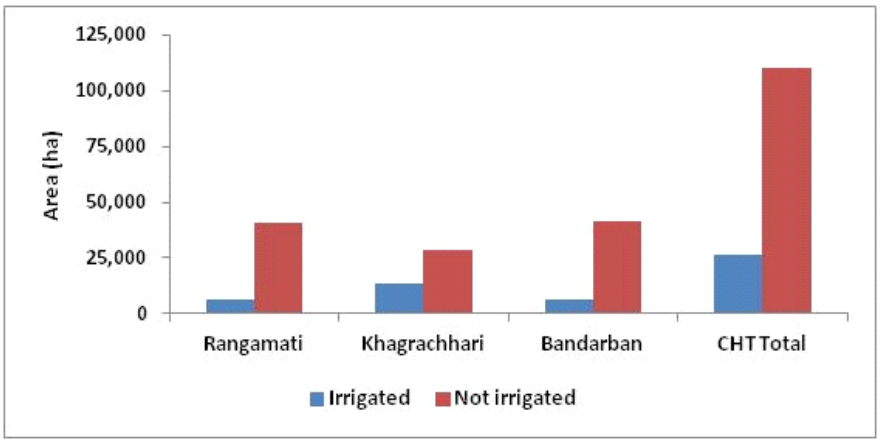


Figure 8.1: Extent of irrigation

8.3.2 Floodplain and valley land rainfed farming system

In the winter, a portion of rice land is utilized for early vegetables, mustard, cowpea and French bean. Farmers do not use or use minimal inputs other than seeds and labor. Besides, a vast area of the valley land is used for growing cowpea and mustard under rainfed farming system. Transplanted Aman rice is also grown well in summer season.

The Dominant cropping patters in rainfed farming system are:

Fallow - Fallow - T.Aman

Cowpea /mustard - T.Aus - T.Aman

Sugarcane intercropped with peas or vegetables

8.3.3 Upland mono crop based farming system

Ginger, turmeric, aroid, kakrol, string bean, water gourd, ash gourd, lady's finger, etc are major monoculture crops. Cultivation of these crops is mainly done in mild to moderate steep slope. But sometimes high steep slopes are also used. Intercultural operation and harvesting of ginger, turmeric and aroid leads to soil erosion and land degradation is compounded. Restricted land preparation, use of only chemical fertilizers or only organic manure or both or none, and use or nonuse of pesticides are main features of monoculture system of farming. Dominant cropping patterns are annual crops, such as, pineapple, aroid, ginger and kakrol.

8.3.4 Mixed crop based farming system

Mixed cropping is an important farming system in the CHT. Generally, it is practiced in homesteads and hills with gentle to moderate slopes. Crops grown are maize, millet, cassava, bush bean, chewing tobacco, red amaranths and different kinds of vegetables and spices. The mixed farming is practiced round the year except the dry months.

8.3.5 Upland jum cultivation

Jum is a traditional farming system in the uplands. It is a major indigenous land use practiced by local communities in the kharif season and accounts for 10 percent of the net cropped area in the CHT. Cultivating multiple agricultural crops in the cleared patch of hill slopes for one or two seasons and then shifting to another place is a major trait of this land use (Table 8.6).

Table 8.6: *Jum* area by upazila

Rangamati			Khagrachhari			Bandarban		
Upazila	ha	%	Upazila	ha	%	Upazila	ha	%
Sadar	250	1.7	Sadar	250	1.7	Sadar	662	4.5
Naniarchar	195	1.3	Panchhari	260	1.8	Rowangchhari	350	2.4
Kawkhali	104	0.7	Dighinala	224	1.5	Ruma	1,780	12.0
Barkal	363	2.5	Matiranga	253	1.7	Thanchi	2,800	18.9
Juraichhari	405	2.7	Ramgarh	92	0.6	Lama	1,300	8.8
Langadu	295	2.0	Manikchhari	95	0.6	Alikadam	820	5.5
Baghaichhari	860	5.8	Lakshmichhari	170	1.1	Naikhangchhari	735	5.0
Kaptai	390	2.6	Mahalchhari	240	1.6			
Rajasthali	500	3.4						
Belaichhari	1,398	9.5						
Total	4,760	32.2		1,584	10.7		8,447	57.1
CHT Total	14,791							100.0

Data source: DAE, CHT districts, 2012

Findings of FGDs carried out among *jum* farmers in some sporadically selected villages of six upazilas (three in Bandarban, two in Rangamati and one in Khagrachhari) show that rice, maize,

sesame, cucumber, sweet gourd, ash gourd, and *mamra* (melon) are the main *jum* crops. Turmeric and ginger are also grown widely, though separately in foothills or on the plains in the top of the hills. Two to three times weeding is carried out. Crops are harvested in succession as they mature/ripen between July and April (in the following year) (Table 8.7).

Table 8.7: Crops grown in the *jum*

Crop	Farmers growing the crop (%)						Sowing period	Harvesting period
	Barkal	Belaichhari	Thanchi	Rowangchhari	Ruma	Dighinala		
Rice	100	100	100	100	100	100	May-Jun	Sep-Oct
Maize	100	100	100	100	100	100		Aug-Sep
Brinjal	95	74	0	88	23	7		Aug-Nov
Turmeric	100	100	100	100	100	100		Nov-Dec
Chili	100	100	100	100	100	100		Aug-Dec
Sweet gourd	100	100	100	100	100	100		Jul-Oct
Ash gourd	100	100	100	100	100	100		Jul-Oct
Bottle gourd	52	100	100	100	79	48		Jul- Oct
Bitter gourd	96	85	100	100	97	100		Jul-Sep
Cucumber	100	100	100	100	100	100		Jul-Oct
Bean	100	100	100	100	100	100		Jul- Oct
Dherosh	95	87	77	92	100	78		Jul-Oct
Melon	22	98	100	100	100	28		Aug-Sep
Cotton	54	68	96	88	100	46		Nov-Dec
Yam	26	24	08	57	44	18		Oct-Dec
Arhar	44	52	44	26	34	52		Feb-Apr
Aroid	28	27	23	34	56	18		Oct-Nov
Sesame	100	100	100	100	100	88		Nov-Dec

Source: FGD (2012)

Surface water runoff and faulty methods of cultivation practices are main causes of soil loss and land degradation in the hills. Farmers grow pineapple with a spacing of 1000x30cm apart and making line up and down the slope. They sometimes cultivate aroid, turmeric and ginger in moderate to steep hill slope with deep spading. Intercultural operation is also done by spading without any soil conservation measure, which causes soil erosion.

Soil erosion also occurs due to *jum* cultivation, if not done properly. A survey was conducted at seven different sites to diagnose farming practices and their impacts on soil resource loss in the CHT (Farid, 1988). The survey found that the loss of soil and nutrient and sediment deposits were consequences of agricultural practices and operations at steep and very steep slopes of hills and ridges (Table 8.8).

Table 8.8: Effect of tillage and mulching on soil erosion in hill slope (5-15%)

Treatment	Dry weight of eroded soil (t/ha)
Mulch	22.25
No mulch	58.02
Zero tillage (dibble)	23.77
Minimum tillage (furrow planting)	35.68
Conventional tillage (spading)	61.10
Zero tillage + Mulch	13.12
Zero tillage + no Mulch	34.43
Minimum tillage + Mulch	20.12
Minimum tillage + no Mulch	51.24
Conventional tillage + Mulch	33.43
Conventional tillage + no Mulch	88.85

Source: BARI, 1998

Every year more and more land is denuded due to unplanned agricultural expansion. The impact of high intensity rainfall (2,000 to 4,500mm per year) followed by runoff over slope length results in tremendous soil loss. The effect becomes more severe with the steepness of the areas. In many cases, gullies are formed. These gullies are scattered in hill areas. In some cases, the impact is so pronounced that the sub-surface bed-rock is exposed.

8.3.6 Cash crops

Sugarcane, cotton and tobacco are important cash crops in the CHT. Cotton cultivation has declined much in comparison to the past.[21] Sugarcane cultivation has slowly increased because of market demand and the advent of HYV species (chewing variety). Tobacco cultivation is increasing and has made inroads in remote areas (Table 8.9).

Table 8.9: Area under cotton, sugarcane and tobacco

Crops	Cultivated area (ha)			
	Rangamati	Khagrachhari	Bandarban	Total
Cotton	6,900	5,175	7,475	19,550
Sugarcane	3,510	4,090	3,330	10,930
Tobacco	9,750	21,600	28,050	59,400

Source: DAE, BSRI, CDB

Sugarcane mixed with other crops is the most profitable practice with gross profit of Tk 220,000 per ha (Table 8.10). Cotton in plain land is more profitable than tobacco. However, tobacco growing period is shorter than that of cotton, which can accommodate other crops to grow.

Table 8.10: Comparison between sugarcane, cotton and tobacco

Crop	Planting time	Harvest time	Yield (t/ha, piece	Production Cost (tk/ha)	Gross profit, tk/ha	Remark
Jum cotton	April-May	Nov-Jan	0.29	No cost	15,950	*Jum* cotton cultivated as intercrop, price tk 55/kg
Plain land cotton	Kharif-2 Jul-Aug	Dec.-Jan	2.70	94,000	68,220	Mono crop for 6 months, price tk 60/kg
	Kharif-1 Jan-Feb	June-July				
Sugarcane	Nov-Dec	Oct-Dec	17500 pieces	95,000	220,000	Inter cropping; price tk 18/piece, long durable crop, plus income from vegetables for 5 months
Tobacco	Oct-Jan	April-May	1.00	85,000	45,000	Mono crop for 6 months, price tk 130/kg

Data source: DAE, CDB, BSRI, field visit

[21] The CHT was attractive to the British who occupied the region in 1860 on commercial grounds, mainly because of cotton. At that time, land revenue was collected in the form of cotton.

8.4 Horticulture Based Farming System in Hill Slopes

8.4.1 Fruits and tree crop based farming system

Fruit trees are mainly concentrated in and around homesteads. Banana, pineapple, papaya, jackfruits, guava, lemon, litchi, mango and orange are major fruit crops. *Champa* and *Kabri* are the traditional banana varieties. Besides, *Amritasagar*, *BARI Kola-03* and *BARI Kola-4* are being introduced gradually through tissue culture seedling. The commercial fruit gardens are mainly concentrated with banana, papaya, lemon, pineapple, mango, orange and jackfruit. But a number of other fruit crops are grown slatternly. Farmers hardly follow plant spacing, proper application of different fertilizers and their methods of applications in terms of dose and time, crop care (weeding, mulching) and protection of crops from pests and diseases. As a result, much of the potential remains unexploited (Figure 8.2).

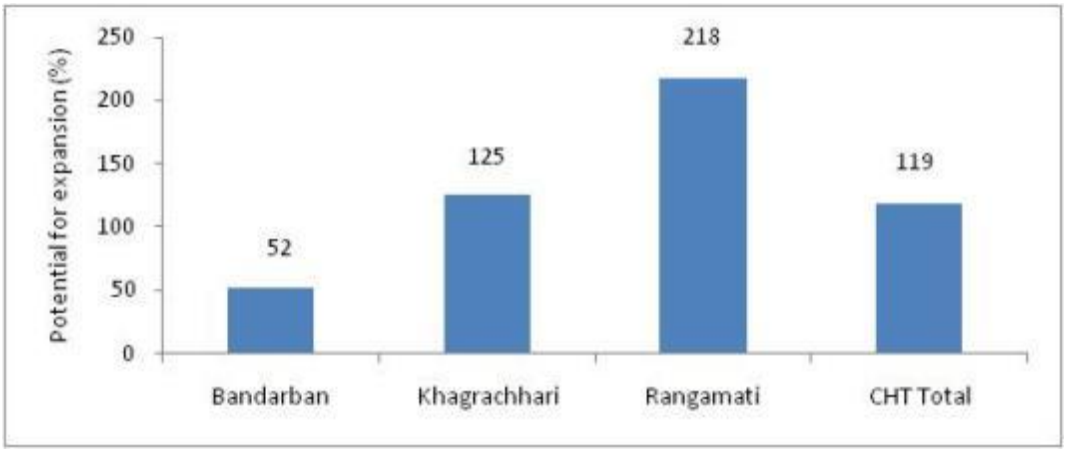


Figure 8.2: Expansion potential of fruit orchards

Many fruit gardens were established by the project support of the DAE and the CHTDB. The fruit trees are in the bearing stage or some are already producing fruits. Since then the DAE and the CHTDB did not provide any support. Therefore, most of the farmers are not able to take proper care of the fruit trees for a good harvest. A few farmers who managed their gardens properly are reaping a better harvest. Same scenario has been observed in CHTDB supported orange gardens.

8.4.2 Mixed orchard in pineapple farming areas

Pineapple is a very suitable fruit crop in the CHT, as the soil and agro-climatic conditions are favorable. It is extensively cultivated in Naniarchar, Rangamati Sadar, Khagrachhari Sadar, Manikchhari, Matiranga, Dighinala, Mahalchhari, Bandarban Sadar, Ruma and Rowangchhari upazilas. The following pineapple based multi strata fruit production model has been developed by the Hill Agricultural Research Station of BARI in Khagrachhari.

- 1st crop: Pineapple: short duration and short structured (1-3) years;
- 2nd crop: Guava: medium duration and medium structured (3-6) years;
- 3rd crop: Mango/ litchi/olive: long duration and tall structured 5-30 years or more;
- 4th crop: Coconut/ betel nut: Surrounding the garden as a boarder crop to protect the garden from strong wind and provide fruits for extra income generation.

8.4.3 Vegetables based farming system

Most of the farmers grow vegetables in their compounds for household consumption. In recent years, some farmers are gradually shifting to commercial cultivation including off-season vegetables and are using fallow upland areas during summer months. Among important vegetables grown are okra, beans, gourd, chili, eggplants and kakrol. Besides, cabbage, cauliflower, potato, tomato are also growing in the winter in lowland areas with irrigation facilities. Aroid is cultivated in low to moderate hill slopes in the summer.

The CHTDF is trying to introduce floating vegetable cultivation in cooperation with the Rangamati HDC in the *Kaptai Lake* with water hyacinth beds. Few farmers are practicing this technology.

8.5 Livestock and Poultry

Livestock is an important economic option. In the CHT, farmers generally do not give any extra feed to their animals. Poultry, cattle, goat, buffalo and pig freely graze on hilly lands (Table 8.11). Almost all livestock are local breed. In some areas, *Chittagong Red* is found.

Table 8.11: Livestock and poultry population

Animal/bird	Number			
	Rangamati	Khagrachhari	Bandarban	CHT total
Cow	184,654	134,814	170,927	490,395
Goat	142,457	109,211	63,623	315,291
Sheep	2,897	3,349	740	6,986
Buffalo	11,470	2,890	1,517	15,877
Pig	74,028	37,110	43,195	154,333
Chicken	483,994	851,344	297,234	1,632,572
Duck	112,837	69,843	51,520	234,200

Source: DLS, CHT districts, 2012

The local *Chittagong Red* is not a recognized breed. But for the CHT, it is suitable. It gives one calf every year and average milk production/day/cow is 4-5 liters. Pig is the most important livestock for local communities. Most of the animals graze freely. The availability of green grass for animals is quite adequate except the dry season months (February to April). In this period, animals suffer from shortage of food and water. Supplementary stall feeding is needed in the lean period to maintain the normal animal health. Besides, the animals and birds suffer from different diseases due to inadequate supply of preventive vaccines and lack of awareness of the farmers.

At present a number farms, such as, milk production cattle (278), goat (164), sheep (8), poultry (636) and duck (18) are commercially operated in the private sector in CHT (Source: DLS, CHT districts, 2012). CHTDF runs a community based livestock improvement program, such as, de-warming and vaccination for cattle and poultry in collaboration with the DLS.

8.6 Fisheries

The aquaculture has a vital economic consideration in the CHT. Fish culture in the *Kaptai Lake* as well as in other water bodies has a good prospect. *Kaptai Lake* is about 68,300 ha in the monsoon and 58,000 ha in the dry season. The annual production of fish from this lake is only 130kg per hectare, which is far below its potential. The fish captured from this reservoir almost entirely goes to big cities.

Total number of *ghona*[22] sites is 1,702 and total area is estimated at 3,064 ha (Table 8.12). These sites are ideally suited for intensive fish culture.

Table 8.12: Distribution of ghona by upazila

Upazila	Number of ghona	Area (ha)
Baghaichhari	107	262.23
Barkal	187	519.04
Belaichhari	237	180.51
Juraichhari	52	134.77
Kaptai	16	11.13
Langadu	258	666.66
Mahalchhari	1	4.02
Naniarchar	137	252.95
Rangamati Sadar	707	1032.27
Total	1702	3063.58

Source: CEGIS estimation

8.7 Forestry

Protection of water resources, protection from wind erosion, and influence on climate are important protective roles of the forests in the CHT. Upland forests reduce the loss of nutrient rich topsoil and protect young plants from wind within their zone of influence. However, forests are dwindling fast.

There are few Reserve Forests (RF) directly managed by the Forest Department (Table 8.13). Total area under RFs is 24 percent of the CHT area. Encroachment in RFs is prohibited. Besides, there are 287,461 ha of Unclassed State Forest (USF) in the CHT (BBS, 2011a). The Deputy Commissioner is the custodian of the USF. Most of the USF is without any tree cover. *Jum* farms are mainly located in USF areas.

Table 8.13: Reserve forest area in the CHT

Reserve forest (ha)			
Rangamati	Khagrachhari	Bandarban*	Total
231,999	36,913	50,702	319,614

Source: FD, Rangamati Circle

Agro forestry is an alternative land use system characterized by cultivating different woody perennials along with agricultural crops which may be appropriate especially in the CHT replacing or complementing the short-fallowed *jum* cultivation. It is evident that upland agro forestry minimizes soil erosion, increases biological interactions of tree, crops and livestock and generates income from farmland. It ameliorates microclimatic condition and confirms the food securities from the risks of food shortage due to crop failure and lower production. It also provides fuel wood and fodder to the rural communities. Among the total lands in the CHT, 72.9

[22] Gorge surrounded by hills in three sides with opening to the lake at one side.

percent are suitable for only forestry practice, while 14.7 percent are suitable for mostly horticulture and partly forestry and other 1.3 percent are suitable for horticulture and forestry practices (Roy, 2002). Almost one-third of the area covering 270,000 ha outside the reserve forests can be put under agro forestry practice (Khisa, 2002).

The CHTDB implemented Upland Settlement Project (USP) in the CHT from 1985 to 2007 in two phases. In the first phase of the project, 1620 ha of homestead agro forestry, 3240 ha of rubber plantations in 39 project villages were established. During the second phase, 506 ha of agro forestry and 1620 ha of rubber plantations were established. In the homestead agro forestry plots, banana, pineapple and Jackfruit were the major fruit crops. Among the forest tree species, Teak and Gamar were the major ones. In the moderate to steep slope lands, it was observed that farmers adopted contour hedgerow type of agro forestry with nitrogen fixing trees and shrubs.

The growing understanding on the change of government policies and strategies to involve people living in and near forests in forest management has led to the development of participatory forestry as a good tool to sustainable forest management in developing countries. Forestry Department of Bangladesh introduced social forestry programs to restore the degraded forests and support the forest dependent peoples in the 1980s. Social forestry programs in the CHT are suitable in degraded Unclassed State Forest (USF) lands at the moderate to steep slopes and the homesteads of the households. However, insecure land rights in the CHT are a constraint to social forestry practices. Hence, negotiation on the land rights of the forest dependent people is crucial before taking any action on agro forestry in the CHT.

Chapter 9

Value Chain

9.1 Input Supply Mechanisms

9.1.1 Farm machinery and tools

Farming in the CHT is undertaken mostly manually with the help of some power machinery like power tiller, power pump, pedal and power thresher, weedier, hand and power sprayer, cleaner, grinder, knives, scissors, spade, *dao* etc. These are used to cover plantation to processing, for cleaning of turmeric, milling and grinding rice, chili and turmeric, different pumps for surface water and ground water irrigation, pedal and power thresher for threshing purpose.

9.1.2 Seeds and planting materials

Seeds and planting materials are preserved by farmers to meet their own needs. Sometimes farmers collect it from neighboring farmers. Some private companies and BADC are main sources of improved or hybrid seeds and have extended their market up to the big bazaar level. Local level nursery or horticulture centers are the sources of seedlings. But horticulture centers are far away and there are very few nurseries. Farmers are not aware of the quality of seeds and saplings and sometimes are in danger when they go for production with bad or adulterated seeds and saplings.

9.1.3 Agro-chemicals

Farmers buy agro-chemicals like fertilizers and pesticides from retail shops, dealers and wholesalers. But these outlets are not easily accessible in remote areas. For application and dose of fertilizers and pesticides, farmers usually depend on the 'advice' of the sellers. In most cases they are not aware of the quality of chemicals. DAE extension staffs are not available for consultation in many places.

9.2 Marketing

9.2.1 Household food and seed storage

Farmers store food and seed generally for three major objectives, (a) food for future consumption before the next harvest, (b) seed for next sowing/plantation season and (c) sale at a better price (Table 9.1). Most of the farmers face problem of storing and marketing their products. Major problems are small space for storing at the household level, absence of storage facilities for perishable commodities and different microbial spoilage of the produces, which compel the farmers to sell their products immediately after the harvest at a very low price. Poor farmers are sometimes forced to sell their seeds before the next sowing season.

9.2.2 Collection mechanisms

Farmers collect their produce from the farm once or bit by bit based on the type of the product, day of nearest bazaar or the market place[23], maturity status, and requirements of cleaning, sorting, grading and drying. Farmers sell it at the farm site or at the local bazaar. Middleman or the *baeari* (*bepari*)[24] collects products from farmers at farm site or the local bazaar at local

[23] Usually twice a week

[24] *Baeari* is *Chakma* colloquial for *bepari* in *Bangla*, which usually denotes trader or broker.

market rates. The *paiker* (wholesaler) usually collects products from farmers or middlemen at the bazaar or sometimes from the farm site. Before loading for the next bigger bazaar, commodities are stockpiled at roadside or in an open place, as good space with shed and parking space is mostly absent in local bazaars. Collection process is prolonged if collection points are located at remote places.

Table 9.1: Household food and seed storage system

Product	Duration	Process
Paddy	0.5-3 years	Kept in sack
Sweet gourd	1 year	Kept on the *machang* (bamboo platform)
Marfa	1 year	Kept in *Chhikka* (made of rope for wrapping and hanging)
Various types yam	1 year	Kept on earthen place
Ginger, turmeric	1year	Kept on earthen place
Seed		
Brinjal, marfa, sweet gourd, ash gourd, bean, maize	At first seeds are sun-dried, tied up with cloth and kept on a bamboo platform over the *chula* (oven); sometimes kept in a bamboo whole, or in plastic pot with small holes.	

Source: FGD (2012)

Data on the marketing chain has been collected for certain commodities at certain points that are traded most. Farmers and retail traders have been interviewed to collect data on prices at every stage. Data collection points were: village Keretchhai, Gilachharu union, Naniarchar upazila; village Kainda, Badalchharimukh union, Rangamati Sadar upazila; and village Panchhari, Moidung union, Juraichhari upazila

For example, products are transported to growth centers located at Kutubchhari Bazaar (Rangamati), Gilachhari Bazaar (Naniarchar) and Ghagra Bazaar (Kawkhali). Part of commodities traded in Kutubchhari and Gilachhari comes to Rangamati town and partly goes directly to Chittagong city, while entire lot from Ghagra goes to Chittagong city. A major collection point in Chittagong city is Reazuddin Bazaar.

As agricultural products are transported to onward direction from the farmyard to local, district and metropolitan city markets, prices soar. Incremental prices are mainly due to loss in storage and transportation, visible and hidden transport costs and profit of the actors in the market chain (Table 9.2).

9.2.3 Transportation and packaging

Depending on the location of the village and the bazaar, farmers have to travel anywhere between 0-25km to sell their produce, with most farmers reporting a distance of 5km to the local market and average distance to the major township market reported at 20km.

Farmers usually carry their products to the bazaar manually or by rickshaw van or push cart if there are all season roads. From small bazaars to bigger ones, commodities are transported by motorized vehicle, such as *chander gari*,[25] pick up van or truck. Commodities from areas around the *Kaptai Lake* are transported by motorized boats and motor launches. Farmers in remote areas

[25] Very old jeep bought in auction and then transformed into a pick up type vehicle. This is a popular mode for passenger and freight traffic in the CHT.

find it difficult or almost impossible to market their products, as they are to carry commodities manually. Carrying costs are very high that often offsets sales proceeds.

Among materials used for packaging are bamboo, cane, banana leaf and trunk, earthen ware, gunny back, poly bag etc.

Table 9.2: Price differential at various points in the value chain

Commodity	Retail price (Taka)				Remarks
	Farmgate	Local market	District market	Chittagong market	
Banana	90	120	150	200	Av size bunch
Papaya (green)	8	10	10	12	Per kg
Papaya (ripen)	50	75	80	90	Average size
Pamelo	8	15	20	30	Average size
Pineapple (season)	1000	1200	1200	1500	100 av. size
Pineapple (off-season)	1500	2000	2500	4000	100 av. size
Jack fruit (green)	60	80	80		1 kg size
Jack (ripen)	30	40	50	60	Average size
Ginger (local variety)	40	50	55	> 60.00	Per kg
Turmeric (raw)	5	8	8		Per kg
Turmeric (dry)	40	50	60	100	Per kg
Sweet gourd (jum)	20	35	50		Per kg
Sweet Gourd (HYV)	10	20	25	30	Per kg
Lemon (season)	80	100	120	200	100 lemons
Lemon (off-season)	500	600	800	1000	100 lemons
Amloki	20	20	25	40	Per kg

Source: FGD

9.2.4 Market infrastructure

Bazaars or growth centers are the usual places where commodity transactions (buying and selling) take place among farmers, retail traders and wholesalers. Like other parts of the country, LGED has developed growth centers with some infrastructures, such as shed for retailers and wholesalers, tube well, toilet, internal road, approach road, etc, though all these places do not have all the facilities. In Rangamati district, there are 19 growth centers and Khagrachhari district has 10 out of 18 planned. Growth centers lack some essential facilities like sanitation and separate shed and toilet for women. Generally these centers are leased out to private parties. Leaseholders are more concerned about collecting tolls, rather than providing services to traders and customers. Anarchy in toll collection is frequently reported.

There are multiple actors in a value chain. Higher the number of actors, larger is the gap between the farm gate price and the ultimate price paid by the consumer. At each stage, actors are to incur costs of transportation, packaging, storage and various kinds of tolls and taxes. Costs are often multiplied because of product loss due to transportation and storage. An analysis of the turmeric trade based on discussions with value chain actors at Gilachhari Bazaar in Naniarchar shows that farmers get the lowest chunk of the profit, while profit margin is higher at each successive stage (Table 9.3).

Table 9.3: Value chain of turmeric

Value chain actor	Per one tonne of turmeric (Tk)			
	Cost	Revenue	Gross profit	Profit (%)
Farmer	45,000	50,000	5,000	11
Small trader	51,000	60,000	9,000	18
Wholesaler	63,000	85,000	21,000	33
Processor	85,000	180,000	95,000	112

Source: FGD

A simplistic analysis based on gross profit earned in the total chain from the farm to the consumer shows that the farmer gets only four percent of the profit generated through the entire value chain, while the processor who makes powder out of turmeric fetches a gross profit of 73 percent (Figure 9.1).

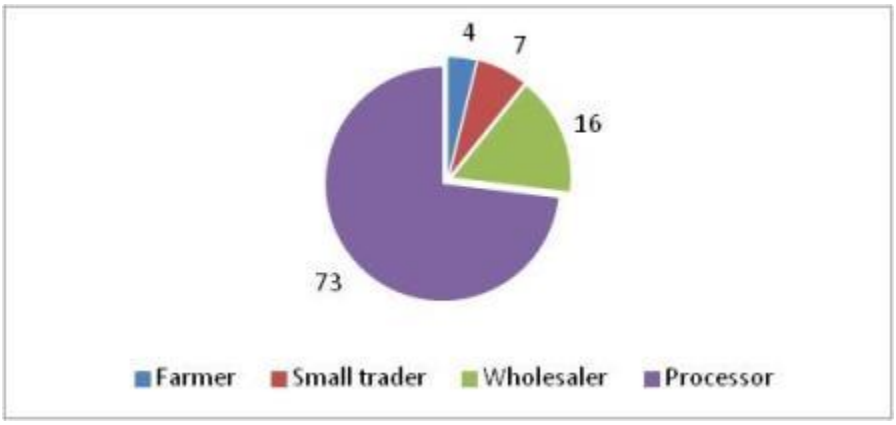


Figure 9.1: Profit sharing in turmeric trade

9.2.5 Market information system

Market information is scarcely available. Currently information on prices is obtained either from the *bepari* or fellow farmers connected with the bazaar. The Department of Agricultural Marketing (DAM) keeps record of some essential products, fruits and vegetables on a daily basis. But farmers hardly use them. Elsewhere in Bangladesh, information on market price, inputs and input use, pests and disease management are currently provided by some telecommunication service providers. But farmers and local traders are not aware of or make very little use of these.

9.3 Agri-business Development

9.3.1 Household agro-processing

Agro-processing is an alternative livelihood and income option which helps in minimizing post harvest losses, increases food security and makes food available in the off-season. Though many fruits of perishable nature are produced in the CHT, fruit processing at the household level is practiced very little. Women make different kinds of *pitha* (cake), *achar* (pickles), *chutney* (sauce), etc from cereals and fruits mainly for household consumption. Some traditional processing and preservation practices are found, especially for seeds. Among other processing of commodities practiced are cashew nut and turmeric powder.

9.4.4 Wholesale agro-processing

Products are almost entirely sold as unprocessed raw materials. Very limited processing takes places in major urban centers in and around the CHT, such as Khagrachhari, Rangamati, Bandarban and Chittagong. Though some private processing companies are registered with the BSCIC or are members of the Chamber of Commerce & Industries, they do not exist. Large agro-processing companies that exist in other parts of the country do not have any processing/ collection point in the CHT.

Agri-business development can be rationalized in a context of favorable production environment, growth potential leading to surplus, potential for processing of selected commodities, value chain development by making the system more efficient, and necessary support services including technology, finance and marketing.

Potential exists for commodities for business promotion and development which are of high value, not so perishable, have demand elsewhere at home and abroad and can easily be managed in a small scale by the farmers at the household or the community level. Financing of small and local entrepreneurship is a crux of the situation.

Chapter 10

Challenges

A number of challenges exist that currently impinge on economic productivity and agricultural development in the CHT, thereby negatively affecting the livelihood and food and nutrition security of the CHT populations. They are described below.

10.1 Population Pressure

During 2001-2011, population of the CHT increased by 19.5 percent. Assuming a simplistic growth pattern and urban-rural divide in the CHT as that of the country and zero net in-migration, population of the CHT will increase to 1.91 million by 2021 and to 2.43 million by 2051. Urban population will surpass rural population in the mid 2030s and will be as high as 64 percent of the total population, compared to 29 percent in 2011 (Figure 10.1).[26] This will have tremendous pressure on the natural resource base and infrastructures.

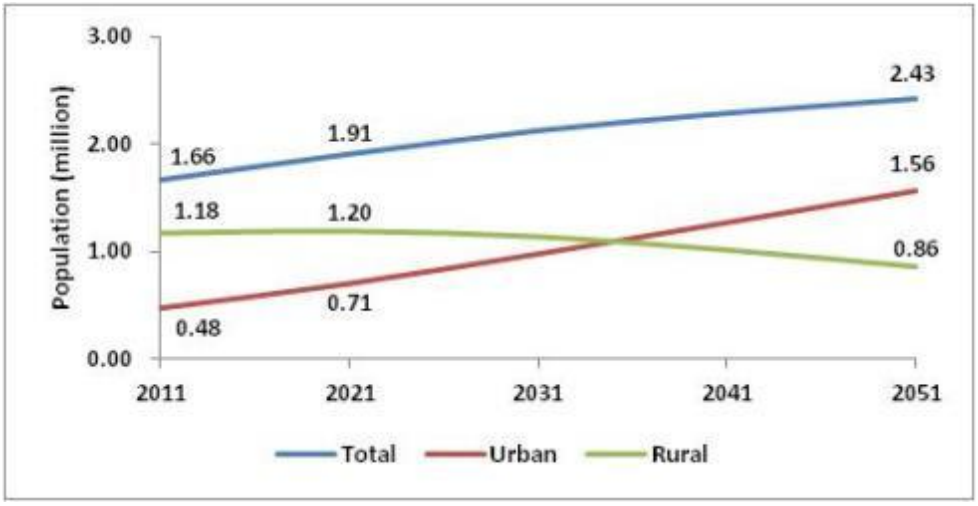


Figure 10.1: CHT population trend

The population of working age (15-59) is estimated at 45 percent of the total population in Bangladesh (BBS, 2007). This means that over 8,600 new jobs need to be created each year on the average to absorb the incremental workforce in the CHT up to 2051. Up to 2021, average annual demand for new jobs would be around 11,000, of which over 800 in rural areas. This is a big challenge.

An increase in population will have the following implications.

- Per capita availability of land will decline, while the demand for food, water, housing, energy and recreational facilities will increase.
- With increasing population and declining land resources, access to food will be constrained, resulting in further food insecurity and malnutrition.
- With increasing urbanization and demand for infrastructure, agricultural land will be more and more shifted to other land uses.

[26] Actual population figure for CHT in 2011 has been used. Other estimates are based on BBS projections on the basis of 2001 census data assuming TFR=1 in 2011.

- There will be increased pressure on the natural resource base, with risks of further degradation of land and water quality.
- With increasing social mobility, particularly of women, and with increased adult population, the supply of labor force and consequently demand for jobs will increase.

10.2 Degradation of the Natural Resource Base

10.2.1. Deforestation

Deforestation is one of the most serious environmental concerns because of the resulting biodiversity loss, soil degradation and significant contribution to global climate change, etc. Livelihoods of the communities and their cultural integrity are also affected by the degradation.

The CHT consisting of hill forests are facing severe degradation due to overpopulation and extension of unplanned agriculture. During the period 2000-2005, the annual rate of deforestation in Bangladesh was 0.3% (2000 ha) (FAO, 2007). Due to the deforestation, many plants and animals have become extinct or endangered in Bangladesh (Chowdhury *et al*, 2009). There are four sets of actors responsible for this: (1) the indigenous forest dwellers, having their own problems (e.g., high population growth); (2) migrants, who move to the forests; (3) the timber industries cutting down too many trees; and (4) the government through its Forest Department which is not able to implement suitable policies to regulate the cutting of trees and to prevent illegal cutting. Mitigating the first and second factors is a time-consuming task.

10.2.2 Declining water resources

Annual total rainfall trend shows increase in Bandarban and decline in Rangamati. Water availability (storage) in rivers, lake and *chharas* in different seasons is decreasing because of siltation. Soil loss in CHT is much more than plain lands. Eroded soils silt up adjacent water bodies and reduce water storage capacity.

10.2.3 Soil erosion

SRDI found that about 76 percent area in the CHT is under erosion, which is much higher than other regions of the country (Table 10.1). About 2.5m tonnes of soil is transported from hills to the foot hills (piedmont), drainage channels and ultimately to floodplains and sea (Shoaib *et al*, 1998).

Table: 10.1: Erosive hilly areas due to different degrees of erosion

Location	Area (km^2)				Erosive area (%)
	Low	Moderate	Strong	Total	
Chittagong Hill Tracts	350	1,814	10,465	12,929	76
Chittagong & Cox's Bazar	414	949	959	2,397	14
Greater Sylhet	161	462	964	1,587	9
Others	-	35	102	137	1
Total	925	3,260	12,785	16,970	100

Source: SRDI

Water erosion is the most widespread form of degradation affecting some 25 percent of agricultural land. Water erosion covers all forms of soil erosion by water including sheet and gully erosion. Human-induced enhancement of landslides, caused by clearing of vegetation, earth removal, road construction, etc., is also included. Though the loss of topsoil due to water erosion

is evident in the vast floodplain areas, only a very limited research results are available for the quantification of soil loss. Soil loss has been estimated to the range of 10-120 t/ha/yr. Besides soil loss, significant quantities of plant nutrients are also being depleted causing tremendous degradation of land quality (Table 10.2).

Table 10.2: Comparative nutrient status of eroded and non-eroded soils

Location	pH		Organic C (%)		Total N (%)		Avail. P (in ppm)		Avail. K Meq/100g soil		Ca (meq/100g soil)		Mg (meq/100g soil)	
	Eroded	Non-eroded	Eroded	Non-eroded	Eroded	Non-eroded	Eroded	Non-eroded	Eroded	Non-eroded	Eroded	Non-eroded	Eroded	Non-eroded
Khagrachhari	3.9-4.8	4.8-5.5	0.38	0.54	0.015	0.019	0.66	0.48	0.05	0.08	2.06	5.14	2.41	3.77
Manikchhari	3.5-3.8	4.3-4.5	0.30	0.47	0.010	0.014	0.25	1.30	0.02	0.04	0.85	0.90	0.83	0.84
Rangamati	4.0-4.3	4.5-5.0	0.32	0.51	0.020	0.031	0.30	0.70	0.04	0.04	2.20	-	1.77	-
Raikhali	4.2-4.5	4.2-5.1	0.30	0.49	0.015	0.028	0.35	0.81	0.02	0.04	2.55	2.97	1.83	2.10
Bandarban	4.3-5.0	4.2-5.5	0.48	0.58	0.017	0.019	0.56	0.87	0.06	0.07	4.61	5.75	3.16	3.96

Source: BARC, 1999

10.2.3 Decreasing soil fertility

Soil is the main supplier of plant nutrient. Soils of the CHT are less fertile compared to other parts of the country, because they mostly originated from the weathering and erosion of bedrocks. Additionally, soils formed over unconsolidated sedimentary rocks (*Dupi Tila* Formation) containing significant amounts of kaolinitic clay, which provides a low capacity to retain nutrients. The fertility is further declining due to unsustainable management practices. Soils over siltstones and mudstones are better in this respect; because they have mainly illitic clays, which have higher nutrient buffering capacities and are a mineral source of K and Mg. Except under natural forests or well-established tree crops, the content of organic matter is low. Due to the leaching effect during high monsoon rainfall, the nitrogen and potash are washed out. Figure 10.2 shows fertility status of the soils of the CHT.

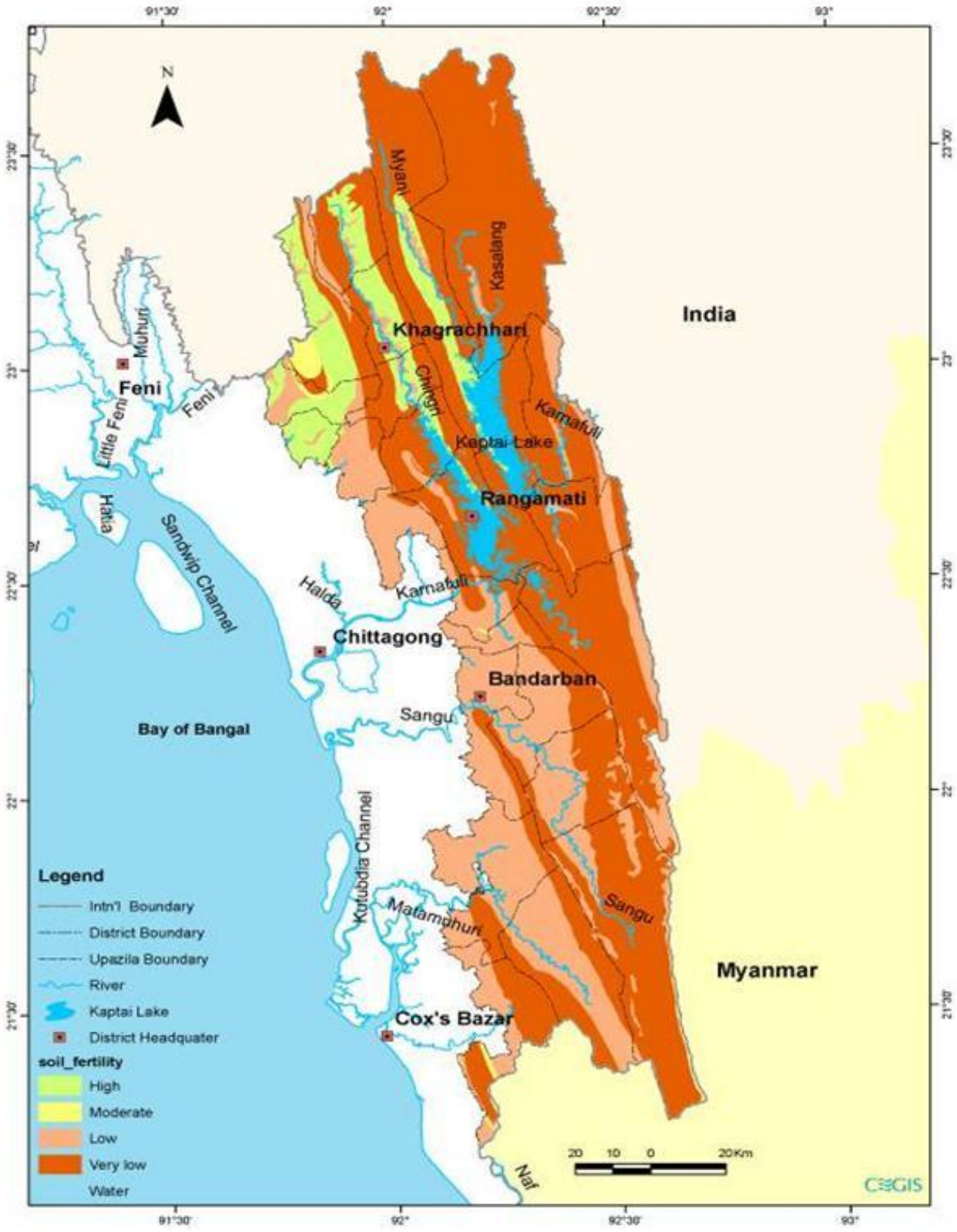


Figure 10.2: Soil fertility status

10.3 Post-harvest Loss

Post-harvest losses of many agricultural products are quite high because of perishable nature of certain products, improper harvesting, storing, packaging and transportation, as well as due to weather conditions. Post-harvest loss can be as high as 33 percent for certain products, which makes horticulture less remunerative (Figure 10.3).

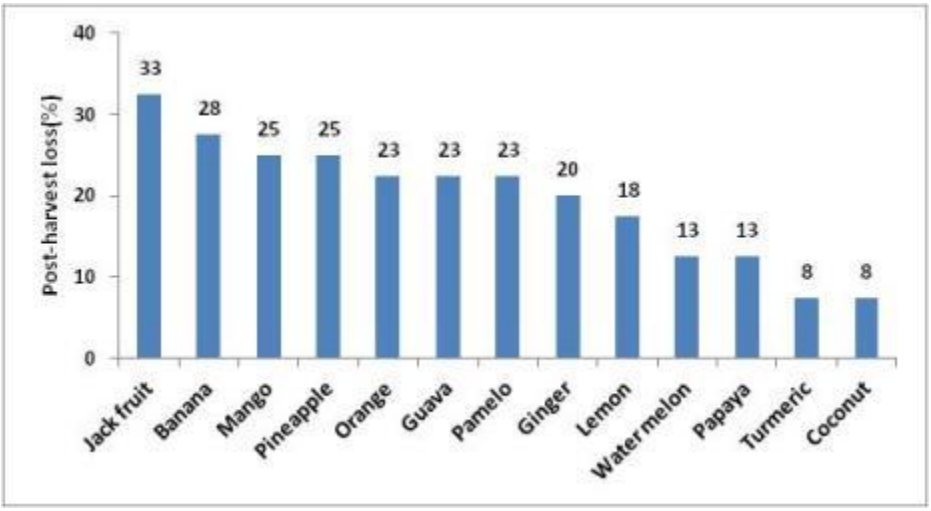


Figure 10.3: Average post-harvest loss of fruits
Source: DAE, DAM, FGD

10.4 Agro Processing and Value Chain Development

10.4.1 Agro processing

Storage facilities for perishable commodities are absent. Modern facilities with high overhead costs may not be feasible, as these need high investments, access to electricity and good road network. Alternatively, simple, homestead-based technology for storage and processing for many commodities is absent. Certain processing activities like mango pickles and dried vegetables are done at the household level, mainly for home consumption.

CHT is yet to be covered by large-scale agro-processing plants. Nor any effective mechanism has yet been developed to procure local products through collection centers, as it works in some other parts of the country. Examples may be cited for *Milk Vita*, *Pran*, *Aarong*, etc, which have established supply networks among poor and small farmers in many districts.

10.4.2 Value chain

Because of poor infrastructure, transport cost remains high and the prices are adjusted at different points by the wholesalers by fixing low prices at the preceding point to maintain competitiveness of similar products coming from elsewhere. The cumulative effect of this phenomenon is a very low price at the producer's end, which is the primary collection point in the value chain.

Discussions on farmers' welfare are going on for decades. Hardly there exists any organization at the micro level that can dictate terms or, at least, bargain with traders. Producers' cooperative remains obscure and elusive. Local government seems more concerned in the collection of tolls from the bazaar through the *ijaradar*, rather than facilitating capacity building of farmers at the grassroots level.

10.5 Input Management

10.5.1 Seed

Access to good quality seeds, particularly those of recently developed improved varieties at affordable price, is essential for productivity enhancement. Hardly four percent of the demand is met by the BADC and another 10 percent by private companies.

10.5.2 Agro-chemicals

Farmers use fertilizers and pesticides haphazardly and arbitrarily, as they are unaware of appropriate combination, dose and time.

10.5.3 Credit

Access to institutional credit is severely constrained for poor farmers, as they cannot offer any collateral to financial institutions. They have only customary rights to land and do not possess any official title, which need to be submitted as collateral. Micro credit program run by the *Grameen Bank* and NGOs do not suit the poor farmers as it requires repayment in weekly installment. Poor farmers do not generate income on a weekly basis.

10.6 Production Constraints

10.6.1 Unsustainable farming practices

Sustainability of farming has been seriously threatened due to several factors, such as, declining *jum* rotation, mono cropping with tillage cultivation of turmeric, ginger, aroids, etc, causing soil erosion and consequent loss of valuable topsoil.

10.6.2 Constraints of livestock

Livestock development is seriously constrained by poor health care and absence of AI service. Besides, there is shortage of forage and water in the dry season.

10.6.3 Poor management and low productivity of Kaptai lake resources

The productive potential of the *Kaptai Lake* is not being utilized. Current yield is unacceptably low. Management of the *Kaptai Lake* needs serious reconsideration with a pro-people approach of mass engagement by farmers.

10.6.4 Lack of planning and investment for aquaculture

Extension of aquaculture is constrained by lack of planning and investment in potential water bodies and sites that could develop in and around the creeks and *ghonas*.

10.7 Weak R&D

R&D systems suited to special geo-physical nature and needs of the CHT is largely absent. Strengthening integration of research-extension-processing-marketing together with improved technologies and management practices is an imperative. As most of the institutions are poorly equipped with technical staff, it is almost impossible for them to deliver required services that they are supposed to provide (Table 10.3).

Table 10.3: Current status of HR in selected GoB organizations in the CHT

Organization	Number of technical staff	
	Sanctioned	Vacant
DAE	641	86
DLS	139	44
DoF	70	29
BADC	13	07
Hill Agriculture Research Station	46	15
Total	909	181

Source: Respective organizations in the CHT

Chapter 11

Options for Development

The CHT represents 9 percent of the landmass with one percent population of the country. It has a wide diversity of resources and large potential for agricultural production, agro processing and livelihood development. In previous chapters, resource potentials and current farming practices have been described. Alternate options for development are projected here.

11.1 Increasing Agricultural Productivity

11.1.1 Enhanced productivity of HYV rice

Around 271 thousand ha of land constitute the valley in CHT. Potential exists to increase productivity of HYV rice, emphasizing on BR dhan-40, 48 and 52 in T.Aman season and BINA-8, BR dhan-28 and 29 in Boro season. Balanced use of fertilizers and scientific cultivation methods should be popularized.

Potential exists for mixed and relay cropping with cowpea, khesari and mustard (short duration).

11.1.2 Year round vegetable cultivation

The CHT terrain provides opportunity for growing vegetables round the year. In the monsoon season, many areas of the country are inundated by flood water and there is very little or no scope for vegetable production in those months. On the other hand, the CHT has scope for summer vegetable production in the hills. The vegetables like sweet gourd, water gourd, string been, cucumber, ash gourd, okra, bitter gourd and kakrol can be grown even in hill slopes by pit methods of cultivation. Besides, BARI and IPSA varieties of country been and drumstick can easily be grown even in the *jum*, roadside and homesteads. Besides, summer tomato, summer onion, cabbage and cauliflower cultivation have good prospect in the CHT.

11.1.3 Promotion of hybrid cotton

Wide range of land and soil is suitable for cotton cultivation. Current productivity is too low. Large scale adaptation trial and demonstration of hybrid cotton varieties should be done in valley lands and low hill slopes. Input support should be provided in order to enhance production to replace tobacco. R&D should also be strengthened for hybrid cotton seed production and employment generation of farmers.

11.1.4 Zoning of sugarcane with mixed crop

Along with sugarcane, vegetables like cabbage, china shak, bati shak, sweet gourd and pulses like French bean, mungbean, soybean and black gram can be grown as mixed crop. Suitable locations are valley, plain and dissected plain lands of Lama, Bandarban Sadar, Khagrachhari Sadar, Dighinala, Panchhari, Ramgarh, Matiranga, Rangamati Sadar, Langadu, Barkal and Belaichhari upazilas.

11.2 Creation of Crop Suitability Zones

For efficient land utilization and maximization of production, crop zoning is essential (Table 11.1). Following parameters have been considered to determine crop zones:

- geological formation;
- parent materials;

- hill elevation;
- hill slope gradient;
- crop root zone;
- temperature and rainfall pattern; and
- availability of seeds, cuttings and saplings.

Table 11.1: Suggested crop zoning for CHT

Land type/ position	Suitable crops for cultivation	Suitable upazila with area-000 ha
Soil on alluvial materials of the valleys	Rice(Aus, Aman, Boro), maize, winter vegetables, onion, chili, potato, water melon, mustard, sunflower, aroids, potato, sweet potato, leafy vegetables, kakrol, sugarcane (chewing variety)	Lama-12, Naikangchhari-11, Dighinala-22, Manikchhari-10 Panchhari-15, Ramgarh-13, Baghaichhari-31, Barkal-14, Langadu-23, Rangamati-20
Soil on alluvial materials of the Plains	Jum rice, summer vegetables, banana, sesame, chili, summer mug bean, millets, soybean, ginger with mulch, eggplants, kakrol, cotton, summer tomato, summer onion Mango, pommel, jackfruit, pineapple, litchi, wood apple, orange ,banana, olive, pear, Litchi, bay leaf, *cinnamon, orange, black pepper,* medicinal species, chew nut, Aroids, turmeric and ginger with mulch	Alikadam-12, Lama-18, Bandarban-13,Thanchi-10, Naikangchhari-11, Dighinala-27, Khagrachhari-10, Matiranga-17, Panchhari-13, Baghaichhari-38, Barkal-14, Belaichhari-14, Langadu- 10, Juraichhari- 10,
Soil on unconsolidated sandstones and mudstones on the dissected plains	Jum crops, summer vegetables, mango, litchi, malta, pamelo, lemon, rambutam, olive, jujube, wood apple, sweet tamarind, bay leaf, cinnamon, orange, black pepper, medicinal species, chew nut, Pineapple, and Banana	Alikadam-23, Lama-22, Bandarban-22,Ruma19, Naikangchhari-15, Thanchi-27, Rowangchhari-17, Dighinala-28, Matiranga-10, Ramgarh-10, Baghaichhari-49, Barkal-15, Belaichhari-30, Langadu-10, Juraichhari- 13, Naniarchar-10, Rangamati-12
Soil on Unconsolidated sandstones and mudstones on the medium gradient hills	Jum crops, Summer vegetables, banana, sesame, chili, pigeon pea, millets, soybean, kakrol, cotton, drumstick, Mango, pommel, jackfruit, pineapple, litchi, wood apple, orange ,banana, olive, sweet tamarind, orange, Tea and coffee	Alikadam-16, Ruma-16, Thanchi-25, Baghaichhari-25 Barkal- 10, Belaichhari-25, Rangamati- 14
Soil on consolidated sandstones, siltstones and shale on the high-gradient hills	Jum rice + other crop combinations in jum, Sweet tamarind, Dram stick, Medicinal plants and hard wood trees.	Alikadam-16,Ruma-17, Thanchi-30, Baghaichhari-16, Barkal- 16, Belaichhari- 23

11.3 Promotion of Conservation Agriculture in Jum Farming System

Jum farming is a dominant practice in the CHT region. The management of *jum* varies widely. Good practice needs to be expanded and poor practice should be discouraged (Table 11.2). Cultivation of aroid, turmeric and ginger should be avoided on hill slopes in *jum* fields in order to avoid soil loss. For good practices, appropriate selection of crops/varieties is essential.

To overcome the prevailing erosion problems and to sustain crop production in CHT, practicing of Conservation Agriculture (CA) is necessary in the hills. The principles of CA basically include minimal soil disturbance (zero-tillage or minimum tillage), contour line and controlled

traffic, crop cover, diversified cropping systems and active weed control management. Surface cover with crop residues, one of the most important principles of CA, is known for its capacity to moderate soil temperature in winter and summer, protect the soils against erosion, increase water infiltration and over the time increase soil organic matter content, facilitate nutrient recycling, cut back unproductive losses of soil moisture through evaporation and provide niches for beneficial microbes, soil fauna and flora to flourish. Mulches also reduce weed infestation in the long run.

Table 11.2: Classification of *jum* by management practice

Scale	Crop combination	Management practices
Good	Rice, maize, melon, cowpea, gourd, pigeon pea, quick growing leafy vegetables, chili + banana	No tillage operation, mixed cropping system for production practices, include legume crops and interplant with Banana, minimum soil erosion .
Moderate	Rice, maize, melon, cowpea, millet, sesame, gourd, melon, cotton, cassava, turmeric + banana	Tillage operations are needed for sowing and harvesting of cassava and aroid
Poor	Rice, maize, melon, cowpea, millet, sesame, gourd, melon, cotton, cassava, aroids and turmeric + banana	Serious soil cultivation is needed for sowing and harvesting cassava, aroids and turmeric.

Source: FGD with farmers

11.3.1 Selection of suitable crop combinations

Rice is the principal crop in the *jum* farming system. The most suitable farming systems are rice+ maize+ ash gourd+ sweet gourd+ melon+ cucumber+ cowpea+ arhar+ mesta+ sesame+ leafy vegetables+ banana.

Some conservation methods of crop cultivation practices suitable in hill slopes suggested by hill research station of BARI and SRDI are as follows:

- Root crops like cassava, ginger, turmeric and aroid should not be cultivated beyond five percent hill slope;
- Planting to be done in contour across the hill slope;
- Planting to be done in zero tillage provided with surface mulch;
- Pit method of planting with surface mulch should be followed;
- Application of fertilizers in dibble method;
- Diversification of cropping system by practicing legume inter/ relay crop or any suitable cover crop;
- Harvesting to be done before and after the rainy season.

11.3.2 Selection of suitable crops and crop varieties

Jum crops mainly grow in the rainy season. Therefore, fast growing crops like cowpea and leafy vegetables should be selected in such a way that the crop canopy is able to cover the entire field with one shower or two, so that rain drops cannot directly hit the soil surface to detach the soil particles. This envisages the following:

- Zero tillage for cultivation: all crops should be seeded in zero-tillage with dibble method. The eroded soil can be conserved into the holes in first or second set of rains; then the crop canopy will cover the soil surface which can protect the soil from erosion;
- Strip cropping system of cultivation: land should be divided into several strips across slopes before seeding; and leguminous hedge crops or pineapple should be planted between the strips to conserve soil from erosion.

11. 4 Upscaling of Sustainable Production Practices of Fruits and High Value Crops

BARI has released improved varieties of several high value fruit and spice crops. These varieties are suitable for different land gradients and geographical locations (Table 11.3). In order to promote adoption of these technologies, these should be quickly transferred through different public and private extension agencies. Spot training of production packages and capacity building should be integral part of promotional activities.

11.4.1 Upscaling of proven and near-proven technologies

While deciding for upscaling, it is necessary to adopt proven and nearly proven technologies. Developed technologies are summarized below (source: Hill Agricultural Research Station of BARI, Khagrachhari).

Proven technologies

i. Year round pineapple production
ii. Multi- strata fruit production model
iii. Integrated hill farming model
iv. Homesteads agro forestry model
v. Production technology of malta
vi. Production technology of BARI aam-3&4
vii. Production technology of passion fruit
viii. Production technology of pears
ix. Production technology of turmeric and ginger
x. Production technology of banana

Nearly proven technologies

i. Production technology of sweet tamarind
ii. Production technology of rambutan
iii. Production technology of japotika
iv. Production technology of summer onion
v. Production technology of summer tomato
vi. Production technology of year round vegetable production in homestead
vii. Seed production technology of cauliflower &broccoli.

Table 11.3: List of BARI varieties for upscaling

Crop	Released variety	Suitable land	Upazila
Fruits			
Malta	BARI malta-1	Foothill and up to 20% hill slope with sandy loam and deep soil	Ramgarh, Manikchhari, Lama, Ruma, Rangamati, Belaichhari, Barkal
Pear	BARI naspati-1	Foothill, hill top plain and up to 10% hill slope with loamy and deep soil	Dighinala, Panchhari, Kaptai, Naniarchar
Guava	BARI peara-3	Foothill and 20% hill slope	Rangamati, Kawkhali, Naikhangchhari
Banana	BARI kola-2 and 3 (tissue culture suckers)	Foothill, hill side moderate slope, lower portion of *jum* field, homestead, base of hills and up to 6-30% slope	Ruma, Thanchi, Juraichhari, Manikchhari, Lakshmichhari, Rangamati, Dighinala
Star fruit	BARI mishty kamranga-2	Hill top plain and up to 10% hill slope	Ramgarh, Manikchhari, Lama, Rangamati, Rangamati, Kawkhali, Naikhangchhari
Mango	BARI aam-8 BARI aam-4	Foot hill , hill top plain and up to 5-30% hill slope with deep soil	Ramgarh, Manikchhari, Lama, Ruma, Rangamati, Belaichhari, Barkal, Kawkhali, Naikhangchhari
Sweet tamarind	BARI misty tetul -1	Up to 30% hill slope with deep soil	Ramgarh, Manikchhari, Lama, Ruma, Rangamati, Belaichhari, Barkal, Thanchi, Juraichhari,
Jackfruit	BARI kathal-2 (off season)	Hill top plain and up to 30% slope with deep soil	Ramgarh, Manikchhari, Lama, Rangamati, Kawkhali, Naikhangchhari, Bandarban
Velvet apple	BARI bilati gab-1	Hill top plain, Up to 50% hill slope having deep soil and as boarder line crops of the mixed fruit garden for wind break	Ramgarh, Manikchhari, Lama, Ruma, Rangamati, Belaichhari, Barkal, Kawkhali, Naikhangchhari, Matiranga, Panchhari
Spices			
Ginger	BARI ada-1	Hill foot, hill top plain, agro-forestry system with fruit tree orchard.	Ramgarh, Manikchhari, Lama, Ruma, Rangamati, Belaichhari, Barkal, Kawkhali, Naikhangchhari, Mahalchhari
Turmeric	BARI holud-1&2	Hill foot, hill top plain, agro-forestry system with fruit tree orchard.	Ramgarh, Manikchhari, Lama, Ruma, Rangamati, Belaichhari, Barkal, Kawkhali, Naikhangchhari, Langadu
Cinnamon	BARI darchini-1	In foot hill, 5 to 10 percent hill slopes	Ramgarh, Manikchhari, Lama, Ruma, Rangamati, Belaichhari, Barkal, Baghaichhari

11.4.2 Adaptation trial of exotic fruits and high value crops at different elevations

The On-Farm Research Division (OFRD) of BARI should develop adaptation plan following the land elevation resource information (Table 11.4). Fruit species, such as apple, pear, malta, star

fruit, grape, orange, cashew nut, palm, etc, that grow in neighboring countries and elsewhere in similar land elevations should be chosen.

Table 11.4: District wise land at different elevations

Elevation (m PWD)	Area (ha)		
	Bandarban	Khagrachhari	Rangamati
1-100	192,599.8	197,599.4	317,673.1
101-200	114,216.9	75,415.6	145,666.3
201-300	60,648.2	13,089.1	56,979.1
301-400	36,197.7	2,502.7	26,069.9
401-500	23,106.2	386.9	12,342.7
501-600	16,838.5		7,224.8
601-700	10,006.5		5,362.4
701-800	4,281.9		3,508.2
801-900	1,495.8		984.4
901-1000	142.3		79.3
1001-1100	11.3		

11.4.3 Establishment of genetic resource conservation center

A large number of indigenous species of plants and animals are endangered or on the verge of extinction. These important resources require immediate conservation. A center/institute under the CHTRC should be established for both *in situ* and *ex-situ* conservation of genetic resources. This needs at least 100 ha of land with necessary lab and other physical facilities.

11.5 Sustainable Orchard Management

Land and climatic resources of the CHT provide huge potential of cultivation of fruits, high value crops and vegetables. In fact, lands at different gradients are not being scientifically utilized and there is no organized planning for orchards.

There is a vast scope to increase production of fruits through improving management practices and establishing national and local level demand/need based new fruit gardens in suitable areas (Table 11.5). Rangamati district has the highest potential, followed by Khagrachhari. Much of the suitable lands in Bandarban are already utilized for orchards.

Table 11.5: Potential area of fruit orchard

Orchard	Area (ha)			
	Bandarban	Khagrachhari	Rangamati	CHT Total
Existing	29,125	22,000	18,018	69,143
Potential	15,265	27,470	39,256	81,991
Total	44,390	49,470	57,274	15,1134
Potential for increase (%)	52	125	218	119

Source: DAE, CHT districts, 2012

Promotional activities for scientific management of orchards with conservation of natural resources are a pre-requisite for sustainable farming. Potential areas for orchards should be used for maximizing production. In the commercial orchards, there should be appropriate selection of varieties/species and application of better management practices with adequate input support.

11.5.1 Promotion of mixed orchards with pineapple cultivation

It has been experienced that pineapple plantation accelerates natural resource losses due to faulty cultivation practices. There should be mixed plantation in the pineapple field that could reduce soil loss. The DAE has successful demonstrations in low to medium gradient hills for pineapple-mixed orchard farming. Strong promotional program and awareness building on management practices are required.

11.5.2 Popularizing of mushroom cultivation in homesteads

Mushroom cultivation has been introduced by a government project in Rangamati. DAE and One local NGO named ASHIKA have been promoting it in a small scale. There is scope for mushroom cultivation on a commercial basis. The availability of seed and technology should be ensured and its cultivation should be popularized. This also needs arrangements for quality control and marketing.

11.6 Ensuring Supply of Improved Seeds and Planting Materials

Rice is cultivated in 83,860 ha of land in the CHT, which requires 2,096 tonnes of seeds. BADC supplies only 82t (less than 4%) of the total requirement. Farmers are mostly using their own seeds. BADC has no seed production activity or program in the CHT. But the DAE has a project on improved seed production, preservation, and distribution at the farmer level. With the help of this project, some farmers are able to grow quality seeds for their own use.

To ensure availability of more HYV seeds, BADC should come forward with seed production program through contract growers and strengthen the DAE seed production and exchange program. This requires

- strengthening of BADC base nurseries, nursery of DAE and private nurseries through supervision, training and monitoring for the production and distribution of HYV fruit saplings to farmers;
- establishment of community based fruit sapling production nurseries through proper training to minimize the transport cost and ensure the supply of quality saplings.

11.6.1 Improving existing nurseries and establishing new ones

Nursery is the mother ground for establishment and promotion of any agricultural commodity. It is necessary to improve and expand vegetable gardening and fruit orchards. Good quality nurseries should be established and the existing ones should be improved. At present, there is no nursery in the private sector. To meet increasing demand, nurseries should be established both at the private and the public sectors at various locations in the CHT, preferably one in each union.

11.7 Promotion of Agro Forestry in Hill Slopes

Four categories of slopes are suitable for agro forestry interventions in the CHT. These are: level to gentle slope (up to 15%), moderately steep slope (15-30%), steep slope (30-60%) and Very steep slope (above 60%). In all the slopes, farmers at the grassroots level prefer functionally contour hedgerows type of agro forestry. In scientific terminology, it can be termed as agro-silvi-horticulture system of agro forestry. However, species preference would vary according to the slope gradient. For example, agriculture dominated land use is preferred in the level to gentle slope, mixed horticulture dominated system in the moderately steep to steep slope and silviculture dominated system in the very steep slope of the hills. Suggested species against different slopes should be promoted (Table 11.6).

Table 11.6: Preferable crops in the contour hedgerows agro forestry systems by slope

Gentle slope (6- 10%)	Moderately steep slope (11-20%)	Steep slope (21-30%)	High steep slope (30-50%)
Jum rice	Jum rice	Jum rice	Jum rice
Summer vegetable	Summer vegetable	Summer vegetable	Summer vegetable
Ginger with mulch	Litchi	Litchi	Gamar
Turmeric with mulch	Jackfruit	Jackfruit	Shil koroi
Banana	Pineapple	Pineapple	Acacia spp.
Pineapple	Mango	Sesame	Casia spp.
Lemon	Amra	Country bean	Leucaena spp.
Guava	Bel	Banana in lower part	Morich
Papaya	Areca nut		Mishti kumra
Custard apple	Pamelo		Shada Kumra
Areca nut	Guava		Sesame
Aroid with mulch	Amloki		Country bean
Ash gourd	Horitoki		Base of the jum land
String bean	Bohera		
Okra	Jujube		
Summer mungbean	Lemon		
Soybean	Orange		
Cowpea	Malta		
	Chalta		
	Banana		

This type of agro forestry can be practiced in homesteads along with the USF land. Especially in the USF land, social forestry should be introduced with appropriate sharing of benefits among the parties involved.

11.7.1 Assessment of carbon stock to benefit from REDD and REDD+ packages

In the upland agricultural ecosystem, sustainable agriculture depends on good health of the corresponding watershed. At the face of massive deforestation in the watershed areas, the sustainability of agriculture is linked with restoration and conservation of forests in the watersheds. To make the restoration and conservation activities sustainable, Reducing Emissions from Deforestation and Degradation (REDD+), conserving and enhancing forest carbon stocks and sustainable management of forest activities are important and relevant for the CHT. To introduce this activity, baseline carbon measurement is necessary in corresponding forests. The REDD+ is likely to be a key activity in the tropical developing countries after 2012. Reserve Forests can be put under REDD+.

For application of REDD and REDD+ packages, most important activities are capacity building for assessment of forest stock, exchange of information with the IPCC negotiation team and enhancing regenerative activities of forestry.

11.8 Livestock Development

11.8.1 Improving community based animal health care

In the CHT, most of the livestock is suffering from warm problem, as well as foot and mouth disease, and poultry die of *renikyat* disease every year. Improvement of livestock health needs strong livestock services at the community level with necessary inputs and medicines. Trained livestock farmers are needed in the communities. CHTDF has already trained 90 Community Poultry Workers (CPW) and 92 Community Livestock Workers (CLW) as outreach workers with the help of the DLS. The CPWs and CLWs are now active in their communities and ensuring livestock vaccination. This approach needs expansion all over the CHT.

11.8.2 Establishing and strengthening AI service for cattle, goat and sheep

Facilities including solar power-driven refrigeration for semen and transportation support system are needed. Such facility should be available at the union and the village level.

11.8.3 Improving homestead based pig rearing

Pig rearing is common throughout CHT. This is an important household asset and should be developed and promoted for increased income and enhanced livelihood. Specific measures toward piggery development are

- selection of good indigenous varieties and establishing breeding program for achieving adequate stock; and
- Ensuring scientific husbandry including improved feed management.

11.8.3 Improving fodder production

The cattle are suffering due to insufficient grazing area. Experiments have proved that fodder (*Napier* and *Para*) production in hill slopes is excellent and it also helps to prevent soil erosion. Improved fodder production should accompany the following:

- orientation of farmers about the importance of fodder crops;
- DLS/BLRI to come forward with technology packages for fodder crop production; and
- training of farmers on production technologies.

11.9 Developing Fisheries

11.9.1 Fish culture in hill creeks

There are many creeks where, with little interventions in their natural flow, aquaculture can be introduced. This mainly requires construction of suitable structures, such as, small earthen dams, for water storage. There are 5,573 creeks in the CHT with total area of 1,378 ha. Khagrachhari district accounts for the highest number of these (Table 11.7). These resources can be used for fish culture.

Table 11.7: Number and area of creeks by upazila

District	Upazila	Number of creeks	Area (ha)
Khagrachhari	Dighinala	440	70.46
	Khagrachhari Sadar	184	81.86
	Lakshmichhari	206	46.93
	Mahalchhari	245	100.20
	Manikchhari	501	154.40
	Matiranga	330	81.78
	Panchhari	354	75.42
	Ramgarh	400	110.22
	Total	2,660	721.27
Rangamati	Baghaichhari	205	46.96
	Barkal	362	76.37
	Belaichhari	120	21.17
	Juraichhari	115	29.35
	Kaptai	74	21.88
	Kawkhali (Betbunia)	86	29.49
	Langadu	329	66.00
	Naniarchar	136	27.53
	Rajasthali	71	20.55
	Rangamati Sadar	59	13.13
	Total	1,557	352.43
Bandarban	Alikadam	292	43.54
	Bandarban Sadar	146	59.00
	Lama	230	78.44
	Naikhangchhari	145	29.90
	Rowangchhari	112	25.40
	Ruma	235	42.66
	Thanchi	196	25.41
	Total	1,356	304.35
CHT total		5,573	1,378.05

Source: CEGIS estimation (2013)

11.9.2 Improving management and productivity of Kaptai Lake resources

Kaptai Lake resources have high potentials in terms of yield augmentation and employment generation. This requires rearrangement of the lake management system involving other direct stakeholders, such as, the DoF and the local communities, under a co-management framework. Adequate stocking of suitable species should be planned in view of the market demand. Marketing of fish needs a more competitive approach.

11.9.3 Cage and pen culture in the Kaptai Lake

There are about 1,200 *ghona* in the *Kaptai Lake* surrounded by hills in three sides and one side connected with the lake. Total area of water bodies of these *ghonas* is about 3,887 ha. Cage/pen culture in the lake and the *ghonas* has good prospect (Figure 11.2). Low-cost feed development at the community level is also important. This intervention needs following measures:

- Identification of villages and communities who live along the shore of the lake and are willing to undertake cage/pen culture;
- Selection of farmers, preferably women, for piloting cage/pen culture;
- Training of selected farmers including women on stocking, low-cost feed production and management;
- Technical and financial support for preparing, installing and maintaining the cage/pen.

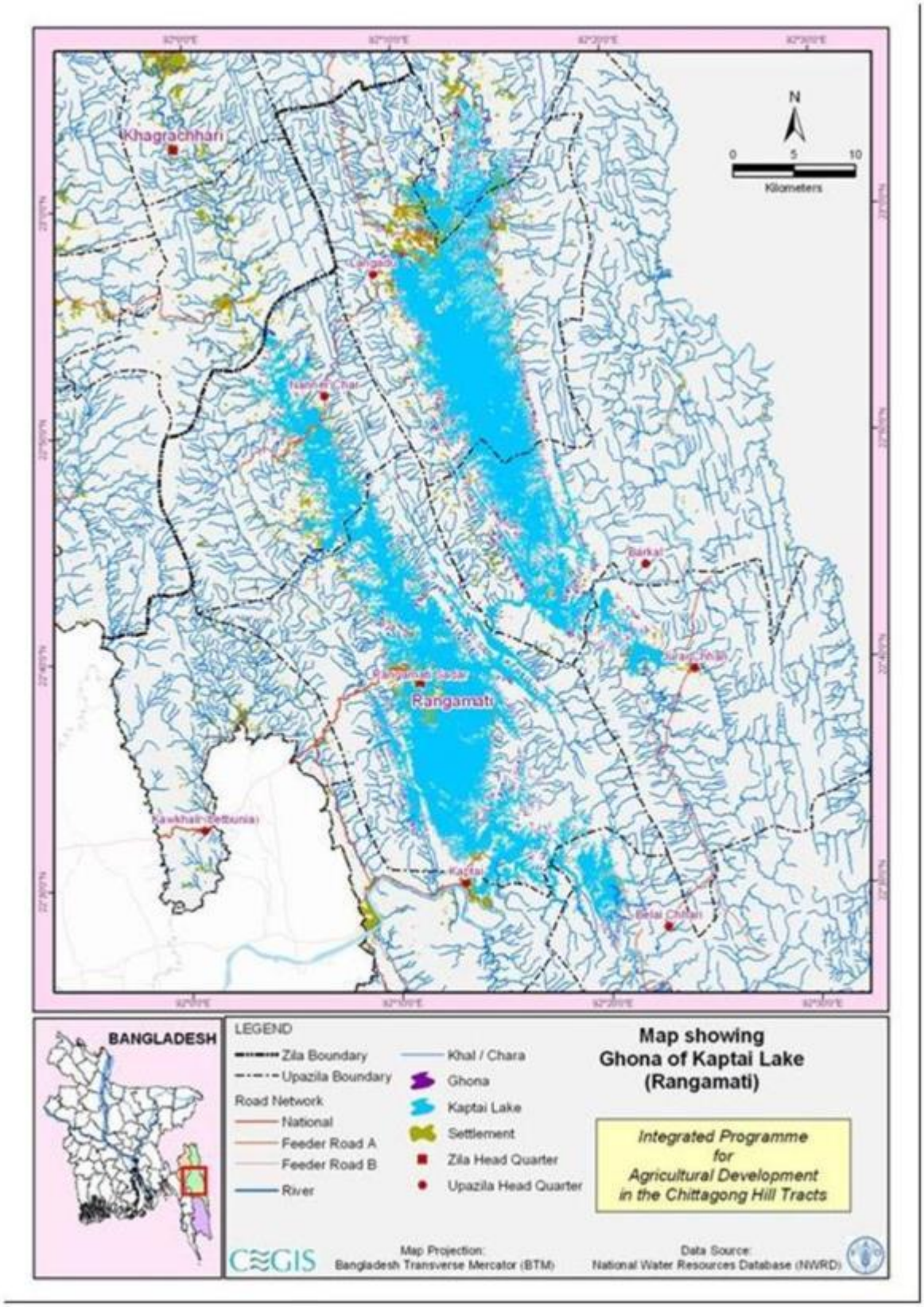


Figure 11.2: Kaptai Lake

11.10 Watershed Management

For sustainable and increased crop production, more areas in the CHT should be brought under irrigated agriculture. Through modification of *chharas* and *khals*, development of creeks and construction of dams in suitable places, irrigation facilities can be increased.

10.10.1 Use of seasonally available water for intensive cropping

Water resources potential for the entire CHT watershed region has been assessed. It provides a basis for deciding diversified cropping during Rabi and pre-kharif seasons. While one-fifth of the region has good prospect for diversified crops during the pre-kharif period, only one-twentieth of the region has good prospect in the Rabi season (Table 11.8). In areas that are moderate or poor in terms of water availability, selected crops can be grown and selection should be made based on water requirement for particular crops (Figures 11.3, 11.4).

Table 11.8: Water availability in pre-kharif and Rabi seasons

District	Area (ha)					
	Pre-Kharif			Rabi		
	Good (>4000, ha-m)	Moderate (2001~4000, ha-m)	Poor (0~2000, ha-m)	Good (>1000, ha-m)	Moderate (501~1000, ha-m)	Poor (0~500, ha-m)
Khagrachhari	109,760	170,690	8,570	36,410	223,120	29,480
Rangamati	50,050	343,890	134,180	7,770	211,310	309,030
Bandarban	101,260	310,170	48,120	13,840	288,240	157,470
Total	261,070	824,750	190,870	58,020	722,670	495,980
Percentage	20.4	64.6	15.0	4.5	56.6	38.8

*Area of the Kaptai Lake has not been considered
Source: CEGIS, 2013

District and upazila level agriculture development planning should be based on seasonal water budgets. Potentials exist for both intensification of high value crops and productivity enhancement.

11.10.2 Augmentation of water for irrigation over varied watersheds

The outfall of each stream represents a potential location for water retention structures (WRS). The generated streams have been checked with satellite images and topographic maps and the WRS locations have been adjusted to be realistic.

Area, elevation and storage of each watershed have been estimated for planning of water retention in each watershed. Planning of WRS for agriculture development in the CHT requires information on water availability and demand in each watershed. Based on demand and availability, WRS parameters are to be designed. Potential locations of WRS have been identified on the outfall of each watershed.

The elevation-area-storage of the watershed number K14 in Khagrachhari is presented in Figure 11.5 as an example.

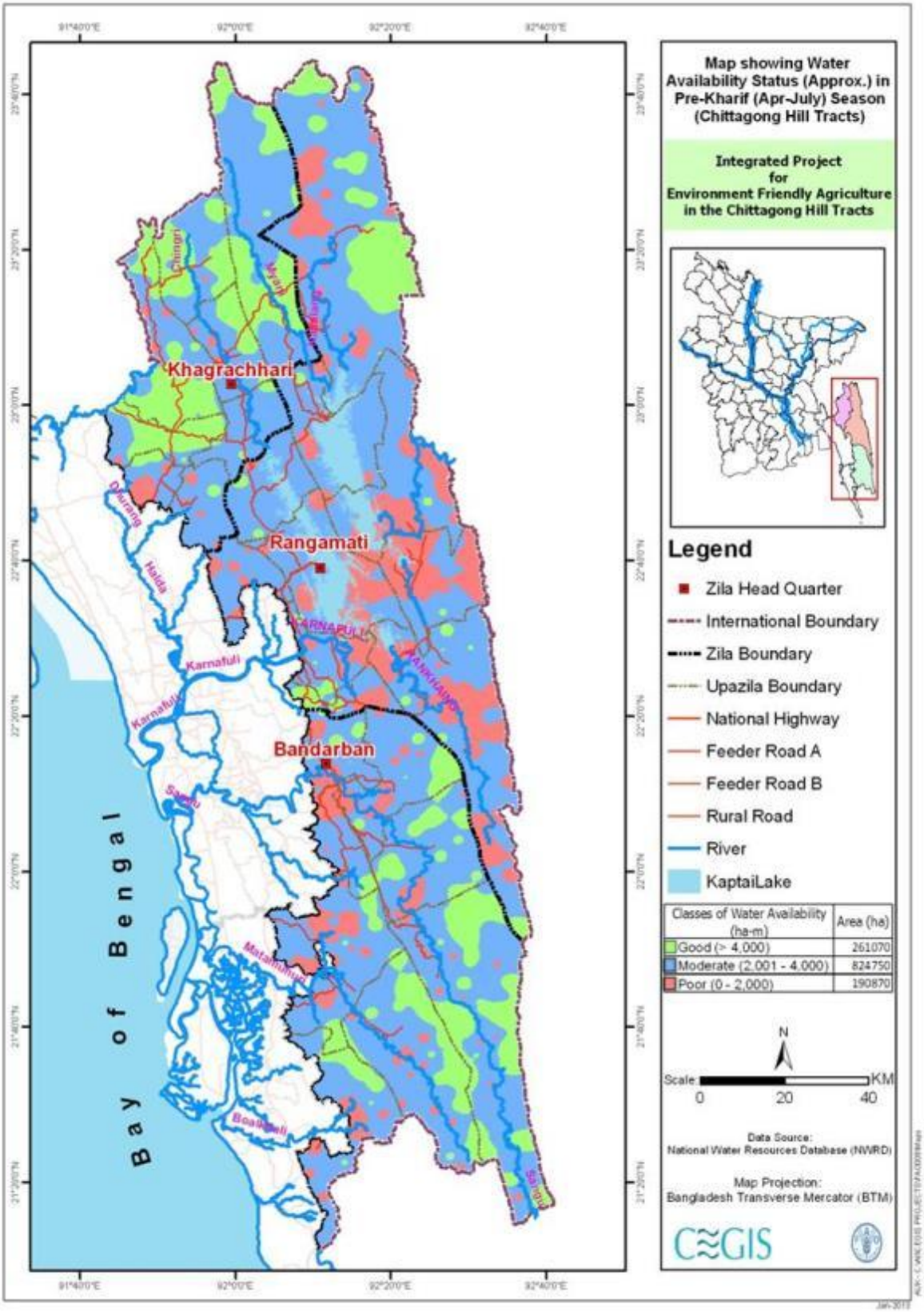


Figure 11.3: Water availability in the pre-kharif season

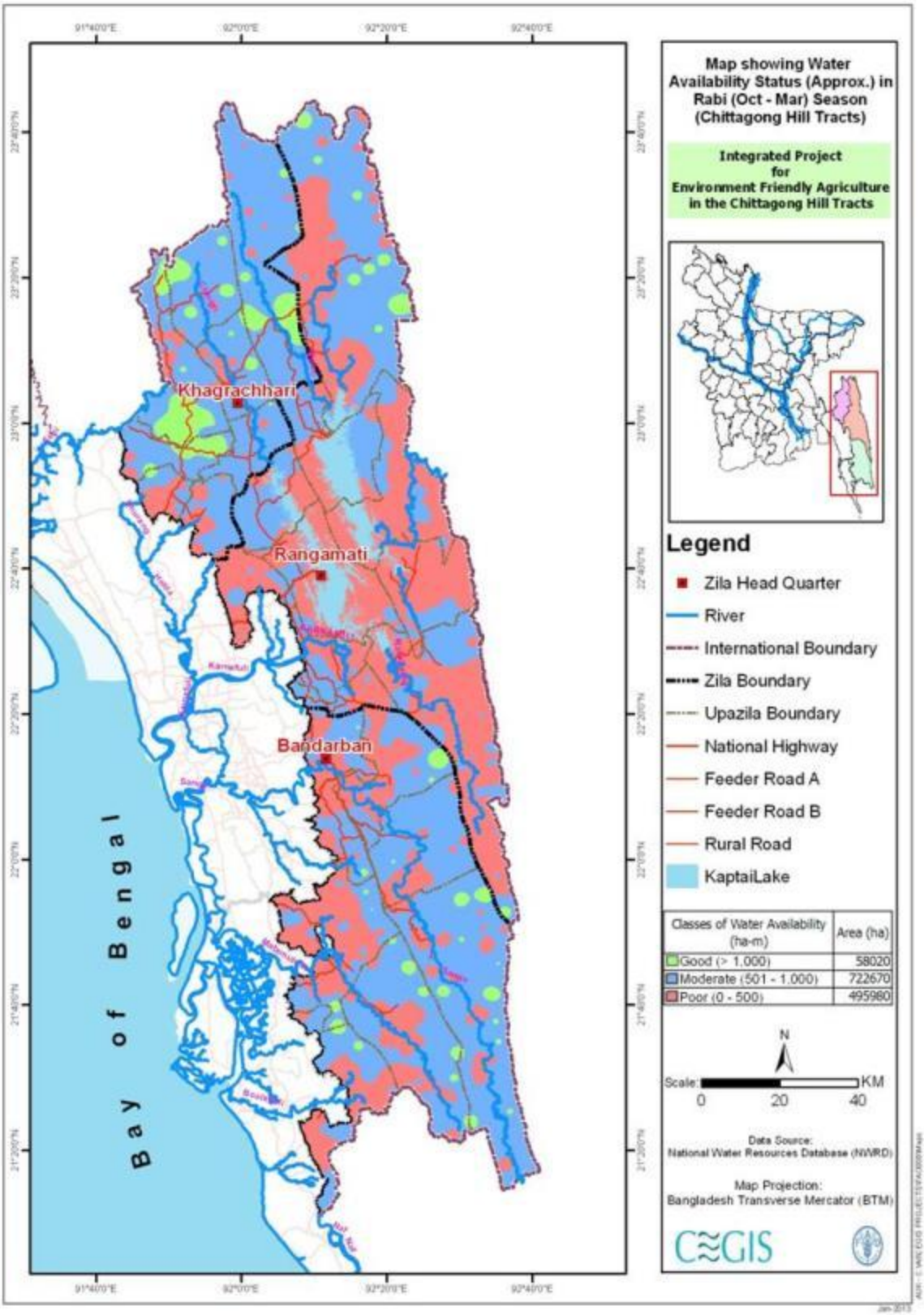


Figure 11.4: Water availability in the Rabi season

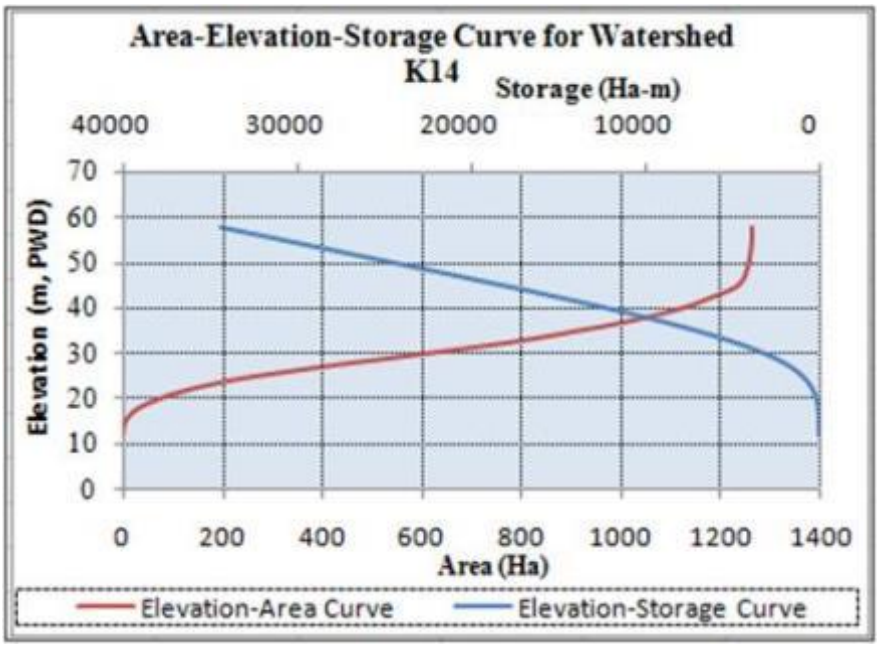


Figure 11.5: Area-elevation-storage curve for watershed K14

If the rainfall volume is estimated and losses (evaporation, percolation, etc) are deducted, then the storage could be quantified by volume for each watershed. Using the chart in Figure 11.5, the elevation of the storage can be found. The WRS parameters (opening/invert level/design level/crest elevation etc.) would be designed based on water demand/ water use (agriculture, fisheries, domestic and others).

Watershed K14 is situated at Manikchhari union (Manikchhari upazila, Khagrachhari District) covering 1,263 ha. Satellite image analysis (2008) shows that 51 percent area of K14 is covered by herb-shrub, 37 percent (466 ha) is covered by agriculture/fellow/jum land and the rest 12 percent is covered by river and settlement. The area-elevation-storage curve shows that most of the land (80%) remains between 12~37m height and the land contains high gradient relate to plain lands. Water holding capacity of steep area is very low. Based on this information, management of the watershed K14 can be done by dividing the watershed in 4 sub-catchments; each sub-catchment will have one or more small scale structure (check structure, earthen dam) because of high gradient of the *chharas*. For the entire catchment, a large scale structure (rubber dam/water retention structure) may be installed for minimum water retention for maintaining biodiversity of the watershed. The watershed K14 with proposed sites of structures and delineated sub-catchments is presented as an indication for watershed management (Figure 11.6).

Different types of water retention structures can be used for storing water in dry season, such as, a) rubber dam, b) earthen dam, c) check structure, d) sluice gate/regulator and e) weir. Detailed study is required for providing structures (i.e. structure type, size, site, etc) based on water requirement on both sides of the structure (countryside and riverside) and other influencing factors.

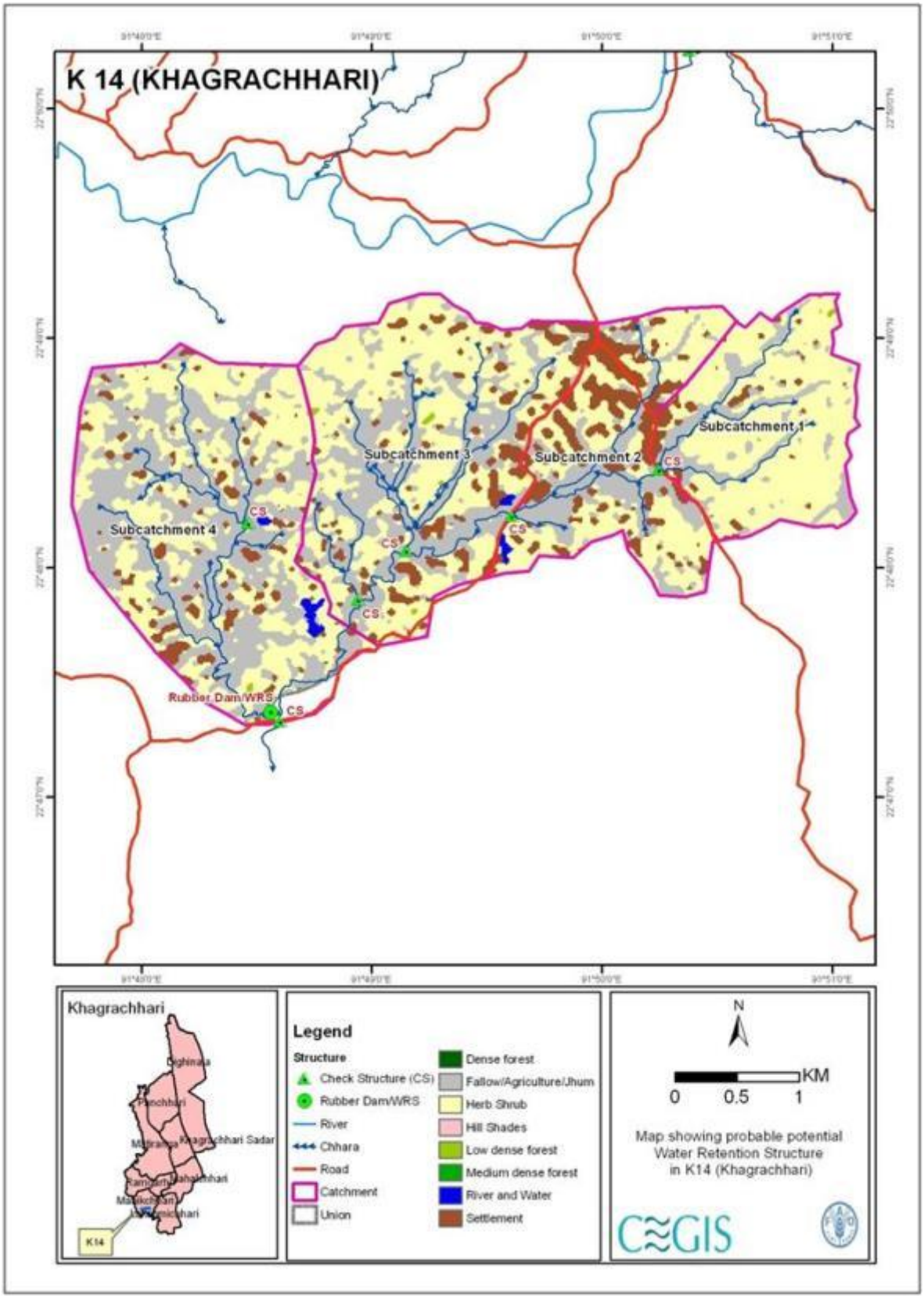


Figure 11.6: Probable location of structures in the watershed K14

11.11 Improved Household Agro-processing and Value Chain

11.11.1 Capacity building

Farmers, particularly the poor, need adequate training on processing, packaging and marketing of high value crops, which can enable the CHT to become a production and processing hub of exotic agro-products for the entire country and beyond. Training and necessary support should be arranged in such a manner that would enable the farmers to become micro-entrepreneurs. Women should be specially targeted to this end. It is important to develop training curriculums with adequate gender dimension. Remunerative small scale activities should be based on the processing of high value crops with simple technology at the household level.

11.11.2 Preferable production zoning based on transport facility

It is important to decide who would produce what. The physical environment may be suitable for many crops. Given the state of storage, transport and market infrastructure, crops/products should be selected for development and promotion. Any high value commodity can be promoted around the *Kaptai Lake* and along all-season roads, which can be transported quickly to other areas outside the region. Figure 11.7 shows areas to the extent of 258,358 ha along all season roads demarcated by black lines on both side to the extent of 1,500m, which is suitable for all products in terms of easy transportation and marketing (Table 11.9). In remote areas, which are difficult to access, only high value and relatively non-perishable products should be selected for development and promotion. Products can be selected from a long list of commodities (Table 11.9).

Table 11.9: Crop suitability by slope in the buffer zone along all seasoned roads

Slope (%)	Area (ha)				Suitability
	Bandarban	Rangamati	Khagrachhari	Total	
0-5	18,266	48,928	40,345	107,539	All purpose agriculture
6 - 10	17,608	40,899	19,375	77,882	Contour planting of horticulture and spices
11-20	19,599	44,843	8,857	73,299	Mostly horticulture and partly forest
21-30	8,405	18,747	2,245	29,397	Mostly forest and horticulture
31-50	6,769	8,401	601	15,771	Horticulture, spices and forest plants
51-70	1,361	689	33	2,083	Forest species and medicinal plants
>70	244	129	3	376	Forest species
Total	72,252	162,636	71,459	306,347	

11.11.3 Upgrading of household level agro processing ventures

There are many existing practices of household level agro processing (Table 11.10). These ventures need to be upgraded and should reach a wider market. Local Government Institutions (LGI) should provide community based technology and financial incentive support. The product certification should be the responsibility of the HDC through BSTI.

11.11.4 Production package

For any promotional activity, it is necessary to provide technology package, training, input support and market access. GoB extension agencies should provide simple and low-cost technology in a decentralized manner. Accessibility of necessary inputs, such as seeds and agro-chemicals, should be ensured in time and with quality through the private sector distribution system. Adequate credit support will be required for financing activities at the micro-level.

Special credit program with little or no interest should be guaranteed. The current practice of loan repayment in weekly installment does not suit the need of the poor farmers. The government should arrange sufficient revolving fund for credit using the NGO service delivery systems with provision of seasonal and longer term credit keeping in mind the gestation period of activities.

Table 11.10: List of household level agro-processing ventures

Commodity	Existing practice	Potential
Fruits		
Jack fruit	*Pitha*, cake	Pickle, juice, leather, squash, jam, jelly
Mango	Chutney, juice	Pickle, juice, squash, leather, Jam, Jelly, Candy
Pineapple	Juice, jam, jelly, use in curry	Juice, squash, leather, jam, jelly, candy
Banana	*Pitha*, custard	Banana chip and packaging
Papaya	Juice, custard	Jam, candy, juice
Coconut	*Pitha*, oil, use in curry	Powder, oil, fried slice
Orange	Juice	Jelly, marmalade, dried skin
Pamelo	Juice	Jelly, marmalade, dried skin
Lemon	*Sorbet*, lemon tea, use in jelly/jam preparation	Jelly, marmalade, dried skin
Olive	Pickle, use in curry, juice	Pickle and chutney with good packaging
Jujube	Pickles and chutney	Pickle and chutney with good packaging
Amloki	Pickle, *morobba*, dried *amloki*	Good packaging
Tamarind	Pickle, chutney and use in curry	Pickle and chutney with good packaging
Chalta	Chutney, use in curry	Pickle and chutney with good packaging
Guava	Jelly, jam	Juice, jelly and jam with good packaging
Other field crops		
Maize	Pop corn, *pitha*, boiled and burned cob, flour	Improved processing, packaging and grinding
Nuts and oilseeds		
Cashew nut	Fried nuts	Improved processing and packaging
Pea nuts	Fried	Butter, oil extraction and good packaging
Sesame	*Pitha*, oil, use in curry	Oil extraction and packaging
Vegetables		
Radish	Drying, curry	Blanching, solar drying and packaging
Bean	Drying and curry	Blanching, solar drying and packaging
Mushroom	Drying, curry, powder	Solar drying and packaging
Ash gourd	*Morobba*	Improved processing and packaging
Bamboo shoot	Drying, curry	Solar drying and packaging
Fish and meat		
Fish	Drying, curry	Solar drying, freezing, salting and packaging
Meat	Drying and curry	Solar drying and packaging, freezing and canning
Spices		
Turmeric	Drying, boiling, powder	Improved drying (solar, mechanical), grinding, packaging
Ginger	Drying, sand preservations in soil pits	Juice, candy, paste, improved packaging
Bay leaf	Curry, tea, pickle	Improved packaging
Black pepper	Curry, dry, powder	Solar drying, improved grinding and packaging

Source: FGD

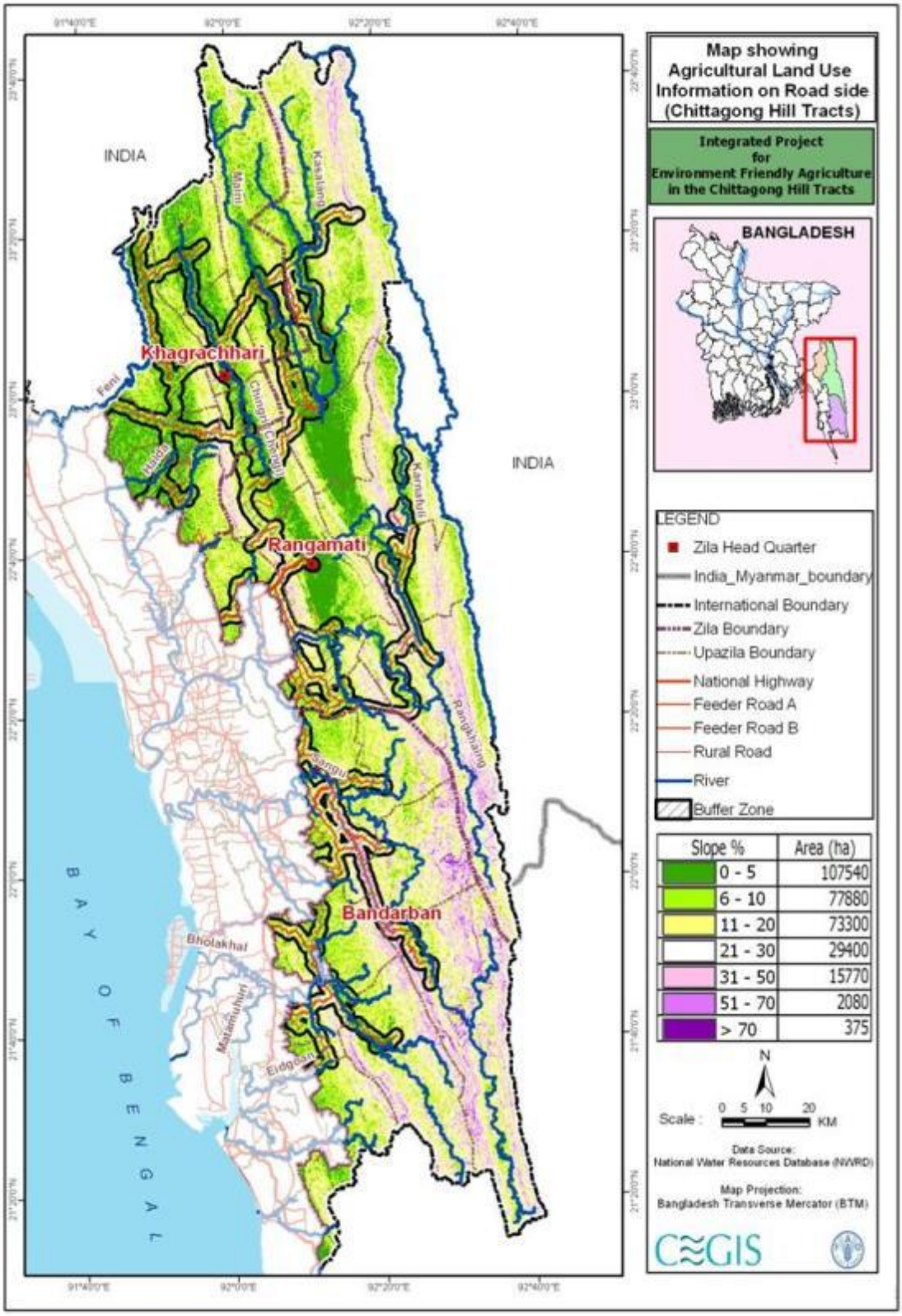


Figure 11.7: Buffer zone along all season roads

11.11.5 Market access

Meaningful market access has always been a challenge for the poor rural producers. This essentially needs some institutional arrangement. This should be sequenced as follows:

(a) Selection of contact growers and their orientation: this will be facilitated by local government institutions (LGIs).
(b) Formation of producers' cooperative for marketing: this will be facilitated by the local government under the aegis of the HDC.
(c) Market infrastructure: such as, shed for temporary storage of perishable commodities, space for women primary producers to display and sell their products, etc should be created by the LGIs.
(d) Product certification with CHT branding: this will be facilitated by the HDC, which needs BSTI personnel at its disposal.
(e) Access to national and international market chain: this will be facilitated by the private sector under a collaborative framework between the HDC and the private sector. Super shop chains in major urban centers should be involved in marketing and provide outlet facility.

Some utensils and equipments are required for household level agro-processing. These need some investments at the outset. For quality processing, households need knowledge and facilities for better storage. Major problems are lack of adequate space, lack of protection from humidity and rat infestation.

Women in local communities dry up vegetables, meat in the sun and fire. They eat dried vegetables in off-season periods. Among these vegetables are radish, bean, mushroom, bamboo shoot, etc. In this regard, their capacity and knowledge should be enhanced through training and demonstration. They can be motivated to preserve and process medicinal herbs and fruits, such as *amloki*, *haritoki*, *boira* (*bohera*), etc which grow plentiful in hilly areas. These trees are wildly produced. They collect these fruits from the hills and forests when they collect firewood and water. They can grow these trees in their homesteads.

If women farmers' knowledge and roles towards seed management are addressed properly through proper seed preservation and management initiative, their knowledge could be enhanced; local species would be available and preserved also. This will also help to develop and promote women entrepreneurs at the local level. To achieve this goal, it is necessary to enhance their capacity on seed preservation and storage, packaging and entrepreneurship development. Various trainings can be designed and provided in local languages to them to strengthen their knowledge base. Training in the following fields is important and relevant:

- Seed management (collection, preservation and storage);
- Packaging, labeling and marketing;
- Entrepreneurship development.

11.12 Alternate Income Generation through Integrated Homestead Farming

At the household level, there are efforts by farmers, particularly women, to do a host of activities that is tantamount to integrated farming. They cultivate crops, prepare home garden for vegetables and fruits and keep poultry and livestock, with a purpose mainly to meet household

consumption needs. This trend is gradually changing, as more and more products grown in homesteads are now sold in the market. Women selling farm products in the bazaar is now a visible phenomenon. This process needs acceleration to enable women to have more say in the household decision making process. However, careful selection of crops/commodities is important in this respect so that women do not loose.

Besides livestock and poultry, high value crops which can be grown in and around homesteads should be an option for development. As access to market is limited, particularly for remote areas which are unlikely to be integrated through transport and communication network in the short run, it would be wise to suggest crops that produce high value commodities and, at the same time, are relatively non-perishable and/or easy to store with minimum post-harvest loss. Medicinal and aromatic plants could be a feasible option for poor women who can grow cinnamon, bay leaf, black paper, cardamom, *amloki, haritoki, boira*, along with conventional crops like turmeric, ginger, lemon, banana, etc.

However, producers still face problems including lack of market information, lack of awareness about quality standards, absence of forward and backward linkages and little or no access to modern technology, finance, storage and market. For livestock and poultry, the main constraint is the lack of facility for disease control.

Integrated homestead farming has twin objectives; first to meet consumption and nutritional need of household members, and secondly to earn income through sale. While some fruits, vegetables dairy and poultry products are mainly needed for nutrition, other high value crops may be grown mainly for sale. Homestead-based small ventures on integrated farming, thus, require adequate policy and material support

Some organization(s) are to play the catalytic role in this respect. While government extension agencies have the required skill, they utterly lack human resource to cater the needs of the entire region. Partnership with NGOs within the framework of the local government would be a useful proposition in this respect.

Integrated farming may be considered as a key intervention that boils down to the following:

- Combination of horticulture, livestock and backyard poultry;
- Combination of high value and non-perishable horticultural products;
- Input support (seed, agro-chemicals, technology, management practice);
- Targeting women for entrepreneurship;
- Adequate provision of credit under easy terms (no interest, seasonal or annual repayment schedule depending on the gestation period of the activity);
- Adequate training and demonstration;
- Market access through intervention in the supply chain (setting up display and sale center in big cities under the auspices of the CHTDB / CHTRC / HDC).

These interventions are proposed for piloting in selected villages. A list of villages has been suggested based on poverty situation, access to facilitation services by NGOs, and so forth (Table 11.11). Concerned service delivery organizations should finalize the list. Interventions would be targeted to poor women. Women-headed households should get the priority.

11.12.1 Improving livelihoods through apiculture

Apiculture offers a useful possibility for the poor and the landless to gain income as it requires minimal start up investment, can be carried out in a small space close to the house, and generally yields profits within the first year of operation. Bees provide honey, wax etc. In addition to the direct income from bee products, beekeeping generates off-farm employment opportunities in many fields including hive carpentry, honey trading, renting and hiring of bee colonies for pollination, and bee-based micro-enterprises. Beekeeping also supports agricultural production, forestry, and maintenance of biodiversity and natural resources through pollination services. But there are many factors that should be addressed so that farmers and others can make use of most of the potentials. This intervention should be targeted to poor and landless women along with necessary technical and financial support (training, materials, credit, etc).

Table 11.11: Proposed areas for intervention on integrated farming

District	Upazila	Union	Village	Community
Rangamati	Belaichhari	Sadar	Pangkhua para	Pangkhua
		Farua	Tarachhari	Tripura, Tanchangya
	Rangamati Sadar	Sadar	Basanta pangkhua para	Pangkhua
			Maghban	Chakma
	Baghaichhari	Sajek	Konglak	Pangkhua, Tripura
			Ruilui	
			Old Langkar	
Khagrachhari	Dighinala	Babuchhara	Jarulchhari	Chakma
		Kobakhali, Merung	Hajachar	
			Kangarimachhara	
			Ketrapur	
		Tarabunnya	Duluchhari	
	Matiranga	Sadar	Wasu	Tripura
			Doldoli	
Bandarban	Ruma	Sadar	Krampo para	Khumi
	Thanchi	Bolipara	Manroya para	Mro
			Binte para	
		Tindu	Amui para	
			Melangya	
			Ronajon	Tripura
			Posaupara	Marma
	Bandarban Sadar	Tankaboti	Ramori para	Mro
		Kuhalong	Chinglung para	Bawm

11.12.2 Nutrition

Nutritional improvement is needed through enhancing the production, supply and consumption of a variety of foods to meet dietary nutrient needs of households and communities. Mass nutrition awareness campaigns and community based programs need to be implemented by providing information on the nutritive value of foods, correct food combinations, food preparation and processing methods, appropriate advice and counseling to enhance dietary intake and improve the nutritional status of the people, particularly children, adolescent girls, pregnant and lactating mothers. Capacity building in nutrition through training and counseling activities should be integrated with agriculture programs and extension services to enhance consumption of a diversity of foods, improved dietary intake and nutritional status. NGOs should be involved as partners in the service delivery of such programs. Following interventions are needed in this respect:

- Development of food based nutrition modules for nutrition education;
- Social mobilization at the *para* level;
- Training on nutrient value of foods and dietary needs for different ages, especially for first 1000 days of life;
- Training on preventive health care, food hygiene and sanitation;
- Monitoring of health and nutritional status of children under five years, pregnant and lactating women.

For improvement of nutritional status of pregnant and lactating women, adolescent girls and young children, there is need for developing capacity and critical mass of resource persons at the village level. Technical support and utilization of the potential of the platform of the PDC and PNDC may develop resource persons from within communities through training of trainers (ToT). In the first year of intervention, two potential women members from each village could be selected for receiving training. These women resource person can serve to counsel and build awareness in respective *para* / community.

Given the severity of the public health and nutrition problems, intensified action to implement direct nutrition interventions such as iron foliate supplementation, deworming, food fortification and dietary improvement need to be implemented on a priority basis. Promoting biodiversity for sustainable diets and improved food and nutrition security is an important area of intervention in this regard.

11.13 Adaptive Research, Participatory Extension and Demonstration

11.13.1 Expansion and strengthening of on-farm research

Adaptive research takes into account different bio-physical and socio-economic circumstances of the users. It demands the involvement of cross-sections of participants in the identification of constraints in farming systems, development of interventions and dissemination of technologies. The process involves partnership among research scientists, extension workers, farmers, farmer organizations, NGOs, CBOs and the private sector. Most of the adaptive research activities are conducted on-farm, with varying degrees of stakeholder involvement in the design and management of on-farm trials. Participatory research techniques should be adopted to ensure the involvement of farmers as equal partners in the diagnosis of constraints, designing of interventions, monitoring and evaluation, dissemination, assessing adoption and impact, and providing feedback.

Three hill research stations of BARI have developed some technologies for farmers. These technologies have not been tested in farmers' fields due to lack of on-farm research activities in Rangamati and Khagrachhari hill districts. The Bandarban on-farm research station is running without adequate staff and other facilities. On-farm research activities should be expanded and strengthened. This can generate appropriate technologies, particularly for small farmers.

Participatory approaches involve information sharing and joint decision making and are essentially interactive and bottom-up. Farmers' Field Schools (FFS) that are operational under the CHTDF can provide effective platform for participatory research and action.

11.13.2 Setting demonstration of advanced technologies

Technology generation and dissemination should go side by side. Demonstration is the major vehicle of technology dissemination. Demonstration programs have been suggested based on

typical geo-physical characteristics of the region, current practices of the communities and potentials based on the natural resource base (Table 11.12).

Table 11.12: Suggested interventions for demonstration

Activity	Intervention need for improvement	Demonstration / trainings
Field crops	Use of balance fertilizer Demonstration on use leaf color chart (LCC) in rice production Integrated crop production on rice, vegetable and fruit. Preparation of compost/FYM and use in the cropped fields Rice & vegetable seed production & preservation Training on integrated crop management on rice, vegetable, fruits, and us of balance fertilizer, LCC, compost & FYM preparation	Total Demons.-12000, one acre per demo (equal number in each district) Farmers' training: 12000, 30 farmers per batch Demo on Preparation and uses of Compost/FYM
Horticulture (Mixed Fruit orchard)	Establishment of mixed fruit orchard Mango-Litchi- Jackfruit-Pamelo Mango- Litchi- Malta/Orange Litchi-Malta-Pamelo Cashew nut-Pineapple-Lemon Mango-Rambutan- Litchi Stone apple- Jack fruit- Lemon Jack fruit –Pineapple-Malta/Orange Cashew nut-Malta/Orange Establishment of community nursery/private nursery at para. Training on fruit orchard management	Demo for mixed fruit orchard, one acre per orchard: 20000 (equal number in each district) Nursery: 150 (50 in each district) Training: 2000 batches, 30 farmers per batch
Species	Plantation of spicy leaf plant (Tej pata) in the medium slop land. Cultivation of ginger in the hill top plain land /hill valleys/intercrop with horticultural orchard/homestead Cultivation of turmeric in the hill top plain land /hill valleys/intercrop with horticultural orchard/homestead	Plantation of bay leaf, black pepper & cinnamon: 30000 acres (10,000 acres in each district) Ginger: 20000 acres Rangamati- 6000, Khagrachari-6000, Bandarban-8000 Turmeric - 30000 acres (10000 acres in each district)
Medicinal herbs, fruits and plants	High value crop, there are natural medicinal plants in the hills. For commercial uses establishment of medicinal plants orchard	Plantation of medicinal plants (amloki, haritoki, bohera, neem, olive, etc): 1200 acres (400acres in each district)
Jum	Seed production & preservation of local indigenous jum rice varieties Time and application method of using fertilizers Jum cultivation on selected crops Management of environment friendly jum Integrated crop management of jum	Total: 9000 acres Rangamati-3500 (Belaichhari, Juraichhari, Rajasthali, Barkal, Baghaichhari) Khagrachari-1000 ((Pancahhri, Lakshmichhari, part of Sadar, Mahalchhari, Dighinala) Bandarban-4500 (Thanchi, Ruma, Rowangchhari, part of Sadar)
Livestock	Cow rearing at homestead Fodder production on valleys/bank of the creeks De-worming for livestock Foot & mouth disease control PPR for goat	Cow rearing: 4500 families, 1 cow per family (1500 families in each district), along with other support services, such as, vaccination, medicine and training (150 batches)
Pig	Pig rearing at homestead	Pig rearing: 3000 families (4+1= 5 pigs per family) Rangamati: 800, Khagrachhari: 1000, Bandarban: 1200
Backyard poultry	Broody hen management Vaccination on indigenous chicken Proper housing of chicks rearing Training for indigenous birds management	Providing indigenous birds to 9000 jumia women and partial fund for housing; for each family, 2 cocks and 10 hen Rangamati-3500, Khagrachari-1000, Bandarban-4500 Training- 9000 (30 per batch)
Kaptai lake	Cage/ pen culture	Only for Rangamati Kaptai lake area

	Duck rearing	Demo on cage culture: 2000 Demo on pen culture: 1200 Duck rearing: 2000 families For each family, 2 male and 18 female ducks
Creek fisheries	Construction/development of creek dam Preparation and management of creek for fish culture Establishment of fruit orchard for irrigation Rearing duck in creek Plantation of para & napier grass as fodder for cattle on the bank of the creek	Development of creek: 6000 with plantation of grass para & napier, fish culture: Rangamati-2500, Khagrachhari 2000, Bandarban-1500 Hatchery improvement: 03 Quality fingerling production & distribution
Minimizing post harvest loss	Training on fruit harvesting, sorting, grading and preservation Training on transportation and marketing	Training: 3000 batches, 30 farmers per batch (1000 in each district)
Fruit/spicy leaf processing and preservation	Training on spicy leaf harvesting and preservation Training on fruit preservation	Training: 3000 batches, 30 farmers per batch (1000 in each district)
Improving market infrastructure	Development of growth centre	Construction of growth centre: 25 (one in each upazila) Three cold storages (one in each district)
Sugarcane with inter cropping	Technology Demonstration on chewing type sugarcane cultivation providing with sets sugarcane, fertilizers. Set up demonstration of sugarcane in tobacco growing area Inter cropping with sugarcane cultivation Training	Demo on sugarcane-2000 acres (Rangamati-600, Khagracahri700, Bandarban-700 Training : 2000 batches, 30 farmers per batch (equal number of trainees in each district)
Cotton	Cultivation of high yielding varieties of cotton in jum Demonstration of hybrid cotton in tobacco growing area	Demo on hybrid cotton-2000 acres (Rangamati-400, Khagrachari-800, Bandarban-800)
Non timber forest plantation	Plantation of bamboo sets/ seedlings in hill sides with community involvement	Total plantation: 15000 acres (Rangamati –5500, Khagrachari4000, Bandarban 5000) Training : 500 batches
Institutions	Upscaling of BARI developed varieties/ technologies, rambutan, sweet tamarind, year round pine apple production, off- season mango, lemon, guava and summer vegetables	Quality sapling production by DAE Horticulture Centers, BADC, BARI Private nurseries

11.14 Human Resource Development

11.14 Filling HR gap

Research and extension agencies working in/for the CHT suffer from serious shortage of skilled human resources (HR). There are many posts lying vacant and, even if there are designated persons, many of them are not available at respective stations. This is a serious constraint, as well as a threat to CHT development. Filling HR gap and ensuring their effective presence in respective duty stations is an imperative and should precede the implementation of any development program.

11.14.2 Capacity building of service providers

Government line agencies and private sector service providers working in the CHT tend to focus on plain land farming issues, problems and interventions. They have no or limited knowledge of hill agriculture or upland farming system, as this has not been addressed in the curriculum. Persons who are posted in the CHT, especially in the fields of agriculture research and extension, need proper training and orientation on upland farming systems. Scientists and extension

personal who are working in the CHT should receive, if necessary, oversees training where research and extension activities are conducted in similar environments.

Farmers at the community level need training on new technology and exposure to demonstration on field trials. Their training and exposure should be addressed simultaneously.

The CHTDF has conducted program on capacity development of relevant institutions, such as, HDCs, RC, MoCHTA and community leaders to deliver quality services and support community development. This program should continue under an institutionalized arrangement.

Chapter 12

Implementation Modalities

12.1 Framework

Implementation of a development project in the CHT envisages a multi-agency framework where interventions will be addressed by relevant stakeholders, such as, the local government, line departments, private sector, CBOs and NGOs.

Formulation of strategy is fundamental to operationalize a development project. Such strategy essentially includes necessary institutional arrangements. This should be finalized in compliance with the tenets of the CHT treaty of 1997 in consultation with relevant stakeholders including concerned Ministries and Departments. For a longer term project or plan, periodical review is necessary to allow adjustments with changed circumstances, particularly with respect to changes in natural conditions (say, climate, water regime, etc) and social environment (community involvement, conflict management, etc) and financial regime (resource flow)

Different time frames are to be considered for different interventions. The outcome of some interventions depends on the successful completion of some other inventions. Hence, interventions that are inter-dependent should be sequenced in a manner that they are initiated and completed more or less at the same time, so that they deliver maximum tangible output.

All interventions are important and necessary. Based on resource availability, interventions may be sequenced over a period of time. Respective line agencies will do necessary prioritization. However, inter-dependent interventions across the agencies should be addressed simultaneously. This needs inter-agency coordination and cooperation.

Involvement of the private sector and NGOs would be relevant for some interventions. Selection of private sector organizations or NGOs needs rigorous criteria based on the government policy and track record.

12.2 Management System

While addressing the management system, it is important to take two aspects into cognizance. These are:

- Involvement of all stakeholders in the system that are relevant and are able to contribute in accomplishing project objectives; and
- Delineation and devolution of responsibilities horizontally and vertically to make the system inclusive and functional.

To have a well-knit system, it is necessary to integrate all tiers of actors, from the national level to the village level. However, it would be logical to base on existing institutions to have optimum results, rather than creating new ones. It is also important to ensure that the system need not be burdened with too many tiers, nor any important constituency is ignored or bypassed. Viewing in this context, a three tier management system has been envisaged to steer the process of implementation and coordination.

National level: At this level, there will be an Inter-Ministerial Steering Committee (IMSC). This will be the highest forum and will be responsible for decisions on policies and strategies.

District level: Districts would be the focal points for project planning, implementation, coordination and monitoring.

Upazila level: Upazilas will be organically linked with the districts in terms of project planning, implementation, coordination and monitoring. Upazila implementation committee (UIC) will directly look after activities of all layers at the upazila level and below, such as, unions and villages. A schematic representation of this system has been presented in Figure 12.1.

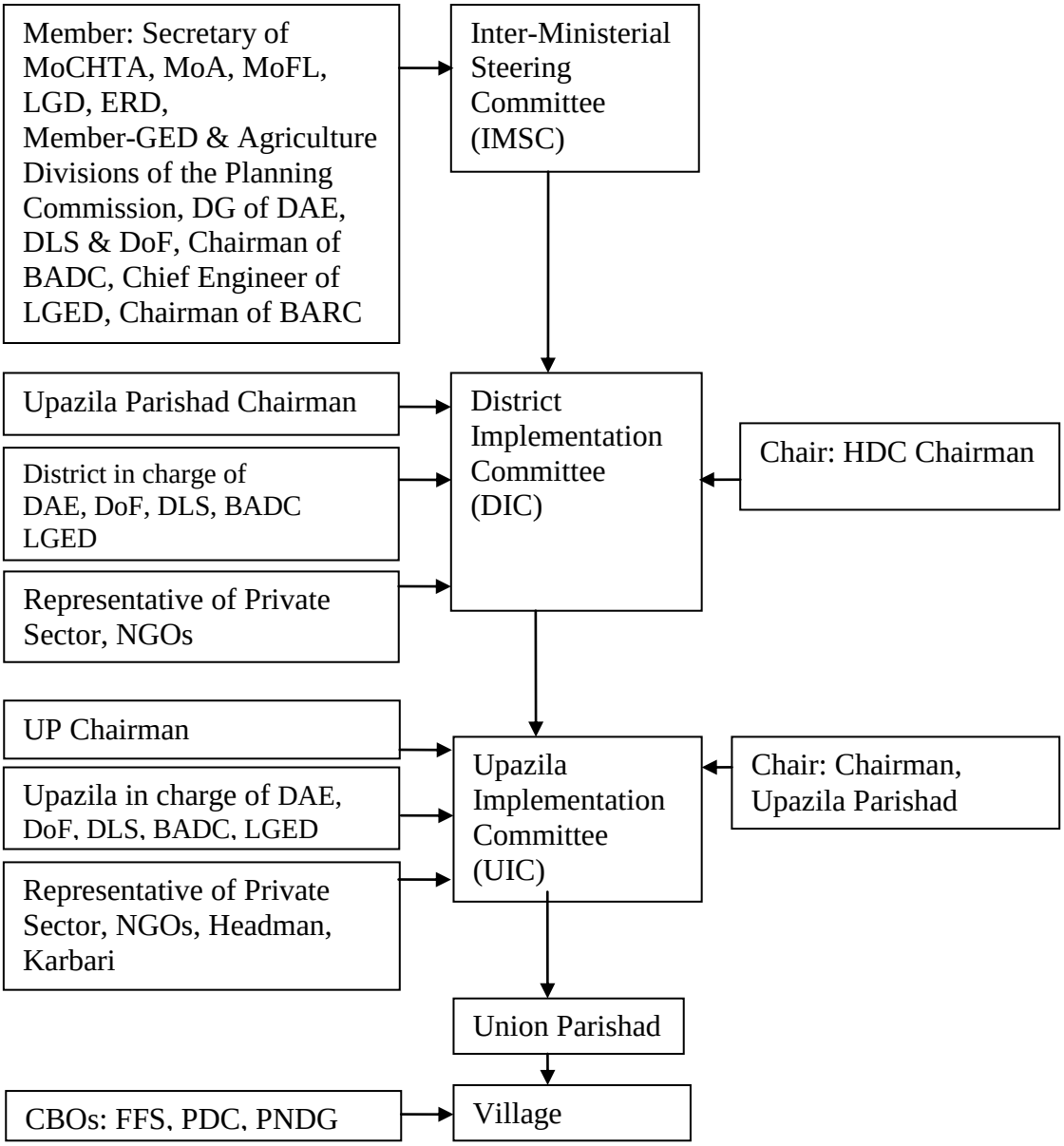


Figure 12.1: Proposed management structure

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