ENDOWED WISDOM

KNOWLEDGE OF NATURE AND COPING WITH DISASTERS IN BANGLADESH

First Published in December 2009 by
Comprehensive Disaster Management Programme (CDMP)

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The Study has been conducted by the Foundation for Women and Child Assistance (FWCA), Rajshahi with Knowledge Management Support from Development Frontiers (DevFront), Dhaka, and technical and financial support from the Comprehensive Disaster Management Programme (CDMP).

Cover Design:

Layout and Typeset:

Printed by Moushumi Printers

ISBN no: 984-300-002926-5

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KNOWLEDGE OF NATURE AND COPING WITH DISASTERS IN BANGLADESH

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Foreword

The experience of sustaining recurrent disaster impacts and the capacities of the local communities are by far the basic strength of disaster management in Bangladesh– one of the most hazard prone countries of the world. Local communities are on the forefronts as both the immediate disaster victims as well as the first line of responders during any such emergency situations. Eventually, people have gained ample experience of dealing with disasters and are indeed optimist enough to find opportunity in every difficult situation they encounter. Local communities have accumulated over the centuries, enormous indigenous knowledge on how to sustainably utilize their natural resources using a variety of innovations to deal with natural disaster. Community people's experience, knowledge base and response practices regarding disasters provide the subject matter of this book.

The escalation of severe disaster events triggered by natural hazards and related technological and environmental disasters is increasingly threatening both sustainable development and poverty-reduction initiatives. The loss of human lives and the rise in the cost of reconstruction efforts and loss of development assets have forced the issue of disaster reduction and risk management higher on the policy agenda of affected governments as well as multilateral and bilateral agencies and NGOs. Bangladesh is now encountering natural hazards induced emergencies on an unprecedented scale causing widespread human, material, economic or environmental losses. Therefore, the imperatives are to build disaster-resilient economic and social infrastructure, as well as thereby building resilient communities in Bangladesh. We have to act decisively now to facilitate the mainstreaming of disaster risk reduction into development planning frameworks to ensure a safer Bangladesh for future generations. Local communities are the essential point of departure for our effort to set the Hyogo Framework for Action in motion for saving lives and livelihoods. Hence, disaster professionals need to listen to and learn from the community people so that their initiatives become grounded in indigenous knowledge and experience.

Indigenous knowledge is, historically speaking, the root of all knowledge and is unique to a culture or society. This knowledge is orally transmitted from generation to generation and has been the basis for agriculture, food preservation, health care, conservation and the wide range of other activities including preparedness and mitigation for disasters that sustain a society and its encompassing environment for many centuries. The local people have a vast knowledge of the ecosystems in which they live and of ways of using natural resources sustainably. Today, there is a grave risk that much indigenous knowledge is being lost and, along with it, valuable knowledge about ways of living sustainably and specifically surviving disasters both ecologically and socially.

This publication entitled, "Endowed Wisdom: Knowledge of Nature and Coping with Disasters in Bangladesh", has been written with that purpose in mind. We hope, it will educate and inspire further practical efforts at the community level while contributing to the overall global movement for disaster resilient communities and risk reduction. As an original work of its kind, the good practices and lessons learned presented in this book would ultimately contribute to raising community preparedness and reducing our vulnerability to future hazards. I sincerely hope that this book will not only be useful to the disaster professionals in Bangladesh but will also act as an awakening call to governments and other stakeholders at the regional level to document, recapture and incorporate this invaluable knowledge in disaster sustainable development.

Md. Mokhlesur Rahman
National Programme Director, CDMP &
Secretary, Ministry of Food and Disaster Management

Acknowledgement

This book is an outgrowth from a research work conducted in sixteen districts of Bangladesh prone to flood, flash flood, water logging, salinity intrusion, cyclone, drought and wild life disturbances in Bangladesh. The Comprehensive Disaster Management Programme (CDMP) expresses gratitude to Mr. Hasan Shafie, A K M Mamunur Rashid and Dr. Shantana R. Halder and the research team from the Foundation for Women and Child Assistance - FWCA for their collective wisdom and the effort in collecting, organizing and analyzing data presented in this book.

Our thanks to the field research team of FWCA, especially to Mr. Md. Esha Shihab, Mr. A.K.M. Rezaul Kabir Khan, Mr. Md. Atikuzzaman, Mr. Md. Mukhlesur Rahman, Ms. Hasena Begum, Mr. Suhanul Arefin, Mr. Md. Mushfikur Rahman, Ms. Ajita Mitra, Mr. Nasiruddin Ahmad, Mr. Md. Rowshan Jahid, Mr. Md. Sultanul Arafin Ms. Umme Nazma and ASM Masudul Hasan. We also acknowledge the contribution of Mr. Md. Jamery Hasan, Ms. Fariba Alamgir, Ms. Eliza Akter, Mr. Md. Wadudul Haq, Mr. Atiqur Rahman, Ms. Rajina Sultana Borna, Mr. Moshrraf Hossain, Mr. Abdullah Al Mannan and administrative personnel of FWCA and Development Frontiers for extending all possible assistance towards the completion of this book. We do express our wholehearted gratitude and owe our indebtedness to all of them.

We acknowledge the earnest support and suggestions of Professor Md. Shofiullah, Retired Additional Secretary of the GoB, Mr. Md. Kamal Pasa of Rajshahi University and Mr. Sifayet Ullah of UNDP, S. S. Bakht Hindole of WaterAid, Tasdiq Ahmed of UNDP, Mr. K M Faruque and Mr. Zahid Rahman of ADO, Mr. Md. Rezaul Karim and Mr. Khaleq of Samadhan and Mr. Mohiruddin Biwas.

We owe our gratitude to the panel of reviewers of this book namely Dr. Islam M Faisal, Environment and Livelihoods Adviser, DFID Bangladesh, Dr. Aminul Islam, Assistant Country Director, UNDP Bangladesh, Dr. A S M Atiqur Rahman, Professor, Institute of Social Welfare and Research, Dhaka University, Dr. Shahnaz Huq-Husain, Professor, Department of Geography and Environment, Dhaka University and Md. Fazlul Huq, Director, Fisheries and Livestock Programme, PROSHIKA, for their invaluable time and professional feedback which helped us to further improve the content.

Finally, we express our deepest gratitude to all of the respondents of this research. They are the actual owner of the primary data presented in this book. We can never equate their respective contribution and cooperation by mere expressing gratefulness.

Policy, Programme and Partnership Development Unit

Comprehensive Disaster Management Programme

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Acronyms

General

AEZ	Agro-Ecological Zone
ARC	Arsenic Contamination
CBO	Community-Based Organization
CI	Corrugated Iron
CPP	Cyclone Preparedness Programme
CRA	Community Risk Assessment
CSPS	Cyclone Shelter Preparedness Study
CSSI	Coping Strategies Selected for Investigation
CYL	Cyclone
DRRO	District Relief and Rehabilitation Officer
DRT	Drought
FLD	Flood
FFL	Flash Flood
GD	Group Discussion
GDP	Gross Domestic Product
GI	Galvanized Iron
HHs	Households
KGDRP	Khulna-Jessore Drainage Rehabilitation Project
KII	Key Informant Interview
MDG	Millennium Development Goal
MoA	Ministry of Agriculture
NAP	National Agriculture Policy
NAPA	National Adaptation Programme of Action
NGO	Non Government Organization
NGOV	Number of NGOs Being Visited
PIC	Project Implementation Committee
PIO	Project Implementation Officer
PLW	Participatory Learning Workshop
PPF	Production Possibility Frontier
PRA	Participatory Rapid/Rural Appraisal
PRSP	Poverty Reduction Strategy Paper
PSU	Primary Sampling Units
RBE	River Bank Erosion
R&D	Research and Development
RHP	Rain Water Harvesting Plant

SAL	Salinity
SSI	Semi Structured Interview
SLR	Secondary Literature Review
SWOC	Strengths, Weaknesses, Opportunities and Challenges
TRM	Tidal River Management
UDMC	Union Disaster Management Committee
WAI	Wild Animal Invasion
WLG	Water Logging

Organizations

ADB	Asian Development Bank
BBS	Bangladesh Bureau of Statistics
BARI	Bangladesh Agriculture Research Institute
BDPF	Bangladesh Disaster Preparedness Forum
BMD	Bangladesh Meteorological Department
BMDA	Barind Multipurpose Development Authority
BRRI	Bangladesh Rice Research Institute
BWDB	Bangladesh Water Development Board
CARE	Cooperative for American Relief Everywhere
CDMP	Comprehensive Disaster Management Programme
CEGIS	Center for Environmental & Geographic Information Services
CNRS	Center for Natural Resource Studies
DER	Disaster Emergency Response
FD	Forest Department
FFWC	Flood Forecasting and Warning Centre
FRRAS	Flood Risk Reduction Activities in Sunamganj
GoB	Government of Bangladesh
MoEF	Ministry of Environment and Forest
SIDA	Swedish International Development Cooperation Agency
SRDI	Soil Resource Development Institute
UNDP	United Nations Development Programme
WAPDA	Water and Power Development Authority
WARPO	Water Resources Planning Organization
WHO	World Health Organization

CHAPTER I

COPING WITH FLASH FLOOD

Chapter 1
Introduction

THE CONTEXT

This book explores the fascinating endowed potential of rural communities to cope with disaster. Indigenous knowledge is rooted in centuries of experience and offers a mighty reservoir of tradition and understanding that some may consider a basic strength of disaster management in Bangladesh.

People survive, mostly without outside intervention, under conditions that are often critical and fragile. For centuries, people have succeeded in overcoming adversity and have managed many challenges to their livelihood. In the everyday struggle of life, indigenous knowledge and coping strategies have become a key to survival. But in recent years, successive crop failures and the significant erosion of livelihood support systems resulting from over-exposure to natural hazards have had a severe impact on livelihood enterprises and coping capacities.

This book examines the often intriguing coping strategies that communities have developed to in their quest to stabilize increasingly fragile livelihood systems and their struggle to withstand recurrent disaster shocks in rural Bangladesh. It hopes to contribute to our broader understanding of the linkages between disaster management, assessment of peoples' capacities to respond to hazard events and the development of disaster resilient communities in Bangladesh.

Bangladesh is highly susceptible to floods, cyclones, tornadoes, droughts, salinity, fire, earthquakes, landslides, riverbank erosion, insecticides and other hazards. Poor and marginal people suffer most from these hazards, because of their high base vulnerabilities and over-exposure to natural hazards. This also provides insights into aspects of local resilience, capacities and traditional coping strategies. The research supports efforts to assess the response strategies of communities that use traditional knowledge and skills to address the consequences of disasters.

Previous research into risks and hazards, the impacts of climate and the resilience of units (individuals, groups, ecosystems, or even places) and systems in Bangladesh and elsewhere tend to sustain the logic that a focus on external hazards and disruptions alone (environmental, socioeconomic, or technological) is inadequate for understanding the responses of, and impacts on, those units. So we need to extend our analysis and understanding of the internal factors, vulnerability and resilience, that influence their ability to avert

risk or to cope with – and ultimately to recover from – the impacts. We need to shed significant light on who and what are at risk from which stresses and disruptions.

This exploration of vulnerability and resilience in Bangladesh will help to provide us with a clear understanding of the coping strategies of individuals, communities and human units that are exposed to risks, natural hazards and climatic impacts. Those strategies have evolved over time into a system of indigenous knowledge: an endowed wisdom.

Knowledge of how vulnerable people respond to a threat is essential, because it is the premise upon which outside interventions to improve the livelihoods of the rural poor must be founded and built. Reducing disaster impacts and fighting poverty in rural areas of Bangladesh requires efforts that are grounded in local perceptions, understanding and indigenous knowledge. Outside interventions need to take due account of local knowledge of farming and natural ecosystems. That knowledge is inherent in people who make their livelihoods in rural areas. Development programmes that incorporate this knowledge have much greater prospects of producing outcomes that are socially beneficial, ecologically sustainable and contribute to developing disaster resilient communities.

This book is a product of research conducted in sixteen districts of Bangladesh. Its findings are founded largely on qualitative data collected using participatory rural appraisal and qualitative research tools and techniques. This immense task has been accomplished by profiling individual case materials found in the study areas.

The book primarily examines how indigenous coping strategies enable the rural poor to respond to natural hazards and other external vulnerabilities. Although it is not a comprehensive catalogue of coping strategies, it attempts to compile many of the good community practices and coping strategies observed during fieldwork in early 2008.

FRAMING THE CONTEXT: PLACE AND PEOPLE

Ecological Features

Bangladesh is endowed with enormous agricultural potential. Its varied physical features make up 30 major agro-ecological zones with a high diversity index of genetic resources. These ecological zones display homogeneity in agricultural and ecological features, while differences are found in their physiography, soil types, land types by inundation levels and agroclimatology. This ecological frame reference is used extensively for agricultural production planning and plays an important role in technology transfer and in designing specific biophysical resource utilization programmes.

Physiography: Physiography is the agro-ecological regions' main delineating factor. There are three broad regions: the floodplain area, the Pleistocene terrace, and the hilly regions in the Northeast and Southeast.

The floodplains cover 80% (NAPA, 2005) of the country's total area. They consist of largely flat land and depressions (back swamps or old channels). Elevation of the tidal floodplains from sea level is less than 1 meter, and between 1 and 3 meters on the main rivers and estuarine floodplains. Floodplain areas are located in the northwestern, central, south-central and northeastern regions, which are also the most hazard-prone areas.

Pleistocene terrace covers 8% (ibid.) of the total area. It consists of two major uplifted blocks, known as the Madhupur Tract and Barind Tracts, towards central and Northwest Bangladesh respectively. Elevation of these terraces averages 15m above sea level.

The hills cover 12% of the total land area. They are an extension of the Eastern Himalayan range and include the low hills and hillocks of Sylhet and the Chittagong Hill Tracts, which divide South Asia from Southeast Asia.

Soil Types: Soil types are also significant in differentiating agro-ecological zones, as well as in determining important properties for plant growth, moisture supply, root aeration and nutrient supply.

The soil classification comprises three major types: the old alluvial soils, the recent alluvial soils and the hill soils.

The fertile recent alluvial soils found mainly in flood prone areas are usually pale brown, sandy, and chalky clays and loams. The old alluvial soils in the Barind and Madhupur jungles are dark brown (reddish) clays and loams. They are sticky during the rainy season and hard during the dry. The hill soils are generally permeable and can support dense forest growth.

Inundation Land Level: Inundation level classifies land area into four types: highland areas – above the normal flood-level; medium highland – normally submerged under 90 cm water during the flood season; medium lowland – normally remains flooded between 90 cm and 180 cm during the flood season; lowland – usually remains flooded between 180 cm and 300 cm during the flood season; and very lowland – mostly remains flooded deeper than 300 cm during the flood season (Figure 1.1).

There are also depression sites that remain wet throughout the year. This scaling of inundation level is somewhat flexible, because the depth varies between years and because the peak level may remain only for a few days.

The average relative humidity for the whole year ranges from 70.5% to 78.1% with a maximum in September and a minimum in March.

The average annual rainfall varies from 1329 mm in the Northwest to 4338 mm in the Northeast. The dry season begins first in the west-central part of the country by December, where it lasts about four months. It advances towards the east and south, reaching the eastern and southern margins by January where its duration is about one and half months.

River Systems and Wetlands: Sometimes known as the land of rivers, Bangladesh is geographically positioned at the receiving end of one of the world's largest river systems and embraces the confluence of the Ganges (Padma), Brahmaputra (Jamuna), and Meghna rivers and their tributaries.

The land is intersected more than 310 times by these three mighty rivers and their tributaries (BBS, 2006). The combined total length of all rivers, streams, creeks and channels is 24,140 km (ibid.). The rivers of the Southeast hilly region are considered part of the Chittagong region river system. The rivers serve as the main source of water for irrigation and as the principal arteries of commercial transportation. The rivers also provide sweet-water fish, an important source of livelihood for many fishing communities.

But at the same time, these rivers bring untold misery and hardship to millions of people in the form of riverbank erosion and floods.

In addition to these extensive river networks, there are about 1.3 million ponds covering about 147,000 hectares of land area, along with some 10,000 haors, baors and beels (ibid.). These water bodies contain a great diversity of flora and fauna and represent huge wetland resources. They are used as water reservoirs during the dry season, as well as for irrigation and sweet-water fishing.

AGRICULTURE AND ECONOMY

Agriculture is the mainstay of the Bangladesh economy and of the people. The sector employs 48.1% of the labour force (BBS, 2007) and plays a crucial role in providing raw materials to the local industries. Agriculture contributes an average of 22% to the Gross Domestic Product (BBS 2007).

But in recent times, agriculture has seen a steady decline in productivity per unit of input, and it entails high risks for yields and crop output. The agricultural sector is based on small family farms that make up more than 80% of the total area under agricultural crop production. The role of small family farms is highly significant in the context of the country's economic progress. Agriculture remains the most strategic sector in the Bangladesh economy's attempts to stimulate meaningful long-term economic growth and development.

The Ministry of Agriculture prepared the first National Agriculture Policy in 1999 pursuant to the broad goal of making "the nation self-sufficient in food through increasing production of all crops, including cereals, and ensure a dependable food security system for all" (MoA 1999).

Food self-sufficiency and food security are also critical components in the successful attainment of the MDGs, as agriculture practices can be both direct causes of, and important solutions to, environmental degradation.

The Poverty Reduction Strategy Paper says that the country's macroeconomic, structural and social policies and programmes in support of growth and poverty reduction are largely based on achieving productivity and profitability gains in agriculture production, diversification and commercialization of agricultural enterprises in the face of trade liberalization and globalization. The Paper also stresses the role of crosscutting issues, such as agricultural research and technology generation, farmers' demand-led extension services, energizing agricultural marketing and agro-processing, increasing land use and facilitating women in agriculture.

Agricultural practices in Bangladesh largely depend on seasonality and are heavily influenced by hydrometeorology. The major crops include rice, jute, sugarcane, potato, pulses, wheat, tea, tobacco, oil seeds, and vegetables. Different crops are cultivated according to the suitability of the land and availability of irrigation. The annual crop calendar is dominated by three seasons (Figure 1.1). These are Rabi (November–February), pre-Kharif (March–June) and late-Kharif (July–October).

In the pre-Kharif season, the transplanted Aus is the main crop and a significant amount of land is left fallow, due to the unfavourable distribution of rainfall. Farmers use surface water to prepare their seedbeds. With normal precipitation, the farmers transplant the T. Aus crop in the field, otherwise the land remains fallow. The late-Kharif season is predominantly rain-fed, with T. Aman the major crop. In the Rabi season, high yielding Boro is the major crop, and land is irrigated where ground water irrigation facilities are available. In addition, wheat, mustard, pulses and other types of vegetables are cultivated where surface water is available.

Livestock sustains another vibrant sub-sector of the rural economy. Livestock is raised for milk, eggs, hides and skins, organic manure and, recently to some extent, for crop cultivation during times of drought. Livestock also offers potential risk mitigation in case of crop failure; livestock is an investment, a supplementary source of cash income and often serves as a measure of the wealth in poor rural communities. Animals also provide an element of stability to the production system by helping to buffer the fluctuation in crop yield or income from climatic variability and the occurrence of natural disasters.

HAZARD PROFILE

Bangladesh is highly susceptible to the impacts of climate change and to natural hazards. Factors like geographical positioning, deltaic formation history and low-line coastal morphology make Bangladesh among the most disaster prone regions on earth. The country is exposed to a range of natural hazards, including floods, river erosion, cyclones, droughts, water logging, arsenic contamination, salinity intrusion, tornadoes, cold waves and earthquakes. The (co-)occurrence of these natural events is often further coupled with and multiplied by the high base vulnerabilities of individuals, households and communities. That results in disasters that drive the country towards greater environmental degradation, hunger, poverty, social deprivation and political conflict. In short, it holds back socio-economic development.

This susceptibility to the impacts of climate change and natural hazards significantly threatens livelihoods. Moreover, underlying a disaster's impact is the issue of vulnerability. At the national level, vulnerability to natural hazards is determined by a complex and dynamic set of influences, such as the economic structure of a country, its stage of development and prevailing economic conditions and policy. Bangladesh is

yet to develop a comprehensive national-level analysis of vulnerability within the broader socio-economic, political and policy contexts, and to capture shifts over time and space. Table 1.1 provides an overview of natural disasters in Bangladesh since 1904.

Table 1.1: Disasters In Bangladesh (1904 – 2006)	
No of events	271
No of people killed	1,069,444
Average killed per year	10,485
Total no of people affected	421,511,107
Total average affected per year	4,132,462
Economic Damage*	17,366,980
Economic Damage per year*	170,265
Note: * In Million USD	
Source: Prevention Web (accessed on 22 Sep 2008)	

The damage scenarios suggest not only macroeconomic significance or implications for longer-term development in Bangladesh, but also imply the severity of indirect and secondary impacts, such as the demand for goods and services and livelihood opportunities. This has triggered a growing awareness of the potential human, structural and economic threats that natural hazards pose. Therefore, over the last few decades, both national and international communities have been engaged in counteracting the negative developmental impacts of disasters, as well as increasing the resilience of communities to disasters.

SCOPING AND FRAMING THE CONCEPTS

This section presents the main concepts involved in analyzing the complex situation and the approach used to understand the interactions involved in real-life situations of the households. The basic concepts and their respective interrelations are mapped out in this part to help explain the coping response and associated decision-making environment.

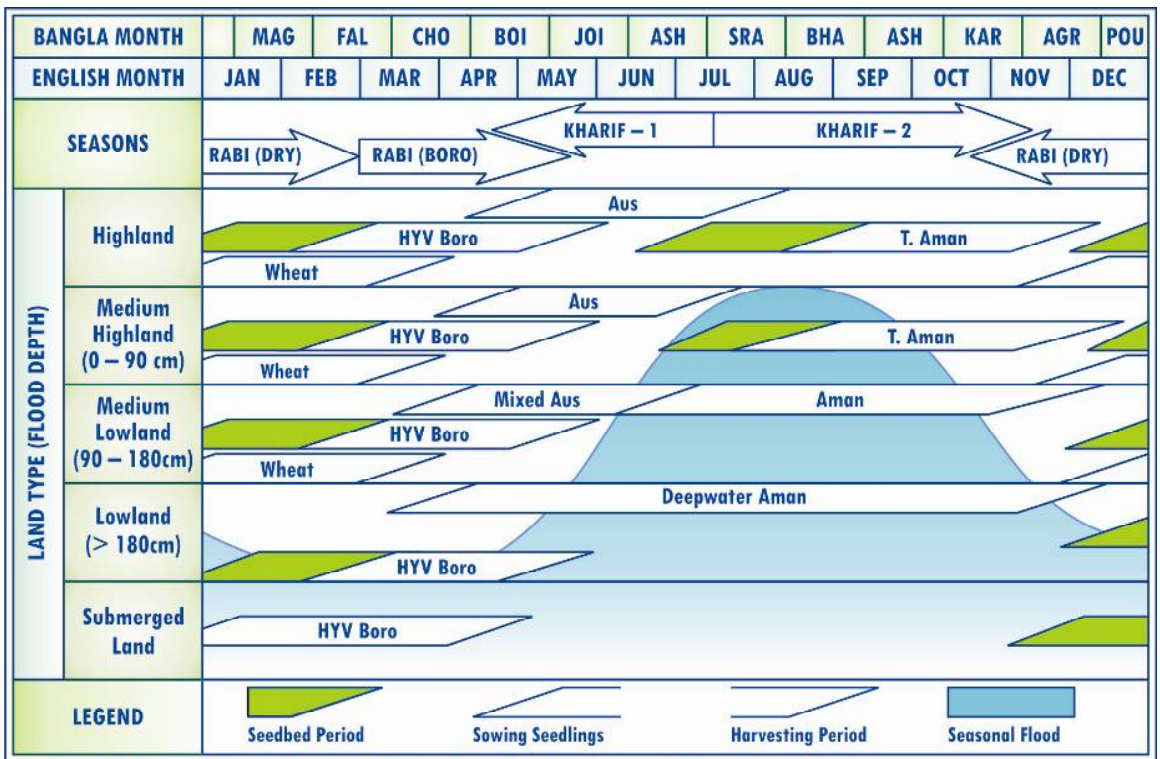

Figure 1.1: Land Types by Inundation Level and Seasonal Cropping Pattern

THE FRONTLINE PEOPLE: RISK PERCEPTION AND COPING STRATEGIES

The perception of risk is a social process.

– Douglas and Wildavsky 1982

Perceptions guide people's coping responses. The coping responses of individuals and their societies to the hazards that confront them depend on the subjectively perceived risk situations defined by the community. There is no such thing as 'real risk' or 'objective risk'. Risk does not exist 'out there', and people do not see risk as an objective entity or activity to be measured in terms of probability and magnitude of hazards. They do not generate coping responses rationally by allocating their resources to reduce the greatest risks first. Context matters. So does the procedure of decision-making independent of outcome.

The categorizations of hazard, disaster, vulnerability or capacity in terms of social, economic and environmental criteria are, so to speak, academic or scientific in essence, but become meaningless to communities, because life if often more a challenge of survival than an opportunity for living. People do not use the concept of vulnerability to describe a worsening situation; instead, they live under stress, confront difficulties, and make decisions that are designed to reduce and control risks. Problems are nearly always perceived in terms of cause and effect. Communities usually base their diverse range of responses on an equally diverse understanding of causes, rather than on an overarching scientific model.

People survive environmental hazards, because they attempt to cope, adapt and adjust by learning derived from experience. Self-protective responses vary tremendously by hazard and society, but are universally found (Kates, 1978). People react to minimize losses and adopt preventive measures prior to hazard events. They respond in terms of what they believe to be the case, rather than what scientists think what would happen. Their understanding of the likelihood, severity and aftermath of hazards and their perceived capacities to respond determine their selection of coping strategies and responses to perceived situations. The nature and character of coping strategies is rooted primarily in a complex interaction of communities' previous experiences, history, politics, socio-economic conditions and institutional dynamics. Therefore, local responses are conditioned and mediated by their respective perceptions of risk situations.

> The coping strategies are diverse and dynamic in nature depending upon contextual factors like region, commu-nity, social class, ethnic identity, household composition, gender, age and season as well as the likelihoods severity and duration of the potential hazard.

The perception of risk is a social process (Douglas and Wildavsky, 1982). People, be they farmers or not, male or female, rich or poor, young or old, see everyday hazards through different lenses, and from different positions and perspectives. Risk perceptions are socially framed and culturally constructed. They are very complex and are influenced by many factors. What people perceive as undesirable and the way people react to a hazardous environment are, largely, based on values and preferences. The way that such risks are perceived and responded to is influenced by educational background, gender, age, historical and personal experience, attitudes and behaviour derived from peers, friends and family. The reasons for the diversity of responses might be due to differences in what people know about hazardous events, how they perceive them, and the concepts they use to classify their experiences and make decisions.

Therefore, it is important to listen to what rural people say about their livelihoods and acknowledge the value of local understanding. Ground realities are complicated, highly interrelated, interwoven and diverse; they help to explain how individuals and societies react to hazards. Whether described as preparedness, mitigation or response, livelihood strategies offer the central challenge to their survival processes, and are evident in the everyday

struggle for existence. It is important to capture communities' visions and understand their perspectives on risk perceptions, food security, sources and types of risks, hazards, perceptions of the types and sources of risks, perceptions of consequences, and the options available to them to overcome these challenges.

INDIGENOUS KNOWLEDGE AND COPING RESPONSE

Knowledge has become the key economic resource and the dominant – perhaps even the only – source of competitive advantage.

– Peter Drucker, 1995

Preferences for coping responses or risk management are derived from combinations of perceived risk-benefit trade-offs based on local knowledge and experience. Social actions to cope with risk are not confined to the simple goal of risk minimization, but include other purposes such as equity, fairness, flexibility, or resilience (Short, 1984; Nowotny and Eisikovic, 1990 cited in Krimsky and Golding, 1992). The practice of risk minimization, therefore, implies a clear distinction between the knowledge traditions of scientists or experts, and those of lay community people.

Expert knowledge and public/indigenous knowledge are conditional. Each reflects underlying social relations and the implicit assumptions of the various actors. What people perceive as an unacceptable situation or undesirable effect depends on their values, preferences and knowledge. The interactions between human activities and consequences are more complex and unique than the average probabilities/magnitudes used in technical risk analyses are usually able to capture (Renn, 1992). It is, therefore, necessary to account for both scientific and indigenous systems of knowledge to understand the contexts of people's coping responses.

Indigenous knowledge represents experience gained over thousands of years of direct human contact with their environment. Local people have developed enormous knowledge of their local environments over the centuries by directly interacting with and experiencing the environment – for instance, knowledge of the local soil, climate, water, forest, wildlife and minerals. This is the endowed wisdom of people and it implies a refined ecological awareness of the nonlinear nature of our environment that shapes and organizes people's livelihood strategies today (*Figure 1.2*).

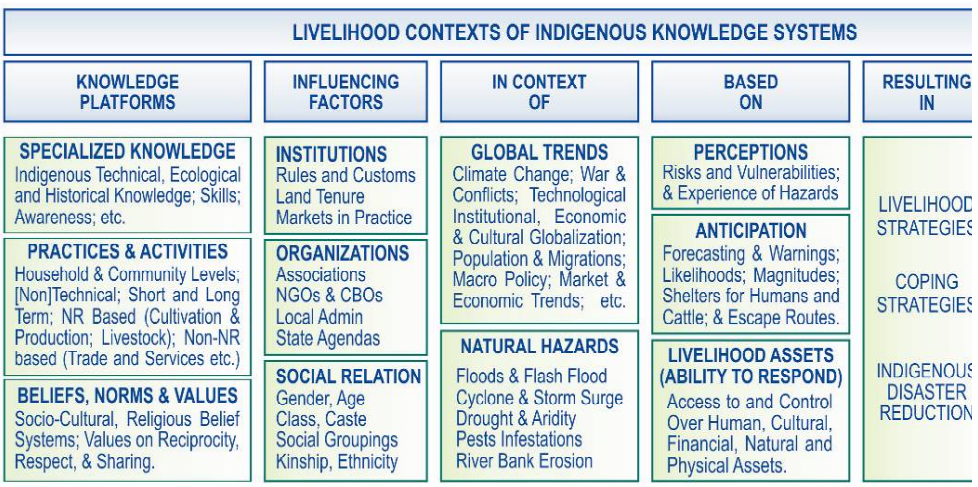

Figure 1.2: A Framework for Understanding Indigenous Knowledge and Coping Strategies for Disaster
Modified and Adopted from DFID (1999) and Ellis (2001) and Gardner and Dekens (2007)

Indigenous knowledge is compiled through cumulative and collective experience, while it is checked, validated and revised daily and seasonally through the annual cycle of activities performed by local people. This knowledge of the environment is gained through ongoing intimate contact with resources. It implies an intuitive mode of thinking that emphasizes emotional involvement and is rooted in a social context that sees the world in terms of social and spiritual relations between all life forms. Relations based on reciprocity and obligations towards both community members and other life forms and communal resource-management institutions are based on shared knowledge and meaning (Figure 1.2).

Knowledge of how vulnerable people respond to a threat is both valuable and essential. External interventions can then be built on these strategies. Natural hazards are not new and people have been living in hazard-prone areas for centuries – in some cases for thousands of years. They have, inevitably, devised their own methods for protecting themselves and their livelihoods. These methods are based on their own skills and resources, as well as their experiences. Their knowledge systems, skills and technologies are usually referred to as 'indigenous knowledge'.

The application of indigenous knowledge in the face of hazards and other threats is referred to as a 'coping strategy' (also sometimes known as an 'adjustment' mechanism or strategy, and in some circumstances as a 'survival' strategy). The choice of skills and resources to be applied varies according to the nature of the hazard threat, the capacities available to deal with it, and to a variety of community and individual priorities that can change during the course of a disaster.

Indigenous knowledge is wide-ranging. It includes technical expertise in seed selection and house building, knowing where to find certain wild foods, economic knowledge of where to buy or sell essential items or find paid work, and knowledge of whom to call upon for assistance. People's resources also include labour, land, tools, seeds, food stocks, animals, cash, jewellery and other items of value. These can be used, bought, sold or requested by calling upon obligations from family, friends or neighbours, depending on circumstances.

Indigenous knowledge related to coping in response to natural disasters has significant implications for planning, disaster reduction and management in Bangladesh. Indigenous knowledge of coping with disasters is crucial for the planning process, because it contributes to decisions on how the future should be different from the present, what changes are necessary and how these changes should be brought about (Lee and Mills, 1983).

This study aims to provide policy makers with indigenous knowledge related to coping strategies, along with its understanding of hazard types and socioeconomic groups, the use of diverse strategies in different ecological settings, the impediments to the use of existing facilities (such as costs, distance, staffing, education, hazard causation beliefs and local power), the perceived quality and appropriateness of services rendered and the impact of public policy actions.

LIVELIHOOD RESOURCES AND THE ABILITY TO COPE

Poor people cope, while rich people manage.

– Anonymous

Coping implies much less control over a situation than what is usually implied by the term 'manage'. Coping strategies are closely related to resources and assets. The ability to generate coping responses is therefore subject to the availability of livelihood resources that individuals and households have access to and control over.

Livelihood describes the means of living or sustenance. An economic definition of livelihood could be the organization of productive resources of households to maximize their standard of living. In other words, the concept of livelihood includes assets and capabilities along with activities or strategies in the productive resources; as Chambers and Conway said,

"Livelihood comprises the capabilities, assets, and activities for a means of living" (1992: 7). By capabilities, they mean something akin to Sen's notion of a set of alternative beings and doings that a person can achieve with his/her economic, social, and personal characteristics (Dreze and Sen 1989; Sen, 1993; 1997). Assets comprise several components. Some represent the economic categories of capital, while others are claims and access to resources. Generally, five categories of assets are identified as contributing to livelihoods. These are natural assets, physical assets, human assets, financial assets, and social assets (Scooner, 1998; Bebbington et al., 1997; Bebbington, 1999; Carney, 1998; Serageldin and Steer, 1994).

Interactions between people in markets, government and civil society provide access to resources or/and development of assets into commodity bundles (Sen, 1981; Evans, 1996; Bebbington, 1999). Institutions play a crucial role in livelihood dynamics. Institutions, market and assets interplay in livelihood dynamics. Access to natural assets such as land, financial assets and social organizations is defined by rules and social norms (institutions). The value of the flow of benefits from productive assets is determined by market forces. By impacting transaction cost, institutions can make markets more efficient or less efficient. Institutions also affect livelihoods directly. State policies on social security directly affect livelihood outcomes. Conversely, changes in livelihoods might make some institutions redundant and others necessary. An understanding of these and other relationships between assets, institutions, markets and livelihoods becomes important in unravelling the different dimensions of stable livelihoods (Figure 1.2).

The ability to pursue different livelihood strategies is dependent on material and social, tangible and intangible assets that people have in their possession. These may be made up of personal capabilities, tangible assets (e.g. material resources) or intangible assets (e.g. rights and access) (Chambers and Conway 1992: 10). At any scale, livelihoods are composed in complex ways, with multiple and dynamic portfolios of different activities, often improvised as part of an on-going 'performance' (Richards 1989). Creating livelihoods, therefore, entails combining resource endowments that people have access to and control over. Accessibility to resources has a significant bearing on people's capacity for self-protection and their ability to cope with disastrous situations.

This research is an empirical unfolding of this framework. It may be noted that livelihoods are conditioned by extra-local factors. Therefore, understanding the micro-macro linkages is important in the quest to obtain a comprehensive understanding of the factors and processes that condition livelihood and coping strategies.

PROACTIVE AND REACTIVE COPING

What is the main objective of coping? The ultimate goal of a household is to smooth consumption. Coping strategies are pursued by communities as means not only to ensure future income generating capacity (i.e. livelihood), but also to stabilize subsistence levels of food consumption under conditions and footprints of prior and ongoing disaster impacts. Natural disasters, therefore, affect the coping behaviour of the individual, household and community at different phases including before, during and after exposure to any potential hazards.

In their efforts to cope, people can adopt one or more strategies at the same time to manage variability in both space and time. But they do calculate the marginal benefits and costs of adopting different strategies. But people do not live by maximizing output efficiency (physical quantity). Their goal is not to maximize gross margin or net income, either. Rather, they try to minimize risk to an acceptable level by risk-

> Livelihoods also imply a complex web of risk diversification, social networks and coping strategies.
>
> –WFP 1998

spreading measures, while securing subsistence requirements. Coping responses to risks and uncertainty necessarily involve continuous and creative coping practices in livelihood strategies.

People adopt coping strategies in response to both the perceived risk environment and shocks to their livelihoods. They have to deal with the expenses related to their expectation (ex-ante costs) and occurrence (ex-post costs) of such events. Traditional coping strategies may be divided into proactive risk coping practices and reactive loss minimizing coping mechanisms (Walker and Jodha 1986).

Ex-ante or Proactive Risk Coping

The literature on traditional risk analysis is diverse. Von Neuman and Morgenstern (1947) have developed the expected utility approach. Markowitz (1959) and Tobin (1958) developed the portfolio theory. Markowitz (1959), Baumol (1963), Hanoch and Levy (1969), and Hadar and Rusell (1969) were pioneers in developing various risk efficiency criteria. Arrow and Pratt (1964) provided interpersonal comparisons of risk aversion and contributed importantly to empirical analysis of risk attitudes. Anderson, Dillon and Hardakar (1977) have further developed agricultural decision analysis under risk.

The outcome of livelihood strategies may be viewed in terms of income received or consumption achieved by households (Ellis, 2000). However, it could also be affected adversely by the presence of livelihood risks. Livelihood risk is defined as the likelihood of occurrence of (external) shocks and stresses including their severity. When livelihood is faced with risk, households may develop strategies to overcome the risk. These patterns of coping with risk involve a succession of responses to increasingly severe conditions (Jodha, 1975; Cutler and Stephenson, 1984; Shipton, 1990 cited in Webb and von Braun, 1994).

Frontier people have indigenous ways of managing disasters in everyday life that do not depend on scientific models of risk management. Peoples' risk response involves identifying the range of coping options for managing the risk, evaluating those options, and selecting coping responses. For our general conceptual understanding of people's coping strategies, we can classify[1] them in terms of the purposes and objectives of coping with risks by the options of avoidance, transfer, or reduction of likelihood or consequence (Figure 1.3).

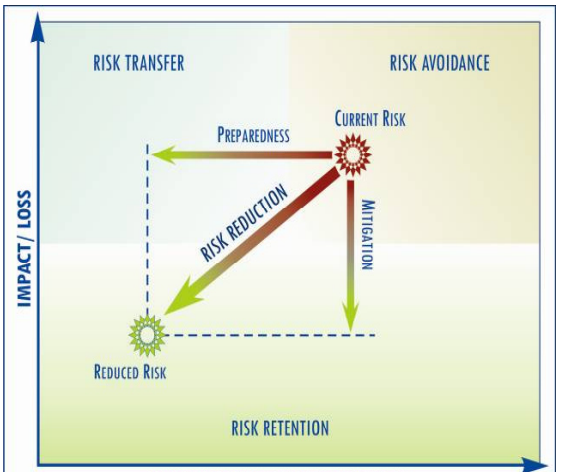

Figure 1.3: Alternative Options in Ex-ante (Proactive) Risk Coping

Risk Avoidance: People cope with risk by avoiding or refusing to undertake an activity where the risk seems too costly. They avoid risks by not proceeding with an activity likely to generate risk for them.

Risk Reduction: Coping may aim at risk reduction or prevention (loss control) by using various strategies or methods to reduce the possibility of loss occurring. Diversification is the most common example of indigenous risk reduction measures found in rural Bangladesh. Actions to reduce or control likelihood can include inspection and process control, investment and portfolio management, preventive maintenance and technical innovation. Actions to reduce or control consequences, meanwhile, can include contingency planning, contractual arrangements,

1 This classification is done to understand the different coping behavior of people but not necessarily mutually exclusive, or appropriate in all circumstances.

portfolio planning, engineering and structural barriers (plinth raising), separation or relocation of activities, building social networks and relations and so on.

Risk Transfer: People also transfer risk by bearing or sharing some part of the risk with other people. This can include sharecropping. The transfer of a risk to other stakeholders, in whole or in part, means that the stakeholder transferring the risk has acquired a new risk, viz. that the person to whom the risk is transferred may not manage it effectively.

Risk Retention: This option is selected when people perceive and expect a low degree of loss without reference to probability. Instead of generating coping responses, people adopt a contingency planning.

Ex-post or Reactive Loss Minimizing Coping

Loss minimizing reactive coping strategies include farmers' responses to lower-than-expected crop production caused by natural hazards. Reductions in crop production can be compensated by various means, including changes in diet, off-farm and non-farm income, sales of assets including productive assets, and seasonal migration. But loss management activities also require good health, good physical condition, a sufficient intake of energy for work and, above all, access and entitlement.

The lack of access to formal financial and insurance markets makes households develop schemes to deal with shocks – both idiosyncratic and systemic. This lack of access has a negative influence on the efficiency of the household (Ray and Bhadra, 1993; Fletschener and Zepeda, 2002; Chavas, Petrie and Roth, 2005).

FRAMING THE RESEARCH ISSUES

Problem Statement

Bangladesh has sustained significant progresses as a developing economy in recent years, but its growth has frequently been challenged by numerous natural and socioeconomic processes. Other factors – such as the deltaic formation history and low-line coastal morphology – have turned Bangladesh into the most disaster prone region on earth and highly susceptible to the impacts of climate change. The situation is made worse by the multiplying effects of high social vulnerabilities. Inadequate governance, weak institutions, relative deprivation, exploitation and denial of fundamental human rights including highly polarized access to resources through commercial and industrial entities and vested interest groups are the defining characteristics of a typical existence in Bangladesh, like many other post-colonial developing countries. Failure to regulate these violations is also related to poor governance that is also responsible for failure to ensure access of poor communities to common resources (Figure 1.4). Additionally, a doubling of the country's total population in the last 30 years has brought a sharp imbalance in the man-resource (particularly land and water) proportionality.

The Bangladesh economy is highly dependent on agriculture. A major constraint for the sustainable and stable growth of food production in Bangladesh is the fact that various natural calamities have made farmers vulnerable to crop failure and food scarcities, thereby accelerating poverty. With this backdrop, the ability to respond, cope, adapt or recover from overexposure to natural hazards has emerged as the central question of survival – the core challenge for a large part of the population. There is a long history of coping with critical fragile conditions, which is an essential strength of disaster management in Bangladesh. Local risk management and coping strategies are proven effective, because people do survive. Therefore, the way farmers perceive and cope with risk needs to be explored and properly understood. But this endowed wisdom of community people, having the potential capacity for becoming the solid basis of sustainable livelihoods, has not, until now, been systematically studied and documented.

The people affected by hazards respond in different ways within the same locality and across localities. So, from both a practical and

academic point of view we need to know why some populations are more vulnerable than others. There remains a serious gap in our understanding of how individuals cope with stress under different contexts. Attempts to increase sustainable productivity in the rural economy, however, need to be based on a sound knowledge of coping strategies, responses to risks and decision-making behaviour of rural agricultural communities.

Reducing the threat of hazards and creating enabling conditions for rural economic growth demands a thorough understanding of perceptions, traditional principles and coping strategies pursued by the community people under different local conditions and scenarios. Among these attempts to cope with and survive adversity, the success stories need to be described scientifically and broadly and effectively disseminated. The focus of this research remains on how traditional coping mechanisms of the rural poor function in response to continuing vulnerabilities to the livelihood systems brought about by natural hazards.

Purposes and Objectives

The purpose of this research is to explore the coping strategies, or traditional risk management systems, that have evolved locally, are culturally sensitive and are used to reduce risks and the impacts of disasters. Peoples' risk perception and management strategies have bearings on the type of intervention measures that may be considered for replication across households and agro-ecological zones. The analysis and findings provide the basis for policy recommendations and may serve to improve interventions and make them more appropriate.

Responses to risk and coping strategies are diverse. People use different strategies for reasons other than their risk reduction effects. Resource endowments at the household level and decision-making characteristics, such as attitude towards risk, play a great role. However, the study will show that people respond to different risks and their coping strategies in complex situations. The main purpose of this study is therefore to explore the alternative ways in which hazards, risks and

LIVELIHOOD RESOURCES	FACTORS IMPACTING LIVELIHOOD RESOURCES				
	NATURAL	NATIONAL	MARKETS	COMMUNITY	
PRODUCTIVE CAPITAL	Increasing Variability & Climatic Extremes; Recurrent Exposure to Natural Hazards.	Weak Policies of Land Reforms Resulting Unequal Access to Land; Confiscation & Taxation.	High Price of Assets & Increasing Cost of Maintenance and etc.	Unequal & Restricted Access to Common Property Resources	Fac Acc Res of L
NON PRODUCTIVE CAPITAL *(savings and liquid assets)*	Pests Infestations; & Animal Diseases.	Ineffective Taxation Systems; Lack of Policy Provisions on Wealth Accumulation and Procurement, & Savings etc.	Volatility, Price Shocks, Rapid Inflation; Erratic Rural Financial Market	Eroded Rural Social Capital & Mechanism of Sharing Resources (e.g. Irrigation, CRPs)	Fra & Ent Ins
HUMAN CAPITAL	Disease Epidemics; Morbidity; Disability.	Inadequate Public Health Facilities; Unequal Access to Public Services; Ineffective Protection of Labour Rights.	Lack of Employment Opportunities; Unequal Access to Enhance Productive Capacities.	Gender and Ethnicity based Discriminations; Segmentation in Rural Labor Market and etc.	Er Ec du So
SOCIOECONOMIC & INCOME SECURITY *(farm & off-farm)*	Erosion of Livelihood Base due to Hazards & Climatic Variability	Shrinking Extension Services, Declining Subsidies on Inputs; Inadequate Safetynet Programs, Weak Governance & Institutions	Fluctuations in Market Pricing & Policies, Lack of Access to Credit & Diversification Options.	Forced and Bonded Labour, Stratification Social Inequality etc.	Dis and to F

Figure 1.4: Vulnerability Factors and Risks Associated to Livelihood Stability in Rural Bang

uncertainties might be reduced, and/or risk management and coping strategies strengthened.

The objective of the study is to examine in detail the coping strategies of vulnerable communities in Bangladesh to natural hazards. It aims to record established indigenous knowledge and non-erosive coping strategies that may have policy implications, and to highlight their potential in developing disaster resilient communities.

The specific objectives pursued in this research are, first, to develop an inventory of onshore coping strategies with the potential to be translated into adaptive capacity among rural communities in different agro-climatic zones. Second, it aims to capture the indigenous knowledge of early warnings and practices associated with anticipating or preventing imminent disaster events in local communities. Third, it assesses capacities vis-à-vis vulnerabilities, risk perceptions and associated preparedness responses by local communities to cope with pre-, during and post-disaster situations. And fourth, it identifies and recommends potential intervention areas (both for government and NGOs) to enhance community resilience and capacities in counteracting disaster situations by strengthening and replicating existing coping strategies.

METHODOLOGY AND STUDY DESIGN

"The production of knowledge and the generation of potential solutions should be carried out by those whose livelihood strategies formed the subject for research."

– Scoones and Thompson 1994

This section explores the different methodological tools, techniques and analytical approaches used by this study. Recent trends in development literature have emphasized the need to listen to people and encourage their participation in the process of change. Participatory Rural Appraisal (PRA) has gained wide acceptance as an efficient methodological approach to help elicit and share local and indigenous knowledge and problem solving strategies at the societal level. PRA guided the primary data collection process of this research, and enabled the research team to set shared priorities as well as potential coping strategies with the leadership of the community people.

Exploring the local context of coping strategies required close relations with local conditions, a high degree of sensitivity in understanding the vulnerabilities of different groups and an in-depth knowledge of the local area. Such participatory approaches are believed to have increased the understanding of changes and variability at various scales encountered by communities in the face of natural disaster. Moreover, the nature of this research required insights into the attitudes, beliefs, knowledge and perceptions of the target population. Again, local communities and other actors and stakeholders are differently positioned in the society and each possesses a unique understanding of hazards. The way that risks are perceived and responded to is based on educational background, gender, age, historical and personal experience, attitudes and behaviour influenced by their environments. The ways people react to a hazardous environment are based on values and preferences. Perceptions of risk built on social traditions are also affected by many factors.

With these tasks and priorities, the research has drawn largely on the traditions of qualitative methodological and epistemological heritage. We made use of qualitative investigation framework to produce descriptions of situations, events, and people-systems interactions (Casley and Kumar, 1988). In this way, capturing attitudes, beliefs, knowledge, perceptions and responses to risk situations and strategies for loss minimization have been accomplished by encouraging interactive participation. The following discussions, however, begin with activity planning to generate the relevant data and continue with brief descriptions of the analytic PRA tools used to unveil the local processes at work in the research sites.

The Study Design

This study has been systematically conducted and consists of activities categorized under

several steps (Figure 1.1; Annex 1). The major steps in research are discussed here to provide a clear overview of the validity, reliability and representativeness of the collected data, and the corresponding analytical processes followed. This was necessitated by the available resources and period within which the project had to be completed.

The discussion then goes on to outline the methodological grounding of this research and, based on this frame of reference, we developed corresponding strategies, tools and techniques to capture the field dynamics. The major challenge was to address the complementarities between the spread and coverage of the research tasks, and the limitations of time and resources. We, however, resolved this challenge by adopting qualitative methods to grasp situations, events, and people-systems interactions.

The Research Team

The research was carried out by a core team that travelled to all target districts. This core team consisted of the principal investigator, two consultant researchers (one disaster reduction expert and one social anthropologist), and two research associates. Altogether, ten research assistants (6 males and 4 females) from a range of backgrounds (anthropology, sociology, geography, folklore, public administration, population sciences and agricultural sciences) and with diverse methodological and epistemological expertise were recruited and trained to conduct fieldwork. The research assistant received extensive training for five days, including a one-day field visit. At each research site, two research assistants conducted the research activities, supervised by one or two members of the core team.

Local government, Upazila administration and local NGO personnel were also involved and helped to facilitate the introduction of the team within the community. They also contributed to a better understanding of the local environment. In Bandarban District, we recruited two interpreters as translators to facilitate communication with the local indigenous respondents.

Review of Secondary Information

Research activities began with an extensive review of the existing knowledge base. Substantial secondary material, including literature and other information, collected from visiting different organizations and from internet resources, were appraised to conceptualize and problematize the research issues, concepts and concerns.

In order to build further on the prior experience of the research team, the review of secondary sources also included information on empirical field situations in the selected districts. These included information on crop production and cropping systems; animal production, utilization and management; credit and marketing; and an assessment of the study areas by natural or physical, socioeconomic and demographic characteristics. Information was also gathered on livelihood support systems and associated risk factors from a temporal perspective of research study locales. Information on the production constraints and opportunities was gathered from governmental and non-governmental sources. The information areas and types we have reviewed were:

- ☐ The available reports of Community Risk Assessment (CRA) of CDMP on the selected Upazilas.
- ☐ Demographic and population information (e.g. age, sex, ethnicity, housing structures).
- ☐ Broad range of social and economic issues in the study areas (e.g. climate data, geographic location, water source, sanitation, sources of income, consumption patterns, poverty levels, use of services).
- ☐ Livelihood support systems and associated risk factors from a temporal perspective. Information on the production constraints and opportunities was also gathered from governmental and non-governmental sources.
- ☐ Well-being, economic status, living environment, work, quality of life, health issues, life satisfaction, community and social supports.
- ☐ Social policy issues (e.g. inequalities, poverty, social capital, access to services social and health). Possible causes and consequences of social, economic, political, environmental changes.

Developing Tools and Techniques

The research made use of both qualitative and quantitative data. The quantitative part is anchored in the review of secondary sources. However, the study is largely founded upon and guided by qualitative research methods. The inferences drawn from the qualitative investigations are supported by quantitative data where necessary. All required tools and techniques were developed by analyzing the secondary information collected at the start of the research. We also conducted initial FGSs and expert interviews and analyzed those responses to guide the development of tools and techniques as well as selecting the research areas.

Qualitative research methods were used to collect, validate and test the reliability of primary data collected from the field. Data collection tools in the form of checklists were developed for different techniques, i.e. Key Informant Interview (KII), Participatory Learning Workshop (PLW), Group Discussion (GD) and Semi Structured Interview (SSI).

Pre-Testing and Finalizing

The checklists were pre-tested in two field sites near Dhaka. Two villages in Kaliakoir, Tangail and Sadar, Gazipur were selected for pre-testing. The research team conducted group discussions, key informant interviews and in-depth interviews with a representative section of stakeholders, and with crosscutting groups such as women and disabled people. The open-ended questionnaires and checklists were sent to CDMP for their expert opinion. The tools and techniques were finalized in a meeting with CDMP disaster reduction experts

Area Selection

To document the types and differences in coping strategies and capacities, within and between regions and ethnic groups, the research was founded on extensive fieldwork conducted in fourteen districts. The selection of districts was based on their vulnerability to high frequency and large-scale hazards. The study was conducted in unions distributed throughout these districts. Unions and villages were selected according to a set of indicators designed to reflect their diversity in different contexts, including (1) prevalence of the main hazards; (2) frequency of hazard exposure; (3) ethnicity of the population; (4) socio-economic indicators – a significant number of households suffering rice insufficiency; (5) existence of CDMP's partner NGOs; and (6) history of external assistance.

Based on these criteria, we selected Jessore, Satkhira, Shariatpur, Pirojpur, Bandarban, Bagerhat, Faridpur, Sunamganj, Sirajganj, Chapai Nababganj, Naogaon, Nilphamari, Gaibandha, and Cox's Bazar. The research team made field visits in Natore and Rajshahi districts, in addition to the selected districts, to investigate details of two different coping strategies.

The Fieldwork

The fieldwork for primary data collection was carried out over a period of 12 weeks, between the second half of February and the first half of May 2008. The fieldwork was conducted in four consecutive phases. Collection of data from primary sources started in the southwest area of the country.

The first phase continued for two weeks during the second half of February and included Jessore, Satkhira, Pirojpur, Bagerhat, Shariatpur and Faridpur districts. The whole research team visited Keshobpur, Jessore and continued fieldwork for three days. Research assistants were divided into pairs and spread over different sites in Jessore district. Every day, team members shared their experiences as well as problems encountered in evening discussion sessions. On completion of the fieldwork in Jessore, the research team was divided into five groups, each composed of two research assistants and a core team member as supervisor, and the groups were assigned to fieldwork in the other five districts.

The fieldwork was extended in the second phase to Sunamganj district in the northeast and Sirajganj, Gaibandha, Nilphamari, Naogaon, Nawabganj, Natore and Rajshahi districts in the northwest for six weeks during March and the first half of April


NILPHAMARI
GAIBANDHA
NAOGAON
NAWABGANJ
RAJSHAHI
NATORE
SIRAJGANJ
SUNAMGANJ
FARIDPUR
SHARIATPUR
JESSORE
PIROJPUR
BAGERHAT
SATKHIRA
BAY OF BENGAL
BANDARBAN
COX'S BAZAR
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2008. The third phase was conducted in Cox's Bazar and Bandarban districts, in the southeast. After initial screening of field data, the core team revisited and recaptured primary data from some research sites in Naogaon and Nawabganj districts. That constitutes the fourth phase of fieldwork, which took place during second week of May 2008.

Data Collection Strategies

The data collection strategies prioritized the reproduction of reality as perceived by the communities. PRA tools were applied to facilitate data collection and analysis as products of a joint enterprise between the communities and the research team. PRA helped involve the communities in investigations, diagramming and mapping out the constraints, preferences and priorities. It also empowered villagers by encouraging them to take the lead in the investigation and analysis (Chambers, 1993). Rather than answering a stream of questions that could have been influenced by the values of the researcher, the local people presented their ideas in ways they could discuss, modify and extend if they were empowered.

Analysis, Appraisal and Assessment of Coping Strategies

The purpose of qualitative inquiry suggests that the process of data collection is not an end in itself. The final activities of qualitative inquiry are analysis, interpretation and presentation of findings. One challenging task for the research team is to extract useful information from the massive amount of data, reducing them to manageable forms, identifying their significance and constructing a framework for communicating the essence of the messages they contain. Various strategies for qualitative data analysis were followed and applied in drawing conclusions and verifying the magnitude of the problem. Guidelines were followed in analyzing the collected data. These guidelines and procedural suggestions, however were not necessarily static.

The research attempted to explore the production possibilities and relationships for each of the coping strategies in order to understand the potentialities and prospects at the conceptual scale. Productive efficiency was achieved when the system operated at its production possibility frontier. This took place when production of one output was achieved at the lowest cost possible. All points, therefore, on the production possibilities were points of maximum productive efficiency. The assessment developed a high-level understanding of efficiency strengths and identified opportunities to improve efficiency. The criteria below were developed to assess each of the coping strategies.

This publication presents a collection of 68 indigenous practices. The cases were chosen based on origin of the knowledge, its relative level of adaptation over time, its relationship to local skills and materials, its success in surviving or coping with disasters over time, and its applicability to other societies facing similar situations.

Productivity

The utilization of resources has been analyzed in terms of gross efficiency, i.e. total input-output ratio, and the extent to which the coping strategy addressed the prevailing risk environment and/or impact situation. Does it generate efficient utilization of resources leading towards the highest possible output? The indigenous technological solutions have been explored to understand whether it has sufficed on its own and fostered efficient use of resources.

Another significant point of analysis remains with the coping strategy's success in stabilizing livelihoods by generating diversification and alternative options. The productivity of the coping strategy has been assessed in terms of its positive effects on creating employment opportunities and, consequently, on livelihood resilience. The coping strategy's optimization of production possibilities has been analyzed by comparing its optimal production level in relation to other alternatives options available under similar conditions.

Stability

Stability refers to the reliability, feasibility and viability of a coping strategy. The extent of feasibility

and viability of a strategy has been assessed in the local community context. This appraisal includes the relevance of a coping strategy's activities and outputs in terms of producing the desired effects and intended results in reducing risks or impacts.

The social feasibility included a coping strategy's adequate sensitivity to everyday activities related to life chances, attitudes, values, perceptions, social relationships and community networks. The technical, governance and planning feasibilities of a coping strategy have been analyzed by addressing issues such as the adoption of a contingency plan, the performing unit's (individual, household or community) capacity to manage risk situations centred on their practice, and the determination of acceptable risk levels for different structures (if any) for implementing the coping response.

Equitability

The selected coping strategy was expected to provide fair solution for a given hazard risk, while the benefits are distributed equitably and are accessible to all those in similar circumstances. The equitability of a coping strategy is measured to determine the distribution and sharing mechanism of its outcomes.

We tried to understand whether a coping strategy avoided producing or transferring risk to another area, or to different sections of a community, particularly towards poorer groups, and/or non-beneficiaries, either intentionally or unintentionally. We also explored its sensitivity to gender relations, its equitable accessibility by a cross-section of community people, including the most vulnerable groups, and the smooth transmission of the skills, knowledge and technical expertise to all groups within a community.

Sustainability

The sustainability of a coping strategy was assessed by its potential to improve the quality of human life without any adverse effect on the carrying capacity of supporting ecosystems. Appraisals were also made over whether a coping strategy had any long-term negative impact on any of the components of livelihood assets, e.g. natural (land, forests, water, common-property resources, flora, fauna); social (community, family, social organizations, organizational networks); financial (wage employment, savings, credit, investments); human (education, health, nutrition) and physical (roads, markets, clinics, schools, bridges).

Scope and Limitations of the Study

Area Portrayal and Coverage

Time and resource constraints, as well as methodological considerations, allowed the study to cover 55 Unions in 35 Upazilas and16 districts. These were chosen to represent some of the most vulnerable and risk prone populations/ communities/regions in Bangladesh. Given the complex diversity of livelihood strategies, hazard profiles and agro-ecological zones, this coping profile cannot, perhaps, be considered as comprehensively representative of the whole of Bangladesh. As already noted, we over-sampled the districts identified in the CDMP risk mapping as most hazard prone in order to identify indigenous knowledge related to coping and good community practices in the most vulnerable communities. The results of this study, therefore, should not be seen as a very comprehensive profile of communities' thresholds in generating coping responses, or of their ability to respond to different hazards throughout Bangladesh.

Respondents and Representation

Sample sizes, because of limited time and resource constraints, remained relatively small *vis-à-vis* the geographic coverage. That limits the extent of confidence in generalizing the scope of analysis and in capturing the full range of variations and diversities.

Coping with Seasonality

Seasonality added two limitations to the study. First, the fieldwork was carried out over three months during the pre-monsoon season. Therefore, the rest of the year remained largely out of this study's primary observation. Second, documentation of coping strategies did not necessarily follow their respective occurrence during different seasons.

Conceptual and Operational Scoping

Stabilizing consumption remained the central goal in pursuing coping responses to disaster. A variety of strategies was adopted, sometimes simultaneously, as people mobilized diverse resources to manage disasters. But when the magnitude of a hazard impact was beyond the capacity of a community to cope, some mechanisms became inadequate. The real crisis emerged when vulnerable communities shifted from reversible to irreversible coping strategies that cut into their long-term options and future ability to respond to hazards. These were erosive coping responses that destroyed or reduced the asset stock of families and led to more permanent impacts. Erosive coping included disposal of productive assets, shark loans, sale of large livestock, land and tools, bonded labour and child labour.

This is often followed by complete destitution of marginal people, leading to dependency on charity, out-migration, and in extreme cases prostitution, or even sale of children. Considering the irreversible or permanent damage of these erosive coping mechanisms, this research deliberately excluded such responses from the inventory of good community practices.

Reporting and Presentation

The categorization of coping strategies, or good community practices, by theme became the central challenge of reporting and of organizing the structure of this publication.

Each case presented in this book follows the same general format, and includes a brief precise, background information to orient the reader to community demographics and location, an explanation of the initiative or event in which the community successfully used its knowledge, a description of the goal and objectives of the practice, a description of outcomes and activities, the key lessons learned from this practice and, finally, an assessment of the potential for replication in similar conditions. While each contribution is distinct, uniform organization allows the cases to be analyzed and discussed as a group, comparing and contrasting these different elements.

Framing the Chapters

Chapter 2 aims to explore indigenous knowledge and coping strategies found in the flood prone regions in Bangladesh. Its discussion includes values, preferences, and normative judgments, i.e. perception guided people's coping responses.

It then discusses good community practices found in regions vulnerable to flash flooding, water logging, salinity intrusion, cyclone, drought and wild life disturbances. Finally, Chapter 10 attempts to scale up some recommendations to increase the resilience of communities against disasters with reference to community-based disaster management policies and programmes in Bangladesh.

CHAPTER 2

COPING IN FLOOD PRONE REGIONS

Chapter 2
Coping in Flood Prone Regions

FLOOD SCENARIO IN BANGLADESH

Bangladesh experiences frequent flooding. The monsoon floods are a consequence of the country's low topography and its location at the end of the world's most concentrated river and draining network system.

Upstream rainwater beyond the national border often results in reduced channel flow and consequent overland runoff water. Factors in catchment areas beyond the national borders lead to reduced channel flows and consequent flooding of land. These factors include heavy rainwater, river siltation, while human intervention (such as construction of barrages and protective works along the banks of the river and deforestation in the upper reaches of the rivers) are not only brining accelerated water flow downstream, but are also causing deposition in river beds.

Other types of flood include flash floods, caused by the onrush of hilly rivers in Eastern and Northern Bangladesh, and storm surges induced by coastal floods.

The history of floods goes hand in hand with the history of land formation in Bangladesh. Floods are annual phenomena with the most severe occurring during July and August. Regular river-floods affect 20% of the country – increasing to 68% in extreme years. Approximately, 37%, 43%, 52% and 68% of the country is inundated with floods of return periods of 10, 20, 50 and 100 years respectively (MPO, 1986). About 68% of the country is susceptible to flooding, while 25% to 30% of the area is inundated during times of normal flooding (Draft National Plan for Disaster Management, 2007).

RIVER EROSION SCENARIO IN BANGLADESH

Morphologically, Bangladesh's rivers are highly dynamic. The main rivers are braided and form islands or chars, where many people live. The rivers erode every year – often several times a year – and that has dramatic consequences for the lives and livelihoods of people living in those areas. River bank erosion is a form of hydraulic action, whereby the force of the water wears away the riverbank from below. Erosion may also be increased by factors such as redirection and acceleration of flow, removal of protective vegetation from banks, intense rainfall events, and inundation of bank soils.

A 1991 study concluded that 100 of the country's 462 administrative units were subject to some form of riverbank erosion; and of those 35 were serious, affecting about 1 million people every year. Around 10,000 hectares of land are eroded annually by rivers (NWMP, 2001). A CEGIS study in 2005 showed that bank erosion along Padma River between 1973 and 2004 claimed 29,390 hectares, while 87,790 hectares were lost along the Jamuna River from 1973 to 2004.

Erosion accelerates acute poverty by producing a significant number of environmental refugees.

OVERVIEW OF THE RISK ENVIRONMENT

In recent years, the frequency of floods has increased substantially, causing serious damage to lives and property. The 1988 flood affected about two-thirds of the country's total area. The 1998 flood, which remained for 65 days from July 12 to September 14, affected about 67% of the area. It caused 1,100 deaths, made 30 million people homeless, damaged 500,000 homes and caused heavy loss to infrastructure. This devastating flood had an enormous impact on the national economy, in addition to causing hardships for people and disrupting livelihood systems in both urban and rural areas. In 2000, Bangladesh faced an unusual flood over its usually flood-free south western plain, which also caused loss of life and massive damage to property. In 2004, floods inundated about 38% of the country (WARPO, 2005) and some 747 people lost their lives. Around 2,500 kilometres of embankment were damaged and 74 primary school buildings were washed away[2].

Flooding is the most severe hazard in Bangladesh in respect of frequency and the magnitude of damage caused. Flooding affects every aspect of livelihoods, including natural resources, physical resources, social resources, economic or financial resources and human resources. Flooding is seen by Bangladeshi people as the most important disaster event, ahead of drought and cyclones. The 1998 flood affected about 73,000,000 people, and is followed in terms of people affected by the floods of 1974, 2004, 1984 and 1987, which affected 38,000,000, 36,000,000, 30,000,000, and 29,700,000 people respectively. The 1983 drought affected 20,000,000 people.

Flooding also accounts for the most economic damage caused. The 2004 flood caused economic loss of about US$7,000,000. The 1988 flood and the 1998 flood caused economic loss of about US$2,137,000 and US$2,000,000 respectively. The 1991 cyclone brought an economic loss of about US$1,780,0002.

River bank erosion is experienced every year. It causes massive loss of land, settlements, roads, embankments and other infrastructures. In 2004 it destroyed 702 hectares of land, 139 hectares of settlements, 160 miles of district roads, 571 miles of upazila roads, 248 miles of rural roads and 3,724 miles embankment in Sirajganj district alone (CEGIS, 2005).

PROFILING THE STUDY AREAS

This research yielded significant ethnographic information on the episodes of good community coping responses related to flood and river bank erosion from various flood plain areas (Shariatpur, Faridpur, Sirajganj, Natore, Gaibandha, Sunamganj, Pirojpur) and coastal areas (Cox's Bazar). The survey areas included 23 villages in 19 unions in 11 upazilas of eight districts. [See Annex XX]

The study revealed that the areas have faced various, year-round hazards. Floods and river

2. www.preventionweb.net

bank erosion was found in Shariatpur; floods and storms in Faridpur; floods, with sand deposition and river bank erosion in Sirajganj; floods in Natore; floods with sand deposition and drought in Gaibandha; floods and flash floods in Sunamganj; floods and water logging in Pirojpur; and floods, flash floods, salinity, cyclones, storm surges and wild animal attacks in Cox's Bazar. Flooding is one of the most common hazards found in these districts and are observed from Ashar to Kartik (mid June to mid October). The study districts consist mostly of flood plain land, except Cox's Bazar, which is a coastal area with some hilly parts, and Sunamganj, which has some depressions, locally known as *haor* (water bodies). Among the selected flood-prone study areas, Gaibandha and Sirajganj districts lie along Jamuna River, while Faridpur and Shariatpur are on the Padma.

Flood and riverbank erosion makes livelihood assets such as agriculture and fisheries more vulnerable. In the same way, economic activities such as crops, vegetation, fish, water resources and livestock are also vulnerable and that can affects the mental health of communities. Floods destroy infrastructure systems, embankments and other institutional structures. Housing systems are also disrupted by flooding and riverbank erosion. Heavy rainfall and sand deposition hamper the agricultural process and massive damage of crops (e.g. paddy, jute, sugarcane, maize, potato, wheat, peanut, mastered seed, vegetables, spices, and onion). Flooding affects all sectors of human life.

COPING IN FLOOD PRONE REGIONS

We observed that people attempt to address risk problems ex ante. In this chapter, we discuss cases of good community practice on ex ante risk management, which often includes enterprise diversification. Using off-farm income to offset risk from farming is one way to diversify.

Flooding is the most severe hazard in Bangladesh according to the magnitude of damage it causes and by frequency. The impacts are cumulative and the effects are magnified at the local level.

It is critically important for scientists to understand the probability of flood and riverbank erosion events at various levels of intensity and duration. But the limited availability of data and its discontinuity means that Bangladesh cannot meaningfully provide a longer lead-time. Moreover, existing dissemination problem hampers flood and riverbank erosion forecasting. Indigenous indicators could help warning systems in this respect.

The risk associated with flood and riverbank erosion for any region is a product of the region's exposure to the natural hazard and the vulnerability of societies within the region to the event. Exposure to flood and river bank erosion varies regionally and over time. The vulnerability to flood is determined by livelihood components such as natural resources, physical resources, social resources, economic or financial resources and human resources. Land, settlements, embankments, roads and other infrastructure situated on the riverbanks are vulnerable to riverbank erosion.

People do not get fresh drinking water during floods, as tube wells remain under floodwater. Consequently, different coping strategies are utilized to supplement the need for water. These include communities raising tube well plinths so that floodwater cannot submerge them.

Rural people use mud stoves for cooking food and for fuel, they use pieces of dry wood, jute sticks, and shrubs, branches of trees, straws and the agricultural wastes collected at the harvesting time. During floods, they often face acute fuel crises. One response is the preservation of fuels.

Indigenous knowledge bases from the various study areas have been proven to help contribute to the community's ability to mitigate the impact of regular flood and riverbank erosion crisis. In general, the indigenous knowledge of housing structure reduces the vulnerability of flood and riverbank erosion. People grow various food grains such as chana, kaon, maize, pera, felon, in fallow and pocket lands, and plant vegetables around homesteads to reduce their

vulnerability. These practices help to ensure their food security. Communities also demonstrate alternative practices, such as cultivation of groundnuts, sugarcane, onions, banana, duck rearing, conservation and cultivation of kashban. These practices provide maximum utilization of land and bring maximum economic returns.

INDIGENOUS PERCEPTIONS, KNOWLEDGE AND EARLY WARNING

Flood Forecasting Scenario

The Flood Forecasting and Warning Centre (FFWC) of the Bangladesh Water Development Board (BWDB) was established in 1972. Flood forecasting is based on measurements of rainfall and river water levels, which are used to interpret the present flood situation and generate flood forecasts. The hydrological data collected through the monitoring are entered into a numerical model, which forms a core component of the forecasting system. The measurements upon which the flood monitoring and forecasting depend comprise: a real time hydrological monitoring system covering Bangladesh; a data exchange agreement with India through which FFWC obtains additional rainfall and water levels measurements from outside its national borders; meteorological data from the Bangladesh Meteorological Department (BMD); and satellite and radar images. FFWC disseminates its forecasts to governmental institutions, relief organizations and local communities using a variety of media, including email, fax and the internet.

The weakness of present flood forecasting system in Bangladesh requires significant attention to explore the need of the indigenous forecasting knowledge. The limited and discontinuous data of stream flow and rainfall available from outside Bangladesh cannot support a meaningful prediction to provide a larger lead-time. Some hydrometric data are sent to FFWC when water levels in some upstream rivers cross danger levels (or close to danger levels). But these data are not sufficient to extend the forecasting system beyond the country's geographical boundary (and are even not sufficient to investigate correlations among gauge stations inside Bangladesh area). Operational flood forecasting is highly dependent on reliable and timely data, which is at present collected manually from gauges. No quantitative rainfall forecasts are available in Bangladesh. Moreover, flood forecasting dissemination system is not effective. Forecasts are made for up to 72 hours, which is useful only for the country's central region, as stations closer to boundaries are influenced by the subjective boundary estimates.

Due to the limited and discontinuous availability of data from outside, Bangladesh cannot generate meaningful predictions to provide a longer lead-time. Moreover, existing dissemination problem hampers the flood and riverbank erosion forecasting. Indigenous indicators may help the warning system.

Communities are engaged in a constant fight for survival with flood and riverbank erosion. This has given them a great deal of knowledge, which them to control and manage the hostile environment. Experience has taught them to read nature and climate. Local people have multiple perceptions and that leads to multiple responses. People in all the study areas agree that flooding has become a recurring phenomenon, albeit of varying magnitude. Riverbank erosion is often linked with flooding.

Indigenous Indicators of Flood

Rainfall: People consider rainfall as an indicator of potential flooding. When the quantity of rainfall is relatively higher in the months of Ashar and Shraban (mid June and mid July), communities will

পূর্ণ আষাঢ় দক্ষিণা বয় ।	*Purna Ashar dakkhina bay.*
সেই বৎসর বন্যা হয় ।	*Sei batsar banna hayll*
আমে বান ।	*Amey ban.*
তেঁতুলে ধান ॥	*Tentuley dhanll*

Interpretation: If there is southerly wind round the month of Ashar, there may be flood in the year. Similarly a good mango harvest accompanies flood, whereas if there is good tamarind crop, there will be good harvest of rice.

often assume that flooding will follow. People have also developed a very good understanding and awareness of the consequences of untimely heavy rains in the months of Bhadra and Aswin (mid August and mid October), which they also see as a portent of floods. Most precipitation occurs in the rainy season, but rain can also start from Falgun and Chaitra (mid February and mid April). There may be heavy rainfall if the raindrops are bigger. Consequently, floods may remain longer and there will be greater river erosion.

Communities can forecast rainfall by considering indigenous indicators. By observing certain indicators, they can predict whether there will be rainfall. These indicators are

- Frogs begin to yell or croak together one or two days before rain. Sometimes, frogs croak when clouds are in the sky, because they understand the incessant rainfall. This is also supported by the simultaneous croaking of at least 20-25 frogs within a 10-minute period.
- Striped snakes emerge from their burrows.
- Both black and red ants climb trees and relocate their food and eggs.
- Insects (e.g. mosquitoes, flies) bite more frequently.
- When doves enter houses more frequently, people deduce that there will be rainfall within one or two days.
- The density of stars in the sky in the months of *Ashar* and *Sraban* (mid May to mid July) is indicative of rainfall.
- The formation of clouds in the southern sky is an indicator of rainfall. When clouds rumble, rain is expected within a short time. The colour of clouds can determine when it will rain. If the clouds begin to gather, there will be rain. When clouds darken, rain will begin to fall very soon, e.g. within 15-20 minutes.
- Then the tide of clouds runs from south to north is expected; there is no rainfall without such tide. If there are persistent, dark tides from morning to evening and the tides are dark, or appear with light yellow-red cloud, then persistent rainfall in the next 7/8 days is likely.
- Local people make deductions about rainfall by observing the behaviour of insects. For example, when centipedes are observed moving rapidly in the house, they infer that there will be rainfall within 2 to 3 days.
- Arum leave is a widely used method that applies in the new moon of the month of *Poush* (mid December to mid January). This method is used at night, especially after the *Maghrib (*evening) prayer of the new moon in the second part of *Poush*. Leaves are separated from their stalks. The selected leaves are named after the names of the Bengali months of the calendar. So each leaf will represent a month of the year. Even if not all months are to be tested there will be selected months and accordingly against each month, the leaves will be identified and named after the months of *Ashar, Shraban, Bhadra and Aswin* (mid June to mid October). The leaves are then covered by other leaves. The next morning, the amount of water collected in each leaf is measured and is

কোদালে কুড়ুলে মেঘের গা ।	*Kodaley kuruley megher ga.*
এলোমেলো বহে বা ॥	*Elomelo bahey ba *
চাষীকে বল বাঁধতে আল ।	*Chashi ke balo bandhtey aal *
আজ না হয় বৃষ্টি হবে কাল ॥	*Asman fara fara.*
আসমান ফাড়া ফাড়া ।	*Batas bahey chawdhara *
বাতাস বহে চৌ ধারা ।	*Krishak kheter bandho aail.*
কৃষক খেতের বান্ধ আইল ।	*Brishti haibey aij kail *
বৃষ্টি হইবে আইজ কাইল ॥	*Paushey garmi Baishakhey jara.*
পৌষে গরমি বৈশাখে জাড়া ।	*Pratham Asharey varbey gara *
প্রথম আষাঢ়ে ভরবে গাড়া ॥	*Khana bole shonohe shwami.*
খনা বলে শোনহে স্বামী ।	*Shrabon vador naiko pani*
শ্রাবণ ভাদর নাইকো পানি ॥	

Interpretation: If scattered pieces of cloud are blown by untrimmed winds; the farmers are to raise ridges around the plots. There will be rainfall either today or tomorrow. If the sky appears torn into pieces and wind blows all around, the farmers raise ridges around the plots, because of the indication of rainfall today or tomorrow. If there is hot in Poush and cold in Baishakh, then the beginning of Ashar will fill all ditches. Khana (the sayer) conveys her husband that there will be no water (rainfall) in Shraban and Bhadra.

believed to indicate the amount of rain that will fall in the corresponding months.

Colour of River Water: Communities sometimes predict what kind of flood the next rainy season will bring by observing the colour of water passing through the river after the rainy season. If the colour is muddy, they infer that heavy water is coming from upstream. The stability of this standing water is observed and if the colour and density of this muddy water increases then the flood and river erosion is likely.

বেঙ ডাকে ঘনঘন ।	*Bang dakey ghana ghana.*
শীঘ্র বৃষ্টি হবে জেনো ॥	*Shigra brishti habey jeno *
বৈশাখের প্রথম জলে ।	*Baishakher pratham jaley.*
আউশ ধান দ্বিগুণ ফলে ॥	*Aush dhan digun faley *
খনা বলে শুন ভাই ।	*Khana baley shuno bhai.*
তুলায় তুলা অধিক পাই ॥	*Tulay tula adhik pai *

Interpretation: Frequent call of frogs indicates immediate rain. The first shower of Boishakh produces double aoush. Knana conveys all that cotton grows more.

Cloud: People can predict that there is the possibility of flood if cloud is seen to move rapidly from west to east.

Jute Stick Used for Flood Measurement: Water level crossing 4ft is considered a warning and some people may consider leaving home for a nearby embankment. To measure floodwater, villagers sometimes use jute sticks in the month of *Ashar* (mid June to mid July). They have their own ways of assessing the water level and the rate of increase. They insert two jute sticks side by side in the soil when 1ft floodwater already exists. One is very long – about 6ft – while the other reaches to the level of water. This means the longer one indicates where the shorter one is. When the shorter one is submerged by the rising water, it is removed and a new one is placed, again at the level of water. Then they compare the new one with the older and they can assess the rate of increasing water level.

Ant movements: Communities predict a flood when they see groups of ants climbing trees in the month of Ashar (mid June to mid July).

Frog movements: When tree frogs emerge from their holes and get into people's houses or take shelter on a high place, this is considered an indicator of coming floods.

Wind flow: By observing the flow of the wind over the river, communities infer river erosion. When the river is full and a wind blows from north to south in the month of *Jyaistha* (mid May-mid June), significant river erosion is likely. An easterly wind, meanwhile, creates a strong current in the river, which causes erosion on a river's opposite bank.

Indigenous Indicators of River Bank Erosion

River current: In the months of Ashar and Shraban (mid June and mid July), river currents increase, causing erosion. Communities infer the amount of river erosion in a given period by the rate of erosion in a given day. This is based on many years' experience and observation. When the river is close to their home, the women begin to arrange the household belongings and furniture, when the month of Aswin (mid September-mid October) approaches them.

Wind Flow: Local people can forecast riverbank erosion by observing wind flow and direction. If there is a strong wind flow in March (mid Falgun to mid Chaitra), and a strong *shubble* (colloquial term for wind flow) in the month of Jyaistha (mid May to mid June) blows from north to south, erosion often occurs on the western bank. During June (mid Jyaistha to mid Ashar), a strong current is created in the river by easterly and northerly winds. As a result, the water of is directed to the south (from the north), which rapidly creates a strong current and increases riverbank erosion.

Rainfall: The indicators mentioned above suggest a forthcoming heavy flood. The reliability of those indicators is high. A water level higher than 4ft is considered a warning, and people start to consider leaving home for a safer nearby embankment.

People can predict riverbank erosion by observing rainfall. In the months of March and April (mid

Falgun to mid Baishakh), if the quantity of rainfall is relatively high, rain drops are relatively large, and the water appears muddy, heavy water is coming from upstream, which will increase river bank erosion. If the water level gradually increases to exceed the usual level accompanied with wind from the north to the south, it is understood that riverbank erosion will occur.

Youthful Strength of Rivers: The youthful strength of the river starts to gain from the end of the month of Jyaistha (mid May-mid June) and gains full momentum in the month of Ashar (mid June-mid July). During this time, a motion is created in the river by the easterly and northerly wind. As a result, the water is directed to the south, from the north, rapidly creating a strong current. This is thought to cause wide scale erosion.

Gull/Sea Gull's Movement: The possibility of riverbank erosion is predicted by the community people by observing the recurrent visits of groups of gulls/sea gulls during the months of Poush and Magh (mid December and mid February).

Ship or Ferries' Movement: The line through which ship or ferries cross frequently is the main flow line of the river and takes a very long time to deposit sands for the formation of chars. Chars form on the bank eroded by the river.

ভাদুরে মেঘে পূবে বায় । *Bhadurey meghey pubey bay.*
সেদিন বৃষ্টি কে ঘোচায় ॥ *Sedin brishti ke thekay *
চৈতে কুয়া ভাদরে বান । *Chaitey kua Bhadarey ban.*
নরের মুণ্ড গড়াগড়ি যান । *Narer mundu garagari jan *

Interpretation: If cloud in the month of Bhadra blows to the east inevitably, there is rainfall. Fog formation in the month of Choitra and occurrence of flood in the month of Bhadra bring forth famine in which people die of starvation.

River Bed: Local people can predict riverbank erosion by observing the riverbed. If the soil adjacent to the riverbed becomes steep and slides, the soils above are displaced and washed away. During this time, the depth of the river is at its maximum and the rate of erosion in the month of Aswin (mid September to mid October) is great. This type of erosion causes great harm.

Validity, Reliability and Lessons Learned

Indigenous indicators of floods can predict heavy flooding. The reliability of those indicators is high. Local people are conscious of forthcoming floods. They stay with flood until the water level rise of 4ft, because most of their houses are higher than 3ft above ground level. When the water crosses 4ft, they prepare to move away.

The reliability of the indigenous indicators of riverbank erosion is high. People observe the scale/rate of erosion and when the river is very near to their home, they begin to store their belongings and furniture and move to higher ground nearby – up to one kilometre away. Women are generally the ones that publicize the warnings. They claim that the warning system they use is perfect. Thus, they understand the rate of river erosion. If the flooded river continues to move closer, they will again shift to another safe place and in course of time, if that safe place is also eroded either they move to a town or a village further away.

Potential for Bridging with Early Warning System

Due to the limited and discontinuous availability of external data, Bangladesh cannot generate a meaningful prediction to provide a longer lead-time. Moreover, existing dissemination problems hamper the flood and riverbank erosion forecasting. Indigenous indicators may help to implement warning system effectively.

RESILIENT HOUSING STRUCTURE

FLOOD RESILIENT HOUSING STRUCTURE

Précis

Units	Location	Seasonality	Hazard
Union Upazila District	Naudoba Jajira Shariatpur	Falgun to Jyaistha	Flood & River Erosion

Prologue

Historically, Naudoba of Jajira upazila under Shariatpur, is vulnerable to devastating floods and erosion of the Padma River. People's survival and well-being are closely interlinked with this river. Floods are regular occurrences in these areas and are most severe during the month of *Ashwin (*mid September). Again, from *Shrabon* to *Ashwin* (mid July to mid September) much erosion occurs in these areas, displacing hundreds and thousands of people. These hostile conditions affect the lives and livelihoods of huge numbers of people and bring immense misery.

The Initiative

In order to cope with the regular flood and river erosion, people have structurally modified their earlier house-building patterns. The plinth of the modified house is higher than the plain land, and the house or its frame can be shifted to another safer place in times of extreme hazard. In addition, banana cultivation around the modified house is practiced by many people and this could lessen soil erosion. Different sizes of houses were observed in the areas. They have different names, including *Ekush bondho ghor* (14 cubits long, 7 cubits wide); *baish bondho ghor* (14.5 cubits long, 7.5 cubits wide); *sotero bondho ghor* (9 cubits long, 8 cubits wide) and *chobbish bondho ghor* (16 cubits long, 8 cubits wide). The strategy has been learned through trial and error over many years.

A GOOD PRACTICE

- ◊ It is a community based technology. The local people innovated it since long for saving their house and assets;
- ◊ The structure is made of cheaper locally available materials, has the advantage that the structure can be opened into pieces (roof, wall and plinth can be separated if needed) and can be carried to a safer place, and assemble again for use as house. This is especially essential when there is the hazard of river erosion approaching the community.
- ◊ As the technology is appropriate, environment friendly and locally developed, it is sustain-able.
- ◊ That the structure ensures and enhances the security of the vulnerable people has been a proven fact.
- ◊ The artisans for manufacture of such houses are locally available and the initiative is com-munity oriented and hence is lasting and adoptable for replication in any place in Bang-ladesh.
- ◊ Effectively enhances the safety of the population at risk.
- ◊ Already adopted & fitted to the local ecology.

Goal and Objectives

The goal of flood resilient housing structure is to reduce the vulnerability of natural hazards, especially flood and riverbank erosion. The flood resilient housing structure initiative aims at protecting the house from flood and riverbank erosion. When threatened by river erosion, the frame of the house can be moved to a safer place within a very short time.

Outcomes and Activities

Structural modification of the house is completed in a few steps. The first step is related to the development of the homestead by raising the foundation with mud. Then, pillars (wooden pillars are used most often) are set in the soil. These are previously soaked with coal tar and then covered with polythene. The second step is raising the wooden platform (pata-ton) at the bottom of the pillar. A two-foot gap is kept between the foundation and the pata-ton, which means pata-ton is fixed at two feet above the ground. The

third step is the job of a carpenter who makes the walls and roof of the house, using tin.

To ensure the longevity of bamboo and wood pillars, a special type of oil (locally called *maita* oil or *pora* oil) is used to polish the bamboo and wooden pillars. Before polishing, the bamboo and wooden pillars are kept for a period in the pond, under water.

Lessons Learned

Key lessons learned from this practice are:

- The technology is generated locally through years of observation and experimentation, which is simple and can be made with basic knowledge.
- It is a community-based technology. Local people participated in the whole process and shift the house when there is the hazard of river erosion approaching the community.
- The frame is made in such a way that it can be dismantled and shifted to the safer place within a very short time during the post hazard period. Again, when the hazard is over the houses can be shifted to its original place as and when needed.
- The materials and equipments are locally available and cheaper than other construction materials such as rods, cement and bricks.
- As the technology is appropriate, environment friendly and locally developed, it is sustainable.
- The artisans that manufacture the houses are locally available and the initiative is community oriented. It is therefore long lasting and can be replicated elsewhere in Bangladesh.

Potential for Replication

As the raw materials are available locally and the technology is easy and safer for emergent period for shelter, this type of house can be replicated in other places where people are vulnerable to hazards.

GO-NGOs structures are ideally suited to disseminating this technology. Indeed, the technology can be improved by NGO's initiative. GO-NGOs can help the poor people to make the structure.

RAISING PLINTHS

Précis

Units	Location	Seasonality
Union Upazila District	Kanchipara Fulchhori Gaibandha	Whole year but especially Ashar to Aswin during the flooding time

Prologue

The area lies in the char land about 10 km east of the district headquarters of Gaibandha. Three sides of area are surrounded by the river Brahmaputra. The ecology of the area is influenced by the river, e.g. the flow of current, soil erosion, river flooding, which engulfs the entire village and causes much damage on lives, livelihood and households. Local people are more concerned about their domestic animals, sometimes more than their own lives, for the domestic animals are main means of livelihood to

GOOD PRACTICE

- ◊ It is a community based technology. The local people innovated it since long for protecting domestic animals;
- ◊ Ensures safety of domestic animals and properties during flood;
- ◊ The place where mud is collected from for raising the plinth becomes a ditch which is again used as factory and storage of bio-fertilizer (locally called 'vehr") latter on;
- ◊ Enhances community's own capacity;
- ◊ Effectively enhances the safety of people at risk;
- ◊ It is used for different shed creeping vegetable & spices which ensure food security by meet-ing up the household demands;
- ◊ It is as environment friendly coping strategy as it has financial benefits.
- ◊ Already adopted by the local people since long and fitted with local ecology.

many of them. This concern is only addressed by their innovative mechanism, i.e. making scaffolds around a space somewhere in the homestead has greater implication to their socio-economic life.

The Initiative

In times of flood, communities put all the domestic properties together with the domestic livestock on a scaffold raised by three feet. After the floodwater recedes, they use this place as a plateau for spreading the creepers of gourd or pumpkin, bean or cucurbitaceous plants that give them another very valuable crop of vegetables.

Goal and Objectives

The goal of plinth raising is to reduce the vulnerability of community people to natural hazards, especially floods. The plinth raising initiative aims to ensure the safety of domestic livestock and family properties against floodwater.

Activities and Outcomes

First, some space is selected on a safe area of the homestead. The space is raised by three feet with mud. The area that supplied the soil becomes a ditch, which is used for storage of bio-fertilizer (vehr). Eight bamboo poles are fixed vertically, one at each corner and one in the middle of each side around the raised soil. Then bamboo sheets are placed horizontally along the poles and tied to the vertical bamboo poles. It takes only one day to do this work and another for the shed/roof (macha). This is done mostly by domestic labour or by short-term hired labour. The bamboos used for the scaffold and the ropes for tying are locally available. The total cost for raising the plinth is Tk960 (Table 22, Annex II for details).

Flood can partially damage the scaffold. So minor annual repairing is necessary, but costs just one-third of the price of the main scaffold.

The scaffold has multiple usages, although the main purpose is to save domestic animals and properties from floods. As trees do not grow in char lands, cattle can also shelter there during the scorching heat of the day. Even at night, it provides shade for cattle during hot weather. Vegetables such as beans, gourds and pumpkins can be grown on the roof all the year round.

Lessons Learned

Key lessons learned from this practice are:

- The respondents reported that the construction of the scaffold is cost effective, because the construction materials are readily available locally at low cost. Most of the work is done by local or domestic labour.
- The place where mud is collected from becomes a ditch, which is used as factory of manufacturing bio-fertilizers and storage of the same (locally called *'vehr'*).
- The local people reported that it is an environmentally friendly coping practice with no bad effects on the environment.
- As it is made of mud, flood damages the plinth every year.
- The height of three feet cannot ensure full protection at the time of high flood.

Potential for Replication

This is an innovative practice, which could be a model for other flood prone areas.

These measures are innovative and effective. Even when there is a gradual rise of floodwater and the farmer is unwilling to evacuate, it may be of use. They can save lives and property.

Kot system of Land

Précis

Location		Seasonality	Hazard
Union Upazila District	Shubogacha Kazipur Shirajgonj	All season	Flood & River Bank Erosion

Prologue

The study area lies on the eastern side of the river Jamuna. Respondents said that after 1988, floods have become a significant hazard for the population. The river begins to erode during a flood and changes its course, advancing to the western side then forming a char on the opposite (eastern) side. Some chars began to rise in 1995-96, and continued to 2003-04 in the Jamuna basin, as a consequence of its devastating erosion in 1992. Notable chars include char Aman Nehar, char Azidpore, Char Boyra and char Bhatir char. Displaced people move to another area and cope with the situation in an alternative way.

The Initiative

The community people, when displaced by the river erosion from one place, move to a temporary alternative place, waiting for the reclamation of their land through char formation. Landless and poor people migrate mostly to the towns in search of a new livelihood and typically settle in the slums. But char dwellers, having lost everything to river erosion, take shelter on a piece of land belonging to the neighbours under terms known locally as *kot*. This is a conventional system of leasing a plot of land for some years on payment of money at a certain rate, agreed through negotiation.

THE GOOD PRACTICE

- Δ The persons who, have no residual land after the erosion but are not willing to migrate to distant places can stay there by this system.
- Δ The ups and downs of the financial condition of family are inevitable and at the time of the needs they are to take money from lend-ers or they are to mortgage land or orna-ments. But mortgaging in lieu of land prop-erty in the rural side is popular.
- Δ It is a community based initiative.
- Δ This initiative can help the affected poor people to cope with the situation.
- Δ This is an effective practice to prevent migration of homeless people towards urban areas and is replicable everywhere.

Goal and Objectives

The goal of the *kot* system is to reduce vulnerability to natural hazards, especially flood and riverbank erosion. It aims to address the uncertain homeless situation and protect property until a better solution or a new home can be found.

Activities and Outcomes

The *kot* system can be of two types. The landowner, due to financial need, may lease a plot of his land to a poor person who has some money. In either case, the lessee and the lessor are identified in the society by the degree of honour. But in chars, the lessors are those that have lands elsewhere, in places protected against erosion. Those that have no residual land after erosion and are not willing to migrate to distant places try to stay near their erstwhile homes, taking land when it may be offered to them, but do not cultivate the land.

When the lessee and the lessor meet, they do so in the presence of witnesses and decide the time and amount of money to be paid to the owner. In determining the rate, the location of the land becomes a great factor. If the land is just on the bank the rate is much less than a piece of land located a bit further from the bank. Generally the rate is low – Tk200 to a maximum of Tk350 per decimal. The conventional leasing system does not require any deed, with a few witnesses being sufficient. But in the modern system, leasing for more than three years, and in case of a strong tie, they make a deed on Tk150 non-judicial stamps, where the terms and conditions, rates or amount of transactions are clearly mentioned and this enables the lessor or the lessee to get the help of a court in case of any controversy or violation from either side.

Generally, the *kot* is taken or given for a period of two to three years. The lessee is to be given notice one year before expiry of the tenure by the lessor and in some cases, the lessee has to pay one or two years' rent in advance.

The lessee will usually build a house or shelter on a corner, around which vegetables will be cultivated.

Lessons Learned

Key lessons learned from this practice are:

- Δ In times of particular penury, a family may have the choice of borrowing money from lenders or mortgaging land or ornaments. Mortgaging in lieu of land property in rural areas is popular.
- Δ Those that have no residual land after erosion, but are not willing to migrate to distant places, can remain where they were using this system.
- Δ This is a community-based initiative and can help poor people to cope with the situation.
- Δ It is effective in reducing out-migration and can be replicated widely.
- Δ There is also some risk involved, notably in the legalities of registering the *kot* deed and in other legal issues.

SECURING AND SOURCING OF FOODS

Flood Resilient Crop Storage -

Keeping The Crop Out Of Water And Preservation

Précis

Units	Location One	Location Two
Union	Nehalpur	Kakara
Upazila	Manirampur	Chakoria
District	Jessore	Cox's Bazar

Prologue

The area, Nehalpur of Jessore district, is vulnerable to water logging. This poses major difficulty to people in preserving food stocks for future use. This hazard can destroy all stocks and people become helpless. So they prepare some device to protect their crops.

Another area, Kakara of Chakoria upazila under Cox's Bazar district, is susceptible to flooding and flash floods. Because the area is surrounded on three sides by the river Matamuhuri, a river that carries water from the hills where, when there is rainfall a huge mass of water flows very strongly overflowing the river as well as the banks and some time flooding the villages where it can remain standing for 4/5 days. As a result, agricultural products such as rice, groundnuts, *felon*, tobacco, pepper and beans are damaged. So communities develop means to protect their food grains.

The Initiative

The community people have experience of the loss of crops due to the floods of 1987, 1997 and 2007, flash floods and water logging. So they developed a type of *gola* that has been used for the last 20 years to protect their products. Villagers take shelter in the nearby shelter centre during a hazard event, but also they can protect their foodstuffs.

THE GOOD PRACTICE

- ◊ This is an innovative practice through which crops can be saved that help to ensure food security.
- ◊ As the technology is appropriate, environment friendly and locally developed it can be used by others.
- ◊ It is sustainable as the local people stated that the durability of this Gola is about 50 years.
- ◊ The structure ensures and enhances the security of the vulnerable people and has been a proven fact.
- ◊ The artisans for erection of such crop storage are locally available and the initiative is community oriented and hence is lasting.
- ◊ Effectively enhances the safety of people at risk.
- ◊ Already adopted by the local people since long and fitted with local ecology.

Goal and Objectives

The goal of hazard resilient crop storage is to reduce the vulnerability of natural hazards, especially of flood, flash flood and water logging. The hazard resilient crop storage initiative aims at protecting the house from flood, flash flood and water logging during a hazard period.

Activities and Outcomes

The Gola in Balidha: A place on the premises near the dwelling house is selected that is relatively untouched by the wind. It is then raised by adding soil from the surrounding area. The top is then levelled. This is the foundation. It is then strengthened by laying bricks and sand. In some cases, this raised platform is concreted to save it from being washed by rainwater.

The raised platform is laid with a chatai of bamboo, over which another chatai of hogla leaf is laid down in a circular form. Above this is placed another bamboo chatai. Then bamboo sheets are set on the bamboo. To make the gola stronger poles are set vertically inside the gola, (pala). Then the roof, hexagonal or circular, is covered with tin and is strongly bound with poles. As a result, wind cannot blow them down. A gate is made of wood at the upper side, big enough for a person to enter. Now the size of the gola is dependent upon the amount of rice to be placed inside. A gola of 5-6 ft long and 6-7 ft. height may cost Tk23,000 (Annex) and three labourers can make an ola in 10 days. As this gola is made of indigenous materials and labour is also available locally, the gola is environment friendly. Respondents stated that a gola can last about 50 years.

The Gola in Kakara: The local farmers select a place on the premises or along the living house. They dig soil from an area measuring about 15 ft x 12 ft and 2 ft deep. This is for the foundation. Then, from a depth of 2 ft, they build six RCC pillars of 4 inches by 4 inches, using four *suta rods and concreting with 30 bricks each 5 ft tall. Then each pillar is fitted with holes to accommodate rods 1 foot longer than the pillars themselves. Above the extended portion are set 14ft x12ft wooden logs. So they need three of 15ft and three of 12 ft wooden sheets. Above this are set doazara (bamboo fence) wood of breadth 6 inches and 1.5 inches width (12ft long) to make fences on both sides. This doazara is 15ft x 12ft and is set on the wooden frame. Outside the doazara are fitted frames of wood sized 15 ft x 12 ft and 3 in. x3 in. and tin sheets are fitted with the frames. After making the doazara and tin, they prepare the frame for making the roof by 3 in. x 2 in. wood (batam), when they require 12 batams above which the tin is set. This 15 ft Gola has three cells: on two sides of 6 ft each, and at the middle one of 3 ft size. The 6 ft ones are used for storing rice and the middle one is for other crops such as felon, nuts, pepper and potato. Steps are built from the 3 ft cell for carrying the crops and a gate of around 4ft x 3.5 ft is attached to this cell. The rods that are raised through the six pillars are fixed with wooden frames and are twisted. By using this portion of the rods, the gola can be carried to a safer place if necessary – for example, during a major flood.

The capacity of this gola is about 1,400 hari (1 hari = 10 kg). Rice of any kind – i.e. raw or dried – can be preserved safely in the gola. The gola takes 1 month 7 days to construct at a total cost of Tk53,000 (Annex). The work is done on a contract basis and the labour cost is about Tk17,000.

*Suta is one eighth of an inch.

Lessons Learned

Key lessons learned from this practice are:

- Δ The technology is generated locally through years of observation and experimentation – it is simple and can be made within a short time.
- Δ The required materials and equipment are locally available.
- Δ The local people reported that it is an environmentally friendly coping strategy.
- Δ It is a sustainable coping mechanism. The respondents stated that the durability of this *gola* is about 50 years.
- Δ The cost of the house is beyond the capacity of the poor in most of the cases.
- Δ To save corn at home from the damage of the floodwater is good practice.

Potential for Replication

This is an innovative practice, which can be replicated for other floods, flash floods and areas prone to water logging, allowing crops to be saved and helping to ensure food security. The raw materials are available locally and the technology is easy.

GO-NGO structure can be used to disseminate this technology. The technology can be improved by NGOs initiative. GO-NGOs can help poor people to build the structures.

Food Preservation

Précis

Units	Location	Seasonality
Union Upazila District	Ratanpur Phulchari Gaibanda	All Season

Prologue

Situated on the river Brahmaputra, every year flood affects this area during the months from *Ashar* to *Aswin* and causes immense loss to the crops. Crops also experience much damage. As a result, during flood time and even after the flood there is an acute vegetable crisis. At this time they use locally processed and prepared *'sidol'* (locally known as *bazali*) with rice as an alternative to vegetables.

The Initiative

The people of Ratanpur have taken the initiative to process and preserve a popular local food called *sidol*. Now most of the families of the areas use this technique to preserve foods. Mainly women are involved in this practice. This practice has been followed for four to five generations in this area.

Goal and Objectives

The goal of sidol preparation is to reduce the vulnerability of natural hazards, especially flood. This initiative aims at ensuring food and nutrition security as well as enhances the capability of the people at risk.

Activities and Outcomes

The raw materials for preparing every 2 kgs of sidol are dry fish (small sized) 1kg, Kachu (arum

THE GOOD PRACTICE

- ◊ It is a subsistence for poor people in different hazard situations;
- ◊ Scope of women involvement is high through out the entire process;
- ◊ It ensures the food needs of the farmer's family with the sufficient amount of nutrient supply. Moreover they can earn their liveli-hood by even selling them to customers;
- ◊ The entire efforts are economically cost effective. The amount of labor, and land they employ, the investment they make in the en-terprise are the minimum;
- ◊ All the elements are available in their own premises and the method of production is as easy as everybody can understand.
- ◊ Already adopted and suited to the local ecology.

of any type) 3kgs and turmeric two to three teaspoonfuls. At first, the arums are cut into small pieces to dry them in the sun placing on the tin roofs or on a mat in the premises for 5-7 days. During this time, the pulp of the arum remains a bit soft and is crushed in the deki (a wooden device especially for husking rice). At the same time, dry fish from the market is also crushed into powder in the deki. These two powders are blended together with 2-3 teaspoonfuls of crushed turmeric thoroughly. These mixtures are again crushed in the deki with 150-200 ml. of water to make paste of it. Then the paste is made into small round shaped balls of 50gm. Then they are given flat shape before placing in the sun for drying up. They are dried in the sun for 4-5 days. A strong rope is pierced through every 4-5 of the balls to create a wreath, keeping intervals of 3-4 inches separation in between and then tying the ends. These are again placed in the sun for 4-5 days more to ensure drying up. These are called sidol and when they are quite dry, they are preserved in either plastic container or glass bottles.

Sidol generally is an individual family food stock and not sold in the market but its market price may be Tk. 90-95 per kg. They generally prepare this sidol in the winter. But throughout the whole year, one can prepare sidol. It can be preserved for about six months. These are to be dried in the sun strongly for 7-8 hours after every 10-15 days. Sidol is not an independent food, but is an element to take with rice. It is taken with rice as a sauce just like curry to increase the taste. Local people say that only with sidol can rice be taken without curry.

Lessons Learned

- It is a food subsistence for poor people in different hazard situations all the year round;
- Women's involvement is high throughout the entire process and women can combine this with the other household work.
- It ensures the food needs of the farmer's family with the sufficient amount of nutrient supply. Moreover, they can earn their livelihood by even selling them to customers.
- The entire efforts are economically cost effective. The amount of labour, and land they employ, the investment they make in the enterprise is the minimal.
- All the elements are available in their own premises and the method of production is as easy as everybody can understand.
- The entire process of preparing sidol is easy and can be done by an individual.
- But the only element used in the sidol is fish, which is very much susceptible to rotting, if there remains water content somehow, or when stored in humid place fungus attack them and renders unfit to use as food.

Potential for Replication

Anybody can join the food processing activity for consumption or subsidiary income even by selling them. But it is essential to remember that sidol can retain its quality for a short time only. The fresh fish and the entire process have to be managed carefully. If these are processed and preserved correctly, Sidol can help people at risk during the adversaries.

Homestead Gardening

Précis

Units	Location One	Location Two	Location Three
Union	Shuvhagacha	Radhainagar	Kanchipara
Upazila	Kazipur	Gomostapur	Phulchari
District	Sirajganj	Nawabganj	Gaibandha

Prologue

The crops of Kanchipara and Shubhagacha unions undergo major damage from flooding each year. The deposition of sands due to annual flooding decreases the fertility of the soil and even renders them unproductive. So farmers looked for alternative livelihoods. They adopted homestead gardening of vegetables.

On the other hand, vegetable cultivation was not possible in the Radhainagar union. The humidity is much low due to drought in this area. Although the tanks and water bodies are full to the brim in the rainy season, in the drought i.e. in the month of

Falgun (Mid February to Mid March) and Boishakh (Mid April to Mid May) they become dry and the soil at the bottom is dried and cracked. In coping with this, people adapted to this situation and began to cultivate vegetables around the houses.

The Initiative

In 1988, Shubagacha union remained under flood water. for long time. So farmers cultivated vegetables around their homes. They achieved very good results, and now they use this practice even to sell beyond their own needs. So others were encouraged by this example and soon were followed by many. Now more than 80% of people are practising homestead gardening.

THE GOOD PRACTICE

This is a good practice because it served successfully several purposes –

- ◊ It is the subsistence weapon in different hazard situation
- ◊ Land utilization increased.
- ◊ Scope of women involvement is high.
- ◊ Different household level debris & wastes are used for as a organic matter
- ◊ It ensures the vegetable needs of the farmer's family with the sufficient amount of nutrient supply. Moreover they can earn their livelihood by selling them in the market.
- ◊ The entire efforts are economically cost effective. The amount of labor, and land they employ, the investment they make in the enter-prise are the cheapest.
- ◊ All the elements are available in their own premises and the method of production is as easy as everybody can understand.
- ◊ About 90% people living in the society are used to practice the homestead gardening and no impediments are found in the society.
- ◊ Homestead gardening is environment friendly initiative. Already adopt & fit with local ecology.

The people of Kanchipara have been practicing homestead gardening for many years for their own consumption, although the exact time is not known.

Since 1998 in Radhanagar, one or two farmers were found to have prepared a vegetable garden around their residence and used the discarded household water to irrigate the garden. This produced for them very useful items. They cultivate them either on the roofs of houses or on the scaffolds. At the beginning, they did not cultivate throughout the whole of the year. But in the last two to three years, they started to do this throughout the year.

Goal and Objectives

The goal of homestead gardening is to lessen the vulnerability of natural hazards, especially flood as well as drought. This initiative aims at ensuring food and nutrition security, increasing land productivity with maximum economic profitability by use of minimum fertility level of soil and land. It also enhances the capability of the people at risk.

Activities and Outcomes

The places near homesteads were once vacant and now have taken hew of greenness. They produce vegetables throughout the whole year. The local people mainly produce vegetables, spices and some fruits in these homestead gardens. In Radhanagar, they produce tomato, spinach (*palong*) l*alshakh, puishakh, patshakh* (bitter), *bhindi*, beans, *karala*, radish, cauliflowers, cabbage, *cholashakh, bastagishakh, brinjal*, cucumber, *jinge, lalmi kathoa*, onion, garlic, ginger, turmeric, and pepper. The

people of Shubagacha union produced gourd, pumpkins, beans and Kanchipara union produced gourd, beans, pumpkins,.

They select a space for gardening in the premises and protect the garden by raising fences around so poultry or cattle cannot get out. In Radhanagar, they dig a small ditch near the garden and the drain in which wastewater is collected and remains standing. Whenever needed, they give water to the plants by tubs from the ditch. They make small seedbed at a corner of the garden.

The soil is ploughed deep and this soil is allowed to dry up for 2-3 days. Then the earthen lumps are broken with bamboo clubs. The weeds and leaves are taken out well. Then the plot is again ploughed with a spade and earthen lumps are clearly broken to make the soil powder. Then beds for different vegetables are made and around each bed drain of breadth 1 foot to 0.75 foot are made so that water can run well and inside the bed also drain is dug to facilitate easy access to water to the plants.

When in the month of *Kartik* (Mid October-Mid November) there is a little dew begin to form in the air at the end of the night, then the red-vegetables, spinach and white *kathoa shakh* seeds are sown. In *Agrahayan* (Mid November-Mid December), when the vegetables excepting the white *Kathoa* are harvested, then onion, garlic tomato cabbages are sown in the plots. Now the plots do not have to be ploughed again and only making a slight hole inside the soil, the seeds are sown. Sometimes they germinate the saplings of pepper, gourd in the beds and when they are about two/three inches long, they are shifted to the beds of the garden.

On the fence of the surrounding garden, *puishakh*, *karala*, *jinge*, and cucumber are sown. These are creepers and are well placed along the fencing. They also grow from soil, but prefer aerial growth. Along the fencing inside the garden, a row of *bhindi*, *patshakh*, and pepper are also sown.

Vegetables can be grown on scaffolding in the house. Generally, scaffolds are made with bamboo and tree branches. Thus, over the scaffolds and roof of houses gourds, cucumber and sweet pumpkins are grown. Papaya is also cultivated. Banana plants are sown but as banana plants cast shadow, they are planted at some distance.

Lessons Learned

- Home gardening plays a very important role in the home economics of farming communities in Bangladesh. It ensures the vegetable needs of the farmer's family with the sufficient amount of nutrient supply. Moreover, they can augment their income by selling them in the market.
- Homestead gardening is environmentally friendly. Although only a little chemical fertilizer is used, that may be avoided and the activity can be made entirely by compost measures.
- The practice involves a large number of women.
- Household waste and wastewater are used as organic manure for the practice.

- Farming life is very busy at the time of sowing and harvesting and during this time people tend not to think of growing vegetables. They just cut or pluck some gourd, pumpkin or beans from the garden and cook them quickly. That is why a farmer without homestead garden is sometimes disliked by others and is said to be unlucky.
- At the time of flowering, insects attack them to spoil the harvests and so spray or ashes must be applied.
- The gourds, sweet pumpkins, beans and green pumpkins are grown on the roof of

the thatches and so there is no cost for the scaffold.

- Δ Homestead cultivation can satisfy the demand of the family and products can be sold. No special care needs to be taken and even insecticide may be avoided, if they can use ashes when needed.
- Δ Land utilization increases, especially the patches of land that once remained idle has come under cultivation;
- Δ About 90% people living in the society are used to practice of the homestead gardening and no impediments are found in the society.

Potential for Replication

The entire process of homestead gardening has few limitations. But farmers who have no tube well or pond have no scope of making homestead gardening, because the initiative needs watering of the plants. But they can does, because it is highly profitable by forming a consortium of a few families, sink a tube well at a convenient location, participate in the process, and benefit. Initiatives to dig ditches for household wastewater storage can help for watering the plants. Attempts by the CBOs can be made to persuade local people to be involved with the coping.

Initiatives for the greater involvement of women in homestead gardening can increase household income and women's empowerment. If the

technology of homestead gardening is improved, or if the technology packages of improved varieties of different crops are made available to women, production will increase and all will be encouraged to be involved in the practice.

The practice ensures the increase in the home economics, promotes family nutritional status to maintain good health of the children.

For poor people, this is source of income from home and the domestic garden and is good a means to save themselves from the clutches of moneylenders during lean times.

Chana

Précis

Units	Location One	Location Two
Union	Uria	Shuvogachha
Upazila	Phulchhari	Kazipur
District	Gaibandha	Sirajgonj

Prologue

The areas are *char* lands, situated in the midst of the Brahmaputra and Jamuna rivers. These areas are periodically flooded by rainwater from the upper areas beyond the border. During the rainy season, the rivers swell up quickly and the

GOOD PRACTICE

- ◊ Chana is used both as staple and auxiliary (mixed with rice in the ratio 3:1) food in want of rice and has the same nutrients as that in rice;
- ◊ Chana is not only an alternative to staple food , it can also be used as an ingredient for many sweet meats;
- ◊ As short term crop and as it grows where no other crop is suitable for growing, its cultiva-tion adds productivity and use lands economi-cally;
- ◊ As chana is a non-traditional crop and beneficial to meet food deficiency, it demands attention;
- ◊ Cultivation of chana does not need much cares, manures and capital/ labor and so is profitably useful for areas where rice and wheat do not grow well or at all;
- ◊ The newly formed chars and lands where the proportion of sand is high is most suitable for chana cultivation and in Bangladesh this type of lands are many .like the areas under inves-tigation;
- ◊ Chana is the only agric product that can help people at risk during emergent situation of food crisis;
- ◊ The cultivation is already adopted and has been found to be suited to the ecology.

raised riverbeds cannot cope with the demanding discharging efficiency and exert tremendous pressure on the riverbanks, which in turn erode the banks dangerously, thereby displacing hundreds and thousands of people. Floods, along with river erosion, is a regular phenomenon that affects normal life and livelihood as floodwater remains standing for four months of the year and soil turns sandy and loamy. Under these changed circumstances, local people have taken recourse to an alternative in their agricultural activities.

The Initiative

As to cope with the changed circumstances, the farmers of the areas have been cultivating *Chana* paddy (which is locally called *Kherachhi)* which is a kind of corn that is much smaller than rice. It resembles the small crystalline round shaped mustard seeds. This is being used as auxiliary to rice and is mixed in the proportion of 3:1 i.e. the ratio is 250 grams of *chana* with 750 grams of rice. *Chana* is also taken separately as an alternative to rice that lessens the immediate food crisis. Chana has been cultivated in these areas since 2000. Now many farmers of the areas have adopted the practice.

Goal and Objectives

The goal of *chana* cultivation is to reduce vulnerability to natural hazards, especially sand deposition from flood and riverbank erosion. The *chana* cultivation initiative aims to ensure food security, increasing land productivity with maximum economic profitability by utilization of minimum soil fertility.

Outcomes and Activities

The sandy lands of the chars are cultivated either by the farmers themselves or are leased to sharecroppers. The selected land is ploughed three times consecutively between *Magh* and the first week of *Falgun* (Mid January to last week of February). Before ploughing, manure is scattered over the plots. As a result, manure is adequately mixed with the soil during ploughing. Then the *chana* seeds are sown, only by scattering and by experienced farmers. Because the seeds are very small, carefully distribution over the plot is essential, otherwise non-uniform density of saplings when germinated on the plot causes nutrition deficiency of the plants, which adversely affects the final productivity of the plot. Afterwards the soil is levelled with a ladder.

Four days after sowing, the seeds start to germinate and complete the process within 7 - 8 days. Cultivation requires once-only irrigation after 15 - 20 days of sowing and even in most of the cases, no irrigation is necessary. Irrigation is done using a shallow machine. A couple of days after irrigation, the soil is weeded; this facilitates the growth of the *chana* plants. After 15-20 days of the first weeding, the second weeding is done. During this time, there is the possibility of the attack of leaf-disease, locally called *kukrimukri. In an attempt to* protect the leaves, Urea and Gypsum fertilizers are thrown on the soil.

The time of harvesting depends on the sowing time; the sooner one sows, the early one gets the harvest. Generally, *chana* is harvested during the month of *Jyoistha* (Mid May-Mid June). The *chana*

plants are to be dried well in the sun for three days to facilitate the separation from the stalks of the plants while thrashing.

Six to seven *maunds* of *chana* are produced from one *bigha* plot. The surplus *chana* is sold in the local market at Tk650 per *maund*. Therefore, if the harvest is 6 maunds, the earning from one *bigha* is Tk650 x 6 = Tk3,900. The total expenditure is Tk3,200 in a *bigha* of plot (see annex for details). The net profit is Tk700.

Lessons Learned

Key lessons learned from this practice are:

- Δ *Chana* is a poor community food in char areas. The local people use it both as staple and auxiliary (mixed with rice in the ratio 3:1) food in place of rice. It has the same nutrients as rice. Moreover, it can be used as the main ingredient for many sweet meats.
- Δ It is suitable for char lands, because it can be grown in low-fertile soil and with minimum care.
- Δ The production process is easy and harvest can be expected within a very short time, compared to agricultural products.
- Δ The total production is poor compared to costs. Total expenditure is Tk3,200 in one *bigha*. Total production is 6 *maunds* and the total price of the crop is Tk3,900.
- Δ As the people are otherwise unemployed, they employ their time in cultivating this crop which – although it brings minimum benefit – does add to the total food quantity of the country.

Potential for Replication

Chana cultivation has wide potential in Bangladesh, as many lands in the riverbank areas have already become sandy and loamy due to the regular riverbank erosion and floods. These are suitable for chana cultivation. If introduced, this copping mechanism among the char communities can increase the total productivity as well as increase the cropping intensity. This will bring many fallow lands under cultivation multiplying both productivity and ensuring food security. For this reason BARI also recommended the crop for char land.

Modern technology along with high-yield seeds can increase productivity further at char and in other areas of Bangladesh. GOs and NGOs can come forward for assisting local farmers to do so.

Maize

Précis

Units	Location One	Location Two	Location Three
Union	Shuvogacha	Kanchipara	Nejampur
Upazila	Kajipur	Fulchori	Nachol
District	Sirajgonj	Gaibandha	Nawabganj

GOOD PRACTICE

- ◊ Ensures food security. A variety of food items can be prepared from maize. In fact, it can be used as food item in the same ways as rice and wheat. More over it is used as raw mate-rial in different industries for production of starch, animal feed, cosmetics, biscuits, hor-licks, corn flakes confectioneries, edible oil etc.
- ◊ Optimizes food production for people at risk;
- ◊ Utilization of lands having minimum fertility level of soil at the char and Barind tracts;
- ◊ Effectively enhances the food security of people at risk.
- ◊ The soil is suitable for this cultivation;
- ◊ Already adopted and fitted with local ecology;
- ◊ Enhances crop diversification essential for food deficit areas;
- ◊ It is a profitable venture;
- ◊ Productivity per unit area is higher than any other crops ;
- ◊ Cost effective because the whole production process involves minimum capital and labor and multifarious market demand is very high both as food item and as industrial raw mate-rial.

Prologue

A wide area under the Upazilas of Kazipur, Phulchari and Nachole has undergone a radical change in ecology due to frequent floods, riverbank erosion and drought. The traditional agricultural products such as rice and wheat cannot be grown. Lands remain idle and poor farmers grow maize as an alternative and short term crop, which help increase their food stocks to be used at emergency.

The Initiative

Initially some farmers have been enlightened about the cultivation of maize by demonstrating the enterprise of maize cultivation in other areas through media and then Go-NGOs intervention was employed since couple of years back. However, good maize production in the soil encouraged many of them to cultivate it as an alternative to the traditional crops. This is a simple history of maize production in the areas around.

Change of soil condition enforced farmers of the areas to shift from traditional crops to maize/ *bhutta* (*Zea mays*), a cereal crop, belongs to the *Graminae* family and order is Cyperales. It is cultivated to a limited extent in *Kharif* and *Rabi* seasons. A variety of food items can be prepared from maize. In fact, it can be used in the same way as rice and wheat. It is also used as a raw material in different industries for production of starch, asbestos board, animal feed, cosmetics, biscuits, Horlicks, cornflakes, confectionery and edible oil. Acetic acid and alcohol are also manufactured from maize.

Goal and Objectives

The goal of maize cultivation is to reduce the vulnerability of natural hazards, especially sand deposition due to flood and riverbank erosion as well as drought. The maize cultivation initiative aims at ensuring food security, increasing the land productivity with maximum economic profitability by utilization of minimum fertility level of soil and enhances the capability of the people at risk.

Outcomes and Activities

Maize is such a corn that can be cultivated throughout the year. The cultivation process starts from ploughing the soil; fertilizer (15 kg of Potash and 15 kg of Phosphate per bigha) is used before the ploughing, but no inorganic fertilizer is being provided at Nejampur. Then one foot gap lines are drawn for sowing seeds with the help of traditional ploughs, farmers of this area borrow ploughs from each other. ½ foot deep holes are made in every one foot gap in each row. 2-3 seeds are sown in each hole (among the three seeds, one seed is sown for fodder of the cattle, and other two for production of maize covering the risk of non germination or destruction of a single seed).

After one month of sowing when the young plants grow 8 to 10 inches long, labourers bring soil from both the sides of the *Null* (*Null means taking soil from the inside of two lines and putting them at the bottom of the plants)* and deposit at the bottom of the plants. When the plants are 1-1 ½ month old, irrigation is done as to increase moisture content of the soil. Afterwards weeding is done when fertilizer (15 kg of urea per *bigha*) including pesticides is given. After 2 months corns starts growing in cluster. Urea (10 kg per *bigha*) fertilizer is applied again for better production. Finally the corn is harvested after 3 -3 ½ months of sowing. After collecting corn from the field, corns are separated from each cluster and are dried up about 2-3 days under sun. This processing and preservation works are usually done at domestic level. Finally the dried plants are used as fuel.

Total cost of per bigha production is Tk 7220 in Shuvogachha, Tk 6940 in Rasulpur and Tk 1822 in Nejampur. Production of maize varies across the areas. However, average production in one *bigha* land is 30 maunds in Shuvogachha, 27 maunds in Rasulpur and 12 maunds in Nejampur. Average price of maize is Tk 600. The selling price of maize is Tk 18000 in Shuvogachha, Tk 16200 in Rasulpur, Tk 7200 in Nejampur.

Lessons Learned

Key lessons learned from this practice are:

- Δ The soil which is not suitable enough to produce rice is very much suitable for maize cultivation.
- Δ The maize production is comparatively higher than the usual production of rice.
- Δ Maize is cultivated round the year. One good season is Kartik to Magh (mid October to mid February) and another is Magh to Chaitro (mid February to mid April)
- Δ The production technique is simple and one could expect harvest within a very short time. The cultivation does not require intensive irrigation and labour.
- Δ In these areas this practice has already become popular and proved to be viable due mainly to food crisis.

Potential for Replication

Maize cultivation is, no doubt, profitable; but in our place people uses this practice in the lands where normal agric products do not grow or cannot be grown. Lands of this area are like sandy lands or pocket lands which are very small for otherwise cultivation. The products help people as food during bad days. Maize can be taken in many different ways as food and its preparation is simple. Today, cultivation seems to have drawn the attention of agric community and different hybrid varieties are available.

The farmers at the far reaching areas should be encouraged for its extension so that fallow lands might be brought under cultivation for production of food items. So the method in its improved form may be replicated in areas where lands are idle and unproductive.

Kaon

Précis

Units	Location	Seasonality
Union Upazila District	Uria Phulcahri Gaibandha	Falgun to Jyaisthya

Prologue

The area known as Uria of Phulchari under Gaibandha district is mostly *char* land, where flood water remains standing for 4 months (*Ashar* to *Aswin* (mid June to mid October), the maximum water being in the months of *Sraban* and *Bhadra* (mid July to mid September). Due to flood water and sand deposition during flood, the soil of the area turns unsuitable to produce the normal agricultural products.

GOOD PRACTICE

- ◊ Ensures food security as supplement to rice when mixed in proportion of 3:1 and even on occasion's alternative to rice.
- ◊ Increases land utility by bringing the fallow lands under cultivation and also the crop pro-ductivity.
- ◊ Crop production by utilizing minimum soil fertility of char land;
- ◊ Effectively enhances food security of people at risk.
- ◊ The soil is suitable for this cultivation.
- ◊ Can be Stored for long & be used during vulnerable situation;
- ◊ Although not much Cost effective, the practice is popular because it is indigenous and help people with some additional short term crops for bad days.
- ◊ The practice helps crop diversification and may have the potential for greater yield if studied properly.
- ◊ Already adopted by the local people long since and suitable for the ecology and environment.

The Initiative

Due to changed condition, agricultural practices are disturbed off and on. But *kaon* (a type of corn, like rice, belongs to *Gramin* family which is much smaller than rice and is like mustard seeds in size) cultivation is comparatively friendlier with this condition. This is being used as auxiliary to the rice mixed in a proportion of 3:1, i.e. the ratio is 250 grams of *kaon* with 750 grams of rice. It is used to make other food items. It has been practiced for some generations. Now this has been adopted by almost all the families of the area.

Goal and Objectives

The goal of *kaon* cultivation is to reduce the vulnerability of natural hazards, especially sand deposition due to flood. The *kaon* cultivation initiative aims at ensuring food security, increasing the land productivity with maximum economic profitability by utilization of minimum fertility level of soil.

Outcomes and Activities

The cultivation period begins from the month of *Falgun* (mid February to mid March). For the purpose, at first the land is given irrigation. After irrigation the land is ploughed and the seeds are scattered over the plot at one kg per plot of one *bigha*. Saplings come out after 3-4 days of the sowing and all saplings are germinated within 6-7 days. The first time seed scattering and cultivation needs two labours. After two days of the sowing the plot is to be given second trip of irrigation and weeding. Weeding helps to drive out the unwanted plants and shrubs. Two labours are to be employed. The crops are harvested in the month of *Jyaisthya* (mid May-mid June) and two labours are employed for cutting and two are for thrashing.

Total costs for one *bigha* plots are only 1760 taka (approx.), but one gets return 3600 taka (one *bigha* plot gives 6 maunds of *kaon* which can be sold at Tk 600 per maund). So, net profit is TK. 1840.

Lessons Learned

Key lessons learned from this practice are:

- Kaon is a poor community food in char region. It is used as supplement to rice and mixed in proportion of 3:1 and even on occasion alternative to rice.
- It is a suitable crop in char land, because the production of kaon needs minimum fertility level of soil.
- It does not require intensive labour and the domestic labours are sufficient to accomplish the relate works for cultivating small plots of land.
- No need of intensive irrigation which could be possible with their traditional methods.
- It does not require much synthetic fertilizer.
- Storage time is long and farmers themselves can store and use this food during vulnerable situation.
- Bangladesh being a riverine country has large number of chars which remain fallow for long. These lands may be made cultivable by introducing these short term crops which grow well in such soil condition.
- The production is not much satisfactory comparing labour and capital employed. Total costs for one bigha plot is Tk. 1760 and one gets return 3600 taka (one bigha plot gives 6 maunds of kaon which can be sold at Tk 600 per maund). But still it contributes to the total food stock of the society.

Potential for Replication

Although the production is not satisfactory comparing labour and capital employed, still people adopt this, because they get employment and some crops which help them as auxiliary to the staple food. This reduces the pressure on the main food items. Moreover the land use is important, which prepares the sandy and fallow lands for normal agric activities. The agric authorities like BARRI also encourages for *kaon* cultivation.

As non-traditional crop, *Kaon* needs to be investigated for booming its productivity and hence scientific R&D should be conducted at the field level for extension and wide cultivation.

Felon

Précis

Units	Location	Seasona-lity	Hazard
Union Upazila District	Kakara Chakoria Cox's Bazar	Agrahayan to Chaitra	Flood and Flash Flood

Prologue

The characteristic landscape in Chakaria of Cox's bazaar area is surrounded by hills and hillocks together with the net-like zigzag rivers and streams passing through the locus of the hills. These , when there is rainfall in the hills become incredible suddenly with irresistible current inundating the areas around depositing sands on the soil rendering them unfit for traditional cultivation. So the practice for short term cultivation of non-traditional crops has been developed.

THE GOOD PRACTICE

- ◊ Ensures daily protein requirement.
- ◊ Ensures food security;
- ◊ Encourage crop diversity;
- ◊ Increase land utility;
- ◊ Optimize production efficiency;
- ◊ Hilly soils are generally sandy and dry. The moisture it receives at the time of precipita-tion does not stand for long. So this soil is most suitable for the cultivation of felon like crops among the hilly soil of CHT in Bangla-desh;
- ◊ Felon seed is used as soup by farmers; its stalks are used as fodder and fuel for cooking;
- ◊ Large scale cultivation even in the hilly areas may have potential of making it exportable item as it has demand outside;
- ◊ It is a proven crop, its food value is also proven and its cultivation has been adopted long since in the area.

The Initiative

Due to the characteristics of soil and land formation of the area, people from time immemorial are used to cultivate felon, a kind of crop born by a kind of bean like creepers that grow one foot or one and a half feet in length. It is short time crop mostly known in the south eastern region of Bangladesh, especially in the Chittagong, Sylhet and adjoining region of the country. The practice of cultivation in this area is from generation to generation. But it has drawn attention of outsiders since last 20-30 years.

Goal and Objectives

The goal of *felon* cultivation is to reduce the vulnerability of natural hazards, especially flood and flash flood. The *felon* cultivation initiative aims at ensuring food security, ensuring daily protein requirement and increasing the land productivity with maximum economic profitability by utilization of minimum soil moisture.

Outcomes and Activities

Different steps needed to cultivate *felon* in 5 *kanis* (2 acres) land are mentioned as follows. For *felon* cultivation there is no need to plough the land. The farmers make holes 2-3 inch deep into the soil and at distances of 6 to 8 inches from each other. They put 2 seeds in each hole in the month of *Agrahayan* (mid October-mid November). The seed requirement for one *kani* of land is about 9 kgs of seeds and so 2 acres or 5 *kanis* of land needs 5x9 = 45 kgs of seeds and the seed cost at the rate Tk 45 per kg is Tk. 2025 but the farmers love to employ their own seeds in the lands that they cultivate.

For cultivation of 2 acres, they need 25 labourers. Male labourers are generally employed for this purpose under consideration that they are more capable than female counterpart and they are paid Tk. 200 each per day. So the total cost for the sowing of seeds is Tk 5000.

The seeds are germinated within 7days of sowing and within 3 months the plants are in flowering. After the second month the plants are irrigated once from the nearby river *Matamuhuri*. After one month of the irrigation the land is given manure and after one month again the land is to be irrigated second time. The irrigation cost is Tk.400 per *kani* and so the total cost is Tk. 4000. One time Manuring of urea needs 20 kg per *kani*. So if a farmer requires 100 kg, the cost is Tk. 800 X 2 sacs (50kg) = Tk. 1600. When they buy from the government appointed dealers they can buy 2 bags of manures at Tk 350 x 2 =Tk. 700. Unfortunately one cannot obtain manure from the government dealers at the fixed rate.

However, within one month of the flowering the fruits are ready for harvesting. Each of the plants bears an amount of maximum 40 to a lowest of 4-7 fruits. This felon fruits look like the bean fruits, 8-10 inches long. When the colour of the fruit turns to yellow from green then it is ready for collection. From this felon the seeds are collected for cultivation later on.

In collecting the harvests they need 4 labours per *kani* of land and so for 2 acres of lands they need 20 labours. The total labour cost at the rate of Tk 100 per labour, for 20 labours is Tk. 2000.

The collection work is comparatively less labour intensive and so they employ women labours at the rate of Tk. 100. The felon plants are taken home and are dried 3-4 days very strongly under the sun and then they are to be thrashed to detach seeds from the fruit shells. They do this by putting the dried up plants onto the sacs and by closing the open side they go on striking with a stick. At a time they find that all the felons are out of the fruit shells and then they winnow to remove the stubs. For this purpose the farmer does not employ any outside labour and they do this by themselves.

The final harvest per *kani* of land is found to be at an average 8 maunds and so the total 2 acres production is 40 maunds. The selling price per maund is Tk. 1600 and so the total sale is =Tk. 64 000.

Total production cost taka 14820 (see annex for details). Total selling price is taka 64000. So, the net profit is (64000-14820) Tk. 49180.

Seed Collection and Preservation

The seeds for the next cultivation are collected from the present harvest. The plants selected for seed preservation are dried in the sun separately more than those meant for consumption or sales. After drying them properly these are put into the polythene bags of capacity 15 kgs each. Then the polythene bags are put into a drum and close its open end tightly with lid.

The cost of preservation:

- 3 polythene bags =Tk. 45
- 3 tin drums =Tk. 120
- The carrying cost =Tk. 30

The drying and necessary arrangements for preservation are done by the members of the family. The seed preservation cost is = 120+ 45+30 =Tk. 195.

Before next sowing, seeds are needed to be taken out to dry in the sun. The seeds are sometimes attacked by insects or fungus and at the time of drying the spoilt ones are removed.

After taking the seeds from the fruits the shells of the fruits are used either as fuel or as the fodder of cattle sheep.

Lessons Learned

Key lessons learned from this practice are:

- Δ The community people adopted the practice of cultivation by self efforts.
- Δ The raw materials are available in the environment itself and the local markets.
- Δ The entire process of cultivation and harvesting do not involve much manpower and capital.
- Δ As the cultivation is on the river banks the irrigation does not need much cost.
- Δ During the cultivation process it is not found to be attacked by natural hazards.
- Δ The felon has a tremendous demand in the local market.
- Δ This soil of the hilly area is most suitable for the cultivation of felon.
- Δ Felon cultivation is profitable and helpful for securing livelihood by the vulnerable people living in the filly areas.

Potential for Replication

As an area of utterly food deficit, our struggle is for increasing the production of food ingredients and thereby to enhance our daily protein requirement. The cultivation of felon opens up a great opportunity for helping us. At the same time land utilization may bring a great benefit in the food sector of the country. So it can be replicated for other suitable areas in Bangladesh.

Both the GO and NGO may come forward to expand the cultivation of felon in areas where suitable and scientific extension may be done on large scale

Pera

Précis

Units	Location	Seasonality
Union Upazila District	Uria Fulchori Gaibandha	Kartik to Choitra (Mid October to Mid March)

Prologue

The area is mostly *char* lands as mentioned above where flood water remains standing for 4 months every year during the months of *Ashar* to *Aswin* (mid June to mid October) and maximum concentration is at the time of *Sraban* and *Bhadra* (mid July to mid September). Due to flood water and sand deposition during flood, the soil of the area turns unfit for the usual agricultural products.

The Initiative

Due to changed condition, agric practices are disturbed off and on. But *pera* cultivation is comparatively friendlier with this condition. Grinded *pera* is eaten like flour with molasses or salt and pepper together. As an alternative to rice, this meets the demand of immediate food crisis at the time of severe food crisis. This *pera* has been cultivated here for some generations. Most of the people of the area cultivate *pera* which is very popular.

Goal and Objectives

The goal of *pera* cultivation is to reduce the vulnerability of natural hazards, especially sand

THE GOOD PRACTICE

- ◊ It is short term crop, grows in char lands with minimum care , capital and labor;
- ◊ Though the production volume is not satisfac-tory, still people cling to the cultivation prac-tice only for food security at the time of monga by the monga-stricken char dwelling people;
- ◊ Grinded pera is eaten like flour with molasses or salt and pepper together ;
- ◊ Increases land utility;
- ◊ Optimizes production efficiency;
- ◊ Utilizes lands with minimum fertility of soil of char land;
- ◊ Storage time is long and farmers themselves can store and use this food during vulnerable situation;
- ◊ The soil is suitable for this cultivation;
- ◊ Already adopted by the farmers in the areas and found to fit with local ecology.

deposition due to flood. The *pera* cultivation initiative aims at ensuring food security, increasing their land productivity with maximum economic profitability by utilization of minimum fertility level of soil.

Outcomes and Activities

The selected soil is irrigated before ploughing. Then seeds are scattered in the month of Kartik (mid October-mid November). After 3-4 days of sowing the seeds, the saplings begin to grow and the germination is completed within 6-7 days. After 15-20 days, the plot is given weeding and irrigation. Harvesting starts from the next Chaitra (mid March-mid April). Thrashing is necessary to separate grains from the stalk of the plants.

The total cost of Pera cultivation per bigha is Tk. 1940 (see annex for details). One bigha plot produces 6 maunds pera, the surplus is sold at Tk. 800 per maund. So, net profit is Tk.2860 per bigha.

Lessons Learned

Key lessons learned from this practice are:

- The cultivation is easy and all the required materials are easily available.
- It is short term crop.
- It grows in char lands with minimum fertility of soil.
- It grows with minimum care, capital and labour.
- Storage time is long and farmers themselves can store and use this food during vulnerable situation.
- The local people take it as alternative food. Grinded *Pera* is eaten like flour with molasses or salt and pepper together.-
- The production is not much satisfactory comparing labour and capital employed. The total cost of *Pera* cultivation is Tk. 1940. One *bigha* plot produces 6 maunds *pera*, the crops are sold at Tk. 800 per maund. So, the selling price is Tk. 4800.
- Crisis of manures off and on is a great hindrance to *Pera* production.

Potential for Replication

This non-traditional crop is very much adaptive to the changing soil condition. As Bangladesh is severely food deficit, the production of *Pera* may be a good alternative to staple food like rice or flour and can stand appreciably for food security of people at risk. Moreover, the recurrent deposition of sands decreases the volume of cultivable paddy fields and these may be utilized by cultivating *Pera*.

It is imperative to establish law and order situation very quickly in char areas by state agencies by improving the policy for promotion of *pera* cultivation, which has the potential for ensuring food security. Modern technology along with high-yielding seeds of *Pera* can increase productivity at char areas and other areas having same ecological condition in Bangladesh. GOs and NGOs can come forward for assisting local farmers for the practice.

WATER RESOURCE MANAGEMENT AND COPING RESPONSE

Protecting Fresh Drinking Water through Raising Tube well's Plinth

The Précis

Units	Location	Seasonality
Union Upazila District	Kamarjani Sadar Gaibandha	Rainy Season

Prologue

During monsoon, floodwater inundates the entire area on regular basis. Tube-wells, which are regarded as prime source of safe drinking water, go under and become inoperative. During floods of 2007, around 50-60% tube-wells of the locality were completely damaged, community people living around were at the risk of health hazards. So, the local people take an initiative to raise the tube well plinths in an attempt to protect their tube wells from being submerged in the flood water.

The Initiative

Having experience of tube wells being submerged on flood time, the villagers began to raise the tube well feet high enough, not to be reached by the sudden rise of water level. But the poor rural people could not do this because of its cost. So to rescue them, an NGO named 'Practical Action' came forward. They sank a tube well on community basis. Generally a tube well is set at a convenient location for 5/6 families who lack safe water source in proximity of their dwelling.

The heads of these tube wells are generally raised 3 ft above the water level recorded by the 1988 flood, which was perhaps the most devastating of all such events during last several decades. The NGO is doing work of surveying a few villages and on the basis its findings identified the poorest ones and helped them by lifting the tube well. The NGO promoting the practice also provides with extra three feet pipe, a toolbox and orientation on the construction know-how to recipients.

Rising of tube wells began from 2006 when 60 tube wells were raised and thereafter the flood of 2007, 28 more tube wells were raised. But the flood level as standard was taken as that of 1988. All these were lifted only in the village Kamarzani on pilot basis. About 550 families are getting benefit from these tube wells.

THE GOOD PRACTICE

- ◊ Ensures safe drinking water during flood when tube wells are submerged and water is pol-luted which spreads water borne diseases;
- ◊ This tube well is not submerged during floods for its raised plinth; So, it can provide safe drinking water;
- ◊ It is an innovative approach to cope with the changing ecology and environment; but the problem lies with high cost and sparsely occa-sional use;
- ◊ It is no doubt the most effective method during the scarcity of drinking water at the emergent time of flood;
- ◊ It is a health sustaining coping strategy which protects people especially children from dif-ferent water born diseases;
- ◊ People realize the utility of pure drinking water and hence on point of this issue people cooperate spontaneously which is the capital for organizing people for this work;
- ◊ Integrated design of tube well for use in both the normal time and emergent time may solve a great problem and such integrated gadget may be of immense value to population at risk.

Goal and Objectives

The goal of the initiative is to reduce the health vulnerability to natural hazards, especially flood. The initiative aims at ensuring supply of water for domestic purpose and drinking of people of the area during flood season.

Outcomes and Activities

During dry season from September-January, the tube wells are sunk in this area. This season is the ideal time to make tube-wells flood proof. During this time the components such as head of tube well, plastic pipe, GI pipe, bricks, cement, sand and labour are easily available in the local market and the concreting work is not damaged by rainfall. So, during dry season, the tube wells are sunk. The pipe of the tube wells go down as deep as 95ft to lift water from underground and five feet galvanized iron (GI) extension pipe fixed on the upper end of the pipe for elevation. A 3-4 feet high platform with stairs was made for use of the tube well. Provision for raising another 3 ft in case of devastating flood was made and the user was given a 3 ft long GI pipe and a tool set to accomplish the work. At the top a 5 ft long GI pipe, which, when there is the risk of rising water level still further the beneficiaries were instructed to open the head and set the head again at the top at 3 ft above. They were taught the mechanism of doing this at the time of sinking the tube well. A tube well cost more than Tk. 8 thousands (see annex for details) which is beyond the capacity of a rural poor. So they cannot, at their own initiative, sink a tube well. An NGO give the entire cost and they did this work on free and did not claim any return.

Lessons Learned

Key lessons learned from the practice are:

- Δ The plinth raised tube wells provide safe drinking water, especially during flood when there is scarcity of water everywhere.
- Δ The elements needed for assembling and raising plinth of the tube wells are available in the local markets.
- Δ It is a health sustaining coping strategy which protects people especially children from different water born diseases like diarrhoea, cholera, skin diseases etc.
- Δ It is the most effective method of avoiding the scarcity of drinking water at the time of emergency.
- Δ People realize the utility of pure drinking water and hence on point of this issue people cooperate spontaneously which is the capital for organizing people for this work.
- Δ The cost is a great weakness, which make it unattractive to the villagers. It takes more than 8 thousand taka which is beyond the capacity of the rural people.
- Δ The costly innovation remains idle awaiting another flood and the high platform raised for the intended time is troublesome for normal use of the users.

Potential for Replication

During flood people can neither move to collect water nor can they get safe drinking water nearby. Moreover, they remain logged by flood water which is polluted and spreads water borne diseases. At this crisis moment, this tube wells can provide safe drinking water. So it can be replicated for other flood prone area in Bangladesh. The density of such tube wells need be much but a few can serve the best at the time of emergency.

A design integrating the convenience of the use in the lean time and that at the emergent period is critical may be designed by some innovator. GO-NGO endeavour may come forward to solve the problem and make it easy for population at risk.

ALTERNATIVE AND RENEWABLE ENERGY SOURCE

Preservation of Traditional Fuel

Précis

Units	Location	Seasonality
Union	Kanchipara Uria	All season
Upazila	Fulchhari	
District	Gaibandha	

Prologue

People of Kanchipara under Fulchari upazila of Gaibanda district use mud stoves for cooking food and they use pieces of dry wood, jute sticks, and shrubs, branches of trees, straws for the purpose and the agricultural waste products collected at the harvesting time, are dried in the sun and use as fuel.. During flood, fuel is an acute crisis. So, people of the area take initiative to preserve fuels to meet the crisis.. So they take recourse to some innovative method for storing fuels for need by the locally available materials. It is the modification of cow dung in bulbous form increasing the volume and drying for preserving.

THE GOOD PRACTICE

- ◊ Cow dung mixed with mud, stubs, rice bran etc has the greater combustibility, when dried are convenient for preservation and transportation and gives advantage of using at the time of emergency;
- ◊ The raw materials are available in the environment of the farmers and the manufac-turing process does not involve any intricacy and farmer's women can accomplish the work at the leisure time;
- ◊ The work is environment friendly, free from any natural hazard and cost effective;
- ◊ It has been adopted by the local people long since as a means of meeting the catastrophic need of fuel for cooking purpose;
- ◊ The practice enables the community people to maximize the use of the available resources for the benefit of themselves.

The Initiative

People of Uria have taken initiative to preserve fuel which is very popular among the women of this area. On the other hand people of Rasulpur have taken initiative to use cow dung as fuel. Now most of the families of the areas use this technique to preserve fuels. These practices have been known to be followed from 4-5 generations in this area.

Goals and Objective

The goal of the initiative is to reduce the vulnerability of the natural hazards, especially flood. The initiative aims at ensuring the demand of fuels and to cope with the growing demand of it with the growth of population.

Outcomes and Activities

The farmers select a place in the kitchen measuring about 6 ft in length and 4 ft in breadth and make a platform 2 ft above the floor of the shed for preservation of fuels. Above the platform they preserve the fuels like jute sticks, cow dung, dried shrubs and whatever they use for cooking in the time of crisis. They can accommodate about 15-20 maunds of fuels on this platform. This amount of fuels can cook the food of a family of 5-6 members for two months.

At the beginning they cut the bamboos according to the necessary size. Then they fix the bamboo pieces in the earthen floor as poles and the numbers are generally 6 in all sides which has 2 ft inside the floor and 3 ft above it, 2 ft above which the cross wise horizontal pieces of bamboos are tied with the poles tightly and then a scaffold above the frame is made by fixing other sheets of bamboos cutting into two halves lengthwise. Above this platform thus made there remains 1 ft length of the bamboo poles which help to protect the contents to be kept on it.

Preservation of Cow dung as fuel: Most of the farmers rear cows as domestic pets which are a good income in time of need and so the cow dung they obtain is used both as fuels and manures for their cultivation of land. So as flood prone area they use cow dung as fuel and preservation of the cow dung is an important issue to them. Using cow dung for cooking food and as manure has been a practice for a long time and the respondents could not exactly locate the time of its introduction in the area. However the practice is very popular in the area.

Each and every farmer of Rasulpur is found to have cows in the HHs and they have cow dung every day. They make a separate place, generally a convenient sized ditch for preserving the fresh cow dung which is left by the cows daily. Then the women of the family make soft mould of the cow dung at their leisure time by adding water and other ingredients to the dung in a separate ditch. They take a handful of the mould, make round of it like a ball and then throw against some flat vertical platform, especially against the walls of the houses and against the big trees and they remain there for 3-4 days. If there is good sun it is dried up for use. They collect them and make ready for use in the stoves and preserve by putting them in sacs and keeping them on the scaffold one after the other.

The entire exercise is done by the women folks of the farmers' families. Sometimes, they take the help of the children. There is flood during Ashar to Aswin and they cannot prepare the dung for cooking purpose and they collect the cow dung for the manures.

Lessons Learned

Key lessons learned from this practice are:

- Δ These platforms for preserving fuels are prepared by the farmers themselves in most cases.
- Δ The preparation of the fuel from cow dung is easy and they can do themselves.
- Δ Women make fuel balls from cow dung.
- Δ Cow dung mixed with mud, rice bran and stubs increases the volume and combustibility of fuels. So when dried up and preserved can serve well as fuel at the time of crisis.
- Δ The local people reported that it has no effect on environment.

- Δ It does not cost them anything, rather provides with profitable work;
- Δ The local people can save money from the exercise by meeting the demand of fuels.
- Δ It is economic and cheaper than other fuel materials.
- Δ This fuel can be preserved in sacs and be carried to some place conveniently.
- Δ The preparation of the platforms has one inherent defect and that is the lower portion of the bamboo poles which remain under the floor in the soil of the kitchen and are spoiled by termites within a very short time and they have no immediate solution of this. Sometimes they treat the poles with tar and wrap around with polythene before putting them and then dip the bamboo poles in the soil. This practice protects the bamboo pools from being rotten and the attack of termites.
- Δ If the flood water rises more than 2 ft above the floor, then the poles go under water and rot quickly.
- Δ The straws, stubs, grasses, leaves of trees and other such stuffs appear to be insignificant but they are most vital for our agricultural productivity in the fields. They multiply the micronutrients of the soil which are essential for agricultural fertility of the soil. So the practice contributes to the reduction of the micronutrients of the soil.

Potential for Replication

The fuel needed for the bulk of the population for cooking purpose has not been considered as a huge problem yet. That is an area where attention must be given because of various genuine reasons. The straws, stubs, grasses, leaves of trees and other such stuffs that are used previously as fuel are now disappearing due to tremendous pressure exerted by the population explosion. The fuel preservation process and alternative fuel like dried cow dung need to be promoted in the rural area.

Time is up to give proper attention on the cooking fuels of the rural people and the government of a sovereign country is to extend attention on the issue, if not , the environment will be spoiled, agric productivity will be lost and people will face extreme trouble of cooking food.

LIVELIHOOD DIVERSIFICATIONS AND OPTIMIZING OUTCOMES

Indigenous Way of Seed Storing

The Précis

Units	Location One	Location Two	Location Three
Union	Khokshabari Laxmichap	Radhanagar	Padui Karbaripara
Upazila	Nilphamari Sadar	Gomastapur	Ali Kadam
District	Nilphamari	Nawabganj	Bandarban

Prologue

Decades after decades, agric dependent rural farmers in Bangladesh have been storing various types of seeds in order to sow in the next season. Farmers do not depend on the quality of the seeds available in the market, so they go for preserving their own seeds and have learned how to do this effectively. This is very useful at the time of drought or other natural hazards or crisis of seeds.

The Initiative

It is prestigious that farmers will store their own seeds for cultivating their lands in the next sowing season and in this regard they like to be dependent neither on the market nor on other farmers. They say that real farmers will have their own seeds as they do have their own plough. Although in storing seeds they follow different methods and methodology which differ from place to place in Bangladesh, the main emphasis being on retaining the seeds safe from moisture and insects.

Goal and Objectives

The goal of seed storage is to reduce the vulnerability of any kind of natural hazards. The seed storage initiative aims at ensuring good quality of seeds, saving money for buying with cash at the time of need, reducing dependency on market or others and assuring seed accessibility for cultivation.

Outcomes and Activities

Indigenous knowledge on seed storing at Khokshabari: Seeds which are being stored years after years are not similar in crops and types. If farmers found new types of seeds in the market then, they use the seeds for cropping the same on as little as 20-25 decimal land to prove its efficacy in productivity. Later on, if found satisfactory, farmers store the seeds for adaptation in next

THE GOOD PRACTICE

- ◊ Ensures good quality seeds;
- ◊ Assures seed availability for further cultiva-tion;
- ◊ Saves money from buying with cash money at the time of need;
- ◊ Reduces dependency on market seeds which are never dependable; because the unscrupu-lous traders make commerce of fake seeds when there is crisis of genuine seeds at the time of sowing ;
- ◊ Encourages crop diversity by the seeds stored by the farmers themselves;
- ◊ Optimizes production efficiency; because the production is dependent on the quality of seeds;
- ◊ Effectively enhances the safety of cropping by the people at risk;
- ◊ It is useful at the time of drought or any other natural hazards;
- ◊ The role of Women is the main in the entire process of seed preservation and storing and also taking care at every step;
- ◊ Seed preservation and storing them is the precondition of farming life and that's why the farmers are boasting of having seeds of each and every item they cultivate;
- ◊ Seed storing and preservation does not involve any harmful effect on the environment and is part and parcel of farming life.

season of farming. The farmers in this region are found particularly fond of storing seeds of Aman crops. Of the 30% land owning farmers, 70% are found to store seeds by themselves. Storing the seeds of a particular variety depends on how much land or how many acres /bigha is going to be cultivated with the particular seed in the next sowing season. The respondent farmers opined that they need on an average 10kgs of rice seeds for cultivating a one - bigha plot.

Storing procedure: The farmers select the plants from which they are going to collect seeds even when they are in the field. Generally the luxuriously grown plants having well developed fruits at the top are selected. Then the farmers ensure their maturity in the field. They cut them and bind them in bundles separately and then dry. Before thrashing is done they isolate any other different paddy if any in them. At thrashing the farmer dash the plants twice or thrice against some log so that only the fully matured seeds are separated and the seeds thus collected are dried carefully in the sun for two or three consecutive days each day for 5/6 hours.

The storing has many ways. Some store them in poly bags. Putting the seeds in the bags, they keep some space above the seeds and then close the open end carefully so that humidity or moisture cannot enter. Some put them in earthen pots clean and dry and then close the open mouth first with some stubs and then with some mud and then dry it in the sun.

Storing the bags or earthen pots is also done very carefully. They put them in dry and cold places where no insect or moisture can enter.

In the month of *Kartik* (mid July - mid August), processed seeds need to be taken out for sowing in the field. They take the bags or the pots from the store and then take the seeds out and again dry them for some time in the sun. Then they put the seeds in water pots or tubs and keep them immersed for some time to ensure the unfilled seeds to be separated because if there is any, they will float on water. There is another intention of soaking the paddy seeds and that is to quicken the process of germination when scattered in the beds. Before sowing in the bed they keep them in a sac for 2 to 3 hours to suck up water. After that, this soaked paddy again disperse on the seed bed.

In preparing the bed, first, a four angle bed in length and breadth is designed according to the amount of paddy seeds. About 8 to 9 inches deep soil is made ready by ploughing them properly and then the seeds are scattered on the soil thus made ready and then cover the bed by the soil. The bed is then is covered by sac or some sort of stubs or grass and over them some weights are placed to keep them under pressure so that wind cannot remove them. After 3-4 days the farmers open the coverings and find the newly born saplings peeping through the soil and they see that about 90/95% seeds have been germinated. When these saplings are grown enough they again take them out from the bed and carry them to the plots to plant in place.

The market value of each kg of paddy seed is around Tk.40.

The preservation techniques of other vegetable seeds are more or less same as that of paddy seeds.

Seed preservation at Goladighi

In this area, rice, wheat, maize or other crops are preserved in an especially mud pots which are locally called *Kuthi*.

Preparation of *Kuthi* : The process of making the *kuthi* is begun in the sunny place. *Kuthi* is prepared with clayey mud, stubs and the rice bran. They collect clay from the ponds and make paste of it so uniformly that there remains no concrete substance. Then they add half inch stubs and mix them uniformly with the stuff and at the end they add two handfuls of rice bran with the stuff. After smearing the components well, they lay the foundation of the *kuthi*. The foundation side of this *kuthi* is made 1.5/2 ft. The gradual layers of mud make the upper side 2.5/3 ft or 3/4 ft. The front side becomes smaller and becomes equal to the foundation. A lid is made equal to the front side and to the lower side there remains a

hole of 2 inches diameter. When the mud work is finished and the *kuthi* is dried up, the *kuthi* is stationed in the desired place. The place is chosen in such a way that it is not affected by rainfall or any of the climatic harm or insects.

Seed Preservation Process: The seeds that are to be preserved are dried in strong sun light for three days and during the drying process they are made upside down time and again with broom or legs. Whether the seeds are ready to be preserved or not is tested by putting them under the teeth and pressing by teeth. If they make heavy sound on cracking, the farmers understand that they are properly dried and they put them in to the preservation chamber. Placing the seeds in the chamber also follows some rule. They keep a layer of seeds and then place some *neem* leaves above and then place again another layer of seeds and put some *neem* leaves. In this way they fill the *kuthi* and seal off the mouth of the *kuthi* and close the mouth with mud. The small hole at the lower side is closed with old cloths and then closed with mud. At the time of need the lower hole is opened by taking out the cloths and the necessary amounts of seeds are taken out and the hole is again closed.

At the time of selecting and collecting the seeds, the farmers immerse the seeds in water and separate the paddy floating on water. They are the *chita* (grains having no inner substance) which never germinate. The take only the drowned seeds and process them. In case of seeds of rice, wheat or maize the preserving environment has some quality such as, it must be closed environment with constant atmospheric condition and dry and it must not be attacked by insects. In the case of small seeds like that of vegetables and jute etc. they are preserved in bottles of brown colour for protection against the light of some specific wavelength.

There is risk for the seeds preserved in the *kuthi*. This relates to the placement of the *kuthi* and the time of flood and storm or water surge. If these cannot reach them, then they are safe. The risk of attacking by the insects and fungus remains always there.

Preservation of Seeds of Gourds, Pumpkins and Sweet pumpkins

Gourds, pumpkins and sweet pumpkins are harvested twice a year. The first planting is done in the months of *Chaitra* and *Baishakh* (mid March-mid May) and is harvested in the months of *Ashar* and *Sraban* (mid June-mid July) and the second is sown in the month of *Kartik* (mid October-mid November) and is harvested in Baishakh (mid April-mid May).

The farmers select the maiden fruits of the plants for seeds and from all of the maiden fruits the best one or two they, finally earmarked for seeds and they never cut them until they are properly ripen and the creeping stems are dried up In doing this they take care whether there is any leakage or scratch around the body of the fruits. If this kind of defect is found they avoid it because they think that this may lead to rotting of the seeds. They have other signs of fruits being ripen. When fruits are ripened their bulk undergoes change in colour or the bulk becomes hard. Pumpkins, gourds or sweet pumpkins become matured very soon, within a month or so they become matured and seeds can germinate.

Then they take them from the plants and cut the gourd or pumpkin or the sweet pumpkin to take the seeds out. The seeds are then put on a winnowing platter to dry in the sun, the seeds are not washed because, as the farmers opine, washing may wash away the nutrients of the seeds around it. The drying process continues for 5/6 days, 7-8 hours daily.

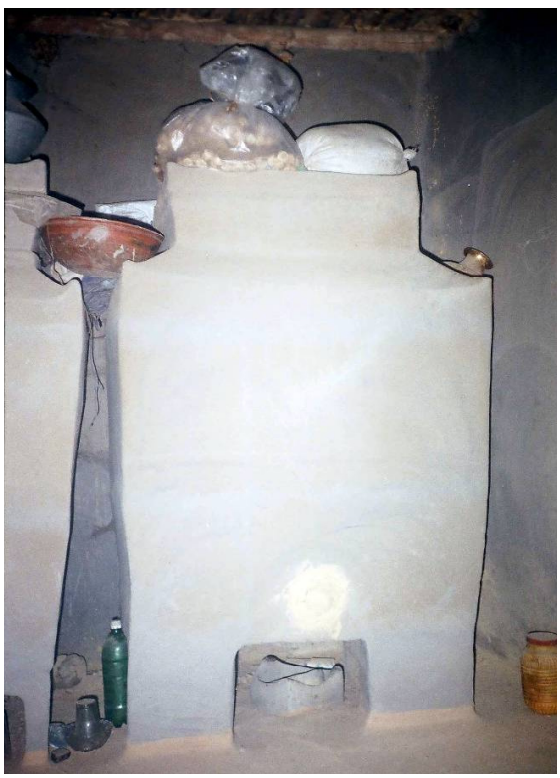
Then the farmers put them in a bottle keeping 10 or 12 inches free above and then the mouth of the bottle is closed so tightly that there is no air communication. The bottle should be under observation and after every 15-20 days they see whether there is any fungus formed around the seeds. They then dry the seeds in the sun. The bottles are placed in dry place where there is no temperature variation or humidity.

Spinach, red vegetables and palong shakh seeds: These vegetables are also cultivated twice a year. Once it is cultivated in the months of Chaitra-

Ashar (mid March-mid July) and second in the month of Kartik - Baishakh (mid October – mid May).

The luxuriously grown plants are kept in the plot. During the harvesting time the plants bear flowers and the flowers turn into fruits and the fruits then are ripen and at a time the plants become old and dry up or the flowering stems are dried up. Then the farmers pluck the fruits and are brought home and then placed in the sun to dry completely for 8-10 days. Then the farmers clip them seeds from the flower stems and separate from the unwanted matters and finally winnow to make them free from any dust or anything else. Then the seeds are allowed to cool and then they are put into bottles of plastic or in the polythene bags like the gourd/ pumpkin seeds.

The seeds can be stored for one year. The seeds of vegetables are very susceptible to many insects and fungus. So the farmers take care and precaution against the attack of these insects.



Marketing of Seeds: The farmers do not bring the seeds to the market for sale. The retailers visit the houses. The farmers having no packaging materials sell the seeds to the retailers. The retailers buy them per 750 gm at Tk. 15-20. They make pack of them and sell them at twice the prices. The prices of vegetable seeds are almost same. The seed transmission in the society is a medium of friendship. At the time of sowing seeds they exchange seeds as gifts to the neighbours and the neighbours in return gifts the vegetables to the neighbours at the time of plucking the vegetables. This reaffirms the friendly ties and helps establishment of harmony in the social life.

The entire process of seed preservation is localized and does not involve any money excepting a little labour and care. In preserving seeds no insecticide is required. The only care that is to be taken is that frequent eye is to given so that the fungus may not attack and that also can be killed by simply putting the stuff in the sun for a few hours. So the effort is environment friendly and as it does not involve any finance and so it is economically beneficial.

The preservation of crops in Bandarban: The preservation of seeds in the tribal areas is influenced by their belief or culture. The tribal people of Bandarban preserve the paddy seeds in a kind of local contrivance known as khurong, a word of the MRU language. It is a nicely looking pot made of bamboo having bigger, smaller or medium size. They themselves prepare it and putting the seeds inside, they never show the khurong to any body and keep them covered under the banana leaves. They believe that if somebody sees this seeds their evil look may spoil the seeds. Besides, they preserve other seeds like pepper seeds, cucumber seeds, sweet pumpkin seeds, etc also in the khurong. These khurongs with seeds are hung from the poles of the house. For preserving the seeds of cotton they have separate pot known as La-parong made of bamboo again. They use this la-parong for preserving paddy seeds also.

Lessons Learned

Key lessons learned from this practice are:

- Δ The entire process of preserving the seeds does not need any money or labour from outside.
- Δ It saves money for buying seeds with cash at the time of need.
- Δ In preserving the seeds they use herbal protective which has no long term effect on environment.
- Δ The process reduces dependency on market for buying seeds and makes the farmer self dependent.
- Δ The required raw materials are available in their home environment.
- Δ The process is very simple and everybody can do it.
- Δ The process is done mostly by women.
- Δ The risk of attacking by the insects and fungus remains here.

Potential for Replication

As a nation, we are struggling to meet up our seed requirement for cultivation. For the purpose, these mechanisms will be a great opportunity regarding ensuring quality seed demand.

GOs and NGOs can take initiative to ensure quality seeds and improved technology towards existing and potential areas so that it meets up nutritional food security.

Mushuri Kalai

Précis

Locations	Location	Seasonality
Union Upazila District	Shuvogachha Kazipur Sirajganj	Aswin to Agrahayan

Prologue

The area mentioned above lies on the western bank of the river Jamuna. Once, the area was very fertile due to alluvial deposits carried by the river. However, now things have undergone a radical change due to frequent floods and river erosion. According to the local people, floods have been occurring occasionally in the Jamuna basin till 1988. Afterwards it has become a regular phenomenon in the area. Along with floods the rate of soil erosion of the river bank has also been increased. According to the respondents, at present almost three-fourths of the Shuvogachha union have been dissolved into the riverbed. The cultivable lands are decreased gradually due to the riverbank erosion. Moreover the existing lands are becoming sandy due to floods which carry a large amount of sands as well as silts. The changing ecological condition enforced the farmers to change their traditional crop pattern.

The Initiative

Change of soil condition enforced the farmer to shift from traditional crops to *mushuri kalai*

THE GOOD PRACTICE

- ◊ Ensures daily protein requirement of common people;
- ◊ Ensures food security with its nutrients;
- ◊ Adds to crop diversity;
- ◊ Increases land utility in areas where no other crop grow so easily;
- ◊ Optimizing production efficiency ;
- ◊ A short term crop that grows with minimum fertility of soil of char areas;
- ◊ The soils of char areas are suitable for this cultivation;
- ◊ The production process involves minimum cares ,capital and labor
- ◊ Lentils can be preserved for long time and the process is known to the farmers themselves;
- ◊ More profitable venture compared with other traditional crops on a same piece of land in the char area;
- ◊ Effectively enhances the food security of people during emergent period;
- ◊ Already adopted and fitted with local ecology long since.

*(*lentil or pulse*)* which is locally called *dal*. Lentil (*Lens culinaris*) is a bushy annual plant grown for its lens-shaped seeds. It is about 15 inches tall and the seeds grow in pods, usually with a number of seeds in each capsule. The pulse is mostly preferred by the *Bangali* community and it has high protein content but it is comparatively cheaper than animal protein. *Mushuri kalai* is cultivated in organized manner here since 2005-2006. Now most of the farmers cultivate *mushuri kalai* as an alternative to livelihood option.

Goal and Objectives

The goal of *mushuri kalai* cultivation is to reduce the vulnerability to natural hazards, especially sand deposition due to flood. The *mushuri kalai* cultivation initiative aims at ensuring daily protein requirement, increasing the land productivity with maximum economic profitability by utilization of minimum fertility level of soil.

Outcomes and Activities

To cultivate *mushuri kalai, at* first a field has to be selected based on the type of the soil. It grows well in sandy fields, especially in one foot layer of sand. The field has to be ploughed thrice. The alluvial deposit beneath the sand does not come up after being ploughed. The ploughing is done in the beginning of the Bengali month of *Aswin* (mid September-mid October). After the first two ploughs, necessary fertilizers are applied in the fields. Afterwards the field is again ploughed for the last time so that the fertilizer mixes up well with the soil. No irrigation is needed during the period.

Immediately after the ploughing, the seeds are sown in the field. An experienced from among the farmers is invited to do the work, for uniform scattering is essential for equitable distribution of sapling density over the plot to ensure uniform growth. After that the field is levelled by using a ladder. Five Kg of *mushuri kalai* seed is needed for one *bigha* land. About an hour is needed to scatter the seeds.

The saplings start to grow within three days of sowing the seeds and within seven days all the saplings come out. The field is to weed within 20-25 days. While weeding the field, the soil is also loosened. When the saplings are about 25-30 days old, special care has to be taken to keep the plants healthy. One common problem that occurs during this time is *lona dhora,* which is indicated by the leaves becoming withered or discoloured (red or yellow). To prevent this, the farmers apply Gypsum and Urea fertilizer in the fields. Afterwards the farmers have nothing more to do until harvesting the crop.

The crop is harvested at the end of *Agrahayan* (Mid November-Mid December). The harvested crop is left out in the sun for 3-4 days to dry. Then the plants are thrashed to get the pulse from the capsules of the plants. Cows are used for thrashing.

About seven maunds of *mushuri Kalai is obtained* from one *bigha* plot but it varies anyway. One maund of *mushuri Kalai* is sold at about Tk.2000. So total amount of crops can be sold at about Tk.14000.

Most of the farmers sell all the crops right after harvesting. Some of them store part of the harvest to get higher price at high demand but not for preserving seeds. Because, germination of these seeds are not good and seeds are available and low-priced in the local market. Moreover seed preservation process is time consuming but cost effective. Still some careful farmers of the area have reported to have preserved seeds to avoid hassle during the season of sowing.

Lessons Learned

Key lessons learned from this practice are:

- The cultivation of *mushuri kalai* is a very profitable venture compared to other traditional crops on a same piece of lands in the char areas.
- It is a short term crop which can be harvested within three months of sowing.
- The harvest is cost effective. The local farmers reported that it does not require intensive labour, even any sort of irrigation does not require. It helps the farmers to derive livelihood benefit from the practice.

- Any sort of irrigation does not require.
- *Lona dhora* or the withering of the leaves limits the production if not treated well.
- This cultivation has potential for Bangladesh as ecological change due to floods and erosion turns many lands sandy, which is favourable for the cultivation.
- High protein foods are beyond the reach of common people, and hence lentils can supply them with sufficient protein.
- The cereal *kalai* has the value of purgative and so people use this at the time of constipation.

Potential for Replication

As an area of utterly food deficit, our struggle is for increasing the production of food ingredients and thereby to enhance our daily protein requirement. The cultivation of *mushuri kalai* opens up a great opportunity for helping us. At the same time land utilization may bring a great benefit in the food sector of the country. So it can be replicated for other areas in Bangladesh.

It is imperative to establish law and order situation very quickly in char areas by state agencies by improving the policy. Lentil cultivation entails scarcity of seeds of high yielding variety and salinity resistance technology, especially the prevention of Lona Dhara. Go-NGO should come forward for rapid extension of the cultivation in Bangladesh.

Organic Manure

Précis

Units	Location One	Location Two	Location Three	Location Four
Union	Khokshabari	Shuvogacha	Radhanagar	Sufolakathi
Upazila	Nilphamari Sadar	Kajipur	Gomastapur	Keshobpur
District	Nilphamari	Sirajganj	Nawabganj	Jessore

Prologue

Decades after decades, agric dependent rural farmers in Bangladesh have been storing household wastes and animal dung and using them for good production. All farmers do not depend on the chemical fertilizer available in the market, so they go for preserving organic manure and have learned how to do this effectively. This is very useful at the time of drought or other natural hazards.

The Initiative

Over centuries our farmers have been producing organic manures from compost at domestic level and scatter it to their agricultural fields across the country. The technique of production of organic manures has been transmitted from generation to generation. This organic fertilizer is proven and effective to increase fertility of land. Even in this modern era of agricultural advancement, organic manure is being used side by side inorganic fertilizers. But there is often crisis of inorganic fertilizers and so demand of organic manure is on the increase.

Goal and Objectives

The goal of this organic manure is to increase fertility of cultivable land and meet the demand of fertilizer due to the crisis of inorganic fertilizer.

THE GOOD PRACTICE

- The manure is environment and soil friendly and the soil characteristics are never changed by the recurrent use of this manure in the crop fields;
- Cost effective, because the farmers them-selves can produce it with elements available in their environment;
- The manure can be prepared at their own premises at the minimum labor and care;
- Different compost manures of very high quality have been developed by many NGOs and R&D organizations and can be used prof-itably at the advantage of the farmers; wide dissemination is needed.
- Already adopted at the field level and proved to be fitted to local ecology.

The aim is to increase the productivity of the soil for increasing the yields due to pressure on food stuffs with the rapid growth of population.

Outcomes and Activities

For preserving the cow dung, a hole is dug at about 6 ft in length, 5 ft in breadth and 3 ft in depth nearer to the cowshed. The selected place is comparatively higher than the surrounding land so that water could not get into the ditch easily. A roof is necessary above the ditch, because there is frequent rainfall. Within two months the ditch can be filled with cow dung of two cows of a family. In addition, solid waste including vegetable wastes, kitchen rubbishes, ashes of the stoves, straws, and even the filthy things from animal leavings etc are also put into the ditch. All the elements are gradually decomposed to turn into organic manure. Afterwards the manure is carried to the plots and is kept in heaps and finally before ploughing are scattered over the plots. There is no definite rule for giving the cow dung manures to the lands. Local farmers reported that these are just scattered by them and then plough the land when these are mixed with soil.

Lessons Learned

Key lessons learned from this practice are:

- The local farmers reported that the raw materials are easily collected from the farm as a by-product of dairy including livestock and different residual of dairy farm and kitchen activities, and the compost is naturally decomposed.
- This does not require any cost; only a little domestic labour is enough to run the venture for collection of cow dung and other materials.
- This type of nutrient source is free from toxicity..
- Cow dung is such manure which can be used for all types of vegetative production. There is common saying, "the more you scatter (organic manure), the more you harvest (crop)" implies efficacy of organic manure and so local people consider the cow dung manure is more effective than the chemical fertilizers. Cow dung does not have any adverse action on the soil.
- Now scientists proved that the organic manure is capable of fixing up micronutrient in soil without disturbing the flora & fauna composition in the ecology of the soil and also capable of improving soil structure including nutritional status as well as soil texture accompanying increase of microbial population in the soil.
- Cow dung collection is tough for those who do not have any cows.

Potential for Replication

This organic manure has been considered to be potential for crop production. At the time of fertilizer crisis and price hike of inorganic manure, organic manure is an only alternative; the manure has no side effect like the inorganic manures. It is soil friendly and helps increase soil fertility.

GO-NGOs should create awareness among the farmers for increasingly using these fertilizers instead of inorganic manures. The agric extension workers should be all out about convincing the farmers on its long term effect and efficacy.

Groundnut Cultivation

Précis

Units	Location One	Location Two
Union	Shuvogachha	Kakara
Upazila	Kazipur	Chakaria
District	Sirajganj	Cox's Bazar

Prologue

The area of Shuvogachha as mentioned above lies to the western side of the river Jamuna. Once, the area was very fertile due to alluvial deposits carried by the river. However, now things have changed due to frequent floods and river erosion. According to the local people, floods have been occurring occasionally in the Jamuna basin till1988. Afterwards it has become a regular phenomenon in the area. The rate of the riverbank erosion has also been increased. According to the respondents, at present, almost three-fourths of the Shuvogachha union has been dissolved into the riverbed. The cultivable lands are decreased gradually due to the riverbank erosion. Moreover the existing lands are becoming sandy due to floods which carry a large amount of sand as well as silt. The changed ecological condition compelled the farmers to take recourse to alternative crop pattern.

THE GOOD PRACTICE

- ◊ As short term crop and as it grows where no other crop is suitable for growing, its cultiva-tion adds productivity and use lands economi-cally;
- ◊ Increases land utility at the benefit of people at risk;
- ◊ As groundnut is a non-traditional crop and beneficial to meet economic crisis, it demands attention;
- ◊ Cultivation of groundnut does not need much cares, manures and capital/ labor and so is profitably useful for areas where other crops do not grow well or at all;
- ◊ The newly formed chars and lands where the proportion of sand is high is most suitable for groundnut cultivation and in Bangladesh this type of lands are many, like the areas under investigation;
- ◊ The practice helps crop diversification and may have the potential for greater yield if studied properly.
- ◊ Already adopted by the local people long since and suitable for the ecology and environment.

Another area, Kakara of Cox's Bazar was once very fertile due to alluvial deposits carried by the river, Matamuhuri. However, frequent floods have changed the ecology of the area. According to the respondents, land characteristics have turned into sandy and less fertile, specifically after the flood of 1988. Afterwards paddy and other usual crops are not grown well. The changed ecological condition enforced the farmers to change their crop pattern.

The Initiative

Due to sandy and less fertile land, farmers of Shuvogachha and Kakara started to think about alternatives and they started to cultivate groundnut or peanut (Arachis hypogaea), a species in the legume family. It is an annual herbaceous plant growing to 30 to 50 cm (1 to 1½ ft) tall. It is usually cultivated for its fruit. Each pod has 1-2 seeds. Recently a new variety of nut has been appeared in the market and found to have 3-4 seeds in the pod. Removing the shell, the seeds are collected. The seeds are rich in non-drying oil (35-50%), proteins (25-30%) and vitamin B and E. The oil produced from groundnut is used for cooking, and as margarine and vegetable ghee, and in confectioneries and pharmaceutical industries. Inferior quality of oil is used for soap and as lubricant. Groundnuts are also eaten after roasting. It is the second largest source of vegetable oil after soybean.

Ground nut cultivation is a recent event in Shuvogachha. Initially only a few farmers (around 8-10 people) started the plantation in 2005. However, its outputs created a lot of interest among the farmers. So the number of farmers' involvement increased in 2006 and in 2007 and almost 80% of the farmers are now engaged in it. On the other hand, farmers of Kakara started to cultivate groundnut in 1988. Now most of the farmers are engaged in groundnut cultivation.

Goal and Objectives

The goal of peanut cultivation is to reduce the vulnerability to natural hazards, especially, to sand deposition due to flood. The peanut cultivation initiative aims at increasing the land productivity with maximum economic profitability by utilization of minimum fertility level of soil.

Outcomes and Activities

Lands, generally sandy ones with 1 or 1.5 feet sandy layer are selected for peanut plantation. Then the land is ploughed one time in Shuvogachha at the beginning of the month *Agrahayan* (mid August-mid September). After that farmers use *Bhamor* technique (*Bhamor* means making holes 6/7 inch deep and 1 foot apart in the land and then covering it with peanut seeds in the soil. Source: Informal discussion). Once the *Bhamor* is done, it is now time for planting seeds. On the other hand, ploughing is not done in Kakara. The farmers of the area create holes for sowing seeds.

Seed preparing is very important for groundnut cultivation. The most important work is to peel off the skin carefully. It takes a lot of concentration. One needs to be careful so that the pink cover of the nut seed interior is not damaged. If it is damaged, the seed does not germinate. Since the work needs to be carefully done, it takes pretty long time.

Seeds are sown in the holes. After sowing seeds the hole is covered with soil so that the seed can draw necessary nutrition from soil. As a result, young plant comes out of the seed within 8-10 days. Its saplings come out of the soil on the 7th day and takes full shape within 10 days. Usually fertilizer and water is not needed during the nut plantation in Shuvogachha but they are needed in Kakara union during the plants flowering and after one month of flowering the farmers irrigate the plants second time.

Pest attack is common in Shuvogachha. Within 15-20 days of plantation, pests attack and eat the young leaves of the plants. These pests are called *Majra* (or *Mandan*). They look like white ants and take the shape of butterfly as they grow up. Farmers spray pesticide called *Diazenon* to protect the nut plants. *Diazenon* is a liquid pesticide. It is sprayed on the field after being mixed up with water. According to the interviewees, it's good to spray at night. Also one might spray in the afternoon. Comparatively cool weather of night helps the pesticide to get mixed up with the soil. While spraying one should not spray against the direction of the wind. Diazenon is a poison. Everyone should cover his hand and face before spraying. It takes one labourer to spray pesticide on one bigha of land. On the other hand, farmers of Kakara do not need pesticides.

Normally the nuts are ripe by *Falgun* (mid November-mid December). Farmers start picking nuts at the end of *Falgun* (mid November-mid December). Rain plays an important role in picking nuts. If it rains heavily during *Falgun* (mid November-mid December) groundnuts should be picked as soon as possible. Otherwise new plant will start to grow from the nuts. The labourers pick the nuts and carry home. The hard work is not over yet. Nuts are separated from the branches after bringing home. In this case nut clusters (all the nuts together in a bunch is called cluster) are separated from the branches by cutting out the roots from the trees. Labourers are needed to root out trees.

Finally, the groundnuts are dried in the sun for 5-6 days and then they are sold. The average yield per season is not always the same. However, usually it yields 10 *maund* in Shuvogachha and 6 *maunds* in Kakara in one bigha on an average.

The total expenditure of peanut cultivation in one *bigha* is taka 2690 (see details in annex) which gives the output of 10 *maunds* groundnuts in Shuvogachha. In case of selling nuts two methods are observed. Firstly, farmers take the nuts to the market for selling and secondly, Wholesalers go to the farmer's place and buy nuts from them. In this case selling price varies. Farmers hire vans to carry nuts to the market place and the rent

of the vans depends on the distance. (Usually in Shuvogachha farmers spends Tk.10 per *maund* as van rent). If wholesalers come to the farmer's place to buy nuts, the selling price is 20 taka less than the market price. Average selling price is Tk.1300-1350 per *maunds*. Depending on the season, selling price varies. During the harvest season, selling price is comparatively lower. Average selling price during this season is Tk. 1100-1200. So, an input of Tk.2690, for one *bigha* provides 10 *maunds* nuts which earn Tk.12000 and from this Tk.9310 is net profit in the pick season and in the off peak season, Tk.13500 for 10 *maunds* and of those Tk.10810 is net profit for the farmers.

On the other hand, Tk.5416 gives an output of 6 *maunds* nuts in Kakara village. In case of selling, the wholesalers go to the farmer's place to buy nut. Through this process the farmers get taka 70 less for each maund rather than bringing them to market place for sale but they avoid going to the market. The farmers of South Kakara get 1000 taka for each *maund* which makes the total of Tk.6000 for 6 *maunds* and according to input and output the net profit is Tk.581.

Lessons Learned

Key lessons learned from this practice are:

- Nut cultivation is a short term crop which does not need much care, capital and labour.
- Economically nut is a cost-effective crop. Because of the market demand, the harvest is increasing day by day.
- Ground nut plantation contributes influential part in the local economy because the sandy land is unproductive for other crops and as the area has no alternatives, people become encouraged to nut cultivation.
- Usually the rate of seed damage is very low. But for some reason if the seed is not fully formed or the skin is damaged, it does not germinate.
- The multifarious uses of nuts, of course, help decrease pressure upon staple foods and hence enhance food security.
- The edible oil that is produced from the nuts are nationally valuable as this can save our foreign currency for importing edible oil and even it has potential, if grown plentifully, of exporting outside. More over the nut plants can be used as cow fodder and fuel.

Potential for Replication

Bangladesh has vast char *and* riverine lands and most of them are cultivable but remain fallow due to lack of the application of appropriate seeds and saplings. If ground nut cultivation is introduced in the char lands the community people will get much incentive by having enough crops, the practice will no doubt increase productivity and land utility will be enhanced.

If the technology of cultivation is modernized the production efficiency can be raised sufficiently and the farmers will get much incentive. GO-NGO efforts are essential for this purpose.

Sugar Cane

Précis

Units	Location	Seasonality	Hazard
Union	Shuvogacha	Bhadra, Aswin or	Flood
Upazila	Kazipur	Kartik to Next	and River
District	Sirajgonj	year Kartik	Erosion

Prologue

The area as mentioned above lies to the western side of the river Jamuna. Once, the area was very fertile due to alluvial deposits carried by the river. However, now things have undergone a radical change due to frequent floods and river bank erosion. According to the local people, floods have been occurring occasionally in the Jamuna basin since 1988; afterwards it becomes a regular phenomenon in the area. Along with the floods the rate of erosion of the riverbanks has also increased. According to the respondents, at present almost three-fourths of the Shuvogachha union have been dissolved into the riverbed. The cultivable lands are decreased gradually due to the riverbank erosion. Moreover the existing lands are becoming sandy due to floods which carry a large amount of sand as well as silt. The changing ecological condition enforced the farmers to change their traditional crop pattern.

THE GOOD PRACTICE

- ◊ Encourages integrated farming. It allows many short term crops like pepper, pulse, beans, lentils etc and some tuber crops in the same plot;
- ◊ Enhances crop diversity and land use adding to the total economy of the country;
- ◊ Increases land utility in areas where no other crop grow so easily;
- ◊ Optimizes production efficiency;
- ◊ Crop production by utilizing minimum fertility level of soil of char lands;
- ◊ The soil is suitable for this cultivation;
- ◊ More profitable venture compared to traditional crops on a same piece of land in the char area;
- ◊ No need to think about its selling as the sugarcane mill authority buys it with pr-fixed rate. Even farmers could not have worried how to meet the production cost as mill authority extends credit with small rate of interest dur-ing cultivation period;
- Δ The cultivation is already adopted by the local people since log and fitted with local ecology.

3.7.18.3. The Initiative

Change of soil condition enforced the farmer to shift from traditional crops to sugarcane; a tall tropical annual plant, has significantly jointed stalks, each bearing two ranks of sword-shaped but gracefully arching leaves. Locally sugarcane is known as *Akh*. This sugarcane cultivation is not a new initiative; people of the area have been cultivating it since 40 to 50 year. But the cultivation has been intensively started at the '*aman mehar*' and '*boyrer*' chars after devastating flood of 1998. At present most the farmers are cultivating sugarcane. The sugarcanes are crushed to extract juice for crystallizing sugar or *ghur*. This has become popular as sugarcane cultivation offers integrated farming facilities along with short term mustards, pepper, lentils, brinjal and other pulses.

Goal and Objectives

The goal of sugarcane cultivation is to reduce the vulnerability posed by natural hazards, especially sand deposition due to flood and riverbank erosion. The sugarcane cultivation initiative aims at increasing the land productivity with maximum economic profitability by utilization of minimum fertility level of soil and applying the integrated farming with maximum productivity of the land.

Outcomes and Activities

Loamy soil of the *char* land is suitable for the production of sugar cane. The farmers who have own lands may either cultivate sugarcane by themselves or they can lease out the land to landless cultivators. Saplings, power tiller, fertilizers (phosphate, potash), irrigation, labour etc are also required for this cultivation. All these materials are easily accessible to the local people.

The cultivation starts from the month of *Bhadra* to *Aswin* (Mid August to Mid October) and is harvested in the months of next *Kartik* (Mid October-Mid November) of the following year. It is a perennial crop and is produced in both the seasons.

Today, power-tillers are used to plough fields. Afterwards necessary fertilizers such as phosphate (TSP) and potash (K) are scattered in the field. Before planting the saplings (sapling is collected from mother sugarcane by cutting bottom edge at about 10 inches long), long rows (locally termed as *bhamar*) is made with a relative depth by a traditional ploughing equipment and the sapling is put down into the soil at a distance 1.5 to 2 ft according to the row. Each piece of sapling produces at least 2/3 bud from which another new sugarcane grows, if water is given properly.

After couple of days irrigation is provided and after the first irrigation fertilizers, especially TSP and potash together are scattered over the plot. Weeding including shaking the dead leaves is usually done when the cane grows at about 5 ft long which facilitates quality production. Again irrigation is necessary at the month of *Jyostya*

(mid May-mid June), if no rainfall occurs. Finally insecticide is given at the month of *Agrahayan* (mid Nov-mid Dec) to prevent attack of termites. Afterwards 5 to 7 canes are bound together with ropes or with the leaves of the plants themselves so that the long cane plants are not uprooted or bent down by the blow of the stormy wind at rough weather. The sugarcane is harvested after one year at the next *Kartik* month (Mid Oct-Mid Nov).

In the sugarcane plot different crops like pepper, pulse, beans, lentils etc and some tubers crops can be cultivated as integrated practice. Notable is the fact that sugarcane cultivation is generally done for consecutive three years, because the cultivation of the first year follows consecutively another two years with the same seed plants, as when the first harvest is cut the roots give out plants which grow one after the other. This is profitable venture, as the second and third time they are not to plant. So, just one harvest is not profitable for the cultivators.

The sugarcane plot is usually sold to sugarcane mills at about 10000 taka per *bigha* plot,

Lessons Learned

Key lessons learned from this practice are:

- Integrated farming is main strength of the enterprise. Sugarcane cultivation allows many short term crops like pepper, pulse, beans, lentils etc and some tuber crops in the same plot.

- This is a profitable venture compared with traditional other crops on a same piece of land in the char lands.
- The cultivation process is simple and one plantation offers three times harvesting.
- The required inputs are easily accessible to the local people.
- The cultivation is adaptive to the changing soil condition which traditional crops cannot.
- The farmers are not to hassle for selling their products as the sugarcane mill authority buys at a fixed rate.
- Farmers are not to be worried as to how to meet the production cost, as mill authority advances credit at simple rate of interest during cultivation period.
- Pricing of the sugarcane, at times, creates frustration among the farmers.

Potential for Replication

The sugarcane cultivation can be replicated for other char areas of Bangladesh because it utilizes minimum fertility soil of char lands with the maximum economic return by using integrated farming.

Mill authority should think about the price of sugarcane, otherwise farmers may become disinterested and reluctant to cultivate the sugarcane. The govt. should fix the price. There is an urgent need of law and order as well as char land reform policy. Otherwise poor and powerless farmers never get access to the new char lands. GO-NGOs should come forward to give credit to the poor farmers for this cultivation.

Onion

Précis

Units	Location	Seasonality
Union Upazila District	Gajaria Gaibandha Gajaria	Poush to Chaitra

THE GOOD PRACTICE

- ◊ Onion cultivation gives short term crop and is grown in lands where traditional crops do not grow well;
- ◊ It does not involve much care, capital and labor. The production is satisfactory;
- ◊ It is used as medicinal herb against cold and other complains;
- ◊ The most common and popular use is as spice in the many countries of the world and an essential spice in our country which is always deficit;
- ◊ Adds to crop diversity;
- ◊ Increases land utility;
- ◊ Optimizes production efficiency comparing other non-traditional items;
- ◊ Grows in the minimum fertility of soil of char area;
- ◊ The soil, too, of this lands are suitable for its cultivation.
- ◊ Profitable venture compared to traditional crops on a same piece of land;
- ◊ Effectively enhances the food purchasing ability of the population at risk by selling on-ion;
- ◊ Already adopted and fitted with local ecology long since.

Prologue

An isolated small mass of *char* land as mentioned above is in the midst of the river Brahmaputra. It is flooded off and on by the river tides and waves and the on rush of the frequent flood due to the upcoming rainwater from beyond the border. Along with this, river erosion is a regular phenomenon. However this flood together with the river erosion affects life and livelihood. Agricultural fields are mostly affected by both the hazards; even soil condition is changed every year.

The Initiative

The changed circumstances enforce the farmers to cultivate onion, belonging to *Allium cepa*, is also known as the 'garden onion' or 'bulb onion' and 'shallot' etc. Although intensive cultivation of onion had been started in the area ten years back, but it had a long history of cultivation at individual level. In Bangladesh it is mostly used as spice rather than vegetables. Onion can be ranked first among all other spices grown in Bangladesh.

Goal and Objectives

The goal of onion cultivation is to reduce the vulnerability of natural hazards, especially sand deposition due to flood and riverbank erosion. The onion cultivation initiative aims at ensuring commonly used spice, increasing the land productivity with maximum economic profitability by utilization of minimum fertility level of soil in *char* land.

Outcomes and Activities

The cultivation starts from the end of *Poush* to the beginning of *Magh* (mid December to mid February) and harvesting starts at the end of *Falgoon* to *Chaitrya* (mid February to mid April). During the period the *char* land becomes dry, a favourable condition for onion cultivation.

The plot is ploughed crosswise consecutively twice as to blend top sandy soil with the blackish soil below. Then the land is given fertilizer (5 kg urea, 5 kg potash and 10 kg TSP) and levelled and finally left for a few days. Again the plot is ploughed crosswise twice and levelled. Then the land is ready for sowing the seeds. 7.50 kg of onion seeds are needed to sow one *bigha* plot. They buy the seeds from the local market and dry in the scorching sun for 2-3 hours. The well dried seeds

are soaked in about 2 litres of water at about 2-3 hours and it is taken out. Then the wet seeds are wrapped up with cloth and hung up to remove water from the seeds. After 4-5 hours when water is completely removed, it is scattered over the plot and soil is levelled. Generally farmers scatter the seeds in the morning. Then sand is given on the surface of the plot at about 0.25 inches thick in order to cover the seeds under the soil.

After 5-7 days saplings come out from the seeds. Then after about 20 days onion plants grow 3-4 inches long, weeding is done and the first irrigation is given to the land. This irrigation has a technique and is done like sprinkling by putting the fingers in the opening of the pipe so that the water comes out in jets lightly. The farmers are aware that water should not stand in the plot which might be harmful to the plants. Along with this, 7 kg of Urea is given to the plots. After about 20 days, irrigation, as done earlier, is given and further 5 kg urea is given to the plot.

Onion is harvested at the end of *Falgoon* (mid February-mid March) to the middle of *Choitrya* (mid March-mid April). After harvesting the onion is scattered over the plot and are left for two days for drying of the leaves. During this time if the plot is away from the farmer's house, one has to watch over there continuously to prevent stealing. Harvesting is done on fare weather day to avoid rainfall which might rot the product in the field.

About 15 maunds of onion grow in one *bigha* land. The produce is sold at an average Tk 400 per maund, total selling price being Tk 6000.

Net profit of the onion cultivation in one *bigha* plot is Tk 3044. When total production cost is Tk 2956 while the total selling price is Tk 6000.

Lessons Learned

Key lessons learned from this practice are:

- Δ The cultivation process is simple.
- Δ The harvest could be done within a very short duration. The cultivation starts from the end of *Poush* to the beginning of *Magh* (mid December to mid February) and harvests at the end of *Falgoon* to *Chaitrya* (mid February to mid April).
- Δ The cultivation of onion brings cash money for the farmers and so they are interested for this practice.
- Δ The local farmers of this area are very much conscious and concerned with onion cultivation.
- Δ Rapid change of soil condition due to flood does not allow every year to have good produce.
- Δ The local farmers follow the traditional cultivation method. For this reason productivity is not very satisfactory.
- Δ The local farmers do not know how to process the harvests and store the crop properly. So they sell to the middlemen and do not get the real benefit of the crop.

Potential for Replication

Onion cultivation has a great prospect in Bangladesh as there are huge *char* lands which are on the increase day by day due to land reclamation by the sea and rivers and alluvium deposition by the river current. These chars are suitable for onion cultivation and hence our farmers use the practice of onion cultivation.

Introduction of modern technology of cultivation, processing and storing is essential and the farmers are to be trained and motivated to be acquainted with these for maximum benefit. Also high yielding varieties of seeds should be introduced to the farmers. In this regards, Go-NGO collaboration and farmers facilitation is urgently needed.

Banana – A Multiplan Plant

Précis

Units	Location One	Location Two
Union	Uria	North Chanel
Upazila	Fulchori	Faridpur Sadar
District	Gaibandha	Faridpur

Prologue

The areas are *char* lands which are vulnerable to flood, river bank erosion and other natural hazards. These hazards are reducing people of the villages landless and ultra-poor. The vulnerable people adopt many alternative strategies for earning their livelihood, of which the cultivation of banana being one of them.

The Initiative

The farmers of both the chars practice banana cultivation around their homesteads. Banana is richer than any other fruits and has multiple uses. The *char* dwellers raise banana garden as safety wall around, because banana plants are water tolerant owing to having clustered roots which spread around parallel to the ground and remain attached to the soil and hence is effective in preventing soil erosion. Moreover they use the plants as cow fodder. A plant give fruit only once and then the plant is cut to harvest the fruit and the kernel inside is used as curry and the remaining portion is used as fodder. The left over part of the tree is easily degradable within a few days. The green leaves are used as plates to serve people with food during mass festival by the Hindu community. Even the degradable part is also used to retain water in the land. It Is not that people use the ripe banana, the green banana also is used as good curry. The ripe banana is used in preparing many sweet meats and jelly. The banana plants find a very important use in making raft used as life saving vehicle at the time of floods. People collect 4-5 plants of 8-10 ft long and pierce through a stick to get together and then bind them with rope so that the combination cannot get loose and then use this as vehicle for their movement, carrying essentials to safe places, and even carry their cattle sheep to a safer high land or even they can reside on the raft for some days together.

Goal and Objectives

The goal of banana cultivation is to reduce the vulnerability to natural hazards, especially flood. The banana cultivation initiative aims at preventing soil erosion, ensuring food security, increasing land productivity with maximum economic profitability by utilization of minimum fertility level of soil.

Outcomes and Activities

Although banana plants can be planted throughout the year, the people of the areas prefer to plant them at the beginning of the rainy season. Once

THE GOOD PRACTICE

- For protecting newly formed soil from erosion or weathering by its multiple roots spread around.
- The banana plants find a very important use at the time of flood situation in an area, when they make raft of it to be used as life saving vehicle and carry essentials to safer places.
- Banana plants, when cut off their fruits are used as cow fodder and the kernel is used as curry by the farmers.
- The fruits are rich in nutrients and can be used in different forms at ripe and green stages.
- Increases land productivity by capturing and providing moisture to soil.
- Utilization of char lands and fallow lands around homesteads with minimum fertility and efforts for better production.
- Effectively enhances the food security and safe mode of communication at the time of emer-gency of the population at risk.
- Already adopted and fitted with local ecological condition.

the saplings are planted no care is necessary for their growth. Generally the farmers together with their children and ladies plant the saplings and the saplings are also not to buy. They can be collected from the old plants or from the neighbours at free of cost. The plants are rapidly growing and give fruits within the same year of planting.

The cultivation is not planned on lands but on the places around the homesteads. Even when a farmer does for raising a new house at a place he plants banana first and is a culture in this area. Raising the soil of a certain area and then planting banana is a sign of raising a new house.

The banana trees at the age of one year give a clustered conical flower and after 4-5 months the fruits are ripen. Then the farmers harvest the fruits to sell in the market. The banana is economically profitable and the price of the crop fluctuates at different time of the year. Generally it is costly in the winter. Banana is much richer in food nutrients than any other fruits and has multiple uses.

Lessons Learned

Key lessons learned from this practice are:

- The local people reported that it is a profitable venture.
- It protects soil erosion by its multiple roots spread around.
- It does not need any manure or other care.
- A plant gives one time fruit and then die but it leaves many saplings before ending its life cycle.
- The saplings grow rapidly and give fruits at the same rate and time.
- Banana cultivation is environment friendly.
- It has multiple uses. Raft as life saving vehicle and carry essentials to safer places are made at the time of flood situation in an area. It gives fruits with many nutrients. Moreover, banana plants, when cut off their fruits are used as cow fodder and the kernel is used as curry by the farmers. The cone shaped flowers tapering at both ends are also used as good curry
- The cultivation process and harvesting method is not scientific. Food value of many fruits is lost due to mishandling through harvesting, packing and carrying.

Potential for Replication

The fallow lands around homesteads ,roadside and especially in the newly formed char lands banana cultivation is the most beneficial .The southern coastal area of Bangladesh, where char formation is very common may be used for banana cultivation to protect soil effectively at the maximum economic benefit. So, for replication of the practice, should be strongly encouraged among individuals and community people for intensive banana cultivation in these areas.

The cultivation method of banana is primitive and could not get attention of the modern technology in our country. But the method of harvesting of fruits is horrible. More than fifty percent of the economic value is lost due to mishandling of the banana fruits by the inexperienced farmers and the carriers. So this aspect should be seriously cared by all authorities, the Government and NGOs, putting more research and improved technology should be adopted. Farmers should be trained properly to process the fruits they produce to get maximum benefit from them.

Bhenda – A Medicinal Plant

Précis

Location		Seasonality
Union Upazila District	Uria Sadar Gaibandha	Ashar – Aswin

Prologue

Due to flood and river bank erosion people of the above mentioned areas are becoming landless and ultra-poor. These vulnerable people adopt many alternatives for earning their livelihood, making oil from *bhenda* plants being one of the many.

The Initiative

The area grows naturally a kind of creepers locally called *bhenda* plants (one kind of plants that grow 8-10 ft long and have many branches but the branches are little) which have much medicinal value. *Bhenda* has been grown naturally in these areas from over decades.

Goal and Objectives

The goal of *bhenda* cultivation is to reduce the vulnerability of natural hazards, especially drought. The *bhenda* cultivation initiative aims at healing people from different diseases and utilizing the fallow patches of lands at the maximum economic profitability.

Outcomes and Activities

Bhendas are grown naturally in these areas. When the trees are matured they give out flowers, then the flowers are grown to fruits after a few days and when the fruits are matured and are ripen, farmers collect them. Farmers separate these seeds from the trees and dry them. Thus, collecting the dried seeds, they are again treated to more heat to dry them more strongly. Then they are broken into powder by treating them under *dheki*. Then they mix about 2 kg powder of bender fruits with 2.5 kg of water and boil for 2 to three hours on the furnace when some oily fluid appears on the surface of water. They separate the oily liquid from the mixture and this separated oil again is heated for an hour to ensure the removal of water from it. Thus they prepare the bender oil 375 gm from two kg of *bhenda* seeds and put it in to bottle.

THE GOOD PRACTICE

- ◊ Used as medicine for many dermatological diseases at the time of flood. Besides this is good medicine for use externally against headache;
- ◊ Encourages crop diversity in places where no other agric feats are possible;
- ◊ Increases land utility at the benefit of people at risk;
- ◊ Utilizes minimum soil fertility of char land and is not at all an organized agric effort;
- ◊ Does not need any extra effort and the soil is suitable for the growth of bhenda plants;
- ◊ The bhenda cultivation is already adopted by the local people since long and fitted with local ecology;
- ◊ Now what is needed is to improve the technology, organize the farming methodology and extend the practice through out the coun-try.

Lessons Learned

Key lessons learned from this practice are:

- Δ This *bhenda* oil is used as a medicine for many dermatological diseases that appear at the time of flood. Besides this is a good medicine for use externally against headache and it has no side effect like other allopathic products;
- Δ The farmers prepare the oil and sell by themselves at the time or immediately after the flood when people suffer from itching due to infections from flood water.
- Δ The preparation of *bhenda* oil is a good example of extraction of herbal medicine from the indigenous plants and it indicates and encourages people to search in to

some other plants for extracting akin product;

Δ The *bhenda* oil extraction and use against dermatologicaliliments is absolutely harmless, environment friendly and efficacious and also economically profitable for people at risk.

Potential for Replication

Bhenda oil as a medicinal product is used for the treatment of many dermatological diseases at the time of flood and also use against headache and does not have any side effects. Now-a-days the scientists in the developed laboratories are also looking for these plants. So the cultivation needs to be encouraged for its extension in other areas of Bangladesh.

This medicinal plant should be seriously cared by any authorities, the Govt. and NGOs. It needs more research and improved technology. NGOs can come forward to spread this cultivation by providing seeds and technology.

Conservation of Tall Grasses (Kashban)

Précis

Units	Location	Seasonality	Hazard
Union	Shuvogacha	Bhadra, Aswin or	Flood
Upazila	Kazipur	Kartik to Next	and River
District	Sirajgonj	year Kartik	Erosion

Prologue

Shuvogachha union lies to the western side of the river Jamuna. The area was once very fertile; but there has been a radical change in the ecology due to frequent flood and river erosion, rendering the soil ecology changed with heavy deposits of sands. More over river erosion dissolved almost three-fourths of the union into the river bed displacing hundreds of farmer families. The eroded lands are reclaimed naturally after a long time as char lands over which also there are disputes very often. However these chars, when raise their heads above water level appear to be a ray of hope to the people.

THE GOOD PRACTICE

◊ Enhance land reclamation with soil of rich nutrients making the lands more potential for agric production;

◊ The plants are used as materials for fencing of homesteads, fodder of animals and fuel for cook-ing;

◊ Increases the land fertility by the alluvium bearing rich soil elements which ultimately in-creases land productivity;

◊ Helps prepare treacle which contains healthy food nutrients and creates an opportunity for employ-ment to people at risk and gives extra income;

◊ Provides with an opportunity for early utilization of char lands and helps expedite the land forma-tion process;

◊ The saplings are carried by the current and the plants grow naturally in these chars and hence no initiative for cultivation, weeding, manure, labor etc but a little care is needed;

◊ Kasban cultivation and preservation of it has been a proven means for accruing economic bene-fit for people at risk and adopted long since.

The Initiative

Under the circumstances, the farmers at their own initiatives conserve the *kashban* (a kind

of tall grass bearing white flowers with scenic beauty) grown on the char to exploit dual benefit from them. The main objective of the newly formed char dwellers to allow *kashban* to grow is its role for the rapid silt formation of alluvial soil so that the lands may become suitable for cultivation quickly. They have this experience and so at the time of flood, if there are *kashban* on a piece of land, sedimentation of water born soil is favoured and quickened. Soil erosion from one bank and land formation opposite to it is a perennial process and thus the growth of *kashban* has been following all along the land formation side. But the phenomena of frequent erosion and reclamation started in this area since 1992 and people have been extremely shaken by it.

Kash plants are collected, juice is extracted from the tall plants and this initiative started after 1998-99. It is known that the first extraction of treacle occurred with the chars known as Rupsarchar and Harinathpur, but whether it was simultaneous or not, or who was the first innovator is yet unknown. Gradually this practice spread around and at present 5% population are involved in extracting treacle by collecting juice from the plants and treating it in a vessel designed by them.

Goal and Objectives

The main goal of conservation of *kashban* is to catalyze land formation from river bed by rapid sedimentation during flood. The conservation of *kashban* initiative aims at increasing the siltation of alluvial soil so that lands may become suitable for cultivation quickly; increasing the land fertility by the alluvium and the extraction of juice for treacle preparation from *kash* plants is so to say a by-product.

Outcomes and Activities

Kash plants grow naturally in these chars and hence no care for cultivation, weeding and application of manure is needed. It captures silts in large scale during flood. After flooding season is over the role of *kash* plants is also over and they are cut. Then the lands are cleared first for crop cultivation and treacle preparation from *kash* plants in removing the plants of 1 *bigha* 15/16 labours are required and cost is Tk. 1500. For thick bush this cost may be more. These *kash* plants are looked after by the owners. If the owners live far away, they assign someone living nearby for looking after *kashban* to protect from being stolen, paying Tk. 1000 to 1200 per *bigha* in a year. The ownerless lands are generally used by anybody.

Kahsbans grow in clump and 8-10 sticks in a clump are available from each clump in the month of *Ashar* (Mid July to Mid August) and are cut in the month of *Kartik* (November). These are as flexible as a rattan and are crushed for extraction of juice for treacle preparation. *Kash* plants are as hard as jute sticks. These are used both as fuel and fodder for cows.

Basically, people cut these plants in the month of *Katrik* (Nov.) by boats. About 50-55 kgs of treacle can be prepared from the plants of one *bigha* of land. The plants are crushed by a kind of machines and the machine owners are paid Tk. 250 for a maund of treacle. So at the rate Tk. 20 per kg, 50 kgs can be sold at Tk 1000. So it is an income of the idle season.

Lessons Learned

- *Kash* plants can enhance land reclamation with soil of rich nutrients making the lands more potential for producing of rice and other crops that meet up the food demand of this area.
- It increases land fertility by the alluvium bearing rich soil elements which ultimately increases land productivity. According to the respondents, in a season the alluvium of depth 1 ft to 6 ft may be deposited depending on the rate of carrying the alluvium by the current and also on the rate at which the other banks are eroded.
- It increases the land fertility by the alluvium and helps treacle preparation which gives added income to the farmers.
- It captures the mobile soil with its roots spread around with water current to form lands The local people prepare treacle which contains healthy food nutrients. It is an opportunity for employment to people at risk and gives extra income.

- Δ Harvesting plants for the preparation of treacle from plants is of vital importance to people who remain idle during *Aswin* to *Kartik* (mid September to mid November) and suffer from *monga* (food crisis). The activity helps production of food items from non-traditional sources and opens economic opportunity to these people.
- Δ The plants are used as materials for fencing of homesteads, fodder of animals and fuel for cooking.
- Δ People steal *kash* plants and use as fodder for animals.
- Δ The barrier to peaceful cultivation and conservation of *kasban* in the newly formed chars is the ownership crisis of lands over which there is dispute off and on.

Potential for Replication

The conservation and cultivation of *Kasban* can be replicated for other newly raised char areas of Bangladesh. Because, it makes the lands suitable for cultivation quickly, increases the land fertility by the alluvium and helps extract juice from *kash* plants which opens economic opportunity to the char people.

Like many other non traditional harvests the *kasban* cultivation around the chars of Jamuna, Padma and Meghna also benefit people at risk greatly if the Go-NGO intervention is taken in time and effectively for maintaining law and order situation in the concerned areas. The *kash* plant cultivation may also be an area where the agric scientists may work for better growth, or devising some efficient method for the growth of these non traditional plants.

Garlic

Précis

Units	Location	Seasonality
Union Upazila District	Biaghat Gurudaspur Natore	Rabi Crop

Prologue

This area known as Biaghat is flooded in the month of *Ashar* (mid July-mid August) and in the month of *Aswin* (mid October-mid November) the flood water recedes. The water current and its level are not so much that that it could do harm to the habitation. But the alluvium deposited at recession of water softens the soil. People take an initiative to utilize this soil by cultivating garlic.

The Initiative

Change of soil condition due to silt deposition interested people to cultivate garlic, a vital spice commonly used by people everywhere. One villager named Gedu member around 2000

THE GOOD PRACTICE

- ◊ Garlic cultivation has many bright sides: it is a good spice; it has medicinal value for patients of heart disease, cold etc;
- ◊ Garlic is more profitable than other short term crops with zero tillage;
- ◊ Garlic cultivation does not involve much capital and labor and is a short term crop;
- ◊ Garlic cultivation employs either fallow lands or newly formed lands or is an intermediate crop and so is profitable to the marginal farmers;
- ◊ The soil of the area under investigation has been found to be quite suitable to give expected outputs and the farmers were found to be quite happy with the harvests;
- ◊ Its is an essential spice, its harvests are profitable, the cultivation enhances crop diver-sity, increases productivity and makes the land ready for other crop in time;
- ◊ The cultivation has already been adopted by the local farmers and now is ready to be replicated the method in other areas.
- ◊ Already adopted by the community people and found to be suited to the local ecology.
- ◊ Profitable venture compared to other traditional crops on a same piece of land.

introduced the cultivation of garlic first. Garlic cultivation has been proven to be more profitable. So, gradually garlic cultivation became popular. At present, 70% of the farmers have adopted this practice.

Goal and Objectives

The goal of garlic cultivation is to utilize the ad-interim opportunity (alluvium deposition) created by the aftermath of flood for a short term crop. The garlic cultivation initiative aims at ensuring commonly used spice, increasing the land productivity with maximum economic profitability by utilization of alluvial soil.

Outcomes and Activities

Land is available for garlic cultivation in this area, 70% of the land holders cultivate garlic by themselves and others do not lease for crops but they lease for money and the lease is either for 6 months or for 12 months or a year. The lease rate for 1 *bigha* land is Taka 5000 (period is Kartik-Chaitra – Nov. to May) for 6 months and Tk. 7000 (period is Kartik to Kartik- Nov. to Oct.) for 12 months. But in this area generally 6 month lease is on the go.

The rice plants are cut and in place garlic seeds are sown. The stub of paddy plants remains about one foot when the plants are harvested for rice. These stubs are to be cut clean before sowing garlic seeds and the stubs are collected and preserved beside the land. This may be done even before the day of sowing. This costs one to clear one *bigha* for 6 labours at the rate Tk.100 per labour and it is Tk. 600. Garlic is sown as soon as the feet of the paddy plants remain soft. If that cannot be done, then irrigation becomes necessary and the irrigation costs per *bigha* at Tk 230 including Tk. 150 as rent of the machine and Tk 80 for diesel.

Before sowing the seeds manure is to be applied to the plot and the stubs that were collected are to be spread over the garlic saplings so that they may get shadow. Then 50 kgs of *Dep* manure, 40 kgs of Potash, 10 kgs of Urea and 1 kg insecticides (*Bakunin*) are to be applied so that the stubs are not eaten by termites. The labour cost for spreading these manures in the land and raising ridges around the land is a labour value equal to Tk.100.

Cells of the garlic are used as seeds. All these cells are not sown. Because of the little ones do not grow well or even they do not give any sapling. So these are not selected for sowing. Only the matured ones are sown one after every four fingers. As seeds the farmers buy 3 maunds of garlic for one *bigha* of land. The seed value is Tk. 2500 x 3= Tk. 7500. For sowing they separate the cells of garlic from each other. They employ women labours for the purpose and Tk. 160 per maund is needed for this work. After separation, they select the good cells only and it is seen that 2.5 maunds are found to be suitable for sowing. The labourers sow the seeds and then spread the stubs formerly preserved above the soil. For sowing 25 labours are necessary and cost is 25*100 = 2500. After 20-25 days, when the saplings grow 6 inches long, one time irrigation is necessary. In all four irrigations are necessary till harvesting and the cost for this purpose is @ Tk. 230 per bigha including Tk. 150 as rent of the machine and Tk. 80 for diesel.

Within one month of sowing garlic saplings are to be given manures and insecticides. Both irrigation and manures are given for better growth of the saplings. At this time 10 kgs of *Dep* manure, 5 kgs of Potash, 20 kgs of Urea and 1 kg insecticides () are to be applied so that the stubs are not eaten by termites. The labour cost for spreading these manures in the land is a labour value equal to Tk.100.

After 2nd Irrigation *Dep 1*0 kgs and Potash 5 kgs which together cost Tk (10 x40 + 5 x 30) = Tk. 550 are applied in the field. These are given by the family members. After 3rd irrigation no manure or insecticide is needed. At the second half of Falgun (mid March- mid April), 15 days before the day of harvesting irrigation is necessary. This helps harvesting of garlic, as the soil remains soft.

15 labours are needed for every *bigha* harvesting. So the cost is Tk 100 x 15 =Tk 1500. Then 5

days are taken to be dried up and this is done by the members of the farmer's family. The dried up garlic are tied into bundles with every 40-50 garlic plants. For this purpose the labour cost is Tk100 x 8 = Tk800.

At the time of selling the dried plants are removed and only the garlic seeds are sold. Removing this is done on contract basis with the labourers at Tk 50 per maund of cleaned seeds and so the cost for this purpose is Tk 50 x 20 = Tk 1000, if the product is 20 maunds of garlic.

The market price on whole sale varies from time to time of the year. During Chaitra- Boishakh (mid April - mid May) the price of a maund of garlic is Tk. 2000 whereas in Ashar – Sraban (mid July – mid August) the price is Tk. 3000 per maund. So for 20 maunds of the harvest in the second season is Tk. 60 000.

The total cost of labour, seeds and other investment turns out to be Tk. 20 430 and the net profit of the farmer is Tk. 39 570.

Lessons Learned

Key lessons learned from this practice are:

- Garlic is more profitable than other short term crops. Before farmers used to cultivate other crops like wheat etc. but when they saw the profitability of garlic with zero tillage, they have adopted this practice.
- The respondents reported that the cultivation is easy, does not involve much labour and capital and the yield is satisfactory.
- Garlic cultivation has many bright sides: it is a good spice; it has medicinal value for patients of heart disease, cold etc.
- Garlic cultivation does not involve much capital and labour and is a short term crop.
- Garlic cultivation employs either fallow lands or newly formed lands or is an intermediate crop and so is profitable to the marginal farmers.
- The soil of the area under investigation has been found to be quite suitable to give expected outputs and the farmers were found to be quite happy with the harvests.
- It is an essential spice, its harvests are profitable, and the cultivation enhances crop diversity, increases productivity and makes the land ready for other crop in time.
- Adverse or unwanted calamities like flash flooding and prolonged flooding is the one of the threat of this practice.
- Garlic production is essential for saving foreign currency of the national exchequer.

Potential for Replication

Garlic is an important spice and has medicinal value in heart diseases, cold. . The national need cannot, as yet, be satisfied by our own products and are to be imported hundreds of thousands of tons every year. So cultivation of such an important item is of vital importance to save currency and to meet the need of the people.

Government and the private sector initiatives should be deployed to harness the ways and means for the quick and large quantity production of garlic and there should be specific program for the purpose. The agric scientists may come forward with R&D (research and development) programs and intensify the efforts for tissue culture and other methods of garlic production.

COPING AND COMMUNITY RESILIENCE

Constructions of Protection Embankment

Précis

Units	Location	Seasonality
Union Upazila District	No.10 Khesra Tala Satkhira	Dry Season

Prologue

The area is situated at the remote end of the upazila and on the river *Kabodak*.There are more than 400 Prawn cultivation fields over about 1500 *bighas* of waterlogged land (locally known as '*Gher*'). And they are used for cultivation of paddy in the months of *Ashar-Magh* and the lower lands are used for prawn cultivation at the same time. At times every year the tide of the river *Kabodak* floods the *Gher*, but the 2007 flood washed away the river banks and the influx of alluvial soil along with water was so severe that after the recession of the flood water, it was seen that the lands were raised 4 ft. above the original level.So the lands became unfit for cultivation of prawn. Every time the tide water enters through the broken banks and creates problems for cultivation.

The Initiative

The main occupation of the local community people is agriculture and cultivation of prawn in the besiegement. Since the prawn cultivation has been stopped, they are now striving for cultivation of paddy and other crops. About months ago there was an initiative by the local people to raise an embankment on this part but it was washed away by the river current. Then the villagers having land (*Gher*) in that area moved for determined initiative and formed a committee known as 'Beal Committee' and this committee started the present project after much consideration and determination.Thus with the beginning of *Katrik* 2007, about four months since, local people started the project and is not yet to be completed.

THE GOOD PRACTICE

- To get rid of the of the adverse effect of WAPDA dam the villagers are united and they have found out the remedy by themselves;
- The cooperative attitude is at the root of the success;
- It appears that the villagers may succeed to revive their normal agric activities for their survival;
- Amazingly, the WAPDA dam construction did not assess this before hand;
- People's united efforts can bring back their lot;
- The initiators are convinced of the efficacy and sustenance of the action in the ecology.

Goal and Objectives

The goal of the initiative is to reduce the vulnerability to natural hazards, especially flood and silt deposition. The intention of raising this dam is to resist the tide water entering the crop fields.

Activities and Outcomes

Raw materials being used for the embankment are mainly straight logs of wood and stems of big trees like *Palmyra, coconut, chambol, segun, mahogany, dulbergia shishoo, accacia* etc which were collected from the local people on donation basis.The area does not grow bamboo well and so they had to procure bamboo. Ropes, wires and polythene (resist from rotting in water), Iron rods were collected from local market stores.Various materials like bamboo branches, branches of trees, straws etc. and soil for protection were collected locally.

Method being followed for preparation: The part of the river Kabodak where the tide water enters the village is about 60-70 ft in length. It was still bigger and due to filling now this length has been decreased and is still vulnerable.

At first the local people inserted the big logs of woods in an attempt to filing as mentioned by

the seesaw method from about 30 ft below the floor level of the damaged area, in a manner as the pillars are piled in a foundation, by exerting pressure upon the logs by weight tied with a rod and pulling the other end against an edge of pivot. The logs that are inserted in the ground are again tied with rods along, which are driven through the logs. Then encircling the rods are laid down two bamboo pieces tied together crosswise (with wire and polythene papers). Then among the gaps are introduced straws, branches of plants and trees etc. Tide water coming to this place leaves the deposition of alluvial soil, and when the first frame is filled with the alluvial, and then the second frame is made and is filled in the same process. Then about 20 m away the former frame they make another frame of the same type and are filled with the alluvial in the same way. The distance between the frames is filled with water borne soil as usual. The third frame was under preparation at the time of observation. Though the length of the broken part is 60-70 ft, the repaired part under process is of length 100ft. This has been done so that the part is not washed away anyway.

Though the local people could not yet measure its sustainability, yet the frame work so far done is not damaged anyway and they are determined to complete the project to extract benefit.

Financing the project: Although the local initiative has much response from the local people, they have not yet received government aid for the project. The initiators have spent so far Tk 6 00 000 and this amount of money they have collected by imposing initial voluntary contribution to the farmers having lands in the area @ Tk 1400 for each bigha of land holding. Thereafter they collected Tk. 100 per *bigha* for wages of daily labourers. As because the work is not yet completed they do not know how much more they are to pay for completion of the project.

One of the initiator said,'all the able bodied persons of our village gave physical labour to this project at free of cost.' Each day from the morning to 3.00 or 3:30 in the afternoon they worked for 8 hours. Besides labours were employed on daily basis and they were paid Tk. 80-100 per head. These labours worked for 10 hours daily. But up till now how many labours worked for the project has not been enumerated.

Lessons Learned

- Δ Opportunity lies ahead is infinite and if the dam stands against the tide water they will be able to produce golden crops which will secure their food and they are not to starve.
- Δ The main strength lies in the fact that the dam will achieve cent percent belongingness to the villagers, if they can finally complete the project. This sort of owning to a social property in our society is not observed generally and that's why public properties are spoiled.
- Δ The unity that has been achieved by the initiators of the area is rare and to maintain this may be difficult. The people are very poor and if there is a single nefarious element among them, the whole thing may be spoiled.
- Δ The weakness as appeared is that the initiators were found to be unrestraint and maintaining the attitude of benevolence. However this is a good example of cooperative enterprise for communal welfare.

Potential for Replication

'United we stand' is the axiom and that is seen in the case we study here. This is urgently needed for our society infested with so many problems. If this example of the local people is followed by

the people of other places, in spite of looking to the government, almost all problems may be solved and the country as a whole will certainly be self dependent.

The policy makers, in making each and every developmental program, can follow the principle of infusing self help motto so that people may learn how to rely on themselves.

They believe that the dam is their ultimate hope of emancipation from hunger. The government reinforcement would make their dam more sustainable, they believe. They said that a sluice gate at the root of the WAPDA dam would withhold the tide water and the current could not directly hit the dam.

CHAPTER 3

COPING WITH FLASH FLOOD

Chapter 3
COPING WITH FLASH FLOOD

FLASH FLOOD SCENARIO IN BANGLADESH

Bangladesh is the most vulnerable to several natural disasters, of which, the occurrences of flood is common. There are mainly four types of floods, the flash flood being relatively unique. Flash floods can occur within quite a few minutes to some hours, with little or no warning. And it can be dangerous because they produce rapid rises in water levels and have devastating flow velocities. Different factors influence flash flooding situation i.e. rainfall intensity, rainfall duration, surface conditions, and topography and slope of the receiving basin. Typically, flash floods occur in areas where the upstream basin topography is relatively steep and the concentration time of the basin is relatively short.

In Bangladesh flash floods generally occur in the north-east, south-east and Chittagong hilly regions. But the devastating and extended flash flood is a recurrent phenomenon for the north-east region of the country, especially in Sunamganj, Sylhet and Netrokona districts. Most of the rivers in these areas originate from nearby hilly areas of India. These rivers are characterized by sudden and wide variation in flow due to excessive rainfall. When heavy rainfall occurs in the nearby hilly region, water quickly moves towards the *haor* areas through a number of rivers and *Khals*. These *haor* areas lie again on steep uplands adjacent to the very region near Assam and Meghalaya hill ranges in India. The flash floods coming suddenly cause immense damage to the standing *boro* crops, lives and properties every year.

OVERVIEW OF THE RISK ENVIRONMENT

Flash flood of the North-east and South-eastern regions mainly damage standing crops and disrupt the life style by causing total destruction of properties. South-western part of Bangladesh was affected by sudden flash flood in 2000 and caused damage of more than TK 800 billion (BDPF 2001). About 98 percent of the mud houses were damaged, households lost their livestock and poultry and other durable assets. Standing crops like Amon paddy, vegetables, and tree resources were lost (CARE Bangladesh 2000). In August 2008, five districts in the northern region were hit by recurrent floods which isolated more than 100,000 people in the submerged villages. The respondents from Shunamgonj reported also a few instances of missing and drowning of the fishers during rampaging flash flood.

Flash floodwater carries sediments from the hilly catchment areas. If the high intensity rainfall

continues for certain period then coarser sediments, such as, big sized stones, boulders etc start to be displaced and move along the river current. Finally these sediments are deposited on the river beds, *khals*, canals and ultimately to the agricultural lands. During flash flood, sediment transportation rates increase significantly in the rivers and hence major flood events make a disproportionate distribution of sediments and change channel size, shape and even location.

Flash flood has another impact on the general flow form of the rivers and canals in the north east haor area. Due to high magnitude flash flood, sometimes severe erosion takes place along the river banks causing not only a huge amount of national loss by damaging standing crops but also creates immense sufferings to the local people.

Sand carpeting induced by flash flood is an impediment to agric activities. This problem is generally found in the *haors* adjacent to the hills such as Martian haor, Angurali Haor, Karchar haor and Kalner haor under Sunamganj district.

PROFILING THE STUDY AREAS

In this research, we captured significant ethnographic information on the episodes of good community coping responses related to flash flood from three different locales of depression areas (Sunamganj) and hilly areas (Bandarban, Cox's Bazar). The survey areas were 7 villages within 5 haors in 4 unions of two upazilas in Sunamganj district and 13 villages, 7 paras in 8 unions of 5 upazilas in Bandarban and Cox's Bazar district. [See Annex XX]

It was revealed through the study that the areas had been facing different hazards all the year round, such as: Sunamganj from Flash floods and floods; Cox's Bazar from floods, flash floods, wild animal attacks, salinity, cyclone & storm surges, and Bandarban district from flash floods, wild animal attacks, landslides and earthquakes. Flash flood was one of the main and common hazards found in these study districts which were generally observed in April - May and in September - November. The study districts were mostly hilly lands except Sunamganj which was a low lying land with some depressed areas locally known as hairs. There were about 50 bevels (wider water bodies with low depth). The hilly areas had different canals which were flowing within the hillocks.

In the study areas mainly livelihood assets like natural, physical, social, human and economic resources were vulnerable due to flash flood. Their economic activities, crops, vegetation, fish, water sources and cattle were vulnerable and so was the mental health of the community people. Moreover, flash flood destroyed infrastructural systems, embankment as well as different institutional structures. Housing system was also affected by this sudden hazard. Heavy rainfall and sand deposition hampered the agricultural process and caused massive damage of crops mainly paddy. As a consequence the agriculture dependent people became extremely poor and had to struggle for survival. This was how flash floods left a devastating effect in the food security and livelihood of people within a short span of time. In this way flash flood affected the food security and livelihood.

COPING IN FLASH FLOOD PRONE REGIONS

We observed that people of the flash flood prone areas attempted to mitigate risk problems *ex ante*. In this chapter we would discuss some cases of good community practices concerning *ex ante* risk management which more often included enterprise diversification. Using off-farm income generation activities to offset risk from farming was one way to diversify.

Flash flood destroyed the agric fields and crops most severely and in a short time. Indigenous knowledge, in different study areas, had proven to help contribute to the community's ability to mitigate the impact of regular flash flood events. In general, the indigenous knowledge of housing pattern reduced the vulnerability of flash floods. They planted different grass and plants in the homesteads and on the river banks for protection of their individual and community Properties. People prepared dry fish and grew different vegetables around homesteads for reducing

the vulnerability. These practices ensured food security in *haor* areas. Duck rearing, harvesting different plants and firewood were some alternative economic activities. These practices provided maximum utilization of their capacity with maximum economic returns. These good community practices of coping were elaborated in the proceeding discussions.

INDIGENOUS PERCEPTIONS AND KNOWLEDGE

Flash Flood Forecasting Scenario

It was gathered from the field that the flash flood was a natural disaster for people living at the feet or slopes of the hilly areas of Bangladesh. All the study areas were surrounded by hills and had different rivers, canals and *choras*. The flash floods that came down to the rivers every year inundate the areas with immense magnitude uprooting everything on the way. Water then entered the villages overflowing the banks of the river and stood for 3/ 4 days. Every year at the end of the month of *Ashar* and at the beginning week of *Shraban* flash flood came down to the villages. Since this was a regular phenomenon, the people living in the concerned areas had gained knowledge to predict about the probable time and magnitude of the flash flood. They used to take precautionary steps accordingly to survive and save their properties and lives.

Early flash flood warnings allowed time for residents to leave low-lying areas, and to remove important personal property, mobile equipment, and livestock to higher land. Sometimes valuable crops were harvested in advance of a possible destructive flood. Flash-flood warnings could be issued in minutes. Successful operation of a flash-flood warning system requires active community participation and planning, but they had very little financial outlay. Still, the communities with cooperative initiatives made flash-flood warning systems successful and only a small fraction of the thousands of community people were left unheeded.

Flash flood occurred frequently in the north-eastern part of Bangladesh, but the existing warning system was not functioning efficiently. (The Daily Star) Bangladesh Meteorological Department (BMD) and Flood Forecasting and Warning Centre (FFWC) had been trying to forecast the flood timely and accurately. But they were unable to obtain adequate data for providing weather forecast and warning for flash flood caused by heavy rainfall in the Hills which located out of the detection range of the existing radar network and measurement equipments of BMD.

Indigenous Indicators of Flash Flood

People in all the study areas considered some indigenous indicators to predict whether there would be flash flood. Flash flood occurred in two different areas like in plain areas near hills and hilly areas. People could make a rough prognostication from the knowledge gained through experience from generation to generation about the onrush of the calamity of the flash flood.

In the plain areas people predict the probability of flash flood by observing the following phenomena:

- ◊ Heavy rainfall continuing for 5/6 hours at a stretch in the nearby hills.
- ◊ Colour of the sky remaining deep dark and coming down near the hill canopy indicated the heavy flood.

In the hilly areas the people predicted the flash flood by the indicators:

- ◊ Eastern sky remained cloudy or appeared to be cloudy.
- ◊ Colour of the sky was deep black and came down very near the hilltop.
- ◊ Rainfall continued for 1 to 1.5 hours in these areas. They anticipated the upcoming onrush.

By studying the different elements of nature, the community people could correctly predict the possible occurrence of the flash flood. The symptoms they observed immediately before the occurrence of the floods were: Clouds in the sky, the colour of the clouds, and heavy rainfall from which they took readings to predict the time of flash flood.

Colour of the Cloud /Sky

- In Sunamganj, the day before the flash flood, black clouds would gather in the Southern sky, which was directed by the wind from the south to the North of the Meghalaya hills with high velocity. Generally these clouds were born by winds to the hills in the evening and come down as rainfall at night.
- On the other hand, in Cox's Bazar and Bandarban, eastern sky remained cloudy or appeared to be cloudy; the colour of the sky was deep dark and came down near the hilltop. This indicated rainfall in the nearby hills, which when looked upon appeared like giving off smokes of water vapours and at the same time there was shower in the adjoining villages too. So the flash flood was imminent, they realized.

Heavy Rainfall

- A heavy rainfall accompanying the flash flood was observed in the areas of Kakara and surrounding areas every year at the end of the month of Ashar and the first week of Shraban. The local people anticipated the upcoming of the onrush, if the rainfall continued for 1 to 1.5 hours in the surrounding hilly areas. If there was rainfall for 6 hours at a stretch in the hills the village would be inundated dangerously, they opined.
- The local people of Sunamganj inferred that if there was rainfall throughout the whole night in the surrounding hills, the flood would come down to the plain lands. Since the hills were clearly visible from this area, the villagers could see the rainfall in the hills. If there was rainfall in the hills there was a persistent shower in the area also. Having rain throughout the whole night, the flood came down to the area in the early morning. The farmers took some instantaneous preparations before the occurrence of such floods.
- In Bandarban, people apprehended the onrush within half an hour if there was rainfall for 1 to 1.5 hours in the hilly areas.

Indigenous Activities after Perception of Flash Flood

In the haor area, the river draining the flash flood water was known as *Chalti nadi* (Current River).

Some villagers collected sands or stones coming with the upstream and use to carry them to the bank of the river Surma by boat for selling as resource of livelihood. They kept their boats at the river banks by tying them with rope. If they guessed that the flood was impending, they carried their boats through the canals to nearby homes. As precaution they tied the boats with a thick rope so that it was not flown away by the onrush of the current. Because they had prior experience that failure to do so resulted in losing boats by the violent current of the flood. However, this curse of flood accompanied a boon too, they mentioned. The flood would bring logs of woods, abundant coals, branches of big trees, and plants in larger quantities along with the current. Villagers who had boats took preparation to go out early in the morning to catch them. If lucky, they use to catch a big tree. Afterwards they used the big trees as wood and the branches and small trees as fuel in the rainy season.

Of all the natural calamities, according to the farmers of Cox's Bazar, flash flood was the hazard that harmed them mostly. What they did as precautionary step to save their properties from the onrush of the flood was that they cleared up the two sides of the canals so that the water of the flood could quickly recede away without any hindrance. They removed other obstructions from the bed of the canals. Here too the flood was at the same time the blessing for them. The forceful current of water use to bring away branches of trees and other vegetations by uprooting them from many places lying on the river banks. The careful ones could catch them to use in the rainy season as fuels.

RESILIENT HOUSING STRUCTURE

Protecting Homestead and Embankments in the Haor Regions

Précis

Location		Hazard
Union	South Sripur	Erosion,
Upazila	Tahirpur	Flood & Flash
District	Shunamgonj	Flood

Prologue

The study area is surrounded by the *Tanguar haor* to the south, Matiar haor to the north, Sanir haor to the east and Tahirpur union to the west. This place looks like a sea in the rainy season because of the flash flood coming from Indian hills and the surrounding *haors*. The houses in the haor and beel areas are always hit by the waves of water raised by the air on the free surface of water in the *beel* or *haor* and, if not protected, they are washed away with the current of the vast water. So, the community people adopt different mechanisms for the protection of the soil of their homesteads, raising '*Hati*' being one of them.

The Initiative

The word *'Hati'* is not available in Bengali dictionary and is perhaps derived from other language. But the meaning can be constructed from the objective of the action and arrangements. Since the houses are usually washed away by the water waves, the people of this community have adopted this mechanism called *'Hati'* to protect the soil around the island like homesteads.

Goal and Objectives

The goal of *'Hati'* is to reduce the vulnerability of natural hazards, especially flash flood, flood and riverbank erosion. The *'Hati'* initiative aims at protecting the house soil from the water waves of haors.

Activities and Outcomes

We found that, as the people lived within the haor (low lying water bodies), the houses are located on high lands. The height of the homesteads was generally 6-7 ft. high from the beds of the haors or beels. The inhabitants of this area made their houses considering two things for the necessity of protection and making the construction cost effective. These were - the houses were made in clusters and some specific plants were cultivated around the periphery of the houses for protection of the soil. To make *'Hati'* they grew *barch* and *hizle* forest nearby the houses or on the homesteads and placed stones around the outer periphery of the houses. To protect the dam they grew *chailya* grass and if possible raised the surrounding places of the houses by piling up soil.

For raising protection dam against the waves, stones were used and they were collected from the Meghalaya of India @ Tk 5000 per maund.

THE GOOD PRACTICE

- Δ 'Hati' protection process is a community effort and all the houses of a village are under this practice for their safety.
- Δ This is the effective practice to prevent soil erosion at the cheapest cost and is replicable everywhere in the case of preventing soil ero-sion.
- Δ It is a subsistence for poor people in the hazardous situations and the entire efforts are economically cost effective;
- Δ All the elements are available in their own premises and the method of production is as easy as everybody can do this;
- Δ These plants grow naturally with the seeds fallen from the trees or by roots.
- Δ Kamli jungle and chailya plants root can protect the soil from erosion.
- Δ Barch and hizle forest can reduce the wave velocity in the rainy season.
- Δ The plants can be used in household, as fuel and fodder.
- Δ Already adopted and suited to the local ecology.

However, then stones were not available even at the rate of Tk 25,000 per maund. To decrease the intensity of the waves, *barch* and *hizle* plants were begun to be used from 10 years before. *Barch* plants were more popular, because these plants grew quickly and were more water tolerant; they could stay in water for 6-7 months. These plants grew naturally from the seeds fallen from the trees. Earlier they used to buy *barch* saplings from the nurseries but then these trees were available plentifully in the area. Besides around the houses they grew *kamli* jungle and *chailya* plants together. *Chailya* plants were taken with their roots and were planted once and continued to grow for many years. During summer *chailya lota* dried up and the roots existed in the soil. When there was rainfall during rainy season the roots again developed shoots and the plants were again there. And they could effectively protect the soil from being eroded. When the plants were big, the creeping part was cut and used as fodder for cows and again the plants gave branches and new leaves. The roots that protected the soil from erosion remained there in the soil.

Lessons Learned

Key lessons learned from this practice were:

- *'Hati'* protection process was community effort and all houses of a village used this practice as part of their safety measure.
- This process was good for protection, cost effective and environment friendly. So they grew barch, hizle and chailya plants at the nearby or on the homesteads, placed stones around the periphery of the houses to protect the dam around.
- *Barch* plants were more popular, because these trees grew quickly and were more water tolerant, and they could stay in water for 6-7 moths.
- These plants could protect the soil and grew easily. During summer main plants dried up but the roots existed in the soil and effectively protected the soil from being eroded and also could grow from seeds.
- The big plants could be used as fodder for cows and livestock. The branches were used in various ways; protection for weak saplings, fuels for cooking etc.
- This was an example of using the environmentally available elements at the benefit of the population without interfering to the ecology.
- For raising protection dam against the waves, stones were collected from Meghalaya of India but the price was increasing.

Potential for Replication

The appropriate technology was applied by people to cope with situation that emerged from nature. It was human adoption practice learnt from nature. To develop this technology they used trial and error method and ultimately they adopted the one which was the most sustainable. *'Hati'* was such a practice which people of Tahirppur learnt by trial and applied for their benefit. This practice was really beneficial, environment friendly and economically cost effective. So people at risk could safely apply this practice.

Housing Pattern of Hilly Area

Précis

Location		Seasona-lity	Hazard
Union Upazila District	Gumdum Naikhyangchari Bandarban	All Seasons	Flash Flood

Prologue

The village Tamru is located in the border of Bangladesh and Myanmar and to the eastern side is the hilly range of Myanmar. People reported that as soon as there was rainfall in the hills of Myanmar, the flash flood rushed to the area and flew through the Tamru canal that passed through the village. The villagers faced twice or thrice the flash floods every year. The canal was 8-10 ft in breadth and the depth was only 6-7 ft. So, the little capacity of the canal was outweighed by the onrush of the vast water mass and hence over flew the banks and entered into the villages inundating the houses and paddy fields. Community people resided at the top, to

the slope and at the feet of the hills. According to the respondents, 2-3 hours incessant rainfall in the hills made the current in the canal so strong that it washed away the plants and woods and whatever and even it was dangerous for humans also. With regards to the nature of the houses, about 40-45% houses were built on soil and the flash floods were dangerous to the earthen houses. As soon as water got in the house walls made of mud were dissolved and washed away. So, the ecological condition enforced the community people to adopt different types of housing patterns.

The Initiative

Due to flash floods the people of the area adopted different types of housing structures. The solvent people of the village adopted an innovative method; instead of mud walls around the house they covered the mud walls with cement plastering so that water could not dissolve them easily. But the poor people of the village wrapped the walls of their houses with thick polythene cloths to save the house from the flash flood current.

The people of Tamru adopted both the processes long since and the exact time and year they could not mention. The practice was popular because of its long lasting effect and every people of the village used it. They used either plastering or polythene process to save their houses.

THE GOOD PRACTICE

- Δ It is a good practice for poor people at risk in different hazardous situations;
- Δ It ensures the safe living and protects the living houses from being washed away by the onrush of the flash flood from the nearby hills.
- Δ The plastering on the mud wall lasts for 8-10 years.
- Δ The entire effort is economically cost effective. The amount of labor, land and investment they make in the enterprise are the minimum;
- Δ All the elements are available in their own premises and the method of production is as easy as everybody can understand.
- Δ Already adopted and suited to the local ecology.

Goal and Objectives

The goal of different housing patterns was to reduce the vulnerability of natural hazards, especially flash floods. The flash flood resilient housing structure initiative aimed at protecting the house from heavy water current of the canal and thereby to achieve security of living.

Activities and Outcomes

The plastering process needed nails, G.I wire, sand, and cement which were available in local market. On the contrary, Polythene process needed polythene and pins which were also available in the market.

The plastering process for a 16 ft. long and 10 ft. broad house: The respondents conveyed that the plaster was to be given 3 ft. from the floor or base and above because at the time of flash flood water level did not rise above the level. For doing this they fixed up 1.5 inch nail after every six inches. The nails being inserted about one inch inside so that wires might be fixed with the remaining portion. The G.I wire was fastened with the half inch head of the nails that remained outside to make net. Doing these work two labourers took a whole day. After completion of this, they began to coil the wires which took 3 days for 2 labours. After completing the coiling work, they began the plastering work. Before they prepared the materials and they did this by mixing 7 volumes of sands to the one volume of cement. One mason and two helpers took 5 days to complete 16 x 10 sq. ft. size plaster work. After putting the plaster on the wires it was to be made plane. About 30 kg iron wires were to be fixed with a house of size 16x10 sq. ft. Thus the plastering saved the house from flash flood. The full pressure exerted by the flash flood could be borne by the plaster and water could not reach the mud walls saving it from being dissolved.

The plastering lasted for 8-10 years and then it fell off slowly. But if it did not face great impact

of some great rush the wall remained intact. Then they again gave plastering to the wall. In this case the net of wires could be reused. But for long lasting they used new wiring. And some reused the good parts of the earlier used materials.

The polythene cloth process for a house of 32 ft length and 10 ft breadth and 7 ft height: A polythene cloth of thickness 1.2mm, diameter measuring 18 x 9 sq. ft. i.e. 18 ft in length and 9 ft in breadth was required for this size of house. So, the total length of the house wall was 54 ft and the inside length was also 54 ft and so the 18 x 9 ft size polythene of all having 7 ft height were needed and the same size polythene was needed for the inside wall also. Total polythene requirement was 54+54= 108 ft with 7 ft height. This polythene was to be set with the wall in such a way that no water could enter inside. This meant that each polythene piece is to be given one on the other so that there remained no gap from inside and outside. At the lower side of the wall, the polythene was given by inserting it quite inside the soil so that water could not reach inside. Importantly the pieces were joined by inserting pins in the wall which again fixed the polythene with the wall. Thus the poor people were trying to save the wall of the living houses. But this polythene process could not save the house on all occasions from the attack of the water current, because at times the current was so fierce that it broke the polythene and at the time of rainfall water entered through the leaks and upper portion. In this respect the poor were the victims. Of the poor, those who had ability they plaster the walls of the houses both on the inside and outside the walls. They applied the plaster 3-3.5 ft above the ground, because water level usually did not rise above the level.

The poor families tried to save their houses with the help of the polythene cloths. When there was rainfall, they understood that the downpour, would very soon within an hour, and there could be rush from the upstream and they wrapped some good polythene with the wall and then bound the cloths on all around so that the polythene could not be torn off or taken away. In binding the polythene they took help of the nails earlier fitted with the walls. Again by inserting nails every 6-7 ft distance they bound the cloths around the wall. But at the time of abnormal pressure exerted by the upcoming water this could not help saving the houses and were washed away. The polythene could not be used more than 2 or 3 years but the poor people had no alternative way than using it.

Lessons Learned

- Δ These two methods were found to be environment friendly and did not bear any adverse effect on the ecology.
- Δ The plastering on the mud wall was beyond the capacity of the poor people but the middle class people used this. They could not afford to construct buildings. So they used this practice.
- Δ The respondent assured that the plaster made the house erect for 8 to 10 years without any anxiety.
- Δ But wrapping polythene with the mud wall was difficult and uncertain. Because the onrush of flood water by overflowing the banks of the canal entered the houses at times and flew sometimes 3 to 4 ft above and under this condition the whirling of waters could remove the polythene and if this happened, at any moment the wall might collapse.
- Δ On the other hand the polythene could not be used more than 3 to 4 years. And even polythene went out of orders in one year. So polythene wrapping was short term and only the low income groups of people used this.

Potential for Replication

Saving mud houses at the time of emergency was essential for living. The plaster and polythene cloth binding processes were the practices people at risk used and they had no other method known. Even the one with cement plastering was also not very costly but was effective and could last for even 10 years, quite a long time. So people living under same condition might adopt this. Government and NGO could promote these practices with modern technology support.

SECURING AND SOURCING OF FOODS

Food Preservation

Précis

Location		Seasonality	Hazard
Union	Tahirpur	All Seasons	Flood and Flash Flood
Upazila	Tahirpur		
District	Sunamgonj		

Prologue

The study area had been suffering from flash flood due to its geographical location. To the east of the village was the Shanir haor, to the west was the Martian haor, to the north was the Tanguar haor and to the south was Tahirpur upazila. The river Bolai passed near the village. Besides there were many water bodies and canals. So the area was infested with fishes. Boro was cultivated once in the agricultural lands of the beels. The flash flood in the months of Ashar and Shraban causes havoc to the crops. When this flash flood came in advance in the months of *Baishakh* and Jyaistha the amount of loss of crops was much more. So the poor farmers were vulnerable to food crisis. To meet up this, four middle class families of the area were found to have taken recourse to, as an alternative means, to develop fish drying centre for whole sale.

The Initiative

Almost each and every family of Bhati Tahirpur prepared dry fish for their domestic consumption, and not for sale. But with time the idea of making the enterprise on commercial scale ……. and from this in 1994, a man of this village started production on commercial scale. Thereafter up till 2007 four farms of dry fishes stood up. Before 1994, only agriculture was the occupation of the community people in this area. Then they were engaged in the dry fish business side by side the agriculture to compensate the loss caused by the floods and flash floods. As profitable venture, this activity had encouraged people of other areas of the district.

Goal and Objectives

The goal of preparation of dry fish was to reduce the vulnerability of natural hazards, especially flood and flash flood. This initiative aimed at ensuring food and nutrition security as well as enhanced the capability of people at risk by developing the industry of dry fish.

Activities and Outcomes

The raw materials were easily available in the local haors and beels of Sunamgonj. In Sunamgonj area dry fish was not only for consumption but was also regarded as a means of earning livelihood by selling. Below are the description of the materials and method of production of the dry fishes.

Preparation of Fish drying scaffold: 'Chang' was the local name given to the scaffold prepared for drying fishes in the locality. This 'chang' was prepared in the later part of Bhadra in an open space in the haor in front of the house, where there were no trees around. This ensured quickly drying of fishes.

The respondents reported that in preparing a *chang* measuring 9x9 square ft they needed 81

THE GOOD PRACTICE

- Δ It is a subsistence for poor people in different hazard situations;
- Δ Scope of women involvement is high through out the entire process;
- Δ It ensures the food needs of the farmer's family with the money they earn by selling them for their livelihood.
- Δ The entire efforts are economically cost effective. The amount of labor, and land they employ, the investment they make in the en-terprise are the minimum;
- Δ All the elements are available in their own environment and the method of collection is so easy that everybody can understand.
- Δ Already adopted and suited to the local ecology.

bamboo poles and these poles were made to be from the lower part of the 60 main bamboos. These were cut of the sizes of 7 ft (5.5 cubits) in length. The remaining 21 poles were taken from the remaining portion of the bamboos. They were also 7 ft in length. 18 pieces of bamboo had been taken for laying in series over the platform from the remaining portion of the bamboos. The poles were cut plane in one end and made v-shaped at the other end. The plane end was inserted in the soil and through the v-shaped end, 10 cubit long bamboo pieces were passed through. Then the poles and the series of bamboo pieces were tied together and to cover the gaps on the frame they put 120 narrow pieces of bamboo shoots.

When the scaffold was ready the *chatai* (mat) was spread over it. The thin sheets of bamboo were woven into to prepare the *chatai*. Later on above the platform 16 slim poles taken from the remaining portion of the 60 bamboos were fixed. Around these poles and over were fitted nets for the safety of the dry fishes and the nets were used to prevent crows or other birds snatching away the fishes.

Purchasing fishes for drying: Poor people from various walks of life used to catch different fishes early in the morning from the haors at the beginning of the dry season and then they brought them to sell in the markets. Fish, such as *puti, boal, gajar, tengra and chanda,* were purchased from the market by the agents of the dry fish making centre or the owner himself for making dry fishes. These fishes were caught comparatively in larger quantity in these regions and they had market demand also. The poor children of the villages caught fishes in the haor throughout the day and they sold them to the *aratder* (wholesalers) the next morning. So the farmers who made dry fish usually collected these fishes from the *aratder* after 2 pm, when all the catches were thronged together from around the area. The prices at which they purchased fish from the *arat* were *chanda* 70-80 Tk, *puti* 45-50, *tengra* 45-50, *big gajar/ boal* at 150, medium *gajar/ boal* Tk 120, and small *gajar/ boal* Tk 50 per kg.

The price was not fixed and fluctuated on the basis of the lot gathered in the wholesaler's stock and on demand. Even they sold to the farmers on credit. However, when the fishes were sold to the farmers who made dry fish, the price generally went up. The price fluctuated at all levels but drastically fell down when there was bad weather.

Division of labour for making dry fishes: Generally women and children did the work of preparing the fishes before drying. They employed labour on exchange of the part of the fishes. Women from around the house came to do the work of processing the fishes. In exchange they were given the heads and bellies of the gajar fishes and bellies of the boal fishes.

There were seven knives in the farm and at least seven women who did not have their own knives could work at the same time. However, when the collection was huge they needed to employ more women. In that case women with their own knives or *dao* could join the work. Often the existing number of workers could not complete the processing within scheduled time, then they called children and women from the neighbourhood to join the feat and the work is thus completed. Later on the act of drying and taking care of the fishes were done by the women of the family of the farmer himself. The children helped the women and the male member was engaged in supervision. When there was cloud in the sky all the members were engaged in gathering the fishes to carry to a safe place.

The fishes that were dried before 7-10 days were brought to the market and sold. Generally fishes dried up within 7 to 10 days and if the sun was extremely hot it took 7 days for the fishes to dry completely. Otherwise it took more days. Three labours worked for three days and received a wage of Tk120 per day. So the expenses for dry fish production were around Tk30,000.

Selling the fishes in the market: The dried fish were brought to the market for sale. Dried fishes were sold in the markets of Sylhet, Mohangonj and Kishoregonj. Generally *puti, tengra* and *chanda* were sold in the markets of Mohangonj and Kishoregonj. The cost of carrying the dry fishes from Tahirpur to these areas and coming back including food was Tk 800 to 1000.

The price of the dry fish varied. *Chanda, puti* and *tengra* were sold at 150-200 Tk per kg., *big boal/ gajar* 500-550 Tk, medium *gajar/ boal* was at Tk 250-300, and small gajar/ boal Tk 180-200 per kg. The fishes of *gajar* and *boal* had higher prices in Sylhet than in Kishoregonj and Mohangonj and so they carried them to Sylhet. The total cost of conveyance of carrying to Sylhet including food was Tk 1000 to 12000 depending on vehicles. On the other hand the demand and price of *chanda, puti* and *tengra* was higher in Kishoregonj and Mohangonj.

Lessons Learned

- Δ This practice had potential both for the domestic market and market outside.
- Δ When climatic adversity was observed and they saw bad sky condition i.e. when there was cloud in the sky they did not bring fishes to the *chang* to dry. In winter the sun appeared after about half the day and as soon as the sun was out they carried the fishes to the chang.
- Δ Fish drying needed much capital and labour and hence poor people could not afford it.
- Δ The work of preparing dry fishes was at halt from the months of Ashar to Ashwin due to rainfall and humid atmosphere. Moreover the places where *chang* (a raised platform for drying fishes in the sun) was once raised went under water owing to flood and were again raised at the beginning of Kartik.
- Δ The preparation of dry fishes was impeded during winter and also when there was untimely rainfall and dense fog.

Potential for Replication

The entire process was easy and could be done at individual's initiative. Although the natural elements were used, the lack of caution might cause harm to the general health of people when they consumed such dry fishes. Economically the enterprise was beneficial. The elements were available in nature. Anybody could join the activity for consumption or subsidiary income. The dry fishes could not retain food quality for long and hence it had no attraction to many.

Duck Rearing

Précis

Units	Location One	Location Two	Seasonality	Hazard
Union	Chhaor Nitpur	Dakkhin Sreepur Shimulbak	All Seasons	Drought, Flood & Flash Flood
Upazila	Porsha	Tahirpur		
District	Naogaon	Suamganj		

Prologue

It was found in the study area of Tahirpur that wetlands lost their potential for agric activities. The area of Porsha suffered from frequent droughts. Owing to these geo-physical adversities, people of these areas could not depend fully on agriculture for their livelihood. Therefore, they were engaged in subsidiary household incomes for making life tolerable.

THE GOOD PRACTICE

- Δ It is a subsistence for poor people in different hazard situations;
- Δ Scope of women involvement is high throughout the entire process;
- Δ It ensures the food needs of the farmer's family with the money they earn by selling them for their livelihood.
- Δ The entire efforts are economically cost effective. The amount of labor, and land they employ, the investment they make in the enterprise are the minimum;
- Δ All the elements are available in their own environment and the method of collection is so easy that everybody can understand.
- Δ Already adopted and suited to the local ecology.

The Initiative

Duck or gander rearing in the locally had a long history. In order to earn extra income, the people of the area took initiative to rear ducks, a livestock bird. It could live in both land & water. The suitable areas for duck rearing were waterlogged areas and needed open water resources available as they reported. Duck could be a source of income in poor communities as well as meet their nutritional requirements specially protein requirement. Although differences were observed in the methods of rearing of ducks and gander, yet on the basis of the fodders some raised ducks and some gander.

Goal and Objectives

The goal of duck rearing was to reduce the vulnerability of natural hazards, especially, droughts and flash floods. The duck rearing initiative aimed at ensuring complementary income and protein source.

Activities and Outcomes

Duck rearing needed different kinds of materials. At first, it needed food for duck that involved poultry feeds (a crystalline food), vitamins –AD, multivitamins, calcium, vitamin-B-plus, rice bran mixing with rice and broken rice, plastic dish etc. Rice and broken rice were prepared by domestic labour and the other materials were available in local market. Second, duck rearing process needed a house for the ducks, which could be made of mud, straw, bamboo and ropes but mud were available at the local markets.

Picture xx: duck rearing, a common practice in the village

Mud was collected from duck owners' own land. Third, Labour for duck rearing was available here. Generally old helpless men were appointed for this work, and finally, ducks needed medicines to prevent or cure diseases which were also available in the area.

Duck Cages: At the very beginning, the duck rearers built cages for the ducks. The process is illustrated below:

The cages for the ducks were prepared 24 cubits in length and 10 cubits in breadth. All houses were made of mud. They had to buy the house making materials like straws, bamboos, ropes etc. The straws were used to make the roof above the house. They purchased about 3000 bundles of straws, 60 bamboos of 50 ft long. 3 labours worked for 3 days for making the duck house. The soil used for raising the house was sufficiently available in this area at free. The house had mud walls and they were time consuming to make. This wall was to be dried up after laying every 1 or 2 ft and then again 1 or 2 ft were laid and dried. Each layer takes 5 / 7 days in drying and this process took two months time. The work was done on contract with the labour.

The duck houses in the area under investigation were built in 2005. Farmers collected duck babies after every three months and reared them for next 3 months and then sold them.

The Rearing Process: The farmers collected duck chicks aged about one day every 3/4 months. On each occasion, they collected 1000 babies, and after three months they sold them. The rearing process during these three months is described below:

1st Month: The babies were fed at home up to one month. They were served poultry feeds (a crystalline food), vitamins –AD, multivitamins, calcium and vitamin-B-plus. These were given three times a day, and they needed 11 bags of feeds in the first month. Vitamins –AD, fed at 5 /6 days age. Multivitamins were served from the second day to the 4rth day. From the age of 7 days to 12th, they were served with calcium tabs after mixing them with poultry feeds. The babies were fed vitamin B-plus one dose

at the 13th day. These vitamins were fed for their rapid growth. Vitamins came in liquid form and were served with droppers at ½ drops.

2nd Month: In the second month, duck babies were let to the meadows around the house and were given only two meals a day in the morning and in the evening. In the morning they were given rice bran mixed with rice and broken rice. Half maund of rice bran mixed with 3 kgs of paddy and 3 kgs of broken rice were given one time. The same amount was given in the evening too. Then they were served with fewer amounts of feeds, because at this time they went out of the house. Generally an old helpless man was appointed to look after the duck babies outside the house. They were after them from morn to the eve. The chicks at this time roam around the meadow in groups in search of foods. After being fed in the morning, chicks are cared by the caretaker, who accompanies them till the evening. The chicks are fed in plastic containers and at the same time the container is used for their drinking.

3rd month: The chicks are fed morning and evening just the same as the second month. In addition to the salaried man, the owner and others in the house remain vigilant on the rearing of chicks around.

Duck diseases and Medicines: Ducks are attacked by different diseases. In case of duck plague, ducks become slim and die. One of the symptoms of this disease is, cough like humans. If this happens, the owner will generally sell. The price of the preventive duck plague is Tk. 220 and is named *ciprodved*. Often it is found that ducks do not take any food. This is difficult to diagnose. Of course, when the ducks are suspected ill, farmers call in the upazila live stock officer and in return they pay fees.

So, the total expenditure for rearing 1000 duck babies is Tk. 62040. These 1000 babies are sold after 3 months @ Tk 90 per baby and the selling price is Tk. 90 000. So, the net profit is 90000-62040= Tk 27960 tk.

The farmer has a rice terrace and he has a vehicle. The driver of the vehicle and the helper take care of the ducks in the terrace and the labour is paid from the terrace head.

The cost of making cage and the house is not added, because these are prepared one time and will be used for many trips of the duck raising. That may be considered along with the overall investment of the farm.

The duck babies are purchased by the customers from home and the farmer is not to face conveyance cost.

Lessons Learned

- Δ It is a community based technology. It is a great source of protein.
- Δ Water logging is the factor that influences the farming. The diffusion rate of this technology is very low.
- Δ Duck rearing is really a profitable concern and demands dissemination of the rearing technology to the poor community people at risk.

Potential for Replication

Regarding the devastating climate change it is needed to find out alternative livelihood to cope with changed conditions. For this duck rearing can be a potential copping mechanism in costal & river belt region. This practice can possibly be integrated with other farming like aqua - pastoral system or aqua-agro-pastoral system. It may be a poverty eradicating tool with women involvement.

In Bangladesh there is lot of scope to increase duck rearing, because huge number of water bodies in this country is water logged. Moreover, due to climate change and possible sea level rising, the affected community needs to modify current coping mechanism and adopt off-farm activities.

In costal or river belt region the poor having minimum size of homestead, can easily rear duck in their surrounding environment. On the other hand, the protein deficiency is the main problem especially in rural areas of the country. In this case, duck rearing can be a potential opportunity to meet up the protein requirement.

Harvesting Firewood from Flash Floods

Précis

Location		Seasonality	Hazard
Union Upazila District	North Sreepur Tahirpur Shunamgonj	Rainy Season	Flood & Flash Flood

Prologue

Being next to Indian border almost every year, the North Sreepur encounters 'sudden on rush of water' coming from the hills of Meghalaya during monsoon. Based on experience, local people here have developed some predictability of flash flooding, especially when it rains continuously for days. The onrush of water falls into *Tangua* and *Shonir haor* after flowing through North Sripur. On its way the water brings along logs, woods and coals adding to peoples' income opportunities.

The Initiative

Flash flooding usually starts occurring from the Bangla month of Ashar. In some rainy seasons flash floods occur 20 times. This water runs through channels, locally known as *chora* (creek). There are six *choras* in Northern Sreepur. The flood water stays for an hour at best reaching 2-3 feet height. Loads of log and coal have always been carried down by this water. The amount of log and coal brought down by this strong stream has remained almost same over the years. The main economic activities of the local people are agriculture and fishing. But in the rainy season people collect the firewood for household use and extra income. This activity is practiced here from generation to generation.

Goal and Objectives

It was gathered that the goal of harvesting firewood is to reduce the vulnerability of natural hazards, especially flood and flash flood. The harvesting firewood initiative aims at ensuring complementary income and household demands.

Activities and Outcomes

Collection of coal and logs are done by all the local people irrespective of their economic condition and the collection turned a festive mode in the village

THE GOOD PRACTICE

- Δ It is a subsistence for poor people in different hazard situations;
- Δ Scope of women involvement is high throughout the entire process;
- Δ It ensures the fuel needs of the farmer's family and is a source of earning money when they are sold in the market.
- Δ The entire efforts are economically cost effective. The amount of labor they employ.
- Δ All the elements are available in the surrounding environment and the method of collection is easy for everyone to understand.
- Δ Already adopted and suited to the local ecology.

People used a triangular shaped net which they call *jal* (net) to trap coal and log from the stream. It usually rains heavily when the flash flood occurs and the flash flood water come down with a very high current through the *khals* and canals. The people lay the net as trap across the current and wait. The net performs the key function while collectors tie polythene on the head of a net. 7/8 or more persons are involved with a net. The amount of coal that is collected depends upon ones luck. Some people have been fortunate enough to collect up to 400-500 mounds of coal from a big on-rush of water.

Collected coal or logs are sold in the local market. The scale of measuring the logs is determined as 90 seers per mound since they remain wet.

Lessons Learned

The key lessons of this practice is-

- Δ A household can gather logs and coal needed as fuel for an entire year. It is an alternate source of income as well.

- Δ Adult male, females and even adolescent boys get involved in collecting logs and coals.
- Δ The basic requirement in collection process is physical strength and very little skill. The more members of a family are engaged, the more they can collect.
- Δ So far, one death was reported in 1988 while collecting log and coal during flash flood. The risk of injuries exists if someone rolls down the stream while collecting.
- Δ It ensures the fuel needs of the farmer's family. Moreover they can earn their livelihood by even selling them to customers;
- Δ The entire efforts are economically cost effective. The amount of labour, and efforts they employ, the investment they make in the enterprise are the minimum;

Potential for Replication

The people at the place under survey could catch hold of the opportunity of the water current down the hills which accompany wood logs, coal and other useful elements of economic value. They use this natural advantage as livelihood resource. This type of natural advantages may be available in other forms also. Somewhere there are plenty of fishes in the running water, somewhere it may be *golpata* as in the Sundarbans and so on. So, people should take advantage of the natural resources for accruing benefit from them. Harvesting benefits is a great lesson here and this should be adopted everywhere by the people at risk for their survival.

MURTA CULTIVATION AND WEAVING SHITOL PATI

Précis

Location		Seasonality	Hazard
Union Upazila District	South Sripur Tahirpur Shunamgonj	All Season	Flood & Flash Flood

Prologue

The village Junjail under S. Sripore of upazila Tahirpore of district Sunamgonj is surrounded from north by the beel Tanguar haor, west by the matian haor and east by the Shanir haor. So the ecology is humid and the soil remains moist all round the year. The condition is aggravated by the flash flood due to the onrush of the hilly water mass when there is rainfall in the hills. So the area remains under water most of the time of the year, nay, the low lands, ditches and canals or drains.

When community people lose their known way of earning their livelihood, they try to find out the alternatives in their environment. By utilizing environmental resources people try to innovate some way of earning livelihood. As the area remains under water most of the time they try to produce such water tolerant plants useful and economically beneficial.

In the haor area people cultivate aquatic plants, the bark of which they found useful for weaving some domestically useful items.

The plants are locally known as *morta*, which grows in the boggy lands and once planted the original plants give out shoots and saplings at regular intervals and then a site becomes a source of other plants. The farmers take out the bark of the plants and weave a kind of mat which is very soothing and cool to lie

THE GOOD PRACTICE

- Δ Morta cultivation is a good subsistence for poor people under different hazardous situations;
- Δ Scope of women involvement is high.
- Δ Morta product is a good house hold item either as bed cover or as wall mat. So it has wider market possibility and we are to exploit the benefit.
- Δ The entire efforts are economically cost effective. The amount of labor they employ, the investment they make in the enterprise are the minimum;
- Δ All the elements are available in their own premises and the method of production is as easy as everybody can understand.
- Δ Already adopted and suited to the local ecology.

on during the summer season and that's why these are called *shitol pati* meaning cool mat.

The Initiative

The village, being inundated almost throughout the year, cannot be used for agricultural purpose for two crops and only one crop is cultivated and that is *aman* (spring harvest). Being surrounded by the haors, the village cannot produce crops sufficient to meet their demands. So the farmers have taken recourse to some non traditional crop production technique.

Goal and Objectives

The goal of *Murta* cultivation is to reduce the vulnerability of natural hazards, especially flood and flash flood. The *murta* cultivation initiative aims at ensuring complementary income.

Activities and Outcomes

The plots that are moist and remain under water are suitable for *morta* cultivation. Generally the ditches and low lands around the homesteads are used for the purpose. The village Junjail has all the lands suitable for the purpose.

The farmers have the exposure to the technology beforehand. Formerly they were buying *morta* from the adjoining areas and markets. The women of the families at their leisure time and in the rainy days when they don't have any other work engage themselves in weaving the pati. This brings additional money to subsidize their family income. There are 33 Hindu families in the village who have adopted this pati weaving as their source of livelihood. But they were facing problem in collecting *morta* from the distant village market. So one NGO named CNRS has come forward to help them and extended loan of Tk 500 to each of the 19 families to buy the saplings of *morta* and plant them in their own land. This year for the first time they have planted *morta* which have not yet been harvested.

Their involvement with pati weaving: The village community people conveyed that they have learned the art of weaving the pati from their forefathers. Recently they have started cultivating *morta* since their own land remains under water for 6 months.

Morta, as mentioned earlier, is a kind of aquatic grass. These are cultivated in the S. Shripur union. The saplings are planted in the month of *Katrik*. *Morta* cultivation can be done in different ways. Either the farmers can collect the saplings from the market and plant them in the plots. Or, they can sow the seeds in the prepared land. Once or twice they plough the land and then they sow the seeds. In a plot, the ripe fruits from the plants fall down and germinate the saplings. The saplings require to be guarded against the attack of cow. They grow very quickly and generally grow to 5-6 ft high and their leaves are evergreen. The *mortas* are sowed or planted in rows.

The farmers can buy the saplings at Tk 3 per sapling from the market. 19 families have become involved with the cultivation and remaining 14 could not start because of lack of money needed to buy the saplings and for other works. So the farmers in the Junjail have started the cultivation. But the farmers in the South Sripore stopped the cultivation, because of low yield and attack of insects.

The cultivation in the Junjail village has just started and the plants are yet very small and they cannot be used for weaving pati. The plants need at least two years time to be matured. The new plants die because of staying under water for two-three months, at the time of flood. .

Collection of Murta: Although the farmers of Junjail village have started cultivation of, they are

not yet sufficiently mature to be used for weaving *patis*. So they collect from the neighbouring villages. The places where available are Madyanagar, Tahir pore, Badagat, Maisya Khala and Tekerhat. All these places are within Taherpur upazila. They collect according to their convenience from different places in different times. But wherever they go for collection they need to spend the whole day. They go out in the morning and come back on the same day either in the evening or at night. So they are to spend for conveyance and fare of the vehicle they use. The expense rate is as follows:

- To collect from Modyanagar both way journey one time plus food expense is k 100;
- To collect from Taherpore also the expenses inclusive of all is Tk 100;
- To collect from Baghaghat the expenses inclusive of all is Tk 160;
- To collect from Maisyakhala, the inclusive of all the expenses are Tk. 150.

Although is available throughout the whole year, they preferably collect it in the rainy season for convenience in the communication by boat and the boat communication is cheaper also. There is another reason that the growth and production of in the rainy season is very abundant and is available in plenty and the cost is also less. Though they are available in other seasons but are costly, because of less production. So the farmers collect in the month of Bhadra-Aswin, the rainy season and carry home by boat.

The method of weaving the pati: At the initial stage the mortals are wet and 5-6 ft in length. They make sheets length wise in twos and allow them to be dried in the sun for two days. Then they put them in a pond for a day or so to wet them again. This facilitates the separation of the bark of the plants. It is the bark that is used for weaving the pati.

Collection of plants, dipping them in water, taking them out of the ponds, cutting them to make sheets and then separating the barks are done by the male persons of the families and for doing all these they do not need any tools excepting a knife and all are done with bare hands, Even the weaving also is done with hands.

Weaving of the patis is done by the women members of the families. They do this work in any open space, the size of which is 7 x 5 square cubits approximately. This amount of space is available inside the dwelling house or on the verandah or in the premises of the house.

In weaving the patis they use colour and make some designs to make it attractive or even to give some moral values. They sometimes write 'forget me not' on the pati, or they may draw a picture of a mosque to give some religious value to the pati. They try to make it colourful in many different ways. They do this work throughout the whole year as it is main livelihood source.

Size of patis: The sizes of the pati depend on the needs of the use. Sometimes they need to sleep three persons including husband, wife and a child and so they prepare patis of the size 5.5 cubits in length and 3.5 cubits in breadth. Such a big pati requires the labour of women for 10 days,

A pati intended to lay the husband and wife needs the labour of a woman for 7 days. This medium size pati has the size 4.5 cubits in length and 3 cubits in breadth.

A pati meant for single person is also available. But another specific size is for saying the prayer by a Muslim and the size is generally 2.5 cubits in length and 2 cubits in breadth.

Marketing the patis: The farmers are found to sell their products to the local markets. They carry them by boat to the market and for this they are not to pay and only pay for themselves. The price of 5.5 cubits long and 3.5 broad pati is Tk 700. The second category of pati is 4.5 cubits long and 3 cubit broad which sells at Tk. 300. The third size i.e. 2.5 x 2 sq, cubits pati sells at Tk. 125. The conveyance cost is Tk. 50.

The Expenses of a pati measuring 5.5 x 3.5 sq. cubits need plants of 4.5 and the cost of plants is = Tk 180.

A pati measuring 4.5 x 3 sq. cubits require 4 of the plants and the price of the plants is =Tk. 160

And a pati of size 2.5 x 2 sq. cubits needs 2 of plants and the total price is Tk. 80.

The use of colour: Three types of colours, red, black and green are the colours they use for painting the pati. When the barks are separated they add colour to it. One person catch one end of the sheets and the other give colour with a brush. Then they dry the sheets in the sun.

They buy past colour from the market and a medium size tin of colour contains about 400 grams of colour. A tin content of colour costs them Tk. 65 and for three tins of colour. They are to spend Tk. 195 and a small brush costs them Tk. 20.

Lessons Learned

- Δ The work is environment friendly and economically beneficial. They can do the work by themselves.
- Δ The women folks of the village can do the work at their leisure time. This gives them some extra income to add to the family income.
- Δ The raw materials are available in their own environment. The farmers of the village Junjail have began to cultivate the land, as they reported, from the next year they will get these raw materials in their own village. The work is done only with bare hands and do not need any other tools. So it is easy to produce the shitol pati which has local demands. Even sometime the brokers collect from the village market and sell them in the towns or export them.
- Δ They have planted the saplings in their own garden and they expect that they will be in convenient position in the next year. The farmers are encouraged by the CNRS, an NGO by giving loan for cultivating the Murta.
- Δ The farmers are in constraints as they are to buy from far off villages.

Potential for Replication

Morta is an aquatic plant and grows in sweet water. There are many sweet water logged water bodies in Bangladesh. So cultivation may extend.

Morta is used to weave shitol pati, a kind of mat which is soothing to lie on during hot summer. So it is liked by people in tropical regions everywhere and also by the urban people who use it to cover their beds to get a soothing effect in summer.

Shitol pati can be used as wall mat when painted and decorated nicely. The pati has the possibility of being a non-traditional export item.

Therefore the expansion of cultivation and weaving of shitol pati on large scale is earnestly expected.

MANUFACTURING CANE FURNITURE

Précis

Location		Seasonality	Hazard
Union	North Sreepur	All Season	Flood & Flash Flood
Upazila	Tahirpur		
District	Shunamgonj		

Prologue

The village of Lakma Nayapara lies at the foot of the Meghalaya. Every year the land

THE GOOD PRACTICE

- Δ Cane furniture making is a good subsistence for poor people in different hazard situations;
- Δ Scope of women involvement is high through out the entire process;
- Δ Moreover they can earn their livelihood by even selling them to customers;
- Δ The entire efforts are economically more or less cost effective. The amount of labor, and land they employ, the investment they make in the enterprise are not up to satisfaction;
- Δ The elements are not now a days easily available at suitable price.
- Δ Already adopted and suited to the local ecology.
- Δ The industry demands survival and the cane cultivation should be expanded.

here is filled up with sand because of the muddy water coming from the mountain and passing through the village during flash floods. Although the farmers use the water for irrigation, nevertheless the mud that the water carries causes silt deposition making the land unsuitable for cultivation. The floods ruin the crops and as an alternative to livelihood four families in the village started to make cane furniture.

The Initiative

Mohammed Abdul Kashem started the trade here in 2000. His wife helps him in his work.

Goal and Objectives

The goal of manufacturing cane furniture is to reduce the vulnerability of natural hazards, especially flash flood. The manufacturing cane furniture initiative aims at ensuring complementary income.

Activities and Outcomes

Main raw material cane is locally available. They are procured from the neighbouring Bashtola, Chargao, Bataghat, and Kaukandi within the same Upazila. Usually 200-250 pieces of raw canes are bought at a time. One cane is about seven cubits long. These canes are left to dry out in the sun for a week. The crooked ones are straightened by applying heat. Blow lamps are used to heat the canes. These lamps are lit by Kerosene. One blow lamp holds a litre of Kerosene. One litre of Kerosene costs Tk48. The transportation cost for buying the canes from the above places is Tk. 440. One has to travel by boat.

The equipment needed to make cane furniture is *hechko* blade frame, blade, cleaver, knife, hammer, *hambura*, blow lamp, measuring tape and stool. These materials cost about Tk 1800 and once bought can be used for a long time.

Different types of furniture like sofa sets, dress stand, swings, chairs, beds, stools, etc. are made of cane.

The respondents reported that the cost of making a three sweater sofa with two single chairs, a centre and a side table is about Tk3,500. It takes two people one month to make a sofa set and one set is sold for a maximum of Tk 10000. The cost of making a chair is around 500 Taka. It takes a person two days to make a chair. One chair is sold at Tk 500. The cost of making a Dress-stand is more or less Tk 650. It takes a person two days to make a dress stand and is sold at Tk 1100. The making of a square stool costs Tk 166. It is usually sold at Tk 250 and takes a person three hours to make one. A bed takes 15 days for two persons to make. Investment is about Tk 2500 against return of Tk 7000. The making of a swing cost about Tk 500 and sold at Tk 1000 each.

Among the above mentioned furniture items only sofa sets and beds are made on order. The rest of the furniture items are made on a regular basis and sold in the local market.

Lessons Learned

It is learned from the respondents that the work is environmentally friendly and can be carried out as cottage industry. But economically it is no more viable; because of different reasons. The cost of cane has gone very high and very often the investment does not bring good return. At times canes are not available due to the reduction of cane cultivation.

Picture xx: making furniture with cane

Cane furniture items are cheaper than the wood ones and very light and portable. So this industry should not die and in order to keep it flourishing cane cultivation should be encouraged.

Cane furniture has wide market and our products are liked by all both inside and outside. So it is an imperative to enhance the industry.

Potential for Replication

Cane furniture making is a good source of livelihood and a vast section of people at risk may be given employment in this sector, if the industry is given proper patronization.

COPING AND COMMUNITY RESILIENCE

CROP SAVING EMBANKMENTS

Précis

Location		Seasonality	Hazard
Union Upazila District	South Shreepur Tahirpur Sunamgonj	All Season	Flood & Flash Flood

Prologue

The Surma and Shanir Haor of the village Lamgao, under S. Sripur of Upazila Tahir Pur of the district Sunamgonj faces flesh flood and advance flood every year. Within the village is the Surma haor and to the south of the village is the Shanir *haor* and Tanguar *haor* lies to the East.

The village witnesses flood due to the onrush of the hilly water flow every year in the month of Ashar-Shraban. Due to the climatic change flood comes down in the month of Boishakh and Jyostya in some year. The hills are located to the North and when there is incessant rainfall, the water rushes down to the lower planes and the Tanguar haor, Sanir Haor and the Surma Haor are the basins and when these overflow the adjoining villages are submerged. As a result the boro cultivations are submerged under water. The water that has entered the haors takes at least six months to recede.

The Initiative

To save the crops of Surma and Shanir haor areas, an NGO named CNRS has recently taken a project known as FRRAS. The idea behind the project is that if a dam is raised along the river or the canal responsible for carrying water from hills during the flash flood, the farmers can save the crops. They can harvest boro crop. Keeping this in mind the CNRS and the local people are proceeding to raise the dam, however, they are uncertain about how long it will sustain. The CNRS authorities have planned to grow grass at the two sides of the dam and on the dam at two cubits length. There was a dam on the Surma haor and the dam was washed away by the flood. CNRS began to repair the dam from 10th February 2008. The local people contributed to the repair of the dam for saving their crop lands.

THE GOOD PRACTICE

- Δ To get rid off the adverse effect of WAPDA dam the villagers are united and they have found out the remedy by themselves;
- Δ The cooperative attitude is at the root of the success;
- Δ It appears that the villagers may succeed to revive their normal agric activities for their survival;
- Δ Amazingly, the WAPDA dam construction did not assess this before hand;
- Δ People's united efforts can bring back their lot.
- Δ The initiators are convinced of the efficacy and sustenance of the action in the ecology.
- Δ Construction of the dam along the river is a development approach and people accrue real benefit from such enterprise.
- Δ The initiative is environment friendly and beneficial to a great community people.

They realized that it is only with the existence of the dam that they have a chance to cultivate the boro crop.

Goal and Objectives

The CNRS (Centre for Natural Resource Studies), is a development organization that has been funded by the SIDA, Care Bangladesh offering Technical support and CNRS is the implementing agency. The objective of the project is to ensure food security of the local community people from the advance flood and the aim of the work is to arrange food for the people affected off and on by the advance flood.

Activities and Outcomes

To achieve the social sustainability of the project the local Union parishad has been involved and their function is to maintain the trees and the dam.

The CNRS has started the repairing work of the Surma extended dam to protect the crops of this area on 10.02.o8 and the expected end time is 23/03/2008, the supervisor of the FRRAS project of CNRS is in charge of the overall supervision of the work. The estimated expenditure of the project is in grand Total = Tk. 939799.00.

CNRS has developed one Project Implementation Committee (PIC) which was formed of the members of the local people. The committee members hold meetings with the village people and discuss the matters relating to the dam maintenance and the financial aspects of the project. They decide the amount of the contribution of the community people. This is based on the proportionality of the quantity of land a farmer has in the project area. The dam will protect the crops of the farmers of the land holders of the project area and so they cooperated spontaneously. The CNRS associated the union parishad also. Besides, the local responsible stakeholders also are taken to act the dominant role. In this way the whole area has been associated with the construction, maintenance and the future maintenance of the dam so that nobody can do any harm to the dam, rather the initiators tried to achieve the belongingness of all strata of the local people, since the livelihood of people is linked with the well being of the dam.

The contribution of the local people is vested with representative of local community to the PIC and they are 5/6, one from each village. They hold separate meetings with the village people and determine the quantity of land of each villager in the project area. So when they place this statement of land holdings, then CNRS calculate the percentage of different instalments the villagers are to pay and the calculations are according to the following percentage:

- 1st year the villagers to pay 5% of the total budget, and the project implementation authority to pay 95% ,
- 2nd Year the village people to pay the 10% of the total budget, and the project implementation authority to pay 90%,
- 3rd year the villagers to pay the 50% of the total budget, and the project implementation authority to pay 50%,

The PIC decided Tk. 50 for every 30 decimals of land of the nearby villages and the villagers of the next village to pay Tk. 60 for every 39 decimals. This was determined by the representatives of the villages.

The dam is made with the middle high and the two sides low so that water cannot stay at the middle. To save the dam from the wave of water, *binna* grass will be sown on two sides of the dam. This will help the dam from being washed away by the waves created by the wind. Even to make the dam more sustainable, on both sides of the dam bamboo poles are being inserted and bamboo *chatais* are also fitted with the poles. This will protect the dam from being washed by the waves.

Lessons Learned

The work is environment friendly. The people did not do the work by themselves; rather they are facilitated by an agency. In fact such a big work cannot be done without the initiative of a powerful body. The community people when can realize their benefit then they support and cooperate. In this case also the work is no doubt gigantic and needed to be organized by the NGO. People could realize their benefit and they responded.

The raw materials are local and available in the environment itself.

The problem as observed was the contribution paid by the villagers. This was very hard for the poor or small land holders. Even the dam may at any time collapse or washed away by a big natural event and then the villagers cannot repair it again. That's why the government can do such a big work for the welfare of the people. Even the political regime may take voluntary approach to construct such a dam and the people under their leadership will come forward to work without any wages.

To control the hostile environment at the advantage of community people becomes necessary sometimes. The natural flash flood that befalls upon the villagers of Lamgao annually is indeed an impediment to acquiring livelihood of a great community people. They have gathered under the initiative of an NGO named CNRS and could succeed to achieve opportunity of saving the crops from the flood that would otherwise destroy within a few hours. This is the good result of uniting people for common interest.

As the dam is made of soil and the soil again is washed away by the rain water, the work is to repeat and the parties involved are to do the repairing work constantly.

Potential for Replication

The community people are to be vigilant always for the safety and maintenance of the dam against the subversive action of any nefarious group or individual and running repair of the dam. But such a big work should be done under the association of the govt. in a welfare state.

MAINTENANCE OF THE SHACKLE DAM

Précis

Location		Seasonality	Hazard
Union Upazila District	Konakhali Chakoria Cox's Bazar	All Seasons	Flash Flood

Prologue

The people of Konakhali union of Cox's Bazar is affected by the natural calamity like flash flood caused by the onrush of the river water of the Matamuhuri which overflows their farm lands. On seeing the woes and sufferings of the local people, sometime in the past the WAPDA authority raised a dam 6 km long along the river banks in this union.

In the rainy season, especially in the month of *Ashar* there is heavy rainfall in the hills which washes the dam and the strong onrush of the upstream make the dam broken in different places and heavy water enters the farmland causing great harm to the standing crops and homesteads. But the WAPDA authority does not respond for the instantaneous maintenance of the dam. So the villagers for their own interest make sharp response and maintain the urgent works of the dam.

The Initiative

Along the hillsides the farmers plough the lands and sow the seeds of different crops. They take care of the crops with the hope that the golden crops will sustain them and their children through the year. There is heavy rainfall in the nearby hills and in the morning they see they

THE GOOD PRACTICE

- Δ It is a subsistence for poor people in different hazard situations;
- Δ Scope of women involvement is high throughout the entire process;
- Δ It ensures the fuel needs of the farmer's family and is a source of earning money when they are sold in the market.
- Δ The entire efforts are economically cost effective. The amount of labor they employ.
- Δ All the elements are available in the surrounding environment and the method of collection is easy for everyone to understand.
- Δ Already adopted and suited to the local ecology.

are engulfed by vast water mass and they cannot see their crops in the field. This is what the flash flood is and is a great menace to the existence of the community people. The occurrence of this is prevented by raising dam around or along the river banks. This initiative is to secure their livelihood.

Goal and Objectives

The goal of maintaining the dam is to reduce the vulnerability of natural hazards, especially flash flood. This initiative aims at ensuring the houses, land and crops.

Activities and Outcomes

Within 2005 to 2007, 4 places needed urgent maintenance and the village people did it successfully. At the time of the need they call people around. When they apprehend the failure or any leakage anywhere on the dam or overflowing water, they call all villagers at the top of their voice, contact over mobile or send the *chokidar* to gather people for the work. Or even, if necessary, they take the help of the neighbouring villagers. Within a few minutes the villagers respond in hundreds and set to the work. The places of the dam they maintained during the time from 2005 to 2007 are:

- The dam near the village market of Purityakhali village; (1)
- The dam lying to the North side of the village East Konakhali; (2)
- The Northern side of the village Purityakhali and (3)
- The WAPDA shackle dam of the Morongona. (4)

No. 1 and No. 2 as mentioned above had to be maintained three times in 2005-06 and 2007 and the No.3 place of the dam had to be maintained twice in 2006 and 2007. All these works were done by the community people by themselves.

Maintenance at the 1st place of the dam: The maintained length of the dam was 150 ft and height 13 ft and in the maintenance work 250 people were needed to complete the work on the same day. They collected the used up sacks of rice and manures and cement bags and filled them with soil and placed these bags over the damaged place. They collected soil from the outer side of the river and used the soil. Thus they felt 1000 bags full of soil to mend the damaged portion of the dam.

They used 500 pieces of bamboo fences to protect the dam and the bags they were throwing at the onrush of water. As the work was instantaneous, they collected on the spot these fences from the householders who used them around the dwelling houses as safety walls and these were of different sizes and shapes.

They used 300 eucalyptus, mango, lichi and jam trees, big or small, or their branches, all collected from the surrounding villages. These trees were used mostly as poles against the fences. Eucalyptus trees were used as the poles and the work employed 60 eucalyptus trees of length 50-60 ft. The local name of the eucalyptus is *baldi* and they were of different diameters. The village grows ample of the trees.

Maintaining at the 2nd Place of the Dam: The length of the dam they repaired was 300 ft and all along the length they did not need to maintain. There were several gaps created by the washing or erosion, or by the barrows made by the animals and flowing of water. Here, too, they collected the bags and 200 people filled the bags and they were paid at the rate Tk. 180 each. The work used tress, bamboo and fences. The money was reimbursed from the union parishad later on. 30 eucalyptus trees were used for the project. But the number of bamboo and fences used they could not tell.

Maintenance at the 3rd place: The length of the damaged length was 150 ft. 80 people participated in the repairing work in 5-6 days. The villagers did not do the work on emergency basis; because the damage was not as dangerous as the other ones were. For this work also needed trees, bamboo, fences and sacs or bags. About 1200 bags of soil were needed for maintaining this place. The soil was taken from the adjoining lands. 450 pieces of fences were used for the work. The eucalyptus trees were used for poles and the bags full of soil

were placed at the feet of the poles both inside and outside the poles.

Maintenance at the 4th place: Here too bamboos, bags filled with soil and trees were used. The length was 1000 ft. The number of bags was 800 and the trees, bamboos and fence could not be known. Although the work was done on instantaneous basis, later on the union parishad paid to the people worked for the purpose. The fences were paid less than the market rate. Because the fence were very old and some were new. Of course, the new ones were paid at higher rates. The tree owners were paid according to the thickness and length. People engaged in the managing affairs and carrying the trees was also paid. These accounts were done in the union parishad office.

Lessons Learned

The number of bags is very big and so collecting them from house to house might delay the work and by that time much water could enter the village and the length of the damaged portion might be increased. As because the work is instantaneous the cutting of trees, although available in greater number in the village, might spoil much of the time. But this allowance had to be given for organizing the entire affairs.

Though the community people worked on emergency basis to save themselves and others, they did not think of receiving beforehand payment which was done later on and might not be on equitable basis. Any way they did the work jointly in the greater interest of the community.

Through this work, the village culture of tranquillity, unity and fraternity is reflected and no political motivation or thinking can work behind.

The people who live in a place from generation after generation develop a relationship much stronger than the affinity. Due to this relation at the time of any natural calamity they share the sufferings and try to help each other. This is the main feature of the permanent habitation and is a great force that binds people together. So at the time of any common problem they share.

The magnitude of the work is a great weakness. The amount of the raw materials needed for such gigantic work is difficult to collect at the time of urgent need. But that also the people under observation could do successfully.

The village has enough of eucalyptus trees and also the area being hilly other trees and forest products are available abundantly. The people are also united for a common cause. So they can save their properties and save themselves from natural calamities through united efforts.

Potential for Replication

In olden times people were united such and that's why they lived in tribes only to resist the obstacles, natural or manmade. Being united they could surmount any difficulty. Even now the concept is not foregone. But what is needed is the leadership. As the head of the tribe was the symbol of unity, so is the leadership must be the symbol of unity. Thus any work can be done for the common interest of the area or the community.

Leadership should have program for uniting social people for noble cause of the society. Once common people can understand the greatness of a certain project they go forward at once to work as hard as needed.

THE GOOD PRACTICE

- Δ It is a good approach for community people to survive in different hazardous situations;
- Δ Scope of women involvement is limited through out the entire process;
- Δ The entire efforts are economically cost effective. The amount of labor they employ to make their communication easier in the hilly environment is the minimum;
- Δ All the elements are available in their own environment and the method of production is as easy as everybody can understand.
- Δ Already adopted and suited to the local ecology.

BRIDGE OVER BARRIERS

Précis

Location		Seasonality	Hazard
Union Upazila District	Remakri Ruma Bandarban	All Seasons	Erosion, Flood & Flash Flood

Prologue

The environment in the hilly area is completely different from that of the plane land which makes people accustomed to adopting different mechanisms for making life bearable.

The example is the life style in Remakriprangsa union, a bordering place to the North of which is Myanmar, to the South is Thanchi thana and to the East are Farua union and Ruma Sadar, a habitation comprising of 37 *pare*s (villages) having 20 HHs in each *Para*, inhabited by indigenous people like Bowm, Tripura, Khumi, Marma and Mru in the adjoining hills, forming a complex network of mosaic architecture of natural bounties and fallacious landscapes. The hills rise where there is the foot of another hill making the land formation completely uneven and the entire area around is hilly. low and hill leaving spaces with slopes steep and slanting, where the indigenous find rooms for making their abodes on the slants, which is temporary, for they practice slash and burn shifting cultivation (*hum*) on a hill only for 4 /5 years and then leave for another, a mobile life style but they are socially bonded by strong traditional rules having a Karbary in each *Para* for collection of rents from the members, and a headman of a mouza formed by a few Para, to whom the Karbary deposits the rents collected to be deposited in the treasury. There are two mouzas in the area.

The paras lie at a very far distance from each other and the communication is very difficult, where the means is only the feet of the persons involved to cross the ups and downs of the hills. The low is as promising for their livelihood as they are dangerous at the time of rainfalls. Along the lows there are canals like passes for drainages of rain water and when there is heavy rainfall they turn an ugly shape by having the strong current of water all on a sudden coming from the surrounding hills and the intensity is so great that they can carry animals and even humans if they fall victims to them and they inundate the adjoining areas with too rapidity to evacuate anything, standing only for one or two hours. There is Remakri canal in the Remakriprasang union, besides, many other small or big jhiris, small streams carrying hilly water always which are again the sources of their water for drinking and domestic utilities. Not only that these streams carry wooden trees, branches of trees and stones and they collect them to use later on as fuels or for other purposes.

The Initiative

But when there is rainfall the community people are stranded, especially, due to the Remakri canal, which is very important to them. The paras lying on the canal being Thaikhiang Para (Bowm), Empu Para (Mru), Darjeeling Para (Bowm), Parsing Para (Mru) to the North and to the other border to Myanmar to the South, Longpara, (Khumi), Krespaipara and Thingdulappara (Bowm), Selaupipara (Bowm), Cheikhiang Para, Chulchang Para (Mru). So the people living on both the banks of the canal are to communicate sometime instantaneously even but the current in the canal impedes them off and on, the difficulty is intensified when there is incessant rainfall for 3 or 4 days. The length of the canal is only 3 km and the breadth is 120 ft and they raise a bamboo bridge sako over the canal by themselves.

Goal and Objectives

The goal of bridge is to reduce the vulnerability of flash flood. This initiative aims at ensuring the communication and transport during the hazardous situation and after the event.

Activities and Outcomes

They collected the trees and wood coming with the current of water at the time of rainfalls. The ropes and other things they needed for making the *sako* were collected from the members of the *paras* on contribution basis. Then they go for raising the sako by laying the long wooden logs crosswise the canal and fix ropes at the two

ends on the banks at a height with trees on the banks so that they can catch the ropes to balance their weight while crossing over the sako.

The log is again tied with trees with ropes strongly so that it cannot tilt when they are on the sako. The people made one sako earlier but were broken and again they reconstructed the sako. This happens because the wooden materials that are used for raising are subject to rotting with the treatment of water and humidity and so the local chairman demanded permanent bridge over the canal. But in the hill life they are to raise such sako here and there wherever there is a jhiri to cross and they do this easily by laying logs of wood cross-wise the breadth of the jhiri and by fixing some ropes or creepers at suitable height to catch while crossing.

Lessons Learned

This sako is made of all indigenous materials and, especially in the hills, they are not to buy anything but the collection of volunteer labours from among the members of the Para or area who join willingly because they use the sako, which is environment friendly.

Potential for Replication

The overcoming of small barriers in confined areas of hills and deserts teach people to innovate solution. Sako is a traditional barrier overcoming mechanism both in the hills and plane lands, the idea of which taught people of constructing the so-called permanent bridges on greater barriers.

CHAPTER 4

COPING IN WATER LOGGED REGIONS

Chapter 4
COPING IN WATER LOGGED REGIONS

WATER LOGGING SCENARIO IN BANGLADESH

Water logging has caused extensive economic losses and human sufferings in South-west coastal region of Bangladesh. Water logging, in Bangladesh, is not a mere naturally occurring phenomenon, rather unlike floods it is, to a large extent, caused and accelerated by anthropogenic activities restraining the natural water courses and surface water drainage systems. Along with an apparent vision to enhance agricultural productions as well as to promote economic growth, in some areas, large scale embankments were constructed to establish hydro-managerial bureaucracy over natural processes of water systems at the regional level. These infrastructural establishments might be proven to be worth beneficial considering a short span of time but eventually ejected adverse effects on the deltaic land formation process and submerged, either seasonally or permanently, significant land areas in Southwest Bangladesh. People gradually encountered water logging as an emergent threat against their livelihood stability. Water logging changed the traditional agric system, reduced most of the farmers to extreme poor, forced people to migrate as well as caused much havoc for the people of that region.

4 Abhoyanagar, Monirampur, Keshobpur, Dumuria, Tala, Phultala and Aulatpur upazila

One million people of 8 upazilas[4] of Khulna, Jessore and Satkhira districts are affected by water logging for last 35 years. In earlier times, the area was logged by water seasonally particularly during rainy season, but since 2005, the situation has further been deteriorated and water remains logged almost all over the year. Recently water logging continues to spread over a larger region and affected Kolaroa, Jhikorgachha and Sharsha upazilas. Bagerhat and Pirojpur districts have also been experiencing the problem of water logging mostly during the monsoon season.

Several reasons might have been identified to have caused water logging in the Southwest Bangladesh. Off these, the construction of upstream embankments, particularly Farakka Barrage, Polder constructions along the coast lines during 60s and the implementations of unplanned development projects like KGDRP are the most significant among others.

Active and gradual siltation process is the basic characteristics of any deltaic land formation, which is subsequently complemented by continual land subsidence and compaction process. The geographic position and physiographic features

of the Southwest coastal areas exhibit similar processes of land formation as being an active delta. But such natural processes were significantly intercepted by constructing several embankments, polders and other infrastructures. In several futile attempts to convert these low lands under deltaic processes into immediately harvestable agricultural fields as well as to increase the total yields, these large scale infrastructures were constructed during 1960's. Such infrastructures significantly reduced the natural rate of siltation process, while land compaction and subsidence continued over time. Consequently, the rivers became higher than the adjacent land resulting inevitable water logging in several regions of Southwest Bangladesh.

Bangladesh Water Development Board (BWDB) came up to implement Khulna-Jessore Drainage Rehabilitation Project (KJDRP) to address drainage congestion and water logging problem. This project also failed due to design error and practice in relation to technical, environmental and governance context. Moreover, this project accelerated and increased water logging by reducing river depths and increasing silt deposition on the river-beds. These projects eventually became disastrous for failing to anticipate the real adverse forces causing damage to the ecosystem during implementation. They have damaged the environment and ecology and consequently devastated the livelihoods of the people of the area and caused immeasurable sufferings. The reasons of water logging in Bagerhat and Pirojpur districts are: silt deposition, flood water, rain water and coastal inundation. The consequences of the water logging are far reaching. It has changed livelihood patterns, economic activities, social and cultural activities of the area.

OVERVIEW OF THE RISK ENVIRONMENT

Southwest Bangladesh has been experiencing water logging situation for last four decades. Some 86,840 households were water logged and these people lost their normal life activities and livelihood resources (DER 2006). In Jessore district 250 km rural path and 32 km roads were severely affected. Although most people of the affected areas have been peasants, no single crop could be produced in nearly 20,000 hectares of cultivable land. The total damage of crops and infra-structures has been estimated to be about TK. 500 crores. Besides each year more than 500 schools and colleges remained closed during rainy seasons. [5]

The land ownership pattern of this area has been adversely affected. Marginal farmers became landless, small farmers became marginal or landless. This disintegrated the family life. Most of the people of water-logged areas are Hindus. Some of them migrated, as some of the respondents reported, from the area, a few to India and others migrated to other places in the country. The average households' income sources have been drastically reduced. The agric labourers became jobless and migrate seasonally to other neighbouring districts in order to get temporary employments. The female members who earlier used to maintain household affairs are involving themselves in various outside works, such as: catching fishes, collection of water weeds, housemaids in solvent families etc. So the family structure has been totally shattered.

Drinking water has become very scarce for the community people, as most of the tube wells (60%) had gone under water (reference). Various diseases, especially water-borne diseases, like diarrhoea, dysentery, skin diseases have been increased everywhere due to drinking and using polluted water. Scarcity of fodder is very common in the entire region which has drastically reduced the number of livestock and poultry. This ultimately leads to the reduction of protein sources. Environmental degradation has taken place severely. The terrestrial vegetations have been changed due to prolonged water logged situations. Entire Biodiversity of the areas has fallen under serious threat reducing the flora and fauna of the area, as was observed.

PROFILING THE STUDY AREAS

This research initiative has yielded significant ethnographic information on the episodes of

5 www.unnayan.org

good community coping responses related to water logging from different locales of Jessore, Satkhira, Bagerhat and Pirojpur. The investigation areas were 11 villages in 9 unions in 6 upazilas of the four districts including Jessore, Satkhira, Bagerhat and Pirojpur. [See Annex XX]

Water logging is a major and commonly prevailing hazard in these aforementioned four districts. In Jessore and Satkhira it has become a round the year phenomenon, although its severity increases from mid Sraban to mid Paush (August to December). Due to silt deposition, floodwater, rainwater and tidewater cannot recede completely creating water logging in Bagerhat and Pirojpur. It is observed from mid Jyaishtha to mid Agrahayan (June to November).

In the study areas due to water logging, most of the livelihood resources like natural, social, economic or financial resources, human and physical resources are vulnerable. Among them agriculture which is the main means of living is more vulnerable. The agric practices are totally shattered. The worst impact has been on the frequent crop failures and opportunity of work, the only source to earn livelihood by the majority of the population. Consequently the agric dependent people became extremely poor and were struggling for survival. In this way water logging affects in food security and livelihood.

COPING IN WATER LOGGED REGIONS

The research findings suggest that the communities in such areas are highly pro-active in their respective efforts to mitigate the consequences of water logging. People, in the study areas, attempt to address risk problems ex ante. In this chapter we would discuss some cases of good community practices concerning ex ante risk management which more often include diversified coping strategies to offset risk of drought impacts. Water logging has some unique characteristics, as discussed earlier, that makes it difficult to determine the onset and end of the event. Therefore, its potential long duration requires people to adopt different approaches to reduce their impacts.

Unlike other natural hazards, the absence of any effective management systems for operating and maintaining the drainage of logged water remains to be the key challenge for people and professionals to reduce or mitigate the consequences of water logging impact. Most of the time the impacts are cumulative and the effects are magnified at the local level. It is critically important for water board and development practitioner to understand the cause of water logging events and identify the way which makes the people relief from water logged situation.

Indigenous coping strategies, in different study areas, have proven to help contribute to the community's ability to mitigate the impact of regular water logging events. The changed circumstances have compelled people to innovate such agric practices, as floating agriculture that does not require the surface of the soil. They also improvised *kandi* method for cultivation of crops in the submerged lands. Dewatering expel the standing water from affected areas.

INDIGENOUS PERCEPTIONS AND KNOWLEDGE

INDIGENOUS KNOWLEDGE OF WATER LOGGING

People consider rainfall as an indicator of water logging. If the quantity of rainfall is relatively higher during rainy season people predict that water logging may occur. The community people have also a very good understanding and awareness about the consequences of untimely heavy rains in the month of *Bhadra* and *Aswin* (mid August and mid October) or in the months of *Falgun* and *Chaitra* (mid February and mid April) which is the indicator of water logging.

It is gathered from the field that the community people can forecast rainfall by considering some indigenous indicators. By observing the following indicators, they can predict whether there will be rainfall. The indicators as identified by the respondents are as follows:-

চৈত্রে খর খর;	*Chaitrey khar khar,*
বৈশাখে ঝড় পাথর ।	*Baishakhey jhar pathar.*
জ্যৈষ্ঠে তারা ফুটে ।	*Jyaishtey tara futey.*
তবে জানবে বর্ষা বটে ।	*Tobey janbe barsha botey.*

Interpretation: No rain in Chaitra, storms in Baishakh; Stars appear in Jyaistha, are the symptoms of heavy monsoon rain.

- The frogs begin to yell/cry together before 1 to 2 days. Sometimes, frogs cry when they see cloud in the sky, because they understand the incessant rainfall. This is also supported by the simultaneous cry of at least 20-25 frogs around within 10 minutes.
- The striped snakes come out of their barrow.
- The black and red ants climbing the trees and relocating the food and eggs.
- When the insects (mosquitoes, fly) bite more frequently then the rainfall is ensuing,
- When the visit of dove in the houses increases, they presume that there will be rainfall within next 1 /2 days.
- The density of stars in the sky in the months of *Ashar* and *Sraban* (mid May to mid July) indicates the rainfall.
- The formation of cloud in the Southern sky is the symptom of rainfall. On a certain day if the cloud rumbles in the sky, then they apprehend rainfall on that day within a very short time. Here the colour of the cloud decides the time of rainfall. If the clouds begin to gather at a certain place from around, then there will be rainfall. The cloud gathered under the sky becomes black and the blackish colour is very deep or appears to be black, then the rainfall may start very soon, i.e. within 15-20 minutes.
- If the tide (the clouds in the sky) flows from the South to the North they infer the rainfall and there is no rainfall without tide. If there is persistent tide in the sky from morning to evening and the colour of the tide is dark, the light yellow-red cloud together, then there is persistent rainfall in the next 7/8 days and even sometimes they cannot see the sun.
- The local people take readings of rainfall from observation of the behaviour of the insects. As for example, when they see the annoying centipedes (a kind of ant having 100 legs for which they are so named) in the house and always they are moving here and there, they infer that there will be rainfall within 2 to 3 days. Again when the visit of dove in the houses increases, they presume that there will be rainfall within next 1/ 2 days. But the amount of rainfall they could not tell.
- Arum leave is a method which is widely used in inferring the rainy season and this method apply in the new moon of the month *Poush* (mid December to mid January), The method is applied at night, especially after the Magrib prayer of the new moon in the second part of Paush. Some arum plants with leaves are selected for this. From the selected plants some leaves with their stalks are separated. Then the selected leaves are named after the names of the Bengali months of the calendar. So each leaf will represent a month of the year. Even if all months are not to be tested there will be selected months and accordingly against each month, the leaves will be identified such as for the month of Ashar, Sraban, Bhadra and Aswin (mid June to mid October). The selected leaves are covered by the leaves taken later on. They are covered in the manner of caps. Next morning the practice man rises and opens the fastening of the leaves and measures the amount of water collected in each of the leaves representing a month.

LIVELIHOOD DIVERSIFICATIONS AND OPTIMIZING OUTCOMES

FLOATING AGRICULTURE

Précis

Units	Location One	Location Two	Location Three
Union	Bharatkhali	Nehalpur	Deulbari Dobra
Upazila	Shaghata	Manirampur	Nazirpore
District	Gaibandha	Jessore	Pirojpore

A GOOD PRACTICE

- Ensures food security by using shifting agriculture in water logged lands;
- No manure or insecticide needs to be applied after sowing the seeds or planting the saplings;
- Decomposed bed is used as input material of Kandi preparation;
- Increases crop productivity and cropping intensity;
- The floating bed is used as good organic manure;
- Effectively enhances the livelihood safety of people at risk;
- It is a community based technology;
- It is an innovative approach to cope with the changing ecology and environment;
- It's a profitable venture;
- It has already been adopted since long and fitted with local ecology.

Prologue

Due to water logging the crisis of cultivable land has enforced the people to change their traditional agric practices. They now use the water surface for the same agric practice but with some modification with the locally available natural elements by applying a certain innovative mechanism. This option of earning livelihood is learnt from nature by the community people.

The Initiative

The changed circumstances have compelled people to innovate such agric practices that do not require the surface of the soil. The method enables floating crop cultivation on open water without soil. This allows producing different types of vegetables and seeds. The cultivation method has been known to the local people of Deulbari Dobra of Pirojpur since 100 years back. But as livelihood means, it had been implemented very recently in other two areas. One UP chairman introduced the method of cultivation in the Nehalpore union of Jessore in 2002 to cope with water logging condition. Immediately after that this was introduced at Bharatkhali union of Gainbandha from the month of Ashar (Mid June-Mid July), 2007 by the joint patronization of two NGOs named Ganounnayan Kendra and Samaj Kalyan Sangstha.

Goal and Objectives

The goal of floating agriculture is to decrease the consequences of water logging. The initiative intends to utilize the water logged areas with maximum economic profitability and to ensure food security by using floating agriculture.

Activities and Outcomes

The production process including raw materials and equipments for preparing beds and production cost are almost similar in the study areas. However some variations have been observed with types of crops chosen to be cultivated.

At first the local farmers make beds for this cultivation. The beds are 10 meter long; 2 meter width and 1 meter thick, which is generally durable for 6 months. Two labourers are needed to prepare a bed. Several bamboo poles of 10 meter long are needed and the amount of water hyacinth is to be collected from a surface equivalent to 5 decimals area for a floating bed of one decimal of surface area. These hyacinths are locally available in the surrounding environment. The method is given below-

- A bamboo pole of definite length is laid down on the floating water hyacinths the thickness should be such that a man can stand on it;
- Then standing on the bamboo bed, hyacinths are heaped up over the bamboo layer by layer;
- Then the hyacinths are pressed by the legs to put swollen parts above the water and make the surface plane;
- After completion of making the bed, bamboos are taken away slowly from one end ;
- Then thickness of the bed is increased by putting hyacinths adequately;
- The bed requires 15-20 days to be suitable for cultivation.

Multiple crops may be cultivated in a bed. But in the village the farmers make three beds side by side where they cultivate lady's fingers by the 'ball' method. A round ball is made with much rotten water hyacinths which look like a tennis ball. Making a hole in the ball with a finger 2 seeds is sown so that at least one is germinated. Then the balls are placed under shadow and are watered when it dries up completely. This is generally done at the house of the farmer. After 4/ 5 days, the seeds are germinated in the balls and then the balls are taken to the beds and placed on the floating beds in series after every 6-7 inches gap. The seeds of red vegetables and *kalmilota* are directly scattered on the prepared beds.

No manure or insecticide is needed to be applied after sowing the seeds or planting the saplings. Only a long bamboo pole is fixed up to prevent the movement of the bed caused by wind or current.

Banana raft is used to harvest because hyacinth is too rotten to carry weight of any individual. Crops are harvested twice or thrice a week. After harvesting, the beds are used as bio-fertilizers or composts which when dried can also be sold.

The total production cost to cultivate vegetables in three beds of 10 meters long, 2 meter width and 1 meter thick is TK 930 (see annex for details), while the respondents reported to have sold their products for TK 2730 in the market.

Lessons Learned

Key lessons learned from the practice are:

- The local farmers stated that main strength of the enterprise is crop cultivation without using any land.
- They reported that the production process is simple and low cost, material and equipments of production are available in the local environment.
- Insecticides are rarely used. So, it is health friendly.
- The floating bed is used as good organic manure, which is a by-product of the enterprise.
- This allows crops production throughout the whole of the year.
- Sometimes farmers face crisis of adequate hyacinth in the water.
- Fishing and crop cultivation can be done in a single habitat.

Potential for Replication

The cultivation has much possibility as there are many water reservoirs and water logged areas in the country. This initiative creates a window of opportunity for those who become workless due to water logging and are vulnerable to food crisis. It ensures food security and job opportunities in water logged areas.

A few NGOs have initiated and successfully replicated this type of cultivation practice. Considering such successful venture we recommend this practice to be followed in other regions having wetlands. Appropriate policy provisions would yield successful progress in bringing the water reservoirs under this cultivation. In addition, programmatic action plan is necessary from GO-NGOs levels for greater production in the water bodies. The scientific community should develop program for their work on the development of modern technique or improving the traditional ones.

LIVELIHOOD DIVERSIFICATIONS AND OPTIMIZING OUTCOMES

LIVELIHOOD DIVERSIFICATIONS AND OPTIMIZING OUTCOMES

FISH COLLECTION

Précis

Units	Location	Seasonality
Union	Durbadanga Katakhali	All Seasons
Upazila	Keshabpur	
District	Jessore	

Prologue

Water logging due to flood and lack of drainage system in the area, has almost stopped agricultural activities, once being the main source of livelihood of community life and livelihood have been totally shattered. So, the local people had to look for adoption of some means for livelihood. The area remains submerged during most seasons of the year. So it has turned into a marshy land, a good nursing ground of fishes. So community people at risk could discover the option of catching fishes in the boggy lands. There are different fishes together with many other flora and fauna grown in the confined water logged lands. The catches are beneficial and help to procure their livelihood.

The Initiative

Due to the changed environment, the local people have started to catch fishes including young spawns (locally called *Ranu*) from the waterlogged lands. They cultivate them to be bigger in a piece of land by making dam around by themselves. Besides they have different other adoption mechanisms too. They collect fishes with the help of push nets, *charu* (a kind of box, which is made by bamboo and date palm root, it is 1-½ -2 cubit high, and its width is 1 ½ to 2 cubits). They also catch fishes by *'komar deya'* (*komar deya*, a Bengali term, meaning 'an artificial shelter erected by heaping straws or branches of trees in a stagnant or standing water either in a water body (beel) or in an area of a river where water is relatively standing). In the Komar they put some food items of fishes repeatedly for some days after and fishes love this spot to eat idly and to stay safely. When the farmers infer that there is maximum concentration of fishes, they encircle around with nets and remove the straws and branches of trees they put earlier and catch the fishes with different tools.

A GOOD PRACTICE

- Δ Mostly women are involved in these works. Because, the male members of the family re-main outside the villages almost through the whole year and work as a day laborers or agric laborers in other areas;
- Δ Ensures daily protein requirement of common people;
- Δ Ensures food security with its nutrients;
- Δ Utilizes water logged areas which have no alternative use;
- Δ It is cost effective and economically profitable in terms of labor, time and money;
- Δ These methods are appropriate and indigenous and developed by the community people them-selves;
- Δ Enhances the security of the vulnerable people at risk;
- Δ It has already been adopted and fitted to the local ecology.

Goal and Objectives

The goal of fish collection is to reduce the vulnerability of water logging. The fish collection initiative aims at ensuring livelihood security, to utilize natural elements of water logged lands and cultivate young prawns in a piece of land by making dam around by themselves to allow the young ones to be bigger so that they may bring better earnings. The aim is to increase the capability of the people at risk.

Activities and Outcomes

Collection of Prawn Spawns: The male members of a family remain outside the villages almost through the whole year and work as a day labourers or agric labourers in other areas, while the females remain at home and rear their offsprings and take care of their houses. These are the members that are engaged in these activities of catching baby prawns and other small fishes such as *koi, puti, tengra* and *nola* from the water bodies around. They use these fishes as their food and also sell. In a day a women can work for 5-6 hours and catch 2-3 kgs of fishes and the retailers visit their houses and buy them at Tk 40-50 per kg. The manufacturing process of a net is locally called *aine buno or buno kata*. In preparing the nets, they require the fibres of the leaves of palm trees, bamboo etc. Two women can prepare 4-5 such traps by working 2 days and they can sell them in the local market at Tk. 70-80 per kit.

The amount of catches fluctuates on seasonal changes. During the rainy season the water level is very high and hence cannot operate their push nets well and so the catch is poor. So they use other tools for livelihood. They weave nets locally known as *batajal*, a kind of long net with two feet width having square or rectangular holes through which floating fishes are trapped, and sell them in the local markets and thereby earn livelihood.

Komar Deya: The farmers make a bundle of 4/5 branches of trees like tamarind, acacia, 'jiel, khoi' etc which have dense branches and leaves are used for *'komar deya'* in which fishes consider to be secured, safe and comfortable and so they throng under such shelter and they require 10 to 15 such bundles for a *'komar'*. There is another reason and that is the leaves of the trees, as time passes on, begin to rot and planktons grow, which are good food of fishes. So they use such trees and their branches for preparation of *'komar'* in a water body. The farmers insert 4/6 bamboo poles at regular distances in the soil below and tie them with nylon ropes and the bundles of tree branches are placed inside the area and tie them also with the poles so that they are not displaced and stay in position.

Water stands permanently in the boggy land for some years together. So the komar can exist for1-2 years all along and a farmer raises 6/8 *komars* in the water bodies. Of course, it depends on his abilities. The land ownership does not stand on their way, because the water logging is a permanent phenomenon here and they cannot use the land any way.

At the time of catching fishes from the *komar*, they encircle the entire area by a narrow net so that the fishes cannot go out of the area. Then they take out the bundles of branches and straws out of water. The net encircling the komar is fitted around in such a way that the lower end is fixed inside the soil below.

Generally they catch fishes twice a month and on each occasion they have catches of TK 500. So, annual income is (12 x 2 x 500) or TK 12000. The total expenditure for raising a *komar* is TK 1315 (see annex for details). So, the net profit is (12000-1385) or TK 10685.

Fish Collection through *Charu*

Making *Charu:* A 45-50 feet bamboo is used for making a *charu*. These bamboos are called "*Talla* Bamboos" that are used for *Charu*. Two kinds of *charus* are made by one bamboo. 4-5 *charus* can be made from it if sticks are put closed together and if sticks are not used closely then 5-6 *Charu* can be made. Condensed *charu* is used for catching small fish and uncondensed *charu* is used for big fish. About 70% people of Durabdanga and Katakhali union are engaged in *charu* making during rainy season whereas in dry season 20% people are involved in creating charu.

This *Charu* is sold at a higher price during rainy season in the months of *Shraban*, *Bhadra* and *Aswin* (mid July to mid October). For example, one *Charu* can be sold at a price of TK 200-250 in the rainy season and Tk. 100 in the other seasons. In the rainy season people from Khulna, Bagehot set out to Katakhali for purchasing *Charu*. If the *charu* makers sell their *Charu* in Khulna, Bagerhat, Mala, Bealtola bazaar during rainy season, they can sell one piece of *charu* at TK 300 instead of TK 200.

Catching fish with Charu and Pata : Charu is mainly used with one type of fence, which is named pata in local language. Charus are kept in from one side to other side. A charu is placed in the lower portion of pata or fence. The front side of a charu is kept at the same level through which fish get in and backside of "charu" is kept at the back portion of pata.

A *pata* can be used for three seasons which means 3x6=18 months, if it is used continuously. People use pata in rainy season (*Ashar* to *Agrahayan*) because fishes are abundantly available in these six months. Then they keep it at a corner of their house with much care because *charu* and *pata* are damaged by salt and moisture. On the other hand a *charu* may be damaged if it is used for one and a half or two months. Even a *charu* may be damaged within one or two days if big fish enter into it because big fishes might crack the *charu*.

The fish such as *shol*, *taki*, *rui*, *mrigel*, shrimp (called *etcha* in local language), *tangra*, *golda*, *horina* and *bele* are caught by using *Pata* and *Charu*. In average people can earn TK 400-450 daily in rainy season (*Ashar* - *Agrahayan*) if they place 10 *charus* with 100 feet *pata*. The total earning is (450 x 30 x 6) TK 81000. The total cost for 10 *charus* and 100 feet *pata* is TK 6370 (see annex for details). So, the net profit is TK 74630.

Lessons Learned

Key lessons learned from the practice are:

- The methods of fish collection are appropriate and indigenous and developed by the local people themselves.
- Mostly women are involved in these works.
- About 70% people mainly women of the above mentioned area are reported to be engaged in charu making during rainy season, whereas in dry season 20% people are involved in creating charu.
- The local people reported that it is cost effective and economically profitable in terms of labour, time and money.
- It can be done by own initiative.
- Necessary components are available and local people who are involved in it can o the work very easily.
- The local people get protein supply by the practice.
- Due to stagnant water, different water hyacinths and other aquatic plants began to grow, with which are added numerous waste materials to pollute the stagnant water and thus water of the bodies have turned poisonous. Due to the decaying of these materials the water has become polluted and every where there is bad smell. So when women go into this water they are attacked with different skin diseases. They do not take modern treatment and medicine as preventive and cure against the disease. But for hunting their livelihood they use grease over the entire skin of the body and go into the water and sometimes they put on the pants and shirts of male persons and go into the water to catch fishes.
- People cannot earn more money by selling charu all time except rainy season.
- Often there is a conflict on a particular spot for setting a pata between two or more parties. Generally these spots are prospective for hunting fishes and they contest for setting pata over the spot. So some local leader along with the contesting parties sit together to find out a solution. A person who placed his pata earlier gets extra preferences.
- In the rainy season the upper portion of the charus is extended if water overflows so that fish could enter into charu by facing barrier.
- The main difficulty in preparing these traps is the scarcity of bamboo.

Potential for Replication

The people have adopted this practice as a source of livelihood as it is easy to catch fish from the water bodies, the elements are available in the environment, and above all they have not to employ much of their time and energy for the livelihood.

Government and non-government organizations may come forward to take appropriate program to utilize the water bodies of other areas. They may also take initiative to reduce water pollution. The fisheries experts are required to work in these non-traditional areas where fishes can be caught on large scale.

COLLECTION OF LICHEN, MOSS AND ALGAE

Précis

Units	Location	Seasonality
Union	Sufalakathi	
Upazila	Keshabpur	All Seasons
District	Jessore	

Prologue

Due to water logging, the agric practice has been totally shattered in this area since a few years. So the agro-based community labourers have become workless and they are in a fix as to how manage their livelihood. They have been looking into their changed environment to discover some opportunity for work. As the area developed many water bodies due to water logging, many farmers have taken recourse to fish cultivation in their own land by raising dam on the boundaries and this has become a very profitable practice. So with the growth of fish cultivation, demand for fish fodder has also grown up. The poor people of the area have taken an initiative to survive with livelihood through collection of some varieties of aquatic plants as fish fodder.

The Initiative

The water bodies grow a kind of weeds like lichen, moss and algae (it's a kind of aquatic plants which look greenish in colour, and depending on the depth of water, they grow in length 5 ft to 15/20 ft). These are good food for the kind of fish they cultivate in their farms. In order to survive with livelihood, the poor people of the area collect these weeds from the water bodies. Of the 2927 population, 20-25 families of Sufalakathi are engaged in collecting these weeds since 2004. Both the males and females in equal number have adopted this work of collection of weeds for sale. There are 8 canals and 2 beels in this village and both the beels and canals grow these aquatic plants.

Goal and Objectives

The goal of collection of lichen, moss and algae is to reduce the vulnerability of water logging.

A GOOD PRACTICE

- Δ Ensures food security of fish. It is a good food for fishes especially carp fishes;
- Δ It is a source of complementary income of the poor community people;
- Δ Due to water logging, the agric practice is totally shattered in this area since few years. So, the agri dependent community people have become workless. It has given opportunities to the poor people to employ themselves;
- Δ Ensures food security of the poor people in water logged areas;
- Δ Effectively enhances the safety of people at risk;
- Δ It is an innovative approach to cope with the changing ecology and environment.

The initiative intends to ensure a source of complementary income which ensures the food security of the poor people.

Activities and Outcomes

The weeds lichen, moss and algae are naturally grown plants and are not to be cultivated. The weeds of this area are called *chuine sheola*. The collectors are day labourers, fishers or van pullers and they collect weeds side by side of their main occupation to complement their livelihood. Women are also engaged in the collection process.

They hire a boat for 4-5 hours and go for collection of weeds and the rent for the boat is Tk. 20 for 4-5 hours. These boats are 8-10 ft in length and are made of wood. About 2-2.5 ft is the breadth and in depth it is 1.5 ft. One boat full of weeds can fill two vans. 1.5 to 2 hours are needed to collect the weeds for one van. A van of weeds can be sold at Tk. 100 to Tk.150. The buyer bears the cost of carrying to the site of his farm. The fish cultivators can use one van of weeds for 7/8 days.

Comparing other months of the year, weeds are available in plenty in the months of Baishakh

to Bhadra (mid April to mid September). These weeds are good food to the carp types of fishes. The buyers leave the weeds to the project site of fish cultivation in water bodies without any processing.

Lessons Learned

Key lessons learned from the practice are:

- Δ The collection of weeds (sheola) is a source of complementary income of the poor community people.
- Δ It is a good food for carp fishes.
- Δ Weeds in plentiful quantity are not available so that a family or an incumbent can depend for their livelihood.
- Δ The collector itches on his/her body when they collect the weeds.
- Δ The quantity of the weeds is limited. Therefore, the subsidiary income they earn cannot ensure their livelihood.

Potential for Replication

The water bodies of water logged area produce the weeds which are used as fish fodder. In order to survive with livelihood, the poor people of the area collect these weeds. It can be replicated for the other water logged areas where the weeds grow naturally.

This non-traditional area may be tapped to explore programmatic action plan to make it a success. NGOs may promote the activities. It needs attention of fish fodder producers; they may use it for producing of fish fodder.

THE KANDI METHOD

Précis

Units	Location One	Location Two	Location Three
Union	Deulbari Dobra	Balidara	Sanyasi
Upazila	Nazirpur	Zianagar	Morelgonj
District	Pirojepur	Pirojepur	Bagerhat

A GOOD PRACTICE

- Δ Ensures food security by using shifting agriculture in submerged land;
- Δ Increases land utility of submerged lands which were not able to usual agric practices;
- Δ No manure or insecticide needs to be applied after sowing the seeds or planting the saplings. So it is health friendly;
- Δ The decomposed bed is used as an input material for another Kandi preparation;
- Δ Increases crop productivity and cropping intensity;
- Δ The kandi bed is used as good organic manure;
- Δ There is a huge potentiality of fishing in the nearby low patches of the kandi plot as enough water for fish cultivation is always available in between the raised plots;
- Δ Effectively enhances the safety of people at risk;
- Δ It is a community based technology;
- Δ It's a profitable venture;
- Δ It has already been adopted since long and fitted to the local ecology.

Prologue

Being the low lying land, rainwater remains standing for most of the time of the year and moreover the occurrence of flood in this area is common. As the land is low, the water once entered at the wave, cannot be drained at the ebbs. As a result water logging is the reality that the farmers of the area have been facing through years together and the agricultural land become fewer that could not meet the agricultural demand of many. This changed circumstances enforced the farmers to change their usual agric practices and find option for livelihood.

The Initiative

Due to the ecological condition, farmers improvised through trial and error method a technique for cultivation of crops in the

submerged lands. This has emerged now to be one of the main survival strategies of people living in this ecological condition. The cultivation method is called *'kandi'* in Pirojpur and *'berkata-arbadha'* in Bagerhat area.

Goal and Objectives

The goal of *kandi* or *berkatha arkatha* is to decrease the vulnerability of people living in the water logging areas. The initiative intends to utilize the water logged lands with maximum economic profitability and to ensure food security by using shifting agriculture.

Activities and Outcomes

As learnt from the farmers, this is such a cultivation process where farmers divide a piece of submerged land into several numbers of plots and raise one plot with the soil remaining in the adjoining plots. The height of the raised plots is two times higher than the lower one (if the plot from which soil is taken is 4 cubic ft. deep, then the plot raised is 8 cubic ft). This height prevents the plots to be submerged by the tide, besides the flow is undergone and submerged in the land between the raised plots. After completion of the plot raising, rotted hyacinth and powder of *coirs* are given to the plots for increasing fertility of the soil. Finally seeds are sown in the plots.

At Pirojpur potato, cabbage, sugarcane, arum, different saplings of pumpkin, etc are cultivated mostly on a commercial basis but different wood trees and vegetables are cultivated basically as a subsistence means in Bagerhat areas.

At the first venture, net profit is comparatively not attractive (Total income TK110000 – Total expenditure TK 87880= TK 22120 per bigha) due to the high cost of filling the soil, but later on only cultivation cost is needed which is TK 27960 (see annex for details) and recurring cost is TK 11000 (see annex for details).

Lessons Learned

Key lessons learned from the practice are:

- The local farmers reported that necessary raw materials are available in the surroundings and are easy to access.
- The method is easy and same plots could be use again and again for cultivation and hence it is a profitable venture.
- No manure or insecticide is needed to be applied after sowing the seeds or planting the saplings.
- The decomposed kandi bed is used as an input material of another Kandi preparation.
- Preparation of plots need huge amount of cash at the initial stage but many farmers do not have ability to bear the expense.

Potential for Replication

If introduced, this coping practice in submerged areas can increase the total productivity as well as the cropping intensity also. There is a huge potentiality of fishing in the nearby low patches of the kandi plot as enough water for fish cultivation is always available in between the raised plots.

GO-NGOs credit intervention may be extended for preparation of plots which need considerable amount of money beyond the ability of many.

REED COLLECTION AND MAT WEAVING

Précis

Units	Location One	Location Two
Union	Deulbari Dubra	Ashashuni
Upazila	Nazirpur	Ashashuni
District	Pirojpur	Satkhira

Prologue

Due to water logging, boggy lands are found here and there. These kinds of lands are not suitable for normal cultivation practice. This causes much suffering to the poor community of people in the areas. This crisis has led people to take recourse to alternative agric practice.

The Initiative

Under this changed circumstances, people take initiative to cultivate the *mele*, locally called *patra*,

a kind of reed like grass, which may grow 7/8 ft long in height. It grows in the boggy and marshy lands throughout the whole of the year. The bark of the plants is used for making a kind of mat. As it is proved to be economically supportive, people use the practice and the practice has been expanded i.e. adopted by others in other areas.

Goal and Objectives

The goal of reed cultivation and weaving mat is to decrease the vulnerability of people living in the water logged and salinity. The initiative intends to utilize the water logged lands with maximum economic profitability and to increase employment opportunities specially women by making mat.

5.6.5.5. Activities and Outcomes

Reed Cultivation and Reed mat weaving by Hand at Deulbari Dubra: In a plot of boggy land the farmers plant the seeds of *mele*/*patra* and then they are not to take any care of it. The *patra* grows throughout the entire year. The plants take about a year to be mature and a matured *patra* is about 3.5 to 4 ft long. The workers who weave *shitol pati* (a mat very soothing and cool to lie up on in summer) can collect the patra from the farmers. The matured *patras* are cut and bound in to bundles with every 8/10 *patra* and often they are placed in the water of a pond. After 5/6 days the bundles are untied and the *meles* are stripped off the external greenish covering (bark) with a sharp chopper. Then it is allowed to dry up in the sun. Then the upper portion of the stem is taken out with a sharp chopper. These are then a thin sheet like and long and are dried well in the sun.

A GOOD PRACTICE

- Δ Women are involved in the whole working process. In their idle time they remain busy in weaving mats. They can meet up the demand of their family with this work and also earn mon-ey by selling the mats;
- Δ Utilizes boggy lands that do not give any crop;
- Δ It is environment friendly. It is, when used up and thrown away, degradable unlike some plastic products;
- Δ It is economically profitable as it gives employment to the local people;
- Δ Its capital involvement and the labor for production is not much;
- Δ The net income is good and hence the community people can maintain their livelihood by adopting this occupation;
- Δ Enhances community's strength;
- Δ Effectively enhances the safety of people at risk;
- Δ It is hereditary approach to cope with the changing ecology and environment.
- Δ It has already been adopted since long and fitted to the local ecology.

The weavers who like to make coloured and decorated *pati*, they add colour to these sheets and the colour is dried. With these sheets they weave decorated shitol pati.

Generally the house wives, in their off time, weave the *shitol pati*. Each *pati* measuring 4 cubits x 5 cubits involves the production cost of TK 400 (see annex for details). This patis are purchased by the middlemen/ brokers at TK 550/ 600. *Shitol pati* (mat) may be woven bigger size but in that case the price may be TK 1000 to 12000. In weaving a *pati*, one worker takes 4/5 day's time.

Reed mat weaving by handloom in Ashashuni: A suitable place measuring about 5 cubits x 2.5 cubits in the dwelling house is selected for weaving the mat. At the beginning a bamboo 15-18 ft long is needed, which they buy from the local market. Different parts that are produced from the bamboo for weaving the *mele* mat are -

- ➤ Two rings (*kol beri*) of 4 ft long and 1.5 inches width.
- ➤ Back ring (*pith beri*) 3 ft long and 1 inch flat.
- ➤ Cold ring (*shitol beri*) 4 ft long and 1.5 inches flat.
- ➤ 4 small and 2 medium sized poles. Of course, these poles have no definite measurement. These poles may be made of different tree branches also.

For preparing the loom, 4 small poles are fixed to the right side of a place in the ground, both behind and

in front of these poles are fixed two *kol beri*. Within these *kol beri* there are eight rectangular holes. On the other end are fixed two medium poles, behind these poles is the *pith beri* and in front is the *shitol beri*. *Pith beri* and *shitol beri* are bound with thread with the pole at the middle tightly. The wooden *bau* is placed at the middle of the *kol beri* and *shitol beri*. Jute ropes are introduced through the holes of the *kol beri* on one end to the hole of the *shitol beri*. The thread is tightened by the *bau* placed at the middle. The setting of the loom takes 3-4 minutes time and it does not need any extra labour.

Then two persons introduce one piece of *mele* sheet through the threads like waves i.e. one time above one thread and again below the thread. This is done time and again. Thus a mat is prepared.

Mats thus prepared are of many sizes, small, medium and big sizes. Two workers are needed and a mat weaving need 2 hours labour. The threads wrapped around a tau from threads are taken when needed.

Lessons Learned

Key lessons learned from the practice are:

- The women folk of the family are associated with the whole working process. In their idle time they remain busy in weaving mats. They can meet up the financial demand of their family with this work.
- The income is very satisfactory. Its capital involvement and the labour for production is not much. The net income is good and hence the community people can maintain their livelihood by adopting this occupation.
- The local people reported that the reed cultivation and mat weaving has no bad effect on environment. It is, when used up and thrown away, degradable unlike some plastic products.
- The activities have wider cultural impacts. They can put some design of symbolic representation of sorrows, happiness, love and even religious significance in the very frame work of the *pati*.
- It is economically profitable as it gives employment to the local people.
- This work does not involve any limitation. One can do this work with limited capital and the process is very easy.
- It is community based technology. The community people have learned it from progeny.
- *Mele* cultivation uses the lands which cannot be used otherwise, such as: the low lands where there is water logging.

Potential for Replication

The non-traditional cultivation of *mele* for weaving of *pati* is planted in the idle land bringing it to the family use. The women folk are associated with the whole working process. In their idle time they remain busy in weaving mats. They can meet up the demand of their family with this work. So, it can be replicated for people at risk in some other places.

GO-NGOs may come forward to take programs of *mele* cultivation and mat weaving. They also may give credit on low interests to the rural women for weaving mat. They also take initiative to export mats.

INTEGRATED FARMING

Précis

Units	Location One	Location Two	Seasonality
Union	Khoksha Bari	Mulghar	Ashar
Upazila	Nilphamari	Fakirhat	to
District	Nilphamari	Bagerhat	Poush

Prologue

The area, Mulghar of Fakirhat upazila of Bagerhat district is susceptible to water logging. As a result, the lands have lost their productivity. Crop production almost stopped. So the local people of the area prepare some device to increase their production.

The Initiative

Integrated farming employs a more integrated approach to farming as compared to existing monoculture approaches. In the village Faltita under the union Mulghar, the practice of integrated farming is widely used. The local people of the area cultivate paddy together with fishes. In some plots the prawns of saline water

and in some plots the sweet water lobsters are cultivated with paddy. At the same time they cultivate some white fishes like rui, katla, and silver cups. The local people call these fishes white fishes as they look white. Again in some prawn besiegement, together with prawns they cultivate paddy also as additional crop. Some cultivate paddy in one portion of a plot and other crop in another portion.

Goal and Objectives

The goal of integrated farming is to reduce the vulnerability of water logging. The initiative aims at ensuring livelihood security, by utilizing natural elements of water logged lands. They cultivate fish along with paddy in a piece of land by raising dam around by themselves. It allows paddy cultivation as well as the young fishes to be grown bigger so that they may bring better earnings. The aim is to increase the capability of the people at risk.

A GOOD PRACTICE

- Δ Ensures livelihood security of the water logged area where the lands have lost productivity;
- ◊ It ensures food security.
- ◊ Enhances crop diversity and land use adding to the total economy of the country;
- Δ This enterprise is the best example of coping in water logged area;
- Δ Increases utility of water logged land and increases total productivity.
- Δ It allows fish cultivation along with other crops like paddy, mug dal, pepper etc in same be-siegement;
- Δ The net benefit is comparatively higher than any other monoculture agricultural production in same piece of land;
- Δ It is an appropriate approach to cope with the changing ecology and environment.
- Δ Fish cultivation has a potential international demand; every year Bangladesh is earning huge foreign currencies by exporting it;
- Δ It has already been adopted since long and adjusted with local ecology.

Activities and Outcomes

Fish Cultivation: In order to cultivate fish, the besiegement (*gher*) is surrounded by the earthen dam of height 10 to 15 ft height. During the months of Falgun – Chaitra (Mid February to Mid April) the water dries up and the down height increases 2-3 ft and at rainy time the height decreases by 2 -3 ft due to increase in water level. Some time water overflows the dam. The breadths of the dams are generally 5-7 ft. But 3-4 ft breadth is also found in case of some besiegement.

After making a besiegement, the farmer started to cultivate fishes as well as paddy. In some plots the prawns of saline water and in some plots the sweet water lobsters are cultivated with paddy. At the same time they cultivate some white fishes like *rui*, *katla*, and *silver* cups. The local people as mentioned call these fishes white fishes as they look white. Again in some prawn *beels*, they cultivate paddy also as additional crop. Some cultivate paddy in one portion of a plot and in another portion other crop.

Over these dams of the besiegement, the farmers plant banana trees in this area. Then the trend of planting coconut is very intense. Besides, date trees, *baroi* and other crops are planted on the dams. Again some farmers cultivate vegetables on the dams. Pepper, red vegetables, papaya, *brinjal* and *bhindi* are also found to be cultivated on the dams. But the farmers prefer growing big trees. These trees prevent the soil erosion from the dams and they have wood value.

Excepting the dam the besiegement has two layers of soil. In some cases three layers are also found. The main foundation layer covers about 70-80% of the area. This is the general layer of the besiegement (gher). The second layer involves earth removing and in some cases there is the third layer. This layer is above 3 ft of the main plot.

The general layer of the besiegement is that one on which paddy was cultivated earlier. On raising the dam around this plot has been made into a besiegement for prawn. But the plot remains in the former state. But in the plots where there is much mud, some are removed and some are kept for the fishes. The plots which are new or where there is no such mud, the farmer then ploughs with his cows and make some mud. The second layer is called *pagar, or ara locally,* and some call it too. These *aras* are like canals and are created at one side of the plot. The depth of these areas is 3-4 ft deep than the main layer. The length and size depend on the shape of the besiegement and the demand of the farmer.

The plots, which have only one *ara*, can be used for cultivation of prawn, and white fishes of sweet water or, prawn of saline water. The area may be of 10% to 20% of the base of the besiegement, depending on the besiegement excluding the dam around.

Some time they cultivate the lobster of sweet and saline water. In that case, there are two *pagars*. These two *pagars* cover 20% to 25% of the main besiegement and are made at two sides of the besiegement.

If there are old fishes after selling them in one season then there is the third pagar, but if the fishes are of the same type, either of sweet water or of saline water, then two *pagars* are sufficient. Three *pagars* cover 30% to 40% of the main besiegement. The third layer is not visible.

Crop Cultivation: Seed bed is locally called *patkhola* and in some plots *patkhola* is found to be at 2 ft higher than the main land. It is used for germination paddy seeds and water is not allowed to reach there. When this *patkhola* remains idle it is used for some uncertain crop and during the study time one *patkhola* was found to be used for cultivation of pepper. At the same time lentils (*mugdal*) was cultivated in the month of *Magh* (Mid January-Mid February). These are to be harvested in the month of *Chaitra* (Mid March-Mid April).

During the month of *Ashar* (Mid June-Mid July), there is water and the plot is submerged by water. Then if the pepper plants are taken out and again planted along the sides of the plots they give crops throughout the year. The quantity of production from these could not be known but as the respondents conveyed, these crops satisfy the demand of the family throughout the year.

Lessons Learned

Key lessons learned from the practice are:

- The local farmers reported that necessary raw materials are available in the surroundings and are easy to access.
- The method is easy and same plots could be used for fish cultivation as well as paddy cultivation and hence it is a profitable venture.
- Saline water is to be introduced in the plot and as a result the salinity of the soil increases impeding the cultivation of other crops; because the land looses the fertility of production.

Potential for Replication

The enterprise is considered to be one of the best examples of adaptive practice in regard to the growing water logging. It can be replicated for other char areas of Bangladesh, because it utilizes water logged soil of with the maximum economic return by using integrated farming. The policy makers are to be very careful about this and should have program for expansion and improving the methods.

Introduction of modern technology of cultivation, processing and storing is essential and the farmers are to be trained and motivated to be acquainted with these for maximum benefit. Fisheries department of the government may give proper attention to prevent the virus attack which is a threat for the fish cultivation. GO-NGOs may come forward to help the poor farmers by giving financial support. To know the impact of shrimp cultivation on environmental, scientific research is needed.

COPING AND COMMUNITY RESILIENCE

COHESION AND COOPERATION IN DEWATERING

Précis

Units	Location	Seasonality
Union Upazila District	Durbadanga Monirampur Jessore	(Magh –mid Baishakh)

Prologue

Water logging in the above area due to lack of proper drainage system of flood water disrupted the normal living of people for months together every year. This has brought about an overall change in the ecology of the local environment disrupting the sources of livelihood. The worst impact has been on the frequent crop failures and opportunity of work, the only source to earn livelihood for many of them. Consequently the agric dependent people became extremely poor and were struggling for survival.

The Initiative

The adoption of dehydrating water from the logged area for facilitation of farming is a community based cooperative effort of the farmers by which paddy and fish cultivation might have been made possible. One Dipok of the village Monirampur initiated the idea of evacuating/expelling the standing water from the marshy land to make it suitable for paddy and fish cultivation. Locally it is called "*Sech Kaj*" and this year they started this mechanism. This is widely accepted by the villagers' on seeing the possible benefit of agric products. As a result, they have agreed to contribute to meet the expenditure of the project, as the work was, no doubt, labour intensive and painstaking.

Goal and Objectives

The goal of dehydrating is to decrease the vulnerability of water logging. The dewatering initiative intends to evacuate the standing water from the marshy lands which made suitable for paddy and fish cultivation and to increase the land productivity with maximum economic profitability by utilization of the land.

A GOOD PRACTICE

- Δ Evacuates the standing water from the marshy lands which make the land suitable for paddy and fish cultivation Optimizing production efficiency;
- Δ The project is completely community based initiative where all the landholders have united to a self financed project for their benefit;
- Δ Enhances community's strength;
- Δ Due to water logging the living of people of the area is totally disrupted months after months, this initiative has given back their hope for living with agriculture;
- Δ Ensures food security in water logged areas;
- Δ Effectively enhances the safety of people at risk;
- Δ It is an innovative approach to cope with the changing ecology and environment.

Activities and Outcomes

At the beginning, the embankment around the water body is constructed with woods. Polythene cloths are fastened and are wrapped with bamboo sheets at the joint of the wooden planks so that water might not be leaked inside. To make the base more resistant, water hyacinth, weed stuff, clay materials etc are deposited against the embankment. Then 46 pump machines are simultaneously employed for 9 hours a day (8 am to 5 pm) and the irrigated water had to pass through a drain adjacent to the embankment to the sluice gate on the Bhabadaha canal. When water level was reduced to a height of 1.5 feet, the number of pump machine was reduced. The irrigation process is completed within 20 days, and 10 days were taken for preparation. Land owners as per commitment contributed TK 400 for each plot of 1 bigha and now they are very much concern with the safety of the embankment.

When the standing water decreases to a certain level which is suitable for cultivation, paddy saplings are planted. Young fishes were released also in fairly low areas of the project.

The actual production could not be predicted, as during the time of investigation harvest was not completed but at the peg end and the possibility was encouraging anyway. The respondents also expressed their high satisfaction about the ensuing crops and opined that the crop might be better than the normal and adding the fish harvests they were going to be highly benefited somehow.

Lessons Learned

Key lessons learned from the practice are:

- The local people reported that the project was completely a community based initiative, where all the land holders had been united to a self financed project.
- As the initiative was done for the first time, people still are not confident enough whether their endeavour would bring success. But still they are hopeful.
- The project cost was found to be a bit higher, which an individual cannot bear anyway and hence such a project may be taken on community basis and an individual cannot face the expenditure, if one wishes to dehydrate one's own land.
- Wooden embankment, if not cautiously made, can be cracked or leaked to baffle the project. But that can also be mended if there is firm determination.

Potential for Replication

The initiative opens new horizon of agricultural production together with employment opportunity in the water logged areas. Learning from the ongoing project would be helpful to scale up the quality of implementation strategies of such project in other water logged areas.

Shared understanding among the land owners is necessary for successful completion of such project. Wooden embankment need close monitoring and modern technology should be used. NGOs can also come forward to assist the community people to institutionalize the initiative and may give financial and technological support.

CHAPTER 5

COPING WITH SALINITY INTRUSION

Chapter 5
COPING WITH SALINITY INTRUSION

SALINITY SCENARIO IN BANGLADESH

Earlier, the tidal salinity could be compensated by the tide and ebb of the river. But as soon as the river went under control, the compensation process was broken down and the increase of the salinity went on unabated. This began with the regulation of the upland water flow at the Farakka. Consequently water flow fell down drastically and the salinity that enters the land and the canals cannot be washed by the downward ebb. Moreover, due to elevation of the riverbed at the mouth by sift deposition, the amount of saline entering the inland rivers and canals at the tides cannot be discharged fully at the ebbs and so there is always the imbalance in the entry at the tides and evacuating at the ebbs. So there is always accumulation of some saline water in the rivers and canals. Again during the rainy season the rivers and canals begin to be submerged under water and saline water enters into the surrounding areas.

In south-west Bangladesh thus salinity intrusion has been increased gradually after post-diversion period by the upstream Farakka barrage. The salinity of the area has been increased from 380 micromhos during the pre-diversion period in 1974 to about 29,500 micromhos in 1992. In addition, the salinity level of 500 micromhos during the post-diversion period engulfed about 12,000 square miles compared to 7,000 square miles during the pre –diversion period[7]. Saline water intrusion is mostly seasonal in Bangladesh. The estuary of the river Meghna receives huge fresh saline water discharge from the lower Meghna river and this is distributed horizontally over the estuary, which, in turn, influences the fresh water flow with strong salinity of the waters in the southwest corner and the Pussur–Sibsa river system of the area during, monsoon and dry season. The situation is aggravated by the decreasing upstream fresh water flow and silting in the major channels meeting the estuary (WARPO, 2005).

OVERVIEW OF THE RISK ENVIRONMENT

Bangladesh has been experiencing higher rate of salinity intrusion in recent years, causing serious damage to the normal agric activities and livelihood

6 Draft National Plan for Disaster Management 2007-2015

resources. The salinity intrusion has been increasing gradually. It has devastated the sources of livelihoods primarily of the farming communities. The general occupation of the inhabitants of this region had been farming, mostly based on rain fed paddy cultivation. Due to salinity intrusion normal agric products cannot be grown well now-a-days. It has reduced crop production by 2.5% per year[8]. Most of the areas are affected by salinity intrusion. A study was conducted by SRDI (Soil Resource Development Institute) during the period of May to December, 2001 in four upazilas under three districts of Southwest Bangladesh namely Tala in Satkhira, Dumuria and Batiaghata in Khulna and Fakirhat in Bagerhat. The study revealed that the Salinity affected areas were 15620, 30660, 16890 and 6900 hectares out of the total areas, 33713, 44797, 24605 and 15883 hectares in Tala, Dumuria, Batiaghata and Fakirhat respectively[9]. The study also observed that 56.71% of these areas are vulnerable to salinity.

Before intrusion of higher salinity, most of the people of the south-west Bangladesh were involved in cultivating normal agric products, especially Aman and Boro paddy. But as a consequence of salinity, normal agric products cannot be grown. These changed circumstances in the ecology have forced the farmers to shift their livelihood pattern. Farmers have taken initiative to utilize salinity by cultivating salinity resilient products like shrimp, prawn, crab etc. The Daily Star (28 February 2005) reported that in Shyamnagar upazila of Satkhira district, salinity has affected 88 percent of the cultivable lands. The survey also shows that the lands under shrimp cultivation have been increased to 115 lakh hectares now from 1300 hectares in 1975 in Bagerhat and Khulna region. Again the survey showed that Satkhira was the worst affected areas where about 1.47 lakh hectares out of total 2.28 lakh hectares of cultivable lands were contaminated with salinity. It also showed that water of 56 percent of rivers and canals in the south-west region are highly affected by salinity and cannot be used for agriculture. Only 34 percent have salinity within a tolerable limit. The poor farmers of these areas being unable to maintain their livelihood migrated to urban or semi-urban areas[10] outside.

As a consequence of increasing salinity, new investment in industrial sector could not be in vision in these areas, because of lack of freshwater supply. So, industrial workers lost their livelihoods and they are also enforced to migrate to other urban areas. The food security of the affected people is found to be completely shattered because of non-availability of food products and lack of financial capacity. Salinity affects severely biodiversity of the area. According to the forest department officials, about 75 lakh trees of Khulna and Satkhira have been affected with 'top dying' disease. According to the study conducted by the Coast News, a quarterly information bulletin of the PDO-IC in Shyamnagar upazila of Satkhira district, 68 percent forest resources have been reduced during the 1985-2000 period. Guava, jackfruit, black plum, mango, palm tree, hog-plum (*alma*) and sapota are mainly salt sensitive species and they are gradually disappearing. The existing tree species are suffering from top - dying, root rot and leaf shedding[11]. Due to lack of fruit bearing trees, children cannot take vitamins and essential minerals. The poor people's nutrition is also affected. So public health has been facing a great threat. Due to non-availability of grazing lands, cattle heads are declining fast in the areas. It affects economy and livelihood of the poor people.

People of the south-west Bangladesh suffer from fresh drinking water scarcities due to salinity. A team of the Water Aid Bangladesh conducted a study in Assasuni and Shyamnagar upazilas of Satkhira for exploring the degree of scarcity of drinking water due to salinity. Women and adolescent girls usually collect drinking water from a nearby deep tube well at a distance of 3-4 km. So they do not have enough time and energy to carry out other household duties like cooking,

7 Assessment of the current state of agriculture, forestry and marine resources prepared by Ministry of Water Resources, Bangladesh Secretariat.

8 Pakistan Journal of Biological Sciences 4 (3): 309-313, 2004

9 Pakistan Journal of Biological Sciences 7 (8): 1322-1326, 2004

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bathing, washing clothes etc. Respective husbands are out to complain for being unable to serve food on time. Women in their advance pregnancy and lactating mothers find it extremely difficult to carry out such duties. Women suffer from various diseases in the long run for accommodating extra hurdle of work. Sometimes a poor family cannot collect water due to sickness or because of absence of any such member in the family for the job. Then they have to buy water from water vendors at Taka 10 per pitcher. So, they have to spend Taka 300 per month for drinking purposes which is very difficult for them. For that reason they have to use saline water for drinking purposes. Mostly females are the prime consumers of saline water within their family12. and they fall victims to acute diseases.

PROFILING THE STUDY AREAS

In this research, the enterprise has yielded significant ethnographic information on the episodes of good community coping strategies related to salinity from Satkhira, Bagerhat and Cox's Bazar. The survey areas were 13 villages in 11 unions in 10 upazilas of the three districts. [See Annex XX]

In the study areas, it is observed that different hazards are found through the year round. Salinity, arsenic, water logging, flood, river bank erosion and nor'wester are the major hazards of Satkhira district. Bagerhat district is exposed to salinity, water logging, cyclone, storm surge and nor'wester. Cyclone, storm surge, flood, flash flood, salinity, wild animal attack and nor'wester affect mostly Cox's Bazar district. Salinity is the main and common hazard of these study areas which is found through all the year round. But in the dry season of the months of Falgun - Chaitra (mid February – mid April), the intensity of salinity intrusion is higher than the other months of the year and in the rainy season in the months of Ashar – Sraban (mid June – mid July) the rate of salinity intrusion is the lowest. The study districts are comprised of the south-west and eastern coastal area. Satkhira and Bagerhat are situated in the south-west coastal area which is very flat, low and is criss-crossed by numerous rivers and canals. It is the base of the famous mangrove area called the Sundarbans. Cox's Bazar district is situated in the eastern coastal region which is covered by hilly areas and it has the longest beach.

Due to salinity the study areas are vulnerable mainly to livelihood resources like agricultural land, agric products, fresh water fishes and working opportunity of the community people. Salinity reduces usual agric production thereby diminishing the food security base of human beings as well as that of livestock. Most of the community people have been forced to change their occupation. The poor people who could not find any other livelihood means have been forced to migrate to urban and semi-urban areas in order to look for work. The curse of salinity increases the difference between poor and rich people. The rich people can cultivate salinity resilient products like shrimp, prawn and crab which need capital and land. They are becoming rich by exporting these products and the poor people are becoming poorer due to lack of work and opportunity. Salinity affects the state of health and nutrition of people. Mental health of the community people is also vulnerable. It affects drinking water which caused different salinity-related diseases. Women are more vulnerable because they collect fresh drinking water from 4-5 km distance which hampers their usual household work. Salinity reduces vegetation growth; even many salinity sensitive trees are extinct now. Various species of fresh water fishes are also extinct.

COPING IN SALINITY PRONE REGIONS

The community people of the study areas are highly pro-active in their respective efforts to mitigate the consequences of salinity. It is observed that people attempt to address risk problems ex ante. In this chapter we would discuss some cases of good community practices

11 http://www.iczmpbangladesh.org/rep/coast_news/coast_news5. PDF

12 The New Nation, internet edition, October 27, 2008

concerning ex ante risk management which more often includes enterprise diversification. Salinity is the most severe hazard in the coastal areas of Bangladesh so far its magnitude of damages and frequency of occurrences are concerned. Most of the time the impacts are cumulative and the effects are magnified at the local level. There is no effective early warning system. There is some indigenous knowledge which can predict the intensity of salinity intrusion. But it cannot reduce the vulnerability. Because, salinity intrusion continues through all the year round and affects livelihood slowly. Therefore, it is potentially a long term program for people to adopt different approaches and options to reduce their impacts.

Exposure to salinity varies regionally. The south-west coastal areas are more vulnerable than other coastal areas because of having numerous rivers and canals, which are fed with saline water during every tide. The vulnerability to salinity is determined by the impacts on livelihood components, such as: natural, physical, social, economic or financial and human resources. Salinity has become part and parcel of coastal life. The vulnerability to salinity is also determined by social factors, such as: land use, ground water use, livelihood pattern and migrations. River management, environmental degradation, technological changes, and government policies can also alter vulnerability to salinity.

In the study areas the community people practice different strategies of coping to mitigate the impact of regular salinity event. In order to ensure food security in the changed ecological condition, they have taken initiative to cultivate *kewra*, which can be grown well in the saline land. This practice ensures food security in the coastal area. Salinity has put severe form of constraints in terms of availability of safe drinking water. So, people face acute problem to collect fresh drinking water. In order to meet the crisis of drinking water, the community people practice different coping strategies such as rain water harvesting, preserving fresh drinking water in coastal zones, sourcing and harvesting drinking water – RING Well, and pond water conservation for drinking purpose. These practices ensure the availability of fresh drinking water of the study areas, although all of them are not very safe and dependable.

Rural people of the coastal area use mud stoves for cooking food. Due to unavailability of traditional fuel, the rural women of the area have taken initiative to use cow dung by mixing it with some other elements to increase its combustibility as fuel, which is locally called *gul*. This practice of traditional ways of the preservation of fuels has been discussed in the chapter three.

Due to salinity the lands of the areas cannot grow normal agric products. This changed circumstance has forced the farmers to change their livelihood patterns. In order to exploit more benefit from the saline lands, the community people started to utilize salinity by cultivating salinity resilient products. They have adopted some coping strategies such as shrimp Cultivation, reed cultivation and mat weaving, cultivation of prawn *renu*, crab aquaculture, Golpata, and salt Cultivation since long. These practices ensure maximum utilization of the saline lands of the coastal area with the maximum profitability.

INDIGENOUS KNOWLEDGE OF SALINITY INTRUSION

The community people have multiple perceptions about salinity leading to multiple responses. In the study areas the local people consider salinity as a severe hazard in the coastal area. They have perception that salinity intrusion is higher in the dry season and it is lowest in the rainy season. There is no forecasting system about salinity in Bangladesh.

The community people of Cox's Bazar can apply their knowledge beyond the analysis of climate, to the measurement of the quantity of salt and detection of the presence of fishes in the sea. According to them, the water at any place in the sea, deep or not, if agitated at night will glitter like fire flies. On the other hand, if one soaks ones hand in the sea water and does not wipe, when dries up salt will appear. If touched with the other hand, one can feel the crystals of salt. The amount indicates the concentration of salinity present in the sea water, high or low.

According to them there is equal salinity in the sea water at all sections of the sea. It is only at the meeting point of the river and the sea where due to the influence of the sweet water of the river, there is less salinity in the water. The current of sweet water is muddy and the current of saline water is clear and transparent. According to the people of Badarkhali, if there is gentle breeze from the morning from the South-East, and at the midday if the direction of the wind does not change or increase, then one should understand that the next week will have fare weather.

SECURING AND SOURCING OF FOODS

STRIVING FOR FOOD SECURITY – KEWRA

Précis

Unit	Location	Seasonality
Union Upazila District	Burigoalini Shamnagar Satkhira	Whole Year

Prologue

The above-mentioned area lies within the Sundarbans (a famous place for growing mangrove plants) which is attached to the Bay of Bengal, where salinity is a major problem. With the expansion of salinity in the adjoining areas of the Sundarbans, the union Burigoalini became out of cultivation of paddy and other traditional crops. On the other hand, this ecology is suitable for mangrove plants. Among different types of these plants and trees, a plant known as screw-pine plant (*Sonneratia apetala*), locally known as *kewra* is one of them grown naturally and people have been accruing benefits from these plants for long. These benefits encourage the farmers to cultivate *Kewra* plants in the saline condition.

The Initiative

Kewra (*Sonneratia* apetala) is known as one of the tallest trees in the mangrove forests of the Sundarbans. It can attain a height of about 20m and at the girth, of about 2.5m. The tree grows even on a newly moderate accreted soil in strongly saline areas. This is considered as a pioneer species in ecological succession. The local people have been cultivating *kewra* in this area since last 3-4 years in an attempt to make their livelihood easier.

A GOOD PRACTICE

- Δ The farmers consider it as good cash crop comparing other items;
- Δ Increases land utility by bringing the saline lands, which can not grow normal agric prod-ucts, under cultivation and also increases the crop productivity.
- Δ It is cost effective compared to production cost. A small amount of labor is only required for plantation and watching at the early stage of the plant;
- Δ It is profitable venture than other normal agric products on same piece of land;
- Δ It is a good host for apiculture;
- Δ It has multiple uses. Kewra fruit is a tasty. Its timber and woods are used as fuel for cooking as well as for furniture making purpose;
- Δ Enhances food security of people at risk;
- Δ The soil is suitable for this cultivation;
- Δ Already adopted by the local people long since and suitable for the ecology and environment.

Goal and Objectives

The goal of *kewra* cultivation is to reduce the vulnerability to natural hazards, especially, to salinity. The cultivation initiative aims at growing it as cash crop, ensuring food security, increasing their land productivity with maximum economic profitability by utilization of the soil of saline prone area.

Activities and Outcomes

The screw-pine plants are usually cultivated on permanently saline soil, or on the ridges of a prawn

besiegement, or in the premises of homesteads leached with salinity. The farmers can grow the saplings from the fruits or collect it from the local nursery at taka 2 or so for single sapling. A local NGO named Shushilon also grow the saplings to sell to farmers. The fruits are available in the locality; because the fruits, when ripen, fall down on the river and remain floating on river water. These floating fruits can be collected easily when they are born by the tide of the river to the banks. Another easy way is to collect it direct from the mangrove forest where it is widely distributed. Plantation can be done by single labour or the farmer himself and no need to take intensive nursing.

The plantation does not require to be ploughed the soil rather selected spot needs to be dug and softened with spade where the sapling is planted. The farmers cultivate 36 saplings in one bigha plot. This plant is looked after seriously by the household members, especially women, as herbivores such as cow, goats and other animals are fond of eating the leaves of the plant. The plants are to be given insecticides twice before flowering and once again before ripening of fruits during its life cycle to prevent spoiling of leaves and fruits.

From the age of 2.5 years, fruits, both green and ripened, are harvested and the plants can survive 20-22 years. is now considered as cash crop by the local farmers as cultivation is one of the major livelihood options. Harvesting in the first year is not satisfactory. But increased harvest is obtained from the fourth year. The production is almost similar after the subsequent years. The yearly income from fruit from a one bigha plot is at an average Tk. 12600 (see annex for details). The trees can be sold at Tk.3000 after 20-22 years and the wood can be used for furniture or as fuel.

Lessons Learned

Key lessons learned from this practice are:

- The local farmers consider as cash crop.
- The local farmers reported that cultivation method is easy, a small amount of labour is only required for plantation and some care at the initial stage of planting against livestock is needed.
- This being used for multiple purposes. Its fruit is edible for human beings and could be converted to various food items. Fruits of this perennial plant are also made into fish fodder, especially for prawn, a practice that encourages many of the farmers to plant them in the prawn besiegement areas. In addition, the aerial roots of the trees and shells of the fruits are used as fuel and its wood is used for manufacturing good pieces of furniture. This cultivation brings favourable condition for bee–keeping, so honey is harvested as by-product of plantation.
- It is suitable for cultivation in saline region, as it grows in salinity.
- It is a profitable venture comparing other normal agric items on the same piece of land.
- It is a good host for apiculture, especially for bee keeping.
- Land utilization is increased by the practice. It can grow in the patches of land and on the ridges of ponds.
- roots are spread in huge nets in the adjoining areas, a reason that does not permit other agronomical crops to grow. However the roots prevent soil erosion.

Potential for Replication

This is a saline resistant non-traditional agricultural product, which is efficient enough to reduce adverse effect of salinity. This cultivation would be replicated as alternative livelihood option to other saline region.

GO-NGOs may come forward to promote this cultivation as well as provide high yielding seeds and technology to the far reaching saline areas. The government may take an initiative to advocate and seek international market for exporting.

WATER RESOURCE MANAGEMENT AND COPING RESPONSE

RAIN WATER HARVESTING

Précis

	Location	Seasonality
Union	Ashashuni	
Upazila	Ashashuni	Whole Year
District	Satkhira	

Prologue

The above-mentioned area is situated within the most saline zone in the country and is lying in the network of rivers and canals of the Sundarbans, the world famous mangrove forest. These river networks and canals are swelled up by the sea water twice every tide of the day. The tidal water from the sea is saline and every tide leave behind a good quantity of saline water in the neighbouring canals, rivers and lands. At the time when there was free flow of river current, salinity could not stand due to rain water. So there was easy access to sweet drinking water and people did not face any problem. During fifties last century the flow rate in the river was decreased and salinity engulfed the area posing a great threat to the drinking water system and collection of it began to depend on the availability of potable water. So, Rain Water Harvesting plant (RHP) was established by a NGO for sweet drinking water.

The Initiative

A local Non government organization (NGO) named Uttaran with foreign aid came forward with rain water harvesting technique to meet the crisis of drinking water. Rain Water Harvesting plant is a device where people can collect and store the rain water for household purpose. The work of setting up the plant is organized by the NGO people and villagers at the community or individual level get the establishment of the plant on payment at the rate of taka as mentioned below. There are four Rain Water Harvesting Plants in this area. Of which one is individual RWHP, and other one for 7HHs, one for 10HHs, one for 5HHs and others are for 12 HHs.

Goal and Objectives

The goal of the initiative is to facilitate the availability of safe drinking water to prevent vulnerability to natural hazards in the areas which are inundated by the sea water with saline water.

Activities and Outcomes

NGO workers collect the raw materials and construct the plant at a suitable place where roof water can be drained conveniently through

A GOOD PRACTICE

- Δ Ensures safe drinking water in saline area where drinking water is an acute problem;
- Δ It is health and environment friendly. It has no bad impact on health and environment;
- Δ It reduces the sufferings and saves time of women. Before establishing the Rain Water Harvesting plant, women collected drinking water from a nearby deep tube well which lay even at a distance of 4-5 km and even more than 6-7 km in rainy season. These causes much trouble in their household affairs. Some-times they cannot cook food in time thus break-ing the family peace;
- Δ Women are involved to take care of the plants.
- Δ It is no doubt an effective method during the scarcity of drinking water at the saline area;
- Δ It is a health sustaining coping strategy which protects people especially children from differ-ent water born diseases;
- Δ It is an appropriate approach to cope with the changing ecology and environment.
- Δ The method has already been adopted and found suited to the ecology.

pipe and other means. In Constructing a plants varieties of raw materials like several rings of definite diameters, 3 pieces of pipes 10 ft long each (3″ diameter), 2 pieces of 4ft long pipes, 2 taps, construction of suitable platform slab for the top etc are needed. These are available locally. By employing suitable number of labourers, a RWHP can be raised within 4 days. Rain water harvesting techniques and construction of a plant involves simple technology. Taking the advantage of rain water falling down the roof of a building or a tin roofed house, a tank like a simple 'U' shaped tub made of several concreted round rings with one feet width each, cemented one above the other, the bottom being placed on a concreted platform and the top being covered with another concreted slab, is filled with rain water lead to this tank through appropriate pipes fitted in the network. The size depends on the size and number of the rings employed in the construction of the tank. So making the ring diameter large and employing larger number, a sizably large tank can be raised. But in this case the cost also will be inflated.

A single family size plant is constructed of 7 round rings of 1 ft width each one above the other and then fitted with other accessories and can contain 2200 litres of water. Water so collected can be immediately used if the component parts are properly Cleaned at the time of fitting. After completion of the work if pure water is circulated for some time, the internal components may be cleaned and immediate use of the plant water is possible. Of course, after filling with rain water, use should be avoided for suspended materials, if any, to be settled down. Quality of water stored, if good, will remain good if chance of contamination can be avoided. Purification in the ad interim can be done by bleaching or mixing alum so that the bacteria or germs that are supposed to be born may be killed. One pound of bleaching materials or a kg of alum may be enough to use for purification of water for the whole year. This may cost at best taka 100.

It is learned that a single family size plant costs taka 7510 and the family had to pay taka 2000 each for each plant and the remaining was subsidized by the NGO. But in case of community plant, the cost increased proportionately. The potential users are to pay taka 2000 each for the plant.

Lessons Learned

Key lessons learned from this practice are:

- The community people reported that it ensures safe drinking water.
- It is health and environment friendly. It has no bad impact on health and environment.
- It reduces the sufferings of people and saves time of women. Before establishing the Rain Water Harvesting plant, women collected drinking water from a nearby deep tube well, which lay at different distances from HHs, a deep was even at a distance of 4-5 km distance or even more. These causes much trouble to their household affairs. Sometimes they cannot cook food in time thus breaking the family peace.
- The local people reported that the raw materials are easily available and construction, running and maintenance are simple. Usually the women by terms take care of the plants.
- It is dependent on rain fall and hence runs well in the rainy season.
- Costly for the poor community.
- The capacity of holding rain water is very limited. The stored water can run 6 months and after that again they are in the same problem of collecting water from distant places.
- The stagnant water in a confined dark tank may be threatened to being at times to be polluted. Rain water with contamination can be another threat.
- It is technically complex for installation by the common people of the villages.

Potential for Replication

Rain Water Harvesting plant opens good chance for people at stakes for drinking water in the salinity prone area. It ensures safe drinking water which is health and environment friendly for six months. So, it can be replicated for other salinity

prone areas, dry areas as well as arsenic prone areas of the country.

GO-NGOs may come forward to disseminate the Rain Water Harvesting process. The technology needs to be improved. Nothing is known as to the rain water purity in our land, although we hear acid rain or some other polluted rainfall in India or somewhere else. So this is an area where research may be recommended and also investigation is necessary on the long term standing of rain water in a dark tank.

PRESERVING FRESH DRINKING WATER

Précis

Unit	Location	Seasonality
Union Upazila District	Burigoalini Shamnagar Satkhira	All Season

Prologue

The above-mentioned area lying in the network of rivers and canals of the Sundarbans, the world famous mangrove forest is within the most saline zone of the country. These river network and canals are fed by the sea water during every tide of the day. The tidal water from the sea is saline and every tide leave behind a good quantity of saline water in the neighbouring canals, rivers and lands. This causes acute problem of drinking water to the local people. So, people have devised different techniques to mitigate the drinking water crisis. Local people have been practicing drinking water preservation in ponds.

The Initiative

Having experience of salinity in the area, the villagers began to conserve ponds for getting drinking water. The ponds are not usually owned by communities. Rather some local well-to-do people are the owners and offer access to community people to collect drinking water from these ponds. This is absolutely out of charity.

A GOOD PRACTICE

- Δ Ensures sweet/ fresh drinking water to the poor community people;
- Δ It is a community effort where community people take part to conserve the ponds;
- Δ Mostly women are involved to take care of these ponds;
- Δ It is the last resort of poor people who can not afford pond sand filter, pitcher filter or other commercial water purification devices. So they use pond water;
- Δ It takes minimum cost, only cleaning cost is involved;
- Δ Generally the ponds are donated by the local rich people. Sometimes these are dug volun-tarily by the community initiative;
- Δ It's an innovative approach to cope with the changing ecology and environment of the salinity prone areas;
- Δ Already adopted by the local people and proved to be sustainable with local ecology.

Goal and Objectives

The goal of the initiative is to ensure supply of water for drinking purpose for the people of the area.

The practice enhances community health and saves children and other people from being jeopardized by having diseases from polluted water.

Activities and Outcomes

Two Types of ponds are dug in the area. Community ponds are dug by the users voluntarily. In digging a personal or familial pond, wealthy people employ daily labourers. Generally wealthy people possess more than one and so they devote one for the community use as an expression of goodwill.

When such ponds are available, community people perform necessary cleaning with the use of simple chemicals. They restrict everyone from

washing utensils and cloth and washing cattle heads in that pond. These ponds are cleaned once in every one to two months. Cleaning takes about couple of hours. Polluting substances are taken out. Floating leaves are also picked up from the surface of water. 3 kg of lime is used once in a month and the water becomes drinkable after one or two days. If they use lime in the evening, the water becomes clear next morning and can be used for drinking purpose.

There are five such community ponds in the area at present serving around 200 families. After cleaning the ponds, the community people use it as reservoir of drinking water. Most of the people drink this water directly. A very few people use this water after boiling. Only 2% of them are found to use some chemicals like alum to clean the water. After using a few years these ponds get muddy and water level go down. Then these ponds are cleaned and deepened during the months of Falgun and Chaitra (mid February to mid March).

Lessons Learned

Key lessons learned from this practice are:

- Δ The community people reported that pond water for drinking purpose is the last resort of poor people. They cannot afford pond sand filter, pitcher filter or other commercial water purification devices. So they use only pond water.
- Δ It is a community effort where community people take part to conserve the pond water.
- Δ Mostly women are involved to take care of these ponds.
- Δ It ensures sweet/ fresh drinking water.
- Δ It takes minimum cost, only cleaning cost. Generally the pond services are offered by the local rich people. Sometimes these are dug voluntarily by the community initiative.
- Δ The local people stated that water borne diseases, like diarrhoea, dysentery etc, have been spread out due to drinking of pond water without boiling or purifying by other means.

Potential for Replication

Scarcity of drinking water is an acute problem of salinity prone area. To meet up the crisis, the local people use pond water for drinking purpose and it cost them minimum. It can be replicated for other salinity prone areas of the country. It can also be replicated in the arsenic prone areas of the country. But some precautionary steps to ensure germ free water are to be applied and people may be made aware of taking some measures against vectors carrying diseases by the pond water.

GO-NGOs may come forward to take initiative for purifying the pond water by using different means. They also may disseminate this technique to other far reaching areas of the country. Along with they should have program for raising awareness against using the pond water directly, which can be used if it is purified by proper treatment of germ killing agents available with the public health department and with other government agencies.

SOURCING AND HARVESTING DRINKING WATER – RING TUBE WELL

Précis

Unit	Location	Seasonality	Hazard
Union Upazila District	Koyla Kalaroa Satkhira	All Seasons	Salinity and Arsenic Contamination

Prologue

The area remains under the saline condition throughout the year. But like adding insult to injury, the area also has been suffering from the arsenic contamination of ground water aquifers, since a few decades. Hundreds and thousands of people have been suffering from the deadly action such the poisonous water. The diseases developed from the contamination have no cure and the victims meet pitiable end. The NGO forum took an initiative to setup ring tubewells for safe drinking water in this area.

A GOOD PRACTICE

- Δ Ensures safe drinking water in arsenic and saline area where drinking water is an acute problem;
- Δ As the water is available from the nearest table of the ground, it is free from arsenic contamination and is quite suitable for drinking as safe water. So this is health sustaining.
- Δ The arsenic contamination in the deep tube well water of the area, being much more than o.05mg/L (WHO) is not safe for human health. So this draw ring tube well water is, from the point of hygiene, is safe and harvesting this water is economically profitable compared to the cost.
- Δ It is cost effective. The cost involved are the labor cost of digging the hole and making the platform above together with that of the rings in addition to the cost of a traditional tube well. This amount of cost is negligible comparing the cost of installing a deep tube well.
- Δ It is no doubt an effective method during the scarcity of drinking water at the arsenic and saline area;
- Δ It is an appropriate approach to cope with the changing ecology and environment.

The Initiative

In order to supply arsenic and saline free water to the vulnerable people of the area, the NGO forum introduced the technology of ring tube well (a tube well attached with a well which is made by cemented ring) under the action of the project entitled "Bangladesh Arsenic Mitigation Water Supply project of Khulna zone" the NGO forum has setup nine ring tubewells in 2005 in this area. Each ring tubewell can be used by 10-12 families.

Goal and Objectives

The goal of the initiative is to reduce the health vulnerability to natural hazards, especially arsenic as well as salinity. The initiative aims at ensuring supply of safe drinking water for people of the saline area.

Activities and Outcomes

The construction of the draw ring tubewell needs an ordinary tubewell, a cover, a plastic pipe for air circulation, a communication pipe, some bricks, concrete materials, cement and sand, which are available in the upazila market.

A hole underneath the soil of 20 ft depth is dug in a suitable place selected by the users. Although water is available within 15 ft of the ground, to achieve sustainability the depth is made 20 ft. Then 20 rings are set one above the other and they are cemented one with the other at their joint sealing the gaps. The rings are made of circular iron frames of a certain diameter to be, set one above the other as per necessity and then casting with proportional amount of cement and concrete is done. Then the cover at the mouth is cemented, one side of the cover has a hole and a hollow pipe is introduced for communication of air inside the well. Then a hole is made laterally by the side of the second or third ring from above to fit a pipe 2`-3` long . Another pipe is attached with this pipe whose other end is connected with the main iron tube of the tube well placed at 3` ft away on the platform constructed with cemented materials.

Lessons Learned

Key lessons learned from this practice are:

- Δ The community people reported that it is cost effective. It needs only Tk. 7964 for construction. The cost involved are the labour cost of digging the hole and making the platform above together with that of the ring in addition to the cost of a traditional tube well. This amount of cost is negligible comparing the cost of installing a deep tube well.
- Δ As the water available from the nearest table of the ground is free from arsenic contamination and is quite suitable for drinking as safe water. So this is health sustaining.
- Δ The arsenic contamination in the local deep tube well water, being much more than o.05mg/L (WHO) is not safe for human

- health. So this draw ring tube well water, from the point of hygiene, is safe and harvesting this water is economically viable.
- As the components are available in the local environment, the construction does not need complicated technology, rather is very simple and this has wide applicability.
- Only one draw ring tube well could be found throughout the whole of the union. The awareness among the community people against the adverse effects of arsenic contaminated water drinking is very poor. So they are taking water from the shallow tube wells. Although the draw ring tube well has many advantages, this could not draw the attention of the common people only because of lack of awareness.

Potential for Replication

Supply of safe drinking water is an imperative for the people of the arsenic prone areas to save them from arsenic related diseases. So this kind of tube wells which is cost effective and easy to construct with the materials available in the local environment needs to be popularized in the other areas.

GO-NGOs may come forward to take initiative for awareness building in order to install this tube well. They can take initiative to improve the technology and disseminate the technology to the far reaching people who are vulnerable to arsenic disaster.

LIVELIHOOD DIVERSIFICATIONS AND OPTIMIZING OUTCOMES

SHRIMP CULTIVATION

Précis

Unit	Location	Seasonality
Union Upazila District	Buri Goalini Shamnagar Satkhira	Whole Year

Prologue

Due to saline intrusion, the lands of the area cannot produce normal agric products. So, the occupations of the farmers have undergone a total change. The local farmers take initiatives to utilize saline water by cultivating shrimp, which is comparatively more profitable than other traditional crops in the saline areas.

A GOOD PRACTICE

- Ensures livelihood security of the saline area where the farmers can not grow normal agric products;
- This enterprise is the best example of coping with the salinity in this area;
- Increases utility of saline land and increases total productivity.
- This does not require intensive labor and care can be taken by the members the family.
- It allows other saline tolerant fishes to be cultivated in same besiegement;
- The net benefit is comparatively higher than any other agricultural production in same piece of land;
- It is an appropriate approach to cope with the changing ecology and environment.
- It is profitable venture compare to other traditional crops in the same piece of land;
- The shrimp has a potential international demand; every year Bangladesh is earning huge foreign currencies by exporting it;
- It has already been adopted since long and adjusted with local ecology.

The Initiative

In order to adopt the changed circumstances the local farmers started to cultivate shrimp in their land. In 1985 one Momin of Nildumur village of Burigoalini union started cultivation of shrimps. Later on, people of the area were encouraged to nurse shrimp as to adapt with saline condition which is comparatively more profitable than other traditional crops. Finally from 1988-89, shrimp has been cultivated widely in the area.

Farmers dig canal from the coast to the besiegement of prawn and when there is tide in the sea, saline water rushes to the land through the canal and they trap the water for fish cultivation. They feed the shrimp naturally available fodder and three months after they harvest the fishes.

Goal and Objectives

The goal of shrimp cultivation is to reduce the vulnerability of salinity. The shrimp cultivation initiative aims at ensuring livelihood security by utilizing saline intrusion with the maximum profitability.

Activities and Outcomes

The lands, once used for paddy cultivation, are made into besiegement for shrimp cultivation. Preparation of land for the purpose is essential and involves technicalities and the soil is dried up in the months of mid Kartik to mid Agrahayan (November – December). Then the farmers plough the land by power-tiller either by hiring or by owning one by themselves. After ploughing the land, manures are applied. Then saline water is allowed to enter entering the land up to 2.5 cubits in height through the Kholketua river at the time of tide. The salinity of the water tolerable to the fishes is expressed as 31 ppt (Salinity is usually expressed as 'parts per thousand' or ppt). Then young shrimps, collected from hatcheries located either in the locality or at Cox's Bazaar, are released from the month of mid Poush to mid Magh (January) and this continues up to June and July.

The first release in January was at the rate 2000 per bigha and in the subsequent months the rates were 1500 per bigha per month. The rate at which young fishes are sold is Tk600-700 per 1,000 and to July they become scarce. So they can release only 1200 or 1300 per bigha. In addition, saline tolerant fishes such as *tilapia, pairshya, harina* and *bhetki* can be also cultivated together with shrimps. Saline water is brought from neighbouring Kholketua river tide through either natural canal or dug artificially. The shrimp *beels* always need water of 2-3 ft height. Shrimps are grown up on the naturally available food in saline water and they use no extra food. The cultivator does not know any kind of preventing mechanism of diseases/*morok*/virus. Even they do not know the name of virus.

The fishes that are released in the month of January are caught in March. The time of catching them is the time of 'ghones' (the tide that comes during the full moon and new moon in every month is called in local language 'ghone') which occur twice a month with 15 days break. At the 'ghone' the tide water is allowed to enter the besiegement and a net is put on the passage of the current to catch the fish. Generally fishes like to go opposite to the water current and are trapped into the net but only the bigger ones are collected.

Total cost of shrimp cultivation is Tk. 8274 per bigha (see annex for details). Net benefit from the enterprise is Tk. 30126 in a year and in addition, saline tolerant other fishes made more benefit.

Lessons Learned

Key lessons learned from this practice are:

- The local farmers stated that this enterprise is the best example of coping with the salinity in this area.
- The cultivation process is simple, and it needs only proper utilization of given natural resources.
- This does not require intensive labour and only domestic care is enough.
- It allows other saline tolerant fishes to be cultivated in the same besiegement.
- The net benefit is comparatively higher than any other agricultural production in the same piece of land.
- Leaching salinity, the neighbouring plots are rendered unproductive for any other agric purpose.
- The land once used for shrimp cultivation cannot be used for any agric activity for a long time.
- The farmers reported that threat of virus always lies with the shrimp production.

Δ The shrimp has a potential international demand; every year Bangladesh is earning huge foreign currencies by exporting it.

Potential for Replication

The enterprise is considered to be the one of the best examples of adaptive practice in regard to the growing salinity. In addition saline tolerant other fishes are also produced along with the shrimp. This has a great future as salinity is increased over the areas. So it can be replicated for the other saline prone areas in the country.

Fisheries department of the government may give proper attention to prevent the virus attack which is a threat for the shrimp cultivation. GO-NGOs may come forward to help the poor farmers by giving financial and technical support. To know the impact of shrimp cultivation on the environment, scientific research is needed.

NURSING PRAWN RENU

Précis

Unit	Location	Seasonality
Union	Shovanali	
Upazila	Ashashuni	Whole Year
District	Satkhira	

Prologue

With the change in the environment due to saline intrusion, the farmers sought alternatives for their livelihood. They have adopted different means of livelihood, shrimp cultivation being the most notable. With the passage of time, nursing of the prawn *renu* is initiated due to its huge demand and environmental potential.

The Initiative

In order to cope with the changed circumstances, one villager of Shovanali having some financial background has started nursing of the prawn *renu* since 2004-05. The nursing of prawn *renu* is relatively a new locally devised technology, which is simple but laborious. Thus nursing for a few days they are sold to the cultivators.

A GOOD PRACTICE

Δ Ensures livelihood security of the saline area where the farmers cannot grow normal agric products;

Δ This enterprise is the best example of coping with the salinity in this area;

Δ Increases utility of saline land and increases total productivity;

Δ It has huge demand in the shrimp cultivation areas;

Δ The net benefit is comparatively higher than any other agricultural production in same piece of land;

Δ It is an appropriate approach to cope with the changing ecology and environment;

Δ It is profitable venture compared to other traditional crops in the same piece of land;

Δ It has a potential future. Because, the shrimp cultivation is increasing day by day.

Goal and Objectives

The goal of nursing prawn *renu* is to reduce the vulnerability of salinity. The prawn *renu* initiative aims at ensuring livelihood security by utilizing saline intrusion with the maximum profitability.

Activities and Outcomes

The following resources are needed for nursing prawn *renu*: clayey and loamy soil, net, polythene sheet (thick and thin), brick, sands, cement, pipe, thread, bleaching powder, elbow pipe, lime, sugar, salt, shallow machine, tarpaulin, bamboo, bamboo made fencing needed for construction of wells and house. Most of the elements (cement, pipe, thread, bleaching powder, elbow pipe, lime, sugar, salt) are available in the local market. Brick, sands, shallow machine are collected from the upazila headquarters. Prawn *renus* are bought from brokers or intermediaries. Polythene bags and cartoons are needed for carrying renus. A handy net, cartoon of cork-sheet, spoon and sieve of ordinary cone shaped net are needed to catch the

renus which are bought in market. The labourers are provided either from local households or are hired. The selected piece of land (called *bhita*) is a comparatively high or raised up to 6 ft above the regular tidal level. The tank over a plot can store necessary amount of saline water from the tide and rest passes along the ebb. The project uses a place of 30 ft long and 20ft in breadth i.e. an area of 600 sq ft. A shade is made on the foundation by spreading tarpaulin sheet fastening with bamboo poles fixed at the four corners of the foundation to protect the tanks from outside interference. Fences are made of bamboo sheets and fitted around with the bamboo poles. This gives protection against the attack of cattle sheep and saves from rainfall, fog etc and the shade uses 20 such poles. The height is 5 ft above the foundation. The poles require 7 pieces of bamboo and 200 pieces of bamboo are required for the roof and fences. The shading process is completed by the labours hired from the locality.

Then four tanks of the sizes 7' x 5' ft and 5 ft depth are made and a smaller house (tank) made of bricks at the middle which is connected with the four tanks by 8 elbow pipes underneath the size being 2 ft long and 1.5 inches width. The bottom of the tanks is laid with 0.5 ft deep clay soil levelled with leveller and is allowed to dry up a week. Then a thin polythene sheet is laid on the soil before putting another layer of loamy soil mud of 0.5 ft thickness, which is again overlapped by a thin layer of loamy soil. Finally the whole bottom and the surrounding walls of the tank are covered with thick polythene sheets so that no mixture would occur with the soil underneath or around. All the tanks are constructed at the same time and three labours work for 2 days first, then it dry up for a week. Consequently 2 days work requires for the bottom and dry up a week. So the whole construction process requires 16 days.

The house is built with bricks (about 150 bricks are required), sands (3 cubic ft) and cement (10 kg) and could be completed in a single day. The volume of the house is 2x2= 4sft and 3ft deep. All the tanks are connected at the bottom with 2 ft long elbow pipe having 1.5 inches dia. Another pipe of 35 ft long and 5 inches diameter runs to the river from the house. This pipe helps replenish the tanks, once a week.

They use a shallow machine of 8 HP. 7 pieces of bamboo poles are used and the cost is Tk 770. The roof and fences used 200 pieces of bamboo. At the rate Tk. 30 each, the cost is Tk. 30 x 200 = Tk. 6000. The paling, roofing etc are made by labourer and for these purpose they are to be paid.

After construction of the tanks, water is stored in a complex process which needs water to go through four subsequent steps. In the first step water of high salinity is stored, second step allows comparatively less density of saline water than the first one, third step still lesser density than the second one, and so on.

The renus are collected either from the broker or from the local market. This renu is carried in a 1 square ft cock-sheet container in which transparent polythene is laid inside the whole including necessary amount of saline water of the sea. Then the renus are put into the tank 3-5 days which contain saline water of the same density as that of the sea. Afterwards the *renus* are shifted to the tank of immediate low-density saline water for 3-5 days and consequently to other two tanks for same days for each tank. Finally the renus are kept in the fourth container (a house which is bigger than tanks) which has sweet water and allowed to stay for 3-5 days in order to increase adaptability. Adaptation process of renus with different condition is completed within 15-20 days. Henceforth, in the whole process mortality rate of renu is 10-15%.

If the saline condition in a tank is beyond the tolerance of the renu, the mortality rate increases and in that case they adjust the salinity by adding sugar or salt according as they feel necessary. The tank size as mentioned is 7 x 5 x 3 cubic ft and if necessary to decrease salinity they uses 2-3 kgs of sugar and to increase salinity they use salt. The nursing process requires the services of 4 workers for each enterprise.

Total cost of nursing prawn renu is Tk. 487816 (see annex for details). After the completion of

the adaptation process, the renus are sold to the cultivators. Total production is about 45000 in number in every 15 days in each enterprise. The rate at which they sell the renu is Tk. 350-500 per thousand in off season (April-June) and Tk. 1000-1100 per thousand in pick season (July-March). Total selling price is Tk. 783000. So, net profit is Tk. 295184.

Lessons Learned

Key lessons learned from this practice are:

- Δ The respondents stated that this enterprise was the best example of coping with the salinity in this area.
- Δ It ensures proper use of salinity in a small piece of land.
- Δ The process is simple and can be accomplished with the local resources.
- Δ It is a profitable venture compared to other traditional crops on the same piece of land.
- Δ It has huge demand in the shrimp cultivation areas.
- Δ It does not require more labour.
- Δ In spite of huge profit, the enterprise is not popular among the local people; because of huge capital involvement, which is not possible for by many of them.
- Δ Mortality rate of prawn renu is a threat to this cultivation.

Potential for Replication

Nursing prawn renu is considered one of the best examples of adaptive practice in regard to the growing salinity. This has a great future as salinity is increasing over the areas. So it can be replicated for the other saline prone areas in the country.

This prawn renu nursing may be scaling up to provide financial support by GO-NGOs intervention. In addition, intervention of scientific accomplishment may reduce mortality of prawn renus. To know the impact of shrimp cultivation on environmental, scientific research is necessary.

CRAB AQUACULTURE

Précis

	Location	Seasonality
Union Upazila District	Parulia Debhata Satkhira	All Seasons

Prologue

In this above mentioned saline area the accumulation of the salinity was increased resulting in the change of crop patterns. Along with this, the farmers had to take recourse to different modes of livelihood practice. Of all the options, crab cultivation became popular within a very

A GOOD PRACTICE

- Δ Ensures livelihood security of vulnerable people living in the saline area where the farmers can not grow normal agric products;
- Δ The cultivation of crabs is a purely nontradi-tional export oriented enterprise and so the local people have adopted this enterprise as alternative livelihood source;
- Δ Crabs are cultivated within a small plot of land with materials available in their environment;
- Δ It does not need much capital and labor. It can be done with domestic labor and minimum capital;
- Δ Crab cultivation earns foreign currency by exporting crab;
- Δ This enterprise is the best example of coping with the salinity in any area;
- Δ Increases utility of saline land and increases total productivity;
- Δ It is an appropriate approach to cope with the changing ecology and environment;
- Δ Its productivity and profit is high compare d to other traditional crops in the same piece of land;
- Δ It has already been adopted since long and fitted with the local ecology.

short time, because of some of the comparative advantages, namely: it is easily adaptive to the changing environmental condition, and congenial to the given socio-cultural settings.

The Initiative

The local farmers of the area started crab cultivation since 1997-98 as an alternative livelihood option. This can be cultivated within short duration, on a small plot of land with materials available in their environment, with domestic labour, at minimum capital and finally the practice is friendly to the changed environmental condition.

Goal and Objectives

The goal of crab cultivation is to reduce the vulnerability of salinity. The crab cultivation initiative aims at ensuring livelihood security and to utilize the advantage of saline ecology for extraction of benefit with the maximum profitability.

Activities and Outcomes

The plots, 2-3 ft deep, connected to the nearby rivers, visited regularly by the sea tides i.e. the saline water is constantly replenished, are suitable for crab cultivation. Generally clayey and loamy soil is suitable for it. The farmers use *pata* (a bamboo is cut into pieces of 3-4 ft long and sheets are made of it and then they are made into a paling and tied with threads one after the other to make *pata*), net, basket, a *hatcha* (pulling net), threads, a trapping basket etc are needed for crab cultivation. Generally the small crab calves are collected from the seashores and they are of 50-60 gm weight. These small calves are TK 20-30 per kg.

The cultivator usually nurse 200-500 kg of these calves to a bigha of the besieged area. The water of the besieged area is to be changed once every 3-4 days. If the water is muddy the crabs cannot live, availability of safe clear water is necessary. The growth also depends on the rate at which the water is being replenished i.e. replaced by that of sea water. They supply warm water to the besieged area by irrigating the tide water of the sea. The growth also depends on the fodder. Crab is a nocturnal animal. It eats everything, but it basically lives on small fishes and grass. Farmer buy fishes , cut into pieces, and use as food of crabs at the rate 5-6 kg of fishes per 100 kg of crabs and give 2-3 times a week. Of course, the quantity of food depends on the sizes of the crabs.

Crabs have rapid growth and they reside in the barrows they make on the ridges and sides of the ridges of the land. At times they migrate to the other's lands through the barrows they make. In order to prevent the migration, the *pata* and nets are in use; the *pata* is put on the boundary of the besieged land to make a partition above which the net is fitted through. A plot of one bigha requires net of TK 900 to encircle the four sides and inside generally divided into 9-10 partitions and the partitions need *pata* and the *pata* needs 15-20 bamboos, which are bought at TK 100-120 each, the total cost being TK 1500-2000.

The growth of crabs is measured in terms of weight and expressed in grades. After first release in the besiegement, the calves gain weight 250-300 gms within 120 -150 days time and they need 6-8 months time to have weights 400-500 gms. A crab having weight above 500 gms is called *madda* crab and is graded A, and *madda* crab per kg can be sold at TK 600-800. Generally the crabs that are of weights 250-300 gms are of C-grade and that of 400-500 gms are of grade-B respectively. The crabs having weight 300-400 gms are called light sake. These crabs, when exposed to light, the inner shells are seen to be filled with soft or grey matter within it. The ones that do not have these grey matters are called *kholsa*.

After collection of crabs from the besiegement area, they survive maximum 7 days in air. Crabs are such animals as cannot be eaten after death; because it becomes decomposed as soon as it dies and gives out bad smell. So this very important factor is taken into consideration while harvesting, processing, transporting and marketing in the international market. Crabs are exported to Malaysia, Chana, Singapore, Taiwan etc. Chana is the first market, and then comes Malaysia and Singapore stands third. Big crabs of weight 500-800 gms are marketed in the Malaysia,

of weight 250-400 gms are sold in the Singapore markets and the small crabs of weight 200-300 gms are placed in the Chinese markets. While exporting, the crabs are put into packet in trays which are like baskets having pores around.

The middlemen buy the crabs from the owners of the besiegement and then they classify them according to their weights, which they call grades. Finally these are sold to the exporter. The market price differs in different time of the year depending on the international demands, weight of crab and season. Generally, the demand is great at the time of Christmas and New Year time. Then the price is high in the winter season, because the production is less during the time. Due to seasonal variation crabs die much, mortality rate is 10-15%.

Lessons Learned

Key lessons learned from this practice are:

- The local farmers reported that cultivation of crabs is a purely non-traditional export oriented enterprise and so they have adopted this enterprise as alternative livelihood source.
- Crabs are cultivated within a small plot of land with materials available in their environment.
- It does not need much capital and labour. It can be done with domestic labour and minimum capital.
- The local people think that this cultivation as friendly with changing environmental condition.
- Crab cultivation earns foreign currency by exporting crabs.
- It is a profitable venture compared to other traditional agric products in a same piece of saline land.
- The farmers stated that the collection of crab calves is not available easily. This creates problems off and on.
- Crab cultivation does not allow any other integrated farming.
- Once a farmer cultivates crab in a piece of land he cannot go back to other crops and hence he is to depend on crab cultivation always. To allow entry of saline water to the besiegement area, the adjoining lands also become saline and hence have become useless for cultivation of other items: because salinity leaches through the pores of soil.
- As crab cultivation needs less labour and capital, so many people are employed in the practice. But only those who have access to a small piece of land can cultivate.

Potential for Replication

The crab cultivation is a non-traditional practice, which produces export-oriented item. So the enterprise adds to the foreign currency of the country. There are vast saline lands in the country. These are not suitable for rice or other crops. These lands can be used for crab cultivation, which is profitable in many ways. It increases land utility, production efficiency and helps earn foreign currency. The government may formulate policy to encourage the cultivators for intensive cultivation and may take initiative to increase exports. For extension and expansion of the cultivation GO-NGOs may come forward with proactive programs. They also may disseminate modern technology and high yielding varieties of crabs. Finally a government policy is necessary to implement scientific programme to prevent the soil degradation caused by long term crab cultivation.

SALTED LIVES AND SILTED LIVELIHOODS: GOLPATA

Précis

Location		Seasonality
Union	Gotapara	
Upazila	Sadar	All Seasons
District	Bagerhat	

Prologue

Being close to the sea, Bagerhat is prone to salinity and storms. On an average, three to four notable storms strike Bagerhat successively during the recent times, often during the spring. Storm here typically blows away the house roofs resulting in the significant loss of assets and financial loss to people. In addition, light corrugated iron (CI) sheets

often cause serious cut injuries during storms. As a result, people here started using *golpata* (a big leaf like palm/coconut leaf) for roofs. Although these would naturally grow earlier in the saline soil of the Sundarbans, now to meet the increased demand people also commenced plantation of *golpata* by utilizing salinity of the area.

A GOOD PRACTICE

- Δ Golpata as the roofing materials saves people from accident at the time of storms;
- Δ It does not need much capital and labor. It can be done within domestic labor and involves little or no capital;
- Δ It gives relatively high returns compare to investment;
- Δ It is used as roof of the houses. It is also used for kitchen fences & sheds, cowsheds and fuel storehouses;
- Δ The cost of house making has been reduced greatly with the use of golpata as roofing material instead of corrugated iron sheets. it is cost effective and helpful to the poor commu-nity people;
- Δ This enterprise is the best example of coping with the storm and salinity in this area;
- Δ Increases utility of saline lands which can not produce normal agric products;
- Δ It is an appropriate approach to cope with the changing ecology and environment;
- Δ It has already been adopted since long and fitted with the local ecology.

HE INITIATIVE

Golpata is used traditionally for roofing and fencing of kitchen and sheds of cows and storehouses. This resource is obtainable at free of cost from the Sundarbans and adjacent areas. As house roofing materials the use of *golpata* started about 5-7 years ago. As demand increased nowadays, people started *golpata* plantation in private arrangements.

GOAL AND OBJECTIVES

The goal of *golpata* cultivation is to reduce the vulnerability to storm. The initiative aims at reducing the cost of house making and at the same time for earning money from the enterprise. This has been proved to be safer at the time of storm; because earlier people used to make houses with C.I. sheets which, often, at the time of storm would have blown away by the storm wind and people who remained engaged in arranging cattle and other belongings for safety would be hit by the blowing tins seriously.

ACTIVITIES AND OUTCOMES

The local people collect ripen fruits for seeds of golpata easily from Sundarbans. Seeds are sown during dry seasons, i.e. winter (*Paush-Magh*). About 50 seeds can be planted in a *katha* of land. There is no need for fertilizers, pesticides and other treatment in golpata cultivation. It takes about 3 to 4 years for golpata tree to offer offshoots. Around 4 to 5 offshoots are common to a matured tree. Usually, offshoots are obtained during winter. The tree regenerates.

LESSONS LEARNED

Key lessons learned from this practice are:

- Δ The community people reported that the popularity of *golpata* cultivation is increasing fast because it needs low investment against relatively high return.
- Δ *Golpata* cultivation is environment friendly, coast effective and profitable.
- Δ The poor community people can make their house roofs with *golpata* instead of corrugated iron. It is cost effective and at the same time they can sell the additional stock for earning money for their own livelihood.
- Δ The house made by *golpata* remains cool in the summer and more comfortable in the winter.
- Δ The cultivation of *golpata* increases land utility and productivity.
- Δ But integrated farming is not possible.
- Δ The saline lands does not generally produce any traditional crops and so *golpata* cultivation

can help farmers and others to produce house building materials for the rural areas where there is salinity.

Potential for Replication

The respondents in the coastal areas report that they experience hazard like storms very frequently. They would use C.I. sheets for making houses earlier and at the time of storms very often the tin coming from the house roofs would hit someone and injure seriously. But as they began using the *golpata* as the roofing materials this never happened. So they started using *golpata* roofs which has more advantages than the C.I. sheets. The house remains cool in the summer and more comfortable in the winter also. The most attractive side of the use of *golpata* as the roofing materials is that the cost is the minimum and the materials they can produce and they can earn also by selling the products.

These additional advantages can encourage others to follow the suit. GO-NGO initiative may remain proactive in this regard.

SALT CULTIVATION

Précis

Unit	Location	Seasonality
Union	Chota Maheshkhali Hnila Badarkhali	*Agrahayan* to *Baishakh*
Upazila	Maheshkhali Teknaf Chakaria	
District	Cox's Bazaar	

Prologue

The areas mentioned above are fully submerged by the sea tides every day and the sea water accompanies salinity. As a result the water and soil in the adjoining areas contain maximum salinity rendering the land unfit for crop cultivation. But huge quantity of salt carried by the sea water is left with soil and water in the canals, rivers and lands. These salts are valuable and have universal demand. So people of the area learned to trap and extract this salt from the sea water. Thus salt cultivation has become a very good adoptive practice in this area.

A GOOD PRACTICE

- Δ Ensures livelihood security of the community people of the saline area where the farmers can not grow normal agric products;
- Δ This cultivation is simply the exploitation of nature. Because the famers suffered loss of agric production. So nature has given them another in return;
- Δ It is a short term production. The total production cycle requires only nine days;
- Δ The cultivation process is simple and low cost compared to the profit they earn;
- Δ This does not require huge labor and could be met by the domestic members or by hiring small labor for a short duration on small payment;
- Δ This enterprise is the best example of coping with the salinity in this area;
- Δ Increases utility of saline land and increases total productivity;
- Δ It has huge demand in the local market as well as international markets;
- Δ It is an appropriate approach to cope with the changing ecology and environment;
- Δ It is profitable venture compared to other traditional crops in the same piece of land;
- Δ It has already been adopted since long and fitted with the local ecology.

The Initiative

Due to changed circumstances, the local people of these areas started to produce salt, a nutritional mineral composed of sodium chloride by utilizing saline water. The local people obtain sea salt by evaporating seawater on lands. In this process, the salt contained in the water crystallizes on the soil as water dries up due the sun rays. Then the salt crystals are collected and then refining of salt is done by the farmers. Salt cultivation has a long history at Badarkhali. On the other hand, Choto Maheshkhali

and Hnila people have started it just few years back with the encouragement of the production in the above areas. At present most of the farmers of these areas are involved in the salt cultivation.

Goal and Objectives

The goal of salt cultivation is to reduce the vulnerability of salinity. The initiative aims at ensuring livelihood security by producing salts from the sea water, a natural wealth to be utilized at the benefit of people themselves.

Activities and Outcomes

There are huge fallow lands beside the canal running to the sea. These canals are visited by the sea tide accompanying saline water. Plots lying along the canals visited by the sea tide are the most suitable for salt cultivation. So salt is cultivated in these fallow lands and other lands which were once used for crop cultivation The salt cultivation season starts from Agrahayan (mid November-mid December) and it continues up to Baishakh (mid April-mid May).

At first they divide the land into six plots transversely, and then divide longitudinally. The plot is about 8 ft broad and 17 ft long and in this way one *kani* (40 decimal locally) of land is made into 6 plots. The plots are made in such way that one plot is lower than the other subsequently at about 2-2.5 inches but final sixth plot is lower than the fifth one. The first three plots may have grass and be level, but the next three steps must not contain any grass and must be very uniformly levelled because the grass or uneven surface impedes production of salt. They do this each time after discharging the water from the land and levelling is done by pressing the surface by leveller (locally called *gora*, a kind of roller made of *gorjon* wood). They use *patri* (1 foot long wooden device having a handle which is fitted at the middle and is 5 ft long) to remove water from third to sixth step. A hole, called a *khania*, is dug in the fifth step at about 1 or 1.5 ft deep in order to store the water that could not be discharged adequately. If the plot could not get tide water naturally, then the plots need to be irrigated.

During the salt drying process in the sixth step/ plots, water has to be sprinkled over plot sometime to avoid large granule formation. *Khania* is the source of water at that time. If there is a sufficient sunlight, the salt dries up quickly and within two days they can finally harvest. Since salt is collected from the sixth step, a polythene paper is laid on the bed of the plot in order to receive fresh salt easily. The production process requires nine days approximately. The production of salt depends on sunlight. If the climate is hot, the production increases and it may be about 30 maunds (1 maund is 40 kgs) in a *kani*. The production is high in between the end of February to the end of May. During December to January the production is comparatively less and it is no more than 15-20 maunds; because water does not dry up quickly in winter season.

The price of salt fluctuates due to the climatic condition, political situation and quality of the salts. So, in a season there are about 450 maunds of salt production from a *kani* of land. The average price of salt is Tk. 130 per maunds. So total selling price of produced salt is TK 58500 where total cost of salt production in one kani is TK 23235. So, net profit is TK 35265.

Lessons Learned

Key lessons learned from this practice are:

- The local farmers reported that this cultivation is simply the taping of the natural resources. Nature provides different people with different boons and they are to know how to tap it. Due to ecological change, nature deprives of one resource and provide with another more beneficial than the former. Now they have learnt to tap it at their own benefit.
- It is a short term harvest. The total production process requires only a nine days cycle and the season continues for a few months.
- The cultivation process is simple and low cost compared to the profit the farmers earn.
- Salt cultivation does not involve big capital and the enterprise is not labour intensive. The farmers employ some labours on small payment and mostly the household labours work in the salt fields.

- Δ The tools and equipments are simple and available in the surroundings.
- Δ It is a profitable venture compared to other traditional agric products in the same piece of land.
- Δ Salt cultivation over a long period in a plot damages the quality of the land.
- Δ The enterprise reduces the import dependence from other countries and saves national currencies.
- Δ The salt cultivators stated that the margin between their selling price to the middlemen and the market price discourage them for salt cultivation, as they realize that the actual benefit of their toil is enjoyed by the middlemen. The reality is that the actual cultivators do not get the prize of their labour.

Potential for Replication

Salt is an essential item and hence has the universal demand. The cultivation of such an important item is the imperative upon people of a country. Otherwise this is to be imported from other countries and it requires huge foreign currencies. So to relieve the exchequer of the country the production is to be increased.

We have potential for salt cultivation on the saline coastal area of the country. The enterprise is profitable no doubt. It is a short term crop and is environment friendly. The vast amount of salt that is being carried by the tide of the sea should be taped as a natural resource. So this should be replicated along the entire coastal area of the country.

GO-NGO proactive approach is needed for the extension of the harvest. The hindrance now is the incentive to the farmers and that is the fare price should go to the real producers.

CHAPTER 6

COPING IN CYCLONE PRONE REGIONS

Chapter 6
COPINGIN CYCLONE PRONE REGIONS

CYCLONE SCENARIO IN BANGLADESH

Bangladesh is susceptible to cyclones accompanying water surges. The country is a part of the humid tropics with the Himalayas lying in the north and the funnel shaped coast touching the Bay of Bengal in the south. This type of geography of the country produces life-giving monsoons but also face the catastrophic ravages of disasters. Therefore, the Bay of Bengal is the ideal breeding ground of tropical cyclones. Here severe cyclones associated with water surges occur mostly during pre-monsoon (April-May) and post-monsoon (October-December) periods. Out of a total of 64, 19 coastal districts of the country, all lying on the coastal belt, namely: Bagerhat, Barguna, Barishal, Bhola, Chandpur, Chittagong, Cox's Bazar, Feni, Gopalganj, Jessore, Jhalokati, Khulna, Lakshimipur, Narail, Noakhali, Patuakhali, Pirojpur, Satkhira and Shariatpur, are most vulnerable to the cyclone as well as water surges. The Chittagong-Cox's Bazar coast receives around 27 percent while Khulna-Sundarbans and Barishal-Noakhali coasts are relatively less vulnerable (Rahman: 2001). Less number of trees makes the coastal area more vulnerable to cyclones and storm surges. Most of the people of the coastal area lost their lives or injured in the storms, primarily as a result of the water surges. Also their livelihoods are impeded; crops of agricultural land are damaged; large number of cattle, buffalo, goats and poultry are killed and washed away; community infrastructures are swept away and schools, hospitals and clinics lost their existence with all the equipments.

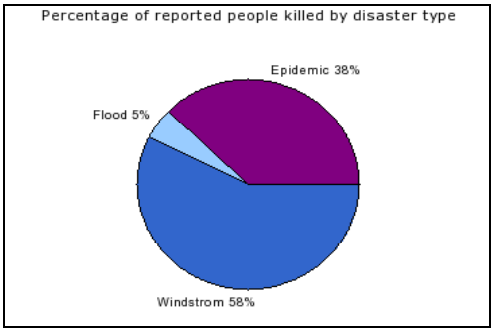
Bangladesh has been experiencing these cyclones and water surges when enormous disruptions and damages are inflicted upon. Over the last 30 years, 39 cyclones of different scales hit the country with loss of valuable lives and property (Cyclone Shelter Preparatory Study (CSPS), 1996). From 1797 to 1998, 67 major cyclonic storms and storm surges have been reported. The cyclones of 1970 (Bhola), 1991 (Tropical) and 2007 (Sidr) are some of the glaring examples. The 1970 Bhola cyclone was a devastating cyclone that struck on November 12, 1970 (Islam, 2006). It was the deadliest tropical cyclone ever recorded, and one of the deadliest natural disasters in modern times. The 1991 cyclone which struck Bangladesh on the night of 29-30 April 1991 was particularly severe causing widespread damage, killing 138882 people (Bern, et al. 1993). Recently Bangladesh has been hit by a major cyclone accompanied by a storm surge during 15-16 November 2007. The

cyclone with winds over 250 kilometres/ hour affected about 7 million people in the southern coastal districts of the country mainly within the administrative divisions of Barisal and Khulna. The periodicity of the devastating cyclones has been observed to decrease remarkably, especially in the couple of decades. The 1970 occurrence was after 50 years, the 1991 occurrence was after 21 years and that in 2007 was after 8 years.[13].

OVERVIEW OF THE RISK ENVIRONMENT

It is reported that four major cyclone storms and tidal surges have struck Bangladesh from 1970 to 2007. This indicates that Bangladesh is prone to frequent destructive tropical cyclones associated with tidal surges. Bangladesh has experienced cyclone of major magnitude in 1970 (Bhola cyclone), 1991 (Tropical cyclone), 1999 (Orissa cyclone) and 2007 (Sidr cyclone). The wind speed of Bhola cyclone was nearly 227 km/ hour, whereas the others were over 230 km/ hour, such as the speeds of 1991, 1999 and 2007 had been 257, 237 and 247 km/ hour respectively. The storm surges as recorded are 7.8 m, 8.8 m, 8.1 m and 8.4 m in height for the cyclones of 1991, 1999 and 2007, respectively[14]. The low-lying coastal areas of the country are particularly vulnerable, thus placing a vast population together with infrastructures, agricultural resources, livestock and economic development in a high-risk situation.

In Bangladesh many people die from different disasters such as flood, cyclone and storm surges, droughts etc. Summary of death events from 1900 to 2006, especially of the top 10 disasters in Bangladesh, shows that 58 percent people are killed by cyclones and storm surges, 38 percent are killed by epidemics and 5 percent are killed by floods[15]



A summary of disaster events from 1900 to 2006

The 1970 Bhola cyclone which struck on November 12, 1970 caused casualties of more than 250000 people's lives in the storm, primarily as a result of the storm surge. The storm surge devastated many of the offshore islands. Tazumuddin Island was the most severely affected, 167000 people were killed by the storm, over 45% of the population (Paul and Rahman, 2006). The coastal Bangladesh was hit by a super cyclone on October 29, 1991 with winds of more than 250 km/ hour accompanying heavy rainfall and tidal waves rising 20 feet high. The cyclone particularly struck greater Chittagong severely, causing widespread damage, killing 138882 people (Bern, et al. 1993). In 2007, Bangladesh witnessed the cyclone Sidr on November 15, an unusually powerful storm accompanied by 260 km/ hour devastating winds and storm surge up to 30ft (7m) high and killed more than 7 thousand people in the south western coastal belt including the districts of Bagerhat, Barisal, Patuakhali, Pirozepur, Khulna and Satkhira of Bangladesh (ADB 2007).

The 1991, cyclone caused serious disruptions in agricultural sector. About 247,000 tons of cereal crops and 35,000 tons of vegetables, tubers, and other crops were lost. Consequently, damages to coastal embankments, intrusion of high salinity as well as a shortage of tools, seeds, and fertilizers hampered drastically the rice production in June-October harvesting season of 1991. About 224,000 cattle heads, 218,000 goats, and 2.4 million poultry were killed in the cyclone. The fisheries sector was highly damaged with extensive loss of 31,000 hectares of shrimp farms as well as many fish processing plants, vessels, and stockyards. The forestry sector

13 Nehal Karim, Ph.D, Department of Sociology, University of Dhaka.

14 M.Z. Hossain, M.T. Islam, T. Sakai and M. Ishida "Impact of Tropical Cyclones on Rural Infrastructures in Bangladesh". Agricultural Engineering International: the CIGR Ejournal. Invited Overview No. 2, Vol. X. April, 2008.

15 http://PreventionWeb_net.htm

also suffered considerable losses of fuel wood and timber, and coastal mangrove plantations were damaged which increases the possibility of serious coastal erosion in the future[16].

The 1991, cyclone and storm surge caused an estimated damage to properties worth $1.5 billion (1991 US dollar). According to the Government of Bangladesh (GBD) estimates, the 1991 cyclone destroyed 780,000 homes, 9,300 schools and 655 health centres. More than 190 kilometres of coastal embankments were destroyed and 940 kilometres damaged. Numerous tube wells were either damaged or contaminated. In many areas, the surface water resources including ponds used for bathing and cleaning were contaminated with saline water. So people suffered immensely from safe drinking water. Almost all industries in the port area of Chittagong suffered heavy damages, and the port itself was left in shambles. Power and communication lines to the affected areas were cut off, and train, road, and air services were disrupted. A large number of boats and smaller ships were damaged. Bangladesh Navy and Air Force were also heavily hit. Most of the fighter planes of the Air Force base were also damaged. The storm surge subsequently swept away the embankment, as well as all the villages nearby. As consequence of the storm surge land erosion resulted en-masse and farmers lost their lands.

PROFILING THE STUDY AREAS

The initiative of this study has yielded significant ethnographic information on the episodes of good community coping strategies related to cyclone and storm surge from Cox's Bazar. The survey areas were 8 villages in 7 unions in 4 upazilas of Cox's Bazar district. [See Annex

In the study areas, it is observed that different hazards are found to befall upon the area round the year. Cyclone, storm surge, salinity, flash flood, flood, river bank erosion, hail storm, wild animal attack and nor'wester are the major hazards of Cox's Bazar district. Cyclones and storm surges are common natural hazard of these study areas which may occur twice a year. It may occur in the months of April-May (pre-monsoon period) and in the months of October-December (post-monsoon period). The intensity of cyclone and storm surge is higher in the months of October – November and April – May. The study districts comprise of the eastern coastal belt covered by hilly areas and it has the longest beach. It is one of the most vulnerable areas of the country to cyclone and storm surge.

In the study areas all livelihood resources like, physical, social and economic or financial resources including humans are vulnerable to cyclones and water surges. Physical resources are the most vulnerable in this hazard. From 1900 to 2006, the top 10 disasters in Bangladesh show that 58 percent people were killed by cyclones. Many people of the coastal area became homeless by cyclone and storm surges. Agric products, fresh water fishes and trees of the area were also vulnerable. It affected surface water resources used for collection of drinking water and contamination caused various water-borne diseases. Mental health of the community people was also vulnerable. Saline water of storm surge decreased the productivity of normal agric plots. As a consequence cyclone and storm surge created food insecurity of the coastal people. In this way cyclone and storm surge affected all the sectors of human life.

COPING IN CYCLONE PRONE REGIONS

The community people of the study areas are highly pro-active in their respective efforts to mitigate the consequences of cyclones and storm surges. It is observed that people attempt to address risk problems ex ante. In this chapter we would discuss one good community practice concerning ex ante risk management. Cyclone and storm surge is the most severe hazard in the coastal areas of Bangladesh. The community people of the area are concerned about its magnitude of damages and frequency of occurrences. Most of the time the impacts are cumulative and the effects are magnified at the local level. There is effective early warning system as well as there is some indigenous knowledge which help

16 http://pdf.usaid.gov/pdf_docs/PNADG744.pdf

community people to predict the likelihood and intensity of cyclone and storm surge. But the early warning cannot reduce the vulnerability of physical assets and economic or financial assets; they only can reduce human casualties. Therefore, it is potentially a long term program for people to adopt different approaches and options to reduce their impacts.

It is critically important for scientists to understand the probability of cyclone and storm surge events at various levels of intensity and duration. The existing cyclone warning system in Bangladesh is not easy to understand, almost incomprehensible even to the most of the educated people. As a result the spirit of the message it carries often fails to reach the general people. Indigenous knowledge, in different study areas, has been proven to help contribute to the community's ability to mitigate the impact of cyclone and storm surge. The indigenous knowledge of cyclone forecasting reduces the vulnerability. People may prepare to go to the cyclone shelter to save their lives.

The vulnerability to cyclone is determined by the impacts on livelihood components, such as: natural, physical, social, economic or financial and human resources. Forecasting system, technological changes, and government policies may alter the vulnerability to cyclone. Cyclone and storm surge is the part and parcel of coastal life. The coastal people cannot avoid these hazards by any means. So, they try to cope with these hazards and take some initiatives to reduce the vulnerability. The community people try different structures in house making only to withstand the severity of the hazard; effectively adopted one is *pusher bari*. They also practice plantation of vegetation around the homestead which reduce the speed of the wind of cyclone and also decreases the velocity of water with the storm surge.

Cyclone Forecasting Scenario in Bangladesh

In Bangladesh, Bangladesh Meteorological Department (BMD) generates the warning of cyclone and storm surge as well as passes this on to public media and preparedness units for dissemination and follow-up action at periodic intervals. There are separate warning system for maritime ports and river ports. Modern technology has been used for the detection and monitoring of cyclones from the forming stage to the striking at a certain place. Warning messages are coined according to the information on the physical aspects of the cyclone when it remains at a far distance such as: tropical cyclone location, its motion, tropical cyclone wind speed and the probability of storm surge. The warnings are forecasted stating the following aspects such as the position of storm centre; wind direction and the rate of physical movement; area likely to be affected specifying upazilas (administrative unit in Bangladesh) of the district if possible; approximate time of commencement of gale winds (speed more than 32 km/ hour or 52 km/ hour), maximum wind speed expected; and approximate height of storm surge/ tide. Cyclone Warning messages are disseminated according to the standing order of the government. These are - warning Stage: 24 hours in advance; danger Stage: Minimum 18 hours in advance; and great danger Stage: Minimum 10 hours in advance[17].

Alo hawa bedhona.
Rogey bhogey morona //
Dakhin duaree ghorer raja.
Pub duaree tahar proja //
Pashchim duarir mukhey chhai.
Uttar duareer khajna nai //

Interpretation: Dwelling houses should be such that free air can flow through and light from outside can enter without any let or hindrance. The scientific opinion today is that the free air contains enough of Oxygen inhaling which people can refresh and replenish Oxygen supply to the body and sun light entering the house kills enough of the germs. So the proverb advises not to obstruct both light and free air flow in the house. This may cause diseases to expedite death and is not at all hygienic.

17 http://www.adrc.or.jp/publications

The weakness of the present cyclone forecasting system in Bangladesh requires significant attention to explore the need of the indigenous forecasting knowledge. The existing cyclone warning system of the country is not easy to understand, even to the most of the educated people. The languages of special weather bulletins are not simple, as a result the message it carries often fail to reach the general people. Weather bulletins forecast simply storm surge height without giving information about the stage (e.g. high/ spring tide and low/ neap tide). The intensity of rainfall from the approaching cyclone is not forecast. The accuracy of the forecasting/ warnings is not out of question. In the past, many of the warnings of destructive cyclones were incorrect[18]. Due to the limitation of cyclone warning, particularly in dissemination system, Bangladesh cannot provide meaningful and effective early warnings of cyclone as well as storm surge. Indigenous indicators may help the warning system to be implemented effectively.

Indigenous Indicators of Cyclone and Storm Surge

The community people are to always fight for their survival with cyclones and storm surges, which gave them much knowledge that helps them to cope with the hostile environment. Nature has taught them to take the readings from her and the characteristics of the climate and its various aspects.The local people have multiple perceptions leading to multiple responses. People in all the study areas are in consensus that cyclone has become a recurring phenomenon with different magnitudes. People in coastal areas apprehend storm surge along with cyclone. They believe in some indigenous indicators to forecast cyclone and storm surge. Indigenous indicators (e.g., wind speed and direction, temperature changes) used by the local people are similar to those used in the scientific forecast. The scientific forecasts rely primarily on meteorological indicators, such as wind and sea surface temperatures. The community people have been using a combination of various biological, meteorological, and astronomical indicators to predict the cyclone and storm surge. Indigenous forecasts are highly locale specific, mostly at the village level within a radius of one to two square kilometres, and are derived from an intimate interaction with the microenvironment as observed over a period.

Cyclone is a common hazard in the disaster prone country like Bangladesh. Several cyclones hit different places of the country during the time in between the months of *Falgun* and *Jyaistha* (mid February to mid June). The community people are very much acquainted with the cyclones from the very birth and the presages are very distinct to them. Rice farming is the main occupation of the coastal area, now-a-days most of the community people are engaged in the collection of salt from the saline water of the sea and fishing in the Bay. Both on fishing and salt preparation, climatic conditions play a very important role. So for ages together they have been trying to take readings on climatic conditions from the different elements of climate. They explained different characteristic symptoms of climate in different manners and in analyzing them gradually they have, by now, minimized the errors. So they are now able to explain the different changes in the climate in the light of their experience gained through knowledge. Below are some of the collections of the predictive indicators on cyclones gathered by the community people through their experience as obtained from different areas of Cox's Bazar:

Pubey hansh, pashchimey bansh,
Uttarey Kola, Daxiney mela.
Daxin chherey uttar berey ghor
korogey pota chhurey //

Interpretation: The best practice of making dwelling house is to leave spaces to the east for rearing ducks, to the west bamboo clump for resisting storms and the southern side is open for free movement of air.

18 Cyclone Disaster Mitigation in Bangladesh, Professor M Alimullah Miyan, South Asian Disaster Management Center (SADMC), IUBAT—International University of Business Agriculture and Technology Dhaka, Bangladesh

Seasonality and Weather Variability

The community people divide the year in three periods without assigning any importance to any specific disaster. The periods are:

(1) Most disastrous period is *Chaitra-Sraban* (mid March-mid August)

(2) Less disastrous period is *Bhadra–Aswin* (mid August-mid October) and

(3) Period of no disaster is *Kartik-Falgun* (mid October-mid March).

Intensity of sunlight

The presage of rainfall with storm is understood by the soaring heat. The increase of the intensity of sunlight indicates the possibility of storm. Then the air temperature is generally above the normal.

Wind Flow

The community people of Kakara union stated that the air temperature is generally above the normal and wind flows from the North in the month of *Ashar-Sraban* (mid June to mid August). The coconut and areca nut trees are violently and abnormally agitated by the winds. The bamboo clumps make fluttering sound i.e. when there is high speed of wind, the bamboo strikes each other and make sound and the knots of the bamboo are cracked On seeing this they can predict the possible onslaught of storm.

According to the people of Badarkhali, the flow of wind from the North-Eastern corner in the months of *Chaitra to Sraban* (mid March to mid August) bears the indicative presages of stormy weather. This wind, in whichever part of the day blows, the velocity may be less or great, if it accompanies drizzling and if that is at the end of the day, will cause storm at any part of the night.

Indicating the magnitude of wind flow:

- The bamboo clumps make fluttering sound and bamboo strikes each other.
- The knots of the bamboo are cracked.
- Wind blowing from certain directions and the wind velocities are evil, to them and these evil winds accompany no small disaster, rather accompanies the fatal disasters like cyclones.
- If wind blows violently from the North to the South and vice-versa in the months of *Chaitra-Baishakh* (mid March-mid May), then there is presage of big storms. Due to the high speed of wind, there will be massacre of homesteads, trees and plants.
- The presage of cyclones lie in the rotation of the wind direction from the *yeshan kone* (North-Eastern angle) to the *agnikone* (South-Eastern angle) and then to the *bayukone* (South–Western angle) within 24 to 72 hours. There will be water surge from the sea accompanying huge water mass.

Animal's Behaviour

If there is any storm or tidal wave in the sea, fishes jump and in that case the fishes along the coast line jump more. The proven fact, they claim, is that if there is any disturbance anywhere in the sea fishes first realize and fishes living in the sea , especially those in the mouth of the river, remain still during the full tide and understand that there is disaster in the sea i.e. the sea is in agitation. Abnormal behaviour of fishes in the pond can be observed for two to three days prior to the storm.

Before 3 – 7 days cattle become restless and stop eating grass. Cattle/ dogs wail continuously at night. Ants climb trees with eggs on their backs. Bees move around in clusters. Birds fly without destination. Number of flies and mosquitoes are increased. Insects attack cattle before 1 – 2 days. Crows/ cockerels cry / fly at night. Frog calls constantly. Foxes bark during the day. Crabs come into the house and courtyard before 3 – 7 days.

Sea / River Patterns

Big waves/ dark rolls of water are found in the sea. *"Goroom goroom"* (imitation sound type created) noise is created in the river. The sea appears smoky or cloudy. Pond and river water become hot up to one day before.

High Temperature

At high temperature they observe the village ponds to get the indication of storm. They opined that in case of big storms, abnormal behaviour of fishes can be observed two to three days before. They jump and rush this way or that.

Cloud

According to the local people of Kakara, during the months of *Baishakh-Jyaistha to Sraban* (mid April-mid June to mid August) the rushing of clouds from the Northern sky to the Southern sky or, vice-versa, is the indication of no little rainfall, there remains the apprehension of big events of fatal storms. Again if the clouds after rushing gather in the Western sky and stand still, there will be big storm.

The clouds that come above due to violent motion or carried by the blow of wind will cause strong storm accompanying rainfall in the direction they burst into rainfall and wind will blow with violent speed. This stormy weather is harmful to human beings, cattle heads, birds, trees, plants, crops and everything. The cloud gains violent speed from the irregular movement in the sky. Consequently the temperature of the water increases, and where-ever the cloud comes down as rainfall does harm to plants and trees and these are burnt.

While in the deep sea, if the local people see that the clouds in the sky are dishevelling this way or that, then they understand the cyclone has started somewhere in the sea. They opined that they can guess whether there will be any cyclone in this Badarkhali area only by observing the speed of the wind. Whether the cyclone will hit a certain area can be guessed by determining the direction of the wind. They can guess the creation of depression at any part of the sea by observing the dishevelled speed of the wind in the sky. During this time the sea is hot and if this hot air blows with light to heavy speeds over Badarkhali from the North to the South, the cyclone will hit this area.

Location of a cyclone

In addition they say that the location of a cyclone to the South of Teknaf, then the cyclone will not hit Badarkhali and if the location is to the deep sea south of Khulna, then the possibility of hitting us is maximum. This is the result of their long standing experience.

They can guess about the possible direction of the cyclone. They conveyed that the direction depends basically on the power at their centre. While moving the direction in which the wind blows the cyclone advances. Mainly the direction in which wind blows around the circle towards the centre, the cyclone moves to that direction.

Validity and Reliability and Lessons Learned

Cyclone forecasting indigenous indicators as mentioned above suggest a forthcoming cyclone associated with storm surge. The reliability of those indicators is high. The warning dissemination takes place mostly by the women folk of the community. The warning system they use is perfect. The local people are conscious about upcoming cyclone; they prepare themselves for leaving home to nearby cyclone shelter or to a neighbour's strong house. The community people of the coastal area have a hierarchy of preparedness strategies which usually include seeking a cyclone shelter as a last resort.

Potential for Bridging with Early Warning System

It is observed that most of the indigenous indicators are based on animal behaviour and weather patterns. These indicators are reliable in both tidal surge and cyclones. They can predict the severity of upcoming disaster. People know from their indigenous knowledge that if cyclone occurs with tidal waves, the height of water is higher which causes more havoc. This information is easily visible and simply disseminated among rural people, without any special equipment. Scientific and indigenous indicators can jointly increase appropriate warning options. It is needed

to explore whether certain combinations of the best indigenous indicators and the best scientific indicators can offer a more appropriate, reliable and comprehensive warning system for vulnerable rural people.

RESILIENT HOUSING STRUCTURE

Cyclone and Storm Surge Resilient Housing Structure: *Pusher Bari*

Précis

Location		Seasonality
Union	Upazila	
Nhila	Teknaf	Falgun to Jyaistha
Bahachi	Kalatali	
Kutubjan		
Chhoto Maheshkhali		
Charpara	Maheshkhali	
Badarkhali	Chakoria	
District	Cox's Bazar	

Prologue

The above areas of Cox's Bazar district are severely affected by the cyclones and water surges every year due to their geographical location on the sea coast. The fiercest speed of the cyclonic wind and the water surges from the nearby sea utterly spoil the houses and dwelling places at the outset. Therefore, people residing in this region have gained a longstanding experience by trial and error method and that helped them to innovate a mechanism to build cyclone and water surge resilient dwelling house. They have learnt to build houses in a special manner to be densely surrounded by planted trees.

The Initiative

The people in this area make their houses in a special manner so that these may be easily saved from the onslaught of cyclones and water surges. The pattern of these houses is such that the plinths are high, the roofs are relatively low having small slopes and the houses are surrounded by walls on all sides. The house inside the walls is made very strong to act as the core house against cyclones and water surges. Besides, people of the area plant sufficient trees so that these trees can withstand the fastest speed of winds and water surges. These types of houses are called *'Pusher Bari'* in these areas. People learnt preparing these houses from ages together.

Goal and Objectives

The objective of this initiative is to reduce the vulnerability of people to natural disasters like cyclones and water surges. The structure is so designed that it can face the fiercest wind flow and the tremendous flow of water surges.

Outcome and Activities

There are a number of steps for preparing a *'pusher bari'*. At the outset they raise the plinth

A GOOD PRACTICE

- This house is encircled by a rigid wall and inside the house 1 or 2 room(s) is/ are built strong and rigid so that during cyclones and water surges they can act as the core house/s.
- It is an indigenous method of coping practice which people have developed through experi-mentation and observation during many years last;
- As the roof is relatively low and with small slope, the magnitude of wind during storm is less;
- As the roof of hemps become heavy with rain water, this roof can not be blown away easily by stormy wind;
- Different plants and trees around the house act as obstruction to the intensity of wind and water current during cyclones and water surges;
- The structure ensures and enhances the security of the vulnerable people has been a proven fact.
- Effectively enhances the safety of the population at risk.
- Already adopted & fitted to the local ecology.

of the house on the foundation. They lay the foundation by filling up to 4/5 ft high with soil from the nearby lands. Then they engage skilled carpenter to make frame of the house. Then they use generally wooden logs of blackberry and jackfruit trees as poles for making the frame of the house and that of the roof (frame of the roof is locally called *'borkha'*). At this very time they make one or two room(s) very strong and rigid so that at the time of cyclones and water surges these can act as the core house. In making the frames of the roofs they make them with relatively small slopes so that the hit of the wind is less. Then the roofs are covered with either C.I. sheets or hemps. Generally the middle class people use C.I. sheets while the lower income people use hemps. But the C.I. sheets are blown away by the stormy winds and acts as blades when reaches a poor victim and hence is dangerous at this time. So in spite of having capability of using C.I. sheets, many use hemps as roofing materials on safety grounds. As the hemp roofs become heavy when exposed to rainwater they cannot be blown away by the storm wind easily.

After making the roof, they go for making the walls around. For the purpose they generally use bamboo made fences. In building a house with tin measuring 28 ft x 26 ft costs them Tk. 42400 and the same with hemp requires Tk. 28900 (see annex for details).

After raising the house people plant sufficient trees around to save the house from cyclone and water surge. In planting these trees they consider their utility also. From longstanding experience they observed that there were some trees like *babul,* acacia, coral tree and silk cotton plants which were dreadful at the time of cyclone and so they avoid planting these trees around their homesteads. Generally they pant the following trees:

Generally 450 or 500 saplings of different trees are planted around a newly built house. This costs them about Tk 1000 (see annex for details). Usually the ladies of the households maintain the saplings to grow and save them from cattle heads and goats.

Lessons Learned

The basic lessons of this coping practice are:

- Δ It is an indigenous method of coping practice which people have developed through experimentation and observation during many years;
- Δ To their mind, this can be practiced with local materials and the construction too is easy.
- Δ This house is encircled by a rigid wall and inside the house 1 or 2 room(s) is/are built strong and rigid so that during cyclones and water surges they can act as the core house/s.

Table xx: The selected plants and trees around the house

Selected trees	Utilities
Bamboo clump	Acts at mitigating the intensity of the cyclones and water surges. It swings along the wind and does not break easily and even though it breaks, it does not harm much to houses. Besides it acts as buoy to float.
Coconut and areca nut trees	Resist the forceful wind and strong current of the cyclones and water surges and the water of coconut and its kernel are used as alternative to food during post disaster period.
Tamarind, *bakul (* a large evergreen flower tree), *Jarul (*a tree of inferior timber),blackberry trees, *Neem,* mangosteens, *arjun* (a medicinal plant)	These trees do not easily break as they have strong and rigid roots and resist wind. As they have many branches they can be used as life saving during water surges.
Malaria (ucalyptus), acacia, mahogany.	They have big twigs and leaves and can effectively resist the intensity of the storm wind and that of water surges.

- As the roof is relatively low and with small slope, the magnitude of wind during storm is less;
- As the roof of hemps become heavy with rain water, this roof cannot be blown away easily by stormy wind;
- Different plants and trees around the house act as obstruction to the intensity of wind and water current during cyclones and water surges;
- During post disaster period the water and kernel of coconuts are used as alternative to food;
- The cost of building this houses is beyond the ability of poor people;
- The tins of tin sheds are easily blown away by the strong wind during cyclones and act as blades to a poor victim and so are very dangerous.

Potential for Replication

The occurrence of cyclones and water surges is very common natural event, which cannot be avoided by any means. The loss of houses and properties can be mitigated to a great extent by raising *'pusher bari'*. This structure helps save the house from the intensity of storm wind and current of water surges. The plants and trees around also stand helpful against the wind and water current. So this type of house structure is replicable along the coastal area of Bangladesh.

Go-NGOs may come forward to disseminate this technology. The technology can be improved by NGO's initiative. Go-NGOs may help the poor people to make the structure.

CHAPTER 7

COPING IN DROUGHT PRONE REGIONS

Chapter 7
COPING IN DROUGHT PRONE REGIONS

Drought Scenario in Bangladesh

Droughts and aridity have caused considerable economic losses and human sufferings in Bangladesh. Like floods. An analysis of the relative effects of flood and drought on rice production between 1969-70 and 1983-84 shows that drought is more devastating than floods to aggregate production (World Bank, 2000). The Northwest part of the country is generally considered as the drier region than other parts of Bangladesh. This research, however, capture indigenous knowledge and coping strategies related to drought and aridity in several research sites located in Barind Tracts (the districts within), arid char-lands of Gaibandha and Nilphamary districts.

Drought appears to be a creeping phenomenon in Bangladesh. The effects of drought accumulate slowly over a considerable period of time, and may linger for years after the termination of the event. The Northwest part is prone to drought mainly because of rainfall variability in the pre-monsoon and the post-monsoon periods. Inadequate pre-monsoon showers, a delay in the onset of the rainy season or an early departure of the monsoon may create drought conditions in Bangladesh, and adversely affect crop output. Again, drought episodes transpire when precipitation has been significantly below normal recorded levels, resulting serious hydrological imbalances that adversely affect land resources production systems.

Consequently, during the dry period, the ground aquifer level goes below 8.95m to 18.56m in some regions of Northwest Bangladesh (MoEF 2002). This indicates that most of the shallow tubewells go below the suction lift capacity having severe implications for terrestrial vegetative cover and aggregated agricultural yields. Drought acts as a catalyst of land degradation through reducing soil moisture and water retention capacity, and thereby increasing soil erosion, decline in soil organic contents and overexploitation of sparse vegetation. Human interventions in the form of land abuse and mismanagement have exacerbated these actions during the spells of periodic droughts.

Profiling the Study Areas

This research enterprise has yielded significant ethnographic information on the episodes of good community coping responses related to drought and aridity from different locales of Rajshahi, Nawabgonj, Naogaon, Gaibandha and Nilphamari. The survey areas were 17 villages in 10 unions in 6 upazilas of the five districts. [See Annex XX]

Fog, cold wave, drought and nor'wester found in Naogaon; flood, sand deposition with flood and drought in Gaibandha; flood, drought and fog in Nilphamari; nor'wester, heavy rainfall, hailstorm and extreme heat in Chapai-Nawabganj; and drought, cold wave, flood and hailstorm in Rajshahi. Drought is one of the main and common hazards found from the districts which are observed in *Ashar to Chaitra* (mid June to mid April). Rajshahi, Nawabganj and Naogaon are located in Barind tract. But the studied areas of Nilfamari and Gaibandha are facing the drought situation due to the land characteristics (sandy soil) of newly formed char land.

In the study areas due to drought, mainly livelihood assets like agriculture and fisheries are more vulnerable. In the same way, their economic activities, crops, vegetation, water sources and cattle are vulnerable and mental health of the community people are also vulnerable. The indigenous people (Santals, Mahali and the like) are more vulnerable due to their poverty and minority status. Aridity and less rainfall hamper the agricultural process and extreme heat and scarcity of water destroy the crops (paddy, jute, tobacco, maize, potato, wheat, and mastered seed, vegetables, onion etc). In this way drought affects in food security and livelihood. Scarcity of water for irrigation, household use and drinking purpose are also making people's life at risk.

Overview of the Risk Environment

After 1971 Bangladesh has experienced droughts of major magnitude in 1973, 1978, 1979, 1981, 1982, 1989, 1992, 1994, and 1995 (MoEF 2002). Past droughts have typically affected about 47 percent area of the country and 53 percent of the population. However, Bangladesh does experience long spells of dry weather and moderate to severe droughts are spread over a region of 5.46 million ha and 33 percent of total land acreage in Bangladesh falls below the minimum threshold for sustainable cultivation. For instance, the droughts of 1994-95 in the Northwest districts of Bangladesh led to a shortfall of rice production of 3.5 million tons (Paul, 1995).

The Rabi and pre-Kharif (January – May) agricultural seasons are likely to be affected by drought (Karim et al., 1990) due to: (1) the cumulative effect of dry days; (2) higher temperatures during pre-Kharif (>40 degrees Celsius in March - May); and (3) low soil moisture availability. This drought affects all the Rabi crops, such as HYV Boro, Aus, wheat, pulses and potatoes, especially where irrigation possibilities are limited. It also affects sugarcane production. Kharif droughts during June to October, caused by sub-humid and dry conditions, affects the critical reproductive stages of transplanted *Aman* crops resulting significant yield reduction, particularly in those areas with low soil moisture holding capacity.

Water is the main limiting condition for human adaptation in the drought prone regions. The people had to depend mainly on rain water for cultivation that does only allow mono crop (single crop throughout the year). The crop production is rarely met the demand of increasing number of population, and again the expected production sometime affects mainly by the natural calamities. The context of climate change and geopolitical aftermath of *Farakka* Barrage have also exposed the region to increased and prolonged drought. The introduction of deep tube-well irrigation by the BMDA has yielded significant change in the production scenario, but still many areas located in upper Barind remain outside of having irrigation facilities due to the unavailability of the ground aquifer as well as for unfavourable geological conditions. Consequently people are always being chased by famine like situations.

Besides these physical conditions, the socially generated pervasive processes of inequality in the distribution of goods and services, exclusion of the minority and indigenous communities, and other concomitant factors accelerate the sufferings of people intensifying wide-scale food insecurity in that region. Again, domestic agriculture itself depends upon a variety of imported inputs such as fertilizer, fuel and machinery. Small family firms suffer from crises, such as a harvest failure or animal disease, or natural disasters, especially drought, which significantly disrupts the domestic food supplies in an uncertain market.

Drought aftermaths multiplied by concomitant social pragmatics have cumulative bearing upon

the socio-economic conditions and livelihood support systems of people living in those regions. It causes scarcity of fresh drinking water, reduces the prospects for irrigation and thereby diminishing of the food security base of human beings as well as livestock. Drought also reduces availability of biomass for fuel and significantly causes bio-diversity loss. It affects the state of health and nutrition of the population, and above of all, drought intensifies poverty.

Coping in Drought Prone Regions

The research findings suggest that the communities in such areas are highly pro-active in their respective efforts to mitigate the consequences of drought. People, in the study areas, attempt to address risk problems *ex ante*. In this chapter we would discuss some cases of good community practice concerning *ex ante* risk management which more often includes diversified coping strategies to offset risk of drought impacts. Drought has some unique characteristics, as discussed earlier, that makes it difficult to determine the onset and end of the event. Therefore, its potentially long duration requires people to adopt different approaches to reduce their impacts.

Unlike other natural hazards, the impacts of droughts are generally non-structural and the absence of any effective early-warning systems for drought remains as to be the central challenges for people and professionals to reduce or mitigate the consequences of drought events. Most of the time the impacts are cumulative and the effects are magnified at the local level. The indigenous weather and climatic knowledge becomes inadequate to address the need for continuous monitoring of climate and water supply indicators to identify the severity of drought conditions, and to represent it in a probabilistic perspective.

It is critically important for scientists to understand the probability of drought events at various levels of intensity and duration.

The risk associated with drought for any region is a product of the region's exposure to the natural hazard and the vulnerability of societies within the region to the event. Exposure to drought varies regionally and over time, and there is little, if anything, that can be done to alter its occurrence, because drought is a normal part of climate. The vulnerability to drought is determined by social factors such as land use, population increases and migrations. Water use trends, environmental degradation, technological changes, and government policies can also alter vulnerability to drought.

Indigenous knowledge, in different study areas, has proven to help contribute to the community's ability to mitigate the impact of regular drought events. In general, the indigenous knowledge of land management increases moisture retention, improves soil fertility and crop yield, and reduces surface runoff and thus withstanding soil erosion. People grow tree species like mango, Mahogany and Jackfruit, and plants different vegetables around homesteads. This practice of homestead gardening[19] provides healthy ecosystem for humans as well as other species.

People do not get sufficient water in the dry season as ground water recedes further below. Consequently people practice different strategies of coping to complement their need of water. The storage of water by making small embankments for segmenting irrigation channel has gained wide popularity in Barind tracts. The local people also plant trees and shrubs to reduce accelerated evaporation (Zuberi, 1998). Digging ponds also facilitates storage of water for domestic and agricultural purposes. Changes in cropping pattern and choice of crops and cereals in some areas are major coping strategies found in the study areas. These good community practices of coping are elaborated in the proceeding discussion.

Local Perceptions of Drought

The community people have multiple perceptions leading to multiple responses. People in all the study areas are in consensus that drought has become a recurring phenomena with different magnitudes. People consider rainfall amount as

19 please see chapter 3 for detail discussion on homestead gardening

an appropriate indicator of drought. But, farmers hinted that the amount of rainfall received alone does not indicate the reality. The start of the rainy season matters because it may vary by as much as a month or more, adversely affecting yield and drought conditions. Farmers have also a very good understanding and awareness about the consequences of untimely rains and inadequate distribution of rain.

The perceived causes of drought are multiple. Our observation reflects that "drought is not perceived as a chance event, but explained in terms of particular cause-effect relationships. Different people offer different interpretations, but all attempt to derive order from apparent chaos" (Scoones *et al.* 1996). The reasons offered by different groups are mostly religion and ritual

INDIGENOUS PERCEPTIONS, KNOWLEDGE AND EARLY WARNING

bound. People of the study areas explain drought, with little variation and exception, as an act of and curse from God. This view of supernatural causes is the same among the adibashis or indigenous communities of Barind region. People are becoming more sinful, and stuck in corruption, as they responded, which caused God to be disappointed. Besides, moral values, mutual respect and tolerance are on the verge of fading. One of our respondents stated that,

> "Drought is the consequence of God's anger and it is a penalty He is charging for various types of sins we are still committing. … His Almighty is not responding to our prayers. 'Day of Judgments' is approaching".

1.5. Knowledge of Early Warning

Given drought's slow onset or creeping characteristics, indigenous early warning knowledge of drought is essential because it provides the foundation on which timely decisions can be made by the people living in draught prone regions. Monitoring and observing the hydrological system (the relevant indicators are: precipitation, temperature, evapotranspiration, soil moisture, stream-flow, ground water, reservoir and pond levels, and etc) is the only mechanism people have for detecting drought's early onset and its potential impacts on sectors, regions, and population groups. Observing and analyzing these indicators at the regional level for generating seasonal draught forecast becomes difficult for localized people because of complexity or variability of these indicators, natural principles and contexts. Unreliable seasonal forecasts and the lack of specificity of information provided by scientific forecasts also limit the use of this information by farmers and other actors at the rural settings.

In forecasting drought, be that scientific or traditional, there always exist unmeasured entities and substantial uncertainties, but people need to take measure to protect livelihoods. The local weather and climate are assessed, predicted, and interpreted by locally observed variables and experiences using combinations of animal, insect,

PROVERB *Diney jol ratey tara.*
Ai dekhbey shukhnor dhara.

Interpretation: At the beginning of the rainy season if there is rain at day time and at cloudless night there appear stars in the sky, the year may have drought.

and meteorological and astronomical indicators. The indigenous weather and climate knowledge approach this substantial uncertainty related to drought on the basis of using different weather and seasonal rainfall indicators used to predict the occurrence of the rainfall. Farmers use different kinds of traditional knowledge to predict rainfall based on their observation of such phenomena as wind movement, lightning, animal behaviour and bird movement. These types of information provide a framework that farmers use to explain relationships between drought events and changes in the climate and weather.

Traditional knowledge concerning seasonal and long-term rain-fall has been discussed earlier (Chapter 3), and here we would try to make the points of lacking yet necessary capacities in generating and disseminating drought early warning information in the study areas, however. Because of the slow-onset nature of drought, it is essential that early warning systems have the capacity to detect the early emergence of rainfall deficiencies, which will normally be the best indicator of an incipient drought period. There is a need for the application of tools or indices that have been recently developed to evaluate the status of climate and water supply conditions and potential impacts in specific sectors (e.g., agriculture, livestock).

The indigenous forecasting knowledge of long-term rainfall ought to be complemented by scientific knowledge of long range forecasts out to a season or more whenever possible. A drought early warning system must not only encompass

mechanisms and procedures for the collection and analysis of information in a timely manner, but also for the dissemination of that information to potential end users, so that it can be applied in decision making. Once an incipient drought period is identified or forecast, there should be continuous information flow on expected onset and timing, intensity, cessation, duration, spatial extent and changes in areal coverage through time, and the estimation of economic, social, and environmental impacts. The scientific knowledge traditions need to better understand the need of information of the farm families in rural settings and devise strategies to communicate how forecasts and other climate/ water supply information can be used by those family farms in decision making to reduce the risks associated with drought.

The Rakkha Gola

Community Based Risk Insurance for Provisional Food Scarcity

The Précis

Units	Location	Seasonality
Union Upazila District	Deopara Godagari Rajshahi	All Seasons

Prologue

Food security has become a vexing matter of concern for the general people of Barind Tract. Given the backdrop of the constraints on the food production and supply chains, as well as the lacking of community people's capacity to have adequate access to affordable and nutritional food, as we have observed, the resilience of their food system significantly weakened over the decades, while transitory and seasonal food insecurity emerged as the central or core challenge in everyday life for people in the Barind tract.

The Initiative

The *rakkha gola* is a community initiated safety-net programme practiced among the indigenous people of Rajshahi district. A group of young people first initiated *rakkha gola* in 1975/76 to counteract seasonal semi-famine situation primarily caused by drought and other natural hazards. Community people's risk response strategies have been translated and operationalized into the 'community safety granary'. They deposit food grains everyday during regular seasons so that the needy could have got assistance during extreme adverse period from such cooperative efforts. This ultimately ensures food security for all even in the extreme hazard period.

In Bengali, the word *'Rakkha'* means to protect, and *'gola'* means a container of food grains. In addition, the *'rakkha gola'* also indicate distinct operational procedure for disbursing and recovery of paddy. Thus the *'rakkha gola'* could be defined as a community based initiative that ensures food security by storing the paddy in to the granary and disbursing it during the adverse period, and recovering during the harvesting period as well. Usually granary is found in most

A GOOD PRACTICE

This is a good practice because it served successfully several purposes –

- Δ This initiative has the potentials to be replicated in other hazard prone areas.
- Δ Built on community's own capacity
- Δ Effective way to reduce risk of transitory and seasonal food insecurity
- Δ Effectively enhances the safety of the population at risk.

The innovative aspect is the real optimization of local knowledge and local resources by local stakeholders, as well as significant mobilization of the energies behind social capital of local actors. These resulted in genuine ownership by and empowerment of local actors and groups.

The findings suggest that in terms of social vulnerabil-ity/ capacity, the rakkha gola facilitates and encourages the creation of a new social dynamics where people shared not only values and behaviors towards cooperation amongst themselves but also a proactive responsibility towards the community.

of the peasant households in Bangladesh for preserving the harvested crops which can be used at the time of needs, the *'rakkha gola'* is owned by the community and people, irrespective of any classification, have equal access to the system.

Goal and Objectives

The goal of *'rakkha gola'* initiative is to reduce the vulnerability to natural hazards, especially drought, and ensuring the food and nutritional security of indigenous, ethnic minority and poor community people living in the most high-risk outlying settlement areas in Barind Tracts of the Northwest Bangladesh.

The *'rakkha gola'* initiative aims *at* enhancing equitable access to food through risk reduction measures and augmenting resilience of the community people during short-term or transitory and seasonal food insecurity brought about by natural disaster.

Outcomes and Activities

The land for the construction of '*Rakkha gola'* was donated by the local people. It was a concrete structure and all the materials such as brick, cement, sand, labour and others were voluntarily given by the community members. The initiators donated 100 Maunds of paddy to make it operational initially and encourage others to donate.

The vase of the '*gola'* made of concrete had 6 ft diameter which is under 2ft ground. The internal maximum diameter was 10ft and the height was 12 ft. The outlet above was 2ft in diameter. The outlet was covered with a lid of 2ft in diameter. During the period maximum 500 maunds of paddy were preserved in this *'gola'*. The sketch (plate 8.1) depicts a '*gola*' as it appeared initially.

At the beginning, a management committee was formed to make it operational including *gola* construction in 1977. The committee was responsible to lend paddy to the needy and to recover it in time, basically during the paddy harvesting period including record keeping. The borrower was to repay 10 *seers* of paddy per maund in each year. In case of failure, one has to pay more accordingly. As paddy cultivation was an annual phenomenon, so repayment was done annually. This transaction had got popularity as farmers could not be able to produce enough to meet their demand in most of the cases. As result the storage increased at 500 maunds in 1980. This made a kind of social security that nobody will die from hunger at the time of severe natural hazard leading to food crisis.

The success of *'Rakha gola'* encouraged people to diffuse the idea to other area. But this enduring success was halted during early 1993-94 due to mismanagement. Eventually, famine could not be tackled down as was possible during *'rakkha gola*' operation period. As a consequence, the poor resorted to lend money from the money lenders and turned into destitute. This situation, thus, encouraged many of them to be united to think and to re-establish the *'rakkha gola'* once again.

Lessons Learned

Key lessons learned from this practice are:

- Technical fault remains in the construction of the *'gola',* which resulted in the accumulation of humidity generated from the basement. Excessive humidity inside the *gola* eventually damaged 20 maunds of rice. The management authority had no options but paying the penalty caused by this damage.
- Gradually the committee became partial while disbursing and recovering the paddy. Once the committee was formed, no initiative was taken to change the committee member and gradually the committee members had became manipulative and adopted preferential treatments in the distribution of benefits. As a result common people lost their enthusiasm and faith.
- Grouping within the members of management committee made it dysfunctional.
- Integrity and cooperation was the main strength of the enterprise. So long the members of the committee worked with honesty and integrity and the organization functioned well.

"During the rakkha gola period no famine is heard"
- An Adibashi Respondent

- Δ This was a community-based initiative, every people had equal access to get loan during the hardship period.
- Δ The '*rakkha gola*' establishment and operational cost was low, procedure was simple and easy.

Potential for Replication

As this practice is driven exclusively by local people through mobilizing local resources, it has a great potential for replication. This is a community-led initiative which is suitable for many other contexts and geographical conditions. The key to

success is the involvement of the community and the formation of a voluntary community-based organization (CBO) which would bring the community people together and put them in a leading role in the formulation and implementation of this coping strategy. This means that the role of the NGO is only to facilitate and support this process. The following challenges need to be resolved prior to implementation:

Humidity Control inside the *Gola*: Granary should not have any technical faults; special attention should be given to the evacuation of humidity during granary construction.

Governance: The establishment of sound governance is important to reduce the risk of possible dysfunctional trend of the *'rakkha gola'*. At implementation level, democratic system should be introduced where elected committee members have to work only in a certain period. In addition, close monitoring at the initial phase may help yield expected results.

RESILIENT HOUSING STRUCTURE

The Mud House

Coping with Weather Extremities

The Précis

Units	Location	Seasonality
Union Upazila District	Radhanagar Gomostapore Nawabgonj	All Seasons

Prologue

The climatic condition of the area has turned hostile and extreme. During the summer temperature goes up and at winter the temperature falls abruptly down giving most uncomfortable feeling to the community people making their daily life impeded for normal activities. Entire population remain stranded at home when the scorching heat comes up in the mid day of the summer and even at home also they are almost fried up. So they have innovated house making technology suited to the environment. Besides, safety concerns of the individual and belongings, they raise boundary wall with mud around the homesteads.

The Initiative

For saving themselves from extreme weather, the people of the area make houses with the mud collected from the surroundings, some time by digging ponds nearby the homesteads and the soil thus obtained is used in making the houses. The soil in this area is clayey and is very hard when they dried up and is as hard as the bricks burnt in the kilns. This helps them in two ways. They can store water during rainy time in the ponds together with fish cultivation and use the water during the summer when no water is available around. The house they make with soil is perquisite for making their living comfortable in the hostile environment of scorching heat and the pond is used for their domestic purposes. Most of the houses of the area have mud walls. The initiative has been used by people generations to generations. There are quite a good number of houses having boundary walls looking like ports of mediaeval ages. The mud built safety walls are also used by people generation to generation.

A GOOD PRACTICE

Because

- Δ The mud house keeps inside cool and makes living comfortable to the inmates during the extreme hot weather;
- Δ The pond which is dug for mud collection, can be used as water reservoir for domestic purposes during the summer when there is water scarcity around;
- Δ This pond facilitates fish cultivation round the year. This fish, being a source of protein, enhances food and nutrition security;
- Δ Mud-built boundary walls around the dwelling houses at suitable distances makes people feel safe for them and their other belongings like chicken house, cowshed, toilet, kitchen, etc. as well;
- Δ Mud-built house is environment friendly and cost effective coping strategy which ensures comfortable living and enhances security for themselves and their assets.
- Δ Community's own developed skills, technology and locally available coloured soil make the view of the structures sophisticated comparable to the modern concrete built houses.
- Δ This practice has been adopted by the community people from generation to generation and fitted with local ecology.

Goal and Objectives

The goal of mud built house is to reduce the vulnerability of natural hazards, especially extreme heat and cold. The mud built house initiative aims at making their living comfortable in the extreme weather and using the pond which is dug for mud

collection as water reservoir for domestic uses and fish cultivation. The aims of the mud built boundary walls are to secure safety of their living and that of their belongings

Outcomes and Activities

Clayey soil, water, tin or straw for making roof, wood, distemper for painting the wall and skilled labour are required for making mud built house. All these materials are available locally.

The Mud Built House: First, people collect soil either by digging pond or from the nearby lands and the soil is then mixed with water and give proper temper to the soil through mixing time and again. Then they raise wall by laying this prepared soil layer by layer and allowing them to be dried in the sun. Thus they raise the main wall within a month or so in the dry season and then they do for making the roof of the house by either tin or straws according to the capability. The well to do families lay tin on the roof to cover when the poor people cover the roof with straws. The tins being good conductor of heat, it is very hot when there is the sun. So they make a ceiling, generally of wood in between the tin and above the living spaces so that the ceiling may withstand the heat waves entering the living space to keep it cool. But in this case, the uses of straws are very good and friendly to the environment.

People make their mud houses nice looking by adding some new techniques and make comparable to the modern concrete built houses. It has been found in the place of observation to make paint with distemper on the outside wall giving the sense of nice building and concreting the wall and the floor. A kind of soil is available in this area, when the floor of a house is smeared with this soil it gives a nice colour, as if, it was painted and the colour is sustainable.

The Mud Built Boundary Wall: They raise safety walls outside the homestead with the soil available in their environment and the soil being clayey when dries up it become as hard as bricks. Some time they raise this wall around the dwelling houses at suitable distance from it irrespective of the main residence. The wall becomes longer. However they raise this wall including the dwelling house i.e. it includes one side of the house and then around at suitable distance. Inside the wall lie the chicken house, cowshed, toilet, cooking shed, etc. so at night they do not need to go out the boundary wall. They have gate which can be closed at night. They enjoy safety of themselves and that of their belongings.

They raise roof on the walls to save it from rain water, because the rainwater easily dissolves the mud of the walls which are very susceptible to water. The boundary walls are again 10-12 ft high and 20-30 inches thick.

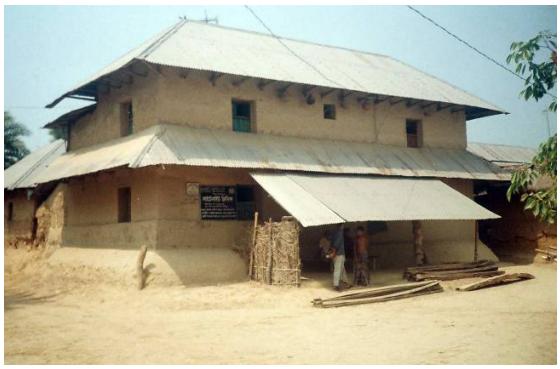
In making this walls they do not need enough money, because the only main material is the soil available free of cost. They are to prepare the soil by themselves and in this case all the members of the family work together to do this. The expense is the roofing materials which they are to buy from the market. The manufacturing process does not involve any complicated technology and is known to every body of the village.

Lessons Learned

Key lessons learned from this practice are:

- Δ The practice of building mud houses is the most suitable in areas where there is less or no rainfall.
- Δ Mud houses and their boundary walls are using by the community generation to generation and they feel that this practice is environment friendly.

- Δ It is a health sustaining coping as the mud house keeps inside cool and makes living comfortable to the inmates during the extreme hot weather;
- Δ Making mud house needs clayey soil, which is collected from adjacent area and needs no extra cost and the skilled labours are available locally. So, the process is cost effective for the local people.
- Δ Addition of some community's own developed skills and locally available coloured soil makes the view of the structures sophisticated comparable to the modern concrete built houses.
- Δ The newly dug pond which was the source of mud for mud-built house can be used as water reservoir for domestic purposes during the summer when there is water scarcity around.
- Δ This pond facilitates fish cultivation round the year. This fish, being a source of protein, enhances food and nutrition security;
- Δ Mud-built boundary walls around the dwelling houses at suitable distances makes people feel safe for them and their other belongings like chicken house, cowshed, toilet, kitchen, etc. as well;
- Δ The mud-build boundary walls are very susceptible to water. The rainwater easily dissolves the mud of the walls. To save the safety wall from heavy rain water, raising roof is essential.



Potential for Replication

Considering that this practice is locally accepted to make hostile and extreme climatic condition friendly and having no other comparable technology ever known to community people, it is suitable for other similar areas having extreme climatic and environmental condition.

Mud house, being health sustaining, cost effective, and environment friendly and suitable to be built with locally available raw materials, demands wide dissemination;

Considering the fact that this practice is suitable in the areas where there is less or no rainfall, different promotional programmes may be chalked out for disseminating this coping strategy.

WATER RESOURCE MANAGEMENT AND COPING RESPONSE

Drinking Water in Dry Days

The Précis

Units	Location	Seasonality
Union Upazila District	Radhanagar Gomostapur Nawabgonj	All Seasons

Prologue

Due to ecological and environmental crisis and drawing enormous amount of water from the underground aquifer for agricultural activities, the ground water level falls off sharply in the dry season and so tube wells at their normal level cannot supply water. So, there is acute crisis of water for drinking and domestic use.

Soil moisture of the area also suffers from water content reducing dryness. As a result general vegetation does not grow well creating crisis of eatable vegetables of the community people.

The average population being poor cannot afford to install deep tube well which costs very high. People living in the area, in an attempt to get rid of the problem, innovated to avail themselves of the peculiarity of land formation and hence digging a shallow tube well in a low patch of land has been found to be at their advantage.

The Initiative

To ensure supply of water in dry season, shallow tube well is set up in low lying land to take advantage of deep tube well. In dry season when all other tube wells go off water this tube well works well and gives water. So people do not have problem of safe water and people from distant places collect water from this tube well. One villager called Matin (known as Matin master) took the initiative first 8-9 years ago.

Goal and Objectives

The goal of the initiative is to reduce the vulnerability to natural hazards, especially drought. The initiative aims at ensuring supply of water for domestic purpose, drinking and irrigation in dry season needed by people of the area.

Outcomes and Activities

Matin dug a shallow tube well in a low land near his house. The level at which he dug the tube well is at 25 ft below his homestead level. The plot lies near a water body. The distance of the well is about 30-40 ft from his homestead around the well 8-10 families reside. He made two holes nearby this tube well, one at about two feet higher level above than the other and the sizes

THE GOOD PRACTICE

- Δ Ensures supply of water for drinking, domestic uses and irrigation purpose in agric field during dry season;
- Δ Digging tube wells in the patches of low land offers the benefit of a deep tube well making it cost effec-tive affordable by poor people;
- Δ The tube well was found to be used on community basis as it was found to give water to all the nine households residing in close proximity.
- Δ The water collected from the tube well is also used in homestead gardening around about 10 kathas of land which is cultivated throughout the whole year.
- Δ Additionally, duck rearing was found to be practiced by the local people in the drains opened for dis-charging water to the agric plots and in waste water ditches.
- Δ The soil moisture in the lands around increased facilitating the growth of different vegetations;
- Δ It is an innovative approach and is appropriate for application to cope with the changing ecology and environment;
- Δ Adoptable in areas where water is in crisis in dry season.

being 20-22ft in breadth and 25- 30 ft in length (approx) and 18-20 ft in breadth and 25-30 ft in length. A drain enters from the tube well platform to the upper hole.

The used up water is led through the upper hole and when it is filled then comes to the lower hole through the connecting drain. The used up water always stay in the holes or in the lower lands around. Around the tube well there is about 10 *kathas* land which is cultivated throughout the whole year. Different vegetables like onion, garlic, potato etc are cultivated. Thus the tube well serves drinking, washing bodies, supplies the homestead needs, washing clothes of nine households around. Two ditches have been developed on the basis of the water of the tube well where some of them rear ducks.

The water collected from the tube well is used in homestead gardening around. They produce garlic, cabbages, and cauliflowers etc. Of course, they do home stead gardening using the waste water of the tube well. The water that collects is the source of their cultivation. A deep tube well requires Tk. 30-35000 for digging, whereas Matin spent only Tk. 10-12000.

Lessons Learned

Key lessons learned from the practice are:

- The tube well is cost effective compared to the deep tube well. This innovation saved much money and they got the benefit of a deep tube well from a shallow one.
- The respondents reported that the tube well water is free from arsenic content and so the water is safe for human health;
- The elements needed for assembling and digging purpose are available in the local markets.
- The tube well helps micro-agro farming (cultivating different vegetables like onion, garlic, potato etc.) by facilitating irrigation of water from the subsurface aquifers.
- In the area two ditches were found to be developed for the storage of excess water of the well and the respondent was found to raise ducks in the ditches.
- The water collected from the tube well is used in homestead gardening around to produce garlic, cabbages, and cauliflowers etc.
- In the rainy season when the land goes under water the tube well may go out of use, but if care is taken it can be saved from being submerged and kept usable equally;
- In a situation when water, especially water for drinking, is not available, people are really at stake. So the tube well as dug by Matin in the village of Iswarporegonj is a great boon both to the families and to community people of the area as well.
- At the same time the enterprise is a glaring example of innovation of appropriate technology to cope with the changing ecology and environment. In this way local coping mechanism for survival develops. The tube well has been serving as a community well.

Potential for Replication

Crisis of drinking water, especially in the summer in places of northern Bangladesh is an acute problem. To solve this problem they take the advantage of the peculiarity of land formation and at the lowest possible point of a low land patch, they set up a shallow tube well to enjoy the advantage of a deep tube well.

This may be an encouraging example for others, where people are facing challenges of nature and suffer from water scarcity. Shallow tube wells may be set up at the lowest level by small digging at the low point to get advantage of even twenty feet depth which otherwise cost much. Tube wells thus sunk may act as a deep tube well.

By raising small roofing above the walls, it can be kept functioning even in the rainy season.

The water thus obtained serves the purpose of drinking, domestic use, watering to the vegetation and small scale farming and above all adds moisture to the ground soil around;

This is an area where different organizations can work and they are to be only cautious about the arsenic contamination

Conservation of Surface Water

The Précis

Units	Location	Seasonality
Union	Radhanagar	
Upazila	Gomostapur	All Seasons
District	Chapainababgonj	

Prologue

The area mentioned above suffers from drought almost every year. So the community people face acute crisis of not only of drinking water but also there is scarcity of water for domestic use and for dairy and poultry.

Due to enormous drawing of subsurface ground water by the deep tube wells used for agricultural activities the water table has gone very low reducing the reach of tube wells and the moisture content in the local soil resulting in the creation of a great barrier for the growth of vegetation in the area. The respondents reported that vegetables of different kinds which would grow once plentifully in the area do not now grow and are not available in the local markets.

The non-availability of water or scarcity of water has created multifarious problems before the community people, the respondents equivocally reported.

The Initiative

There are about 200 HHs in the village. 4-5 tube wells have been sunk at the initiative of the individuals. These are private and others are not allowed for use. However a deep tube well cost Tk. 30-36 thousands but the poor cannot afford so much money to sink a deep tube well.

The villages have 20 ponds at private ownership and of these 15 are used exclusively for irrigation in the month of *Falgun* to the crop fields. So the few cannot extend support to the common people with water for their household use. When there is dry season these 15 ponds also become dry due to continuous irrigation to the croplands and collection of water by 200 HHs. The capacity of the ponds also decreased appreciably due to the silt deposition from the bank erosion at the time rainfall. So the ponds dry up quickly.

Four or five deep tube wells at private ownership lying in the village helps people to collect strictly drinking water only. But the community people are really at stake for water of various domestic uses like washing utensils, taking bath after hard work, feeding cows and sheep etc. So they are to take help, on a very limited scale as they reported, of the remaining 5 ponds from *Choitra* to *Jyostya*.

So, the villagers collect drinking water from the deep tube wells but for domestic use they are to depend on the pond water.

The ponds are full to the brim during the rainy season from Ashar to Magh and the villagers can use the pond water for cultivation from Falgun and excepting five ponds, others become dry very soon.

THE GOOD PRACTICE

Because

- Δ It is cost effective for the people who can not afford the cost of deep tube well.
- Δ Suitable to meet up the domestic demands like washing utensils, taking bath after hard work, feeding cows and sheep etc. during the drought and dry condition;
- Δ It's an innovative approach to cope with the changing ecology and environment of the drought prone areas.
- Δ Preserving water in ponds is useful both for domestic use and irrigation during dry season to keep life activities going on.
- Δ It adds water content of the soil facilitating the growth of different vegetations in the area;
- Δ Water availability in all seasons has turned the area green. Community people may grow kitchen garden and can plant many fruit bearing trees like mango, lichi etc.
- Δ Already adopted by the local people and proved to be sustainable with local ecology.

The respondent opined about the benefit of pond water both for drinking and cultivation by irrigation. So for the last 4-5 years it has been observed that the community people like to dig new ponds and maintain the old ones.

Goal and Objectives

The goal of the initiative is to ensure supply of water for domestic purposes and irrigation in dry season for the people of the area. The practice also enhances the moisture in the soil that helps growing of vegetation and keeps the atmosphere cool.

Outcomes and Activities

Digging pond on high lands cannot retain water during the summer because of water leaching through the soil. It is only the low lands where ponds dug can retain water, which is available locally.

Digging of ponds is done on the basis of contract. The unit of soil is called a *'choka'*. One *choka* is equivalent to 4 cubic cubits i.e. 4 sq. cubits to one cubit deep. The rate depends on the type of the soil, if it is moist the rate is low and if it is dry and hard the rate is high. Generally the rate is Tk. 25 to Tk. 40 per *choka* and a pond of one *bigha* land amounts to 19.5 *choka*. For re-excavating the old ponds they have accordingly the rate is low i.e. at Tk 25 per *choka* because the soil is muddy and the rate is low.

Lessons Learned

Digging pond accompanies many benefits and it is not only that they get water for domestic use, they are now also found to be able to grow kitchen garden.

The community people were found to plant many fruit bearing trees like mango, lichi etc. They have the opportunity to irrigate water to the nearby plots to grow different crops. They were found to plant perennial trees turning the area green.

To keep environment favourable for production of life-oriented elements is the duty of each citizen.

Potential for Replication

The area being drought prone and rainfall being scarce, local people use the technique of retaining water at the time of rainfall stored or trapped in ponds.

Digging new ponds need money and assistance on project basis may be effective.

This technique may be replicated in places where water is in scarcity. Such areas are many in Bangladesh and if it replicated can contribute to the green revolution of the country.

Mini Ponds, Many Lessons

The Précis

Units	Location	Seasonality
Union Upazila District	Radhanagar Gomostapore Nawabgonj	Dry Season

Prologue

Due to the Barind tract's arid ecological condition, the lands out of irrigation facility cannot grow paddy or any food items and to people of the area food security is more concerning issue. Due to the severe draught only a single crop in a year can be produced, which cannot at all ensure their food security. So the production process and the mode of livelihood of the farmers have undergone a change.

Being compelled due to environmental and ecological change the community people had adopted to trap rain water in mini pond digging at the agricultural site to be used in time of necessity for watering to the crops in the plots. It also helps to cultivate fishes.

The area was found to practice the construction of ponds around the fields on community basis. Two or three farmers in collaboration raise a pond near their plots and use it in proportionate, which is very helpful for community people.

The Initiative

Excavation of ponds in the agricultural fields was the only process of irrigation management in the past. But the pace of the traditional irrigation management has been diminished over the years due to BMDA's deep tube well intervention, although BMDA encourages excavating and re-excavating traditional ponds as well as canal now. Again this is not the only advocacy of

THE GOOD PRACTICE

Because

- Δ This practice is the most helpful because it provides water for cultivation together with facilitation of cultivating fishes in small ditch like ponds around the agric plots in summer when there is scarcity of water everywhere;
- Δ Suitable for drought mitigation in crop production as well as to meet household demand during dry season;
- Δ Fish production in the ponds satisfies the house hold protein demand through the year.
- Δ In addition, although in a minor way, it also helps to recharge ground water as ground water level is falling down day by day due huge appropriation of ground water by deep tube well functioning around for irrigation purpose in the agric fields.
- Δ Suitable coping mechanism to adjust with the changed circumstances of climatic condition in drought prone areas;
- Δ The practice adds moisture to the nearby soil making it congenial to the growth of vegetation around and the evaporation helps to keep the atmosphere congenial to human life;
- Δ Already adopted by the community people and proved to fit with local ecology.

BMDA and other GO-NGOs in this line; rather poverty stricken people are forced to seek other livelihood options that have resulted in the growing tendency among the local people to excavate and re-excavation of mini ponds. These ponds have been used for short term fishing and irrigation in the dry season to the crop field.

The mini ponds, once started to be used for irrigation purpose, could give other benefits too and the uses are now expanded. These are now being used for short term fishing in spite of increasing soil moisture facilitating the growth of vegetation. So the community people excavate new ponds and re-excavate the old ones with interest.

The endeavour is also advocated by different GOs-NGOs intervention.

Goal and Objectives

The re-excavated and newly excavated mini pond in the agricultural field has multipurpose such as fishing and irrigation in the dry season. More over the water leached around increases the moisture content of the soil helpful for the growth of vegetation.

Outcomes and Activities

The pond is primarily dug for preserving water for cultivation in the near fields in areas where drought hinders cultivation. The practice being proved beneficial has been accepted by the poor people. In addition to the direct benefit people accrued some accompanying benefits which are also very valuable in respect of the developing environment and the growth of vegetation.

Of the indirect benefits, fishing needs some strategic steps to be done. Preparation of the pond is associated with cleaning either through spraying insecticide or any other means, catching the residual and monstrous fishes and crabs, and also wipe out unwanted shrubs. Again cleaning also attached with spraying lime in the ponds (at least 20 kgs of lime is to be applied in a pond measuring ten *katha*) [Annex xx]. The lime makes the water favourable for fishing. The young fishes, then, are released in the ponds after 10-15 days of preparation (In a pond measuring 10 *kathas*, 10-15 kgs of young fishes of *rui, katla,* brigade, mirror carps, etc. are released). Generally young fishes are released twice in a year (in the month of June to July and March to April) except the cold months *Agrahayan* to *Poush* (Mid November to Mid January) as extreme cold affects fish growth.

The nursing of fishes need to be fed. Different materials are used to generate food such as urea, cow dung, oil cakes, poultry litres and some vitamins. These, staying in water, produce enough plankton to be used as food for the fishes. The fish nursing in a mini pond sometimes require making artificial current of the water and pulling net to generate enough oxygen for fishes. Finally bamboo poles are put down to the pond as to prevent massive stealing.

Beside this, dry season crops could be produced as the ponds could provide necessary water even at the extreme dry season.

The pond (amounting ten *katha*) could produce 18-20 maunds of fishes per year from initial dropping of 10-12 kgs of young fishes (silver carp, brigade, *pangas*) that can be sold Tk. 1800-2000 per maund, the total production sometimes varies due to water and fish condition. Thus, enterprise brings huge economic benefit in comparison to other agricultural production in the same amount of land.

Lessons Learned

Key lessons learned from this practice are:

- A single pond generates double benefits i.e. fish and dry season crop cultivation that brings huge benefit to address the draught led famine and poverty.
- This enterprise also generates employment opportunities for others for digging process;
- In addition, although in a minor way, it also helps to recharge ground water as ground water level is falling down day by day due huge appropriation of ground water by deep tube well functioning around for irrigation purpose in the agric fields;.
- Since the ponds are far away from locality so there is a possibility of stealing the fishes from the ponds and the respondents reported that they are to be vigilant at the time even at night;
- Huge lands are left fallow in the Barind tracts waiting to be brought under cultivation. These lands could be easily brought under cultivation in similar practice of digging ponds on community basis or by the individuals.
- This enhances agriculture, helps fish production, and keeps environment friendly including the soil congenial both for life oriented activities and life saving productions;
- The land ownership is horribly frustrating and maximum lands belong to a few, whereas majority of people are without any land. They are to work in others land for their livelihood.

Potential for Replication

The practice of mini pond accompanies many boons together to the farmers: facilitates agriculture, fish cultivation, keeps environment congenial to living, and helps increase soil moisture favourable to the growth of vegetation and the evaporation keeps the atmosphere cool.

The huge lands in the Barind tracts need to be brought under cultivation and the field study revealed that the farmers are struggling for the purpose. If mini pond practice is introduced among them it will be popular in no time and the farmers will be able to produce crops and other products contributing to the country's food stock

Mini pond digging does not involve any sophisticated technology but involves pretty financial support. So GO-NGO endeavours may be deployed to reinforce the enterprise in the areas as mentioned. Technical support by the agric and fisheries department may enhance the production and introduction of modern means may bring about revolution in this sector.

ALTERNATIVE AND RENEWABLE ENERGY SOURCE

Traditional Ways of Fuel Preservation

The Précis

Units	Location	Seasonality
Union Upazila District	Radhanagar Gomastapur Nawabganj	All Seasons

Prologue

People of this area use earthen stoves for cooking their food and as fuel they use woods, jute sticks, and shrubs, branches of trees, straws and other wastes of agricultural products collected from the harvests of crops etc after drying them in the sun. Due to drought shrubs, plants and trees do not grow well. The sources of straws are the paddy cultivation. But as the area has only one crop in a year and the straws are the main fodders of cows. With the growth of population and verities of natural calamities there appear constraints because of enormous pressure exerted on these things. So, to meet up the demand of fuels, people instigate to produce some alternative fuels in using locally available materials.

The Initiative

Although the village lies within the drought prone area the farmers rear cows from generations to generations. They have cows or buffalos in every house and cow dung is also available in every house. So, people have taken initiative to use *ghuchi*, a ball shaped moulds is prepared from the cow dung which is very popular among the women of this area. 10-12 *ghuchi* are sufficient to cook the food of 5-6 members. Now about 80-85% families of the area use *ghuchi* for cooking their food. Moreover, the *ghuchis'* to be used in the tea stalls and hotels are available for buying in the area.

Goals And Objective

The goal of the initiative is to reduce the vulnerability of the natural hazards, especially of drought. The initiative aims at ensuring the demand of fuels and maximizing the available resources.

Outcomes And Activities

There is a hole in the yard for making *ghuchi*. The hole size is 1 cubit deep, and 1.5 cubits in diameter. At first cow dung is left in the hole and then required quantity of water is given to the hole. Then 1 kg of dried up paddy (a grain having substance within) or stubs is/are mixed with every 50 kgs of cow dung. Stubs are easily and free of cost available. So people mix this stubs with cow dung. Then they mix them well with their hands or legs by pressing them from above. Making the mixture uniform with the contents they take them out little by little and make balls of them in hands and finally throw them against the wall of the house where they stick against the walls easily. After 10-15 days these balls dry up and assume the shapes like ball-shaped moulds.

A villager named Bani has 10 cows and has no land of his own, but he uses to cultivate other's

THE GOOD PRACTICE

Because

- Δ Ensures the demand of fuel manufactured by the farming women themselves with the available resources e.g. the cow dung multiplied by adding rice bran, stubs, soil etc;
- Δ Saves money for buying fuel for house hold cooking and other purpose;
- Δ Effectively enhances the capability of the population at risk;
- Δ The practice the environment friendly and economically viable;
- Δ The practice is an example of maximization of available resources to be used at the advantage of ones capacity.
- Δ The practice is already adopted by the community people and is proven to be profit-able.

land on lease and the cow dung he collects in the dry season can meet up his household demand. In addition he can sell quite a good amount of *ghuchis*. However, one sack of *ghuchi* is prepared in a day for which the requirement of cow dung is approximately 35-40 kgs to be collected from 10 cows on an average. There are 6 families who after meeting their own demands sell *'ghuchis'* in the market. *'Ghuchi'* is sold in sac full and a sac full of *'ghuchi'* is sold at Tk. 40-50. They sell *ghuchi* in secret because selling *ghuchi* is socially shameful act, they think. So, exact amount of *ghuchi* sold by each could not be known.

Lessons Learned

Key lessons learned from this practice are:

- The preparation of the product *ghuchi* is easy and they can do by themselves. It is environment
- friendly and does not cost them anything; rather they can save money from the exercise by meeting the demand of fuels otherwise.
- The availability of wooden fuel has no guarantee because, this is a drought prone area and productions and plants are limited. So people have security to using *ghuchi* in all the cooking purposes.
- The people need to have cows in their houses for making the *ghuchi.* Otherwise, they have to collect from other people.
- *Ghuchi* can be a source of income for female members of the low income household.

Potential For Replication

The fuel needed for the bulk of the population for household purpose has not been considered as a huge problem yet. That is an area where attention must be given because of various genuine reasons. The straws, stubs, grasses, leaves of trees and other such stuffs that are used previously as fuel are now disappearing due to various reasonsing. The alternative fuel like *ghuci* needed to promote in the rural area. Different project for reach the enterprise to remote people need to develop by the Govt. and non- Govt. organizations.

LIVELIHOOD DIVERSIFICATIONS AND OPTIMIZING OUTCOMES

Nurturing Natural Dewdrops

The Précis

Units	Location	Seasonality
Union Upazila District	Konchipara Fulchori Gaibandha	Winter Season

Prologue

The soil of the area is sandy and loamy, which cannot hold sufficient water. These types of soils are difficult for multi-crop farming and hence, the farmers face difficulties in the process. Moreover, during winter season, rivers dry up and there is no rainfall, the climate is dry and so the soil becomes less moist. Then farmers face more difficulty to shallow water into seedbeds and crop fields. So, they have adopted some techniques to get the soil moist and that is applied for cultivation in the dry season.

The Initiative

To increase the moisture of the soil in winter season, farmers take the initiative to use dewdrop as a substitute to rain water. At night, the temperature near the surface of soil falls down to a level favourable to condense the air moisture. This process of dew formation is facilitated by the molecular sands in the air. Farmers very early in the morning go to the fields with a bamboo stick and shake the paddy plants so that the drops fall of the leaves to the ground below to moist the soil around the feet of the plants. They do, usually, this by a piece of bamboo, tied with rope on both the ends, pulling it over paddy plants or crop fields very gently dropping the dew deposited on the leaves of the crops overnight. It allows the land to minimize the shortage of moisture due to lack of rain in winter. All of the farmers of the area adopted this practice.

Goal and Objectives

The initiative using dew drop aims at increasing soil moisture during winter season when rain water is absent. This practice favours growing rice during that season and at the same time, it increases production by reducing premature growth of paddy by eliminating the due drops from rice plants.

Outcomes and Activities

Bamboo and rope are the equipments which are available with the farmers. The farmer can do this and it takes only half an hour for one man to cover an acre of land. The farmers said that they are not to spend extra money for this purpose. Soil moisture is essential to sustain the newly planted saplings. Also when the plants at the end of the *Magh* are ready with crops and they are not properly matured, dew drops for one or two weeks can help mature the crops.

THE GOOD PRACTICE

Because

- Δ Increases soil moisture of the soil during winter season when rain water is absent and surface water becomes scarce;
- Δ Built on community's own capacity, knowledge and skills for meeting up their own necessity of pro-duction in the fields.
- Δ Effectively enhances the livelihood outputs to meet the demand of the population at risk;
- Δ The practice is environment friendly, cost effective and helps add value to the food ingredients in the fields; other wise the products would of no value because the unfilled seeds could not be used as food;
- Δ The newly planted saplings can stand on their feet by sustaining moisture contents from the soil.
- Δ The practice is essential in farming in the fields and it does not involve any hard labor, cost or time; but gives much benefit.
- Δ The practice commands replication in similar areas of agric activities.

When the IRRI plants in the months of *Magh–Jyaistha* (mid January-mid June) grow 3-5 ft in height after 7-8 days of plantation, the farmers arrange to shed the drops of dew formed on the leaves at night by rolling a bamboo pole 5-7 ft long having ropes of 5 ft long tied at the two ends and pulling them. This they do very early in the morning. As a result the dew deposited on the leaves at night fall down the soil due to shaking of the pole and the soil receives and absorbs them to be soaked. They shake the pole in such a manner that the leaves are stirred only to shake the dew drops and the leaves are not broken or tilted.

Thus about 15 days the bamboo pole is rolled over the saplings every alternate day. Because, the moisture they get on one rolling can keep the soil soaked for the next day also. In each attempt it takes about half an hour to cover a *bigha* plot.

In case of wheat cultivation in the months of Paush–Chaitra (mid mid December-mid April) the soil is soaked by the dew in the same way. After sowing the seeds when the new plants grow and become a bit bigger i.e. when the leaves comes out of the soil after 8-10 days, then about 20 days later in the same time, a branch (5-7 ft long) having thorns and leaves is rolled over the plants dew is thrown on the soil by shaking the leaves of the plants. According the local farmers, due to this the upper side of the plants are divided which expedites the growth of leaves in the plants. The labour is same as that for paddy field.

Lessons Learned

Key lessons learned from this practice are:

- The process is environment friendly, cost effective and the labour to drop the dew by shaking the plants with a bamboo stick in the morning is about half an hour per acre of plot and is very meagre comparing other activities of the farmers. So this amount of time the farmer himself can afford to offer. But the result derived from such an exercise is immense comparing irrigation. The plants in the field need some moisture at their final stage of life cycle when the top soil looses moisture due to dry climatic condition and rapid evaporation. So dew dropping for a few days can help crops to be matured.
- The dew dropping for agric activities on large-scale agricultural activities apparently seems to be impossible or appear to be impracticable but if we consider the time of need it is possible.
- Dew is formed everywhere during winter and autumn and can be visible in the morning and evening to be shining on the leaves of plants, grasses or green plants. These droplets individually are negligible but collectively they form the oceans. However the process by which the farmers collect them to fall on the feet of the agric plants do a lot of benefit, give much moisture to the soil to give life to the living plants.
- The process is helpful for agric products to be properly matured and attain food value.

Potential for Replication

The practice of using dew drops to enhance moisture of soil at the peg end of the life cycle of crops in plots during winter can be replicable to other *IRRI* and wheat producing areas of the country where the ecological setting is comparatively similar. Most of the Northern districts of Bangladesh are having such weather and ecological condition. Therefore, dew dropping for maturing crop in the fields can profitably be applied throughout the whole area.

Dew dropping helps the crops to be matured adding the food value which when taken help our nourishment.

If the crops are not supplied with necessary moisture for a few days, the corns cannot be filled with the internal matter rendering them to be empty inside and a massive loss to the farmers.

But to supply moisture by irrigation of water from river or pond is highly expensive. So the process is cost effective in protecting crops and can be replicated elsewhere in Bangladesh.

The farmers are to be disseminated with this simple knowledge and encouraged to follow the process of dew dropping at the time.

Mango Cultivation

The Précis

Units	Location One	Location Two
Union	Radhannar	Chaor
Upazila	Gomostapur	Porsha
District	Chapainobabgon	Naogaon

Prologue

Due to the drought and scarcity of irrigation facility, paddy cultivation cannot yield efficient economic return. For this purpose, the people turn & shift their cultivation practice by highly demandable mango crop as well as increase their land productivity & cropping intensity with maximum economic profitability by utilization of fellow land, which was outside of irrigation facility.

The Initiative

Almost all the farmers used to plant seasonal fruit trees around their houses but planting mangoes on a commercial basis or planting mangoes instead of paddy is what could be considered as mango cultivation. Eight years ago, the farmers first initiated mango cultivation in Radhanagar. Some of the farmers brought good quality seedlings of mango and got a good production while they planted those around their houses. Meanwhile, a few farmers of Porsha started cultivating mangoes on a commercial basis in 2000. Three or four years after plantation of the trees, farmers started collecting fruits. The results accrue by them encouraged eventually other farmers to start planting mango trees in the community homesteads and gardens.

Goal and Objectives

The goal of mango cultivation is to reduce the vulnerability of community people to natural hazards, especially to drought. The mango cultivation initiative aims at increasing their land productivity & cropping intensity with maximum economic profitability by utilization of fallow lands.

Outcomes And Activities

Mango saplings, sacks, labours, cane (used for the fence), mud and trolley on rent, fertilizer, insecticide and irrigation are fundamental components for cultivation. All these items regarding mango and paddy cultivation are available and collected locally.

Though, in Radhanagar of Nawabganj and Nonahar of Naogaon people cultivate mangoes but there are some strategic differences between these two cultivation systems. In Radhanagar people cultivate mango along with paddy for optimum use of land or soil fertility. Here, the reason is that mango is a deep rooted plant and paddy is shallow rooted. At the initial stages of this intercropping of mango saplings and paddy plants, there is minimum interaction of soil – plant but as the mango plants grow bigger and bigger, the nutritional scarcity in the soil is increases. The length of this intercropping is 7 to 8 years. Then the soil can no more feed both at the same time. After this period paddy cultivation is stopped in mango orchard. But in Nonahar mango cultivation as a mono crop is continued.

THE GOOD PRACTICE

Because

- Δ Increases the land utility and productivity from the same plot of land cultivating at the same time mango and paddy for many years;
- Δ Increases cropping intensity and diversity for better productivity;
- Δ Using permanently fallow lands due to drought and scarcity of irrigation facility in Barind tract;
- Δ Increases production possibilities of mango which has increasing demand in home and abroad.
- Δ Effectively enhances income and return to the entrepreneurs for the productive assets.
- Δ The practice is environment friendly and the farmers have already adopted it for their livelihood.
- Δ Cultivating Mango is more profitable than Paddy. It is eco friendly, economically viable and can be done through the will and effort of one's own.

In one *bigha* plot, it is possible to plant fourteen mango trees. The farmers buy the mango saplings from the nurseries of Porsha and Nawabaganj. Usually, the preferred varieties include *Langra, Fazli, Gopalbhog, Ashwini, Heemshagor, Kalapahar, Ranipochondo and Lokhna*.

First, a spot is selected and marked with a thin rope. Then a hole is dug using a spade. The hole is about 1.5 to 2 feet deep with a diameter of two feet. The holes are left uncovered for two to three days to dry. Usually this is done at the end of the Bengali month of *Agrahayan* (mid November-mid December) or at the beginning of the Bengali month of *Baishakh* (mid April-mid May). After this, the holes are filled with mud collected from dried up ponds. To fill up fourteen holes, one needs one

and half trolley full of mud. After the holes are filled with the mud, these are again left out to dry. Then the mango saplings are planted in the holes. The saplings have to be watered every morning and evening from the nearest pond, in return farmers have to pay the pond owner about TK 500/600 for the irrigation in the season (see annex for details).

Every tree has to be fenced with cane in order to keep the cows and goats away, which usually lasts for three years. Throughout the summer the farmers have to use fertilizer in the holes. During the rainy season when the holes become moist then chemical fertilizers can be used for the first time. At this time, the trees are also sprayed with insecticide. If any of the trees start buds at early stage then the buds are nipped because the trees don't grow very well once they start bearing fruits at so an early life.

As the trees grow they require less and less irrigation. So it reduces the labour cost and there is no additional cost of buying new saplings unless the existing ones die. The cost of the rest of the products keeps increasing and so does the amount of yield. The total cost of maintaining mango trees (for the variety of *Gopalbhog*) for eight years up to the fruit bearing stage (when the trees can produce fully) are around 52000 taka (see annex - xx for details of cost). The mango trees start bearing fruits three years after they are planted. Every maund of mango at an average is sold at TK 2500 (see annex – xx for details of income).

Usually, in the first four years of planting the mango trees, paddy can also be cultivated along with the trees. This does not decrease the immediate prospects for paddy production, since the mango plants remain small enough to over shadow the growth of paddy plants. In the fourth year the mango fruits could be collected for the first time. In the 12th year of plantation a full harvest is collected from the Mango orchards. By this time paddy growing stops completely.

The total cost of producing paddy per year is around Tk.2085 (see annex for details of cost). A one *bigha* plot of paddy can be cultivated only once a year to produce a maximum of twelve mounds of paddy. Every maund of paddy at an average is sold at TK 800.

Comparatively, it seems that the farmers make more profit by cultivating mangoes than paddy. The reason is, even though the production of paddy does not decrease in the first four years, it gradually starts decreasing in the next seven years while the mango yield increases and eventually the paddy stops growing totally while the mango trees start giving a full yield. Once the mango trees are fully grown the farmers can also plant turmeric under the trees.

Lessons Learned

- Δ It's shown that cultivating Mango is more profitable than Paddy. It is eco-friendly, economically viable and can be done through the will and effort of one's own. It is convenient in terms of time, labour and money. The implementation is easy and the materials needed are easily available.
- Δ Mango cultivation entails difficulties too. When there is fog or dense dew at the time of blooming or if there is rainfall or there is storm when the flowers are in the bloom then fruit do not grow, rather the flowers together with the buds fall off the trees. This is a great menace to the mango cultivation and no technology or means, whatsoever is ever known to the farmers to get rid of this problem. Otherwise the quantity and quality of crop is highly beneficially to the farmers.
- Δ The only disadvantage of the practice is the landlessness of the common people. The land ownership in this area has the peculiarity that almost all lands are owned by a few and majority is without land and they work in other's land for their livelihood. As a result the cultivation does not get proper attention.
- Δ Mango cultivation earns money both from home and abroad. So the practice is the focus of the agricultural authority. The barriers should be removed and modern technology be introduced for the improvement of the practice.

Potential for Replication

Mango cultivation has been earning money from home and outside market as well. So they work on routine basis and not sincerely for growing more and more fruits. But if they given plots of lands in some way on ownership basis they could produce much more than the present amount, as was known from them.

The cultivation is profitable because it gives cash crops, which has high demand everywhere and at the same time provides farming labour force with employment. The practice should be replicated with the employment of trained labour force on high yielding varieties of mango.

More research is needed for high yielding variety of mango for this area. Mango cultivation may extend only on the lands suitable in land quality for mango yields and not on paddy cultivation lands. But Govt. related department should be cautious about this and control the expansion of mango cultivation.

Lakkha- A Replenished Hope

The Précis

Units	Location	Seasonality
Union	Laxmichap	All season
Upazila	Nilphamari Sadar	
District	Nilphamari	

Prologue

In Northwest districts of Bangladesh every year there is food crisis during the lean season which is known as *Monga* (semi famine situation). This recurring food crisis is triggered by the multiple environmental hazards that occur in the region. The undiversified income based on agriculture of the vast majority is the main source of their vulnerability to this seasonal shock and environmental hazards. In Laxmichap Union of Nilphamari Sadar the list of multiple hazards that affect the agriculture include drought, excessive rain, fogs and floods. Besides consecutive disasters, in recent years crop yield in the locality is found to be severely affected by the changes in the local ecology caused by the reduced flow of water in the tributaries of River Padma. There is a sharp decline in the water level of river Teesta which flow by the union. This has made the water content of soil most minimum and the deposition

THE GOOD PRACTICE

Lakkha cultivation entails significant propensities for income diversification and economic growth in the Northwest Bangladesh particularly for the most vulnerable segments of population. The potential and prospects are–

- Δ This enhance livelihood security by providing an alternative income source
- Δ This provides an effective way to reduce risk of seasonal hardship and consequent food insecurity
- Δ This is an effective strategy to cope with loss of livelihood caused by multiple hazards
- Δ Women and the marginalized population– the landless and small farmers can easily take up this income opportunity without any external support
- Δ The cultivation process is fairly simple requiring quite negligible amount of input in terms of money and labor
- Δ The demand of lakkha is increasing in the global market and expansion of lakhkhacultivation well ensures development for the people of all strata.
- Δ Effectively enhances the safety of the population at risk.

The findings suggest lakhkha cultivation has gained wide acceptance among the farmers as an effective strategy to reduce vulnerabilities and securing livelihood outcomes. It would significantly accelerate the inclusion of vulnerable population into the development process. Formation of community based organization of akhkha cultivators can expand this practice to a large extent. There is a potentiality for establishing small industries to produce resin and also to produce different lac products. This could link the farmers to the global market for lac products and would create new income opportunities for the at risk population of the region.

of sands carried by the flood water or rain water converted the lands sandy resulting in the loss productivity of the traditional agric items. The most vulnerable households to these hazards are those whose income depends on agricultural labour and marginal farming. Alternative livelihood strategy particularly during the period of seasonal hardship is therefore a big focus for the survival of poor households in the northern region.

The Initiative

To diversify the livelihood activities of the local community a new opportunity for income has been introduced in the area by a local NGO, named '*Lokasamaj*'. This has been the cultivation of *lakha since 2007*. They supported the interested farmers by providing training. In February 2008, when field level investigation for this study was conducted, 40 out of 300 households in the village of Harimandir of Laxmichap union were involved in the *lakha* cultivation. The cultivation of *lakha* is found to be ecologically viable and economically profitable in the area. It involves minimum risk since it requires minimum labour, care, lands and capital.

Lakha cultivation involves rearing a kind of insects called Laccifer lakha, which produces a natural resin. Laccifer lakha is a parasite of some particular host trees namely – boroi, dumur and acacia. The principal lakha host in the study village is the boroi tree. Only 3-4 farmers who do not own boroi tree cultivate lakha on the figs and branches of the rain trees. Lakha insect is sufficiently mobile to crawl along the branches of trees to find fresh succulent twigs. When it fixes its position and inserts its proboscis into the trees it secretes a protective coating consisting yellow to reddish resin called the lac resin, which is extracted by a special process. The resin is widely used in industries like food processing, leather, textile, pharmaceuticals and perfume. From a 10-12 year old boroi tree, lakha crop worth of Tk.1000 can be obtained annually by investing only Tk.60/70.

Goal and Objectives

The goal of introducing *Lakha* cultivation is to develop a new livelihood strategy for the poor households to cope with the seasonal hardship, environmental hazards and environmental changes, especially the annual *monga*. The objective is to diversify the livelihood activities to reduce the dependence on the agriculture based income.

Rather depending only on relief and micro credit than on creating new income opportunities like *Lakha* cultivation can effectively reduce people's vulnerability to chronic poverty and increase their resilience to disasters. To cope with crop loss, lack of employment and consequent food inaccessibility increasing number of households are taking *lakha* cultivation as an option. The best thing about the *lakha* cultivation is that the landless poor households can also easily get involved in this, since it requires minimum investment and labour.

"Lakhkha cultivation is like harvesting gold", said Selina. "I earned 1000 taka from lakhka crop only by spending 50 taka. It seems, as if I have got a lottery. I never imagined any cultivation could yield such a huge profit."

Outcomes and Activities

The cultivation of *lakha* is simple. The host trees are pruned in proper seasons. There are three seasons for pruning the *boroi* tree for *lakha* cultivation and according to the Bengali calendar these are –*Bhadro* (Mid August- Mid September), *Kartik* (Mid October- Mid November) and *Falgun* (Mid February – Mid March). A *boroi* tree needs to be 4-5 years old for being used for *lakha* cultivation. Half of branches of these young trees are pruned each time for cultivating *lakha* twice a year. Sometimes the trees aged about 10-12 years, all of the branches are pruned for cultivating *lakha* once a year. After pruning the trees it takes 10 -12 weeks for the new shoots to come out and then two or three sticks of brood lacs containing living insects are tied on to the branches near them. The insects then breed into swarms of their off-springs and settle on the shoots. Care is taken while tying the sticks with the jute ropes so that they have close contacts with the branches. It generally takes three days for the insects to settle on the twigs of the host trees from the brood lac. After that the brood lac can be taken out and sold in the market for Tk. 5 per stick.

After the infection of the trees with brood lac, the crop needs little or no attention till the time of harvesting. One only needs to water the trees in every 10-12 days. The women can easily do the cultivation of Lakha since the host trees are often located in the home yard. The crop period, from pruning to complete emergence of lac larvae, takes 8-10 months. If the tree is pruned in the month of *Badro* (Mid August- Mid September) the crop can be yield in the month of *Jyosta* (Mid May- Mid June). If it is pruned in the month of *Kartik* (Mid October- Mid November) then resin can be harvested in the month of *Aswin* (Mid September – Mid October). And in the case of pruning the tree in the month of *Falgun* (Mid February – Mid March) the crop can be harvested in month of *Aswin* (Mid September – Mid October). Starting the cultivation in the month of *Falgun* (Mid February – Mid March) gives the best harvest in a relatively short time. If trees are pruned in the month of *Falgun* (Mid February- Mid March) new shoots grow rapidly and become more succulent during the rainy season because of the availability of the rainwater. On the other hand if the cultivation begins in the month of *Bhadro* (Mid August- Mid September) and the *lakha* insects are spread on the branches of the host tree in the month of *Agrahayan* before the winter (Mid November – Mid December) it gives lower yield since the insects grow slowly in the cold.

After the total emergence of lac larvae on the host it takes about eight weeks for them to become sexually matured males and females. The male insects die fertilizing the female insects and female insects increase in size to accommodate her large number of growing eggs. At this stage the secretion of resin proceed at a faster rate and coatings are formed rapidly. In another 14 weeks the female insects begin to lay eggs. When hatched, the larvae emerge and begin a new life cycle of about six months. Thus, the insect completes two life cycles in a year yielding two *lakha* crops.

When the insects bear the eggs some branches are cut to serve as brood lac for the next crop. This brood lac is locally called as *lakha* seeds. These are sold in the market for TK5 per branch. These branches are usually 1 ft long. The farmers wrap them in the banana leaves and keep them in a dark corner of the thatched house for 10 days before selling to the market. The rest of the insects are scraped off from the twigs and sold

in the market a month after the insect begins to lay eggs. Freshly scraped *lakha* contain plenty of moisture and is usually left in the shade to dry. These *lakha* insects are sold for Tk200 per kg. Resin from the insects is extracted by machines. The NGO working in the locality buy these from the farmers and collect resin from the insects.

Five kgs of *Lakha* insects can be produced once a year if a 10-12 year old *boroi* tree is used as a host tree. These 5 kgs of the insects can be sold for taka one thousand. According to the farmer, they get a lower yield if they cultivate *lakha* twice a year. Therefore, the farmers prefer to cultivate once a year. They also prefer to prune the *boroi* trees in the month of *Falgun* (mid February – mid March) because in that case they can also get the full harvest of the *boroi* fruit in the winter. On the other hand, if they cultivate *lakha* twice a year, pruning half of the branches of the trees each time, they get total 4 kgs of *lakha* insects which can be sold for taka 800 hundred. Moreover, for cultivating twice a year they have to prune the trees in the month of *Jyosta* (Mid May- Mid June) and in the month of *Aswin* (Mid September – Mid October). If they cut half of the branches in the month of *Aswin* (Mid September - Mid October) which means just before the winter they lose half of the *boroi* fruits that could have grown in the winter.

The outcome of different lakha cultivation practices are shown in Annex.

Lessons Learned

Key lessons learned from this practice are:

- The whole process of cultivating *lakha* is quite simple and easy for the farmers to practice. The farmers do not need any support other than a primary training on the cultivation process. Introducing this livelihood practice to new groups of farmers helps greatly spreading the technology for earning livelihood without much effort. More over this is an effort for utilization of the own environmental elements for one's own benefit. Because *boroi* and other *lakha* cultivable trees are everywhere and if they are not utilized for *lakha* cultivation, yet the *lakha* insects grow in their own way without giving any benefit to anybody.
- *Lakha* cultivation can also increase women's' participation in economic activity in rural Bangladesh. Most of the *lakha* cultivators in the study area are women. The reason behind this is that *boroi* trees are usually planted in the homestead plots. Therefore, women can get involved at different stages of the cultivation process and can take care in the midst of their familial affairs.
- The quality and quantity of *lakha* crops depend on variety of factors, namely, the brood lac, the host trees, weather conditions, and season of harvesting and how the crop is dried and stored. Intervention is needed to ensure that farmers have proper information regarding the issues mentioned above.
- The community is very enthusiastic about large-scale cultivation of *lakha.* In the study village, farmers are planting increasing number of *boroi* trees as host of *lakha* crop. Children are found to be involved in collecting the *boroi* seeds and rearing the trees.
- The farmers do not have proper knowledge regarding the extraction of resin from the insects. Besides, only place where they can sell the crop is the local NGO that introduced the cultivation in the area. So they have the autonomy in deciding the price of the product for the farmers. It is important to diversify the market of *lakha* crop since the practice is spreading rapidly.
- In *lakha* cultivation, a household works as a production unit where the labour of the members remains underexploited. The great potential for large-scale *lakha* cultivation is hampered only by the dearth of the host trees. Producing the saplings on large scales of the host trees has opened up new income opportunity for many.
- Landless people are also cultivating lakha in their homestead plots. They can manage the small amount of money required for the cultivation without much trouble. They are content with the harvest and the profit.

Cultivation of *lakha* is providing them income and reducing their dependence on any sort of relief.

- *Lakha* crop is often damaged by other insects or birds. In the month of *Aswin* (Mid September – Mid October), often red and black ants climb up the tree and eat up the *lakha* insects. 10% of the farmers used insecticide to protect the crop from the predators. They use a kind of poisonous chalk at the foot of trees which cost taka 15 per packet. Kingfishers and other birds also attack the insects and women generally are responsible to drive away the birds.

Potential for Replication

There is a great potential for lakha cultivation to be widely accepted by the farmers. Ecologically cultivation of lakha would be suitable for many other parts of Northern Bangladesh. Most importantly, lakha crop is produced during the lean season when Monga situation prevails in the region. Monga, a seasonal food insecurity that starts from September to the end of November, is not a problem of food availability but of lacking access to food. The basic explanation of monga phenomenon is that the employment and income opportunities of the rural poor greatly decrease between transplantation and harvest of paddy. Additional livelihood like cultivation of lakha can increase people's access to food during this period. The most effective strategy for the poor households to cope with the chronic poverty and to reduce vulnerability to Monga and other hazards is to open new income sources. The minimum investment, tools and labour required for lakha cultivation increase its potential for replication.

For better and wide spread of the practice of lakha cultivation following challenges need to be resolved:

- The farmers are continuing their own experiential research to find out alternative host trees. But more scientific research is required in this line. The information from the BCSIR centre regarding the host trees, *lakha* seeds, problems that can jeopardize the harvest should reach the farmers in effective ways so that the farmers may have latest expertise to use for getting maximum benefit from the exercise.
- A community based organization of *lakha* cultivators can be formed so that the farmers can share their knowledge about different techniques of *lakha* cultivation. The cultivation of *lakha* is new and therefore the farmers' sharing of their knowledge is important. A network of community based organizations can be formed in the locality. This network can be put in to communication with the *Lakha* Research Institute at Chapai Nawabganj so that the farmers can improve their knowledge regarding the cultivation process. This would enable them to exchange *lakha* seeds when required and help them to market their crops. Formation of community-based organization would open up possibilities to undertake different community lead initiatives like taking lease of *khas* land for *lakha* cultivation. This would create an opportunity for the landless and those who do not own host trees to get involved in the lakha cultivation. Thus, together the community people can practice lakha cultivation to cope with the seasonal shock and environmental hazard. NGOs can catalyze the process of forming the community based organization and the network.
- There is an opportunity to increase farmers' profit from lakha cultivation if they have the capacity to extract resin from the insects. This would also enable the farmers to sell their product at higher price and to diversify the market for their product. Building farmers' capacity in producing the resin is a challenge that needs to be taken seriously. Community based organization of the cultivators can initiate the establishment of such industry for producing resin on large scale.
- If proper intervention is made, there can be a boom in lakha cultivation, not only in the study area but also all over Bangladesh. There is a great potential for Bangladesh to enter in to the global lac market as demand of lac product is growing fast. Besides, Bengal

lac was in the greatest demand among the buyers in Europe during colonial time.

- With cooperation and support from GOs and NGOs, the community based Lakha cultivators can eventually establish lac cottage industries. The establishment of a well functioning community based organization of lakha cultivators is prerequisite for further endeavour.

Drought Tolerant Rice Cultivation

The Précis

Units	Location	Seasonality
Union Upazila District	Khokshabari Sadar Nilphamari	Dry Season

The Prologue

The nature of the constituents of the soil of the area is mostly sands and hence the soil is dry and devoid of moisture. Apart from 20% of high lands, the lower lands remains water logged for 6 months starting from the monsoon. Paddy cultivation in the area is not much due to water logging in the low lands and dryness in the high lands. In high lands they cultivate *aman* (autumnal paddy), BRRI and some *Rabi* crops. Paddy cultivation in the area is limited because of exorbitant irrigation cost. Some have tried *rabi* crops such as sweet potato but incurred loss due to poor harvest. And hence the farmers were looking for alternative means for their survival.

The Initiative

BRRI-33 seeds, an improved heat resistant variety developed by the Bangladesh Rice Research Institute (BRRI) scientists and then introduced to the farmers by a local NGO *Grameen Artha Samajik Unnayan Sangstha*, has been a major breakthrough. About 20-22 farmers sowed BRRI- 33 here in 2007. On pilot scale this seeds were sown in 36 *bigha* land. The result was amazing and the farmers were convinced of the productivity of the seeds.

Goals and Objective

The goal of heat tolerant rice cultivation is to reduce the vulnerability of community people to food crisis created by natural hazards, especially extreme heat. The initiative aims at increasing productivity of land and crop intensity, increasing rice production and reducing irrigation cost. The crop helps people at risk, when there is no work to earn livelihood.

Outcomes And Activities

Seeds, power tiller, manure, irrigation (the source of water being the shallow tube wells sunk on community basis), shallow machines for irrigation and labour are required to cultivate heat tolerant rice. These elements are available locally.

First, the selected plot is to be ploughed with a power tiller 5 times on every alternate day. Then manure is given by the farmers to the plot together with one time irrigation. The high lands needs irrigation twice, whereas the low lands are given one-time irrigation. So the cost of irrigation for low lands are half that of the high lands.

Then farmers sow seeds in the 1st week of the month of *Ashar* (mid June – mid July). The seeds are sown with the help of drum seeders. When the seeds are germinated the farmers spray insecticides to the plants and they do this at

THE GOOD PRACTICE

Because

- Δ Optimizes the land utility, increases the production by adding the products to the total volume;
- Δ Increases utility of fallow lands remaining idle due to excessive heat and want of moisture in the soil;
- Δ Makes the fallow land productive under the heat where there is scarcity of water.
- Δ Reduces irrigation cost, because it needs less irrigation than other varieties of rice;
- Δ Effectively enhances the safety of the population at risk
- Δ Meets up acute food crisis before harvesting the aman crops, because it becomes matured for har-vesting before aman crops.

the 15th and 42nd days of the germinated saplings and then 10 kgs of urea per bigha is given to the plot. Some farmers are found to spray *vitagene*, although it is not essential.

After 90-95 days of sowing the paddy is harvested in the 1st week of *Aswin* (mid September – mid October). It is seen that the paddy can be harvested one month and a half before normal cropping time, a practice which help people to meet the interim deficit. The labour input is minimal and the entire process including tilling, spraying, irrigation, harvest, cutting the paddy plants, thrashing, winnowing, drying in the sun etc. are done on contract basis with the labourers. Paddy grows about 15/ 16 maunds per *bigha* plot of land. After sun drying paddy plants are dried and kept as fodder. Stubs are used for roofing houses. After harvesting of paddy there remains adequate time for a maize cultivation.

At the time of harvesting farmers identify the well grown plants and preserve them for collecting seeds for sowing in the next season. During preservation of seeds they follow unique procedure of their own to ensure good quality. Selected seeds are dried properly and then cleaned. Seeds are kept in dry containers well protected from the attack of any insects and stored in cool and dry places so that the container may be even are safer from moisture.

Lessons Learned

Key lessons learned from this practice are:

- Δ These crops are available when there is acute food crisis in the area before the *aman* crops and so the crop enables the farmers to meet up the crisis.
- Δ The cultivation of this heat resistant seeds does not need to be grown in a seed bed and
- Δ Then planted in the plots. Therefore, the cultivation saves much labour and cares for the farmers.
- Δ It reduces the irrigation cost, because it needs less irrigation than other traditional rice varieties. The cultivation is profitable because the output is much more than the input.
- Δ The paddy needs chemical fertilizers, which is not an environment friendly practice.
- Δ The introduction of this variety has increased crop intensity, land utility and has added food stock to the national products.
- Δ The practice has revealed a horizon indicating the possibility of bringing all other areas under cultivation suffering from heat related problems.

Potential for Replication

Northern Bangladesh, currently at the risk of desertification because of complex environmental changes caused by the regional political processes, can make best use of this heat resistant variety. This heat resistant seeds are the only option for farmers to produce crops for them in the lands where there is no or less moisture.

Bangladesh being the seriously food deficit, has the policy to increase the food production and rice is the staple food of her population. So the vast land volume threatened to be deserted can be brought under cultivation by a change of crop pattern and this heat tolerant variety has the potential to turn the area green again.

Research is underway constantly but the need of the day is to apply the results in the fields. So it is the bounden duty of the government to disseminate and popularize the cultivation technique through the related agencies.

Apel Kul Cultivation In Drylands

The Précis

Units	Location	Seasonality
Union Upazila District	Neetpur Porsha Naogaon	Dry Season

Prologue

Due to frequent droughts and arid ecological condition, the lands out of the irrigation facilities, cannot produce paddy. So the local farmers in an attempt to survive have been, on trial basis, cultivating mango together with the paddy. But

the mango crops which give returns after a long lease of time and hence could not be attractive to them. So they were looking for more frequent crop as an alternative as per their need. So, the farmers have taken an alternative crop pattern that is *apel kul* (a variety of palm) that has the potential of annual cropping.

The Initiative

Apel kul is a hybrid variety of *kul* which have colour like an apple, is much bigger than the traditional ones and are sweet to taste, achieved much market attention during the recent time. In Gopalgonj village, one Abdur Rahim and his brother Abdul Karim started the cultivation of apple *kul* since last one year. Last year they cultivated the apple *kul* in two *bigha* land on pilot basis in *Ashar* of 2007. At present, they are cultivating apple *kul* on the entire 25 *bighas* of land they leased out. Now 4/5 farmers are found to have adopted this practice in Neetpur union, nearby place.

THE GOOD PRACTICE

- Δ Increases land utility and adds to the total production of the food stuffs;
- Δ Optimizes the production efficiency by diversifying agric items in places at the patches of the home-steads or by having organized gardening in the farmers land;
- Δ Uses the lands turned fallow by recurrent droughts and scarcity of irrigation facilities in the Barind tracts of Bangladesh;
- Δ Encourages the crop diversity essential for the food deficit areas like Bangladesh;
- Δ Increases the items for commercialization and for industrial ingredients for manufacturing guava juice which has demand everywhere;
- Δ Effectively enhances the production possibilities and returns to the existing and future initiators and
- Δ The soil and the environment are suitable for apel kul cultivation.

Goal and Objectives

The goal of *apel kul* cultivation is to reduce the vulnerability of natural hazards, especially drought. The *apel kul* cultivation initiative aims at increasing the land utility and productivity with maximum economic profitability by utilization of fallow lands. The practice is to enhance the capacity of the marginal farmers or the landless to earn by using at least their homesteads or the patches of lands lying idle throughout the year.

Outcomes and Activities

Land, labour, saplings, cow dung, manures (potash, *cargil* - a crystalline black coloured substance like the crystals of urea), pond for watering, shallow machine and polythene pipes for carrying water are needed to cultivate *apel kul*. All these items are collected locally.

The farmers take lands on lease for *apel kul* cultivation. Arrangement between the lesser and the lessee was found that the lessee were to pay the lesser on existing terms of the market price whenever they would pay. The farmers contacted were found to have collected 200 saplings of aged about 2 months of *apel kul* from Nazirpur. Tractor hired to plough the lands from the area. Some people do this. Cow dung, oil cake, manures (potash, *cargil*) are needed which are obtained from the local market. They dug 2 ponds as water reservoirs for watering the plants. The labourers needed for digging ponds are available in the area. They hired shallow machine and polythene pipes for carrying water from a pond to the reservoirs (ponds). Tubs are used to water the plants from the reservoirs. The labourers are also available.

First, Abdur Rahim and his brother Abdul Karim took on lease 25 bigha land from one land owner on the contract that in return they (lesser) would pay 175 maunds of paddy per year to the lessee for 10 years. Then the lands are ploughed twice with hired tractor at the rate Tk. 150 per trip =tk. 300. Then they collected 200 saplings of apple *kul* of aged about 2 months from Nazirpur at the rate of Tk. 45 each. So the expenses for saplings = Tk. 45 x 200 =Tk. 9000. Then they made holes for plantation of saplings, a hole of 1.5 ft deep for

each of the 200 plants on the 2 *bighas* of land and gave cow dung and oilcake in each of the hole. They needed 10 trolley measure of cow dung and 3 bags of oilcakes for the whole project. The expenses for cow dung at the rate of Tk 600 per trolley = Tk. 6000 and the oilcake at Tk. 1600 per bag = Tk. 4800.

After plantation, the saplings were given water in the morning and evening every day and they employed five *pites* (labourers) for the purpose that were paid @ Tk. 100 each and total labour payment was Tk. 15000. There being no deep tube well nearby, they had to buy water from a pond owner whom they paid at the rate Tk. 100 per hour. They drew water for 50 hours.

They carried the water from ponds through hired shallow machine and polythene pipes and stored in the reservoirs (ponds). They paid Tk. 100 per hour to the owner of the pond and Tk. 80 per hour the owner of the machine and pipes. They have to create water reservoirs (ponds) one pond on 15 decimals and a small one on 8 decimals of land. The pond they dug on 15 decimals was 30 ft in length, 30ft breadth and 12 ft deep which required 20 labourers for 4 days and they had to be paid Tk. 8000 at Tk. 100 each for each day. The smaller one on 8 decimals was of size 10 ft in length , 10 ft in breadth and 8 ft deep and 8 labourers worked for 2 days for the digging and at the rate Tk 100 per labour they spent Tk. 16000 .

The labourers used to water the plants about 5kgs each from the ponds with tubs on their shoulders. During the 1st month, the plants were given water daily but at the second month, water was given only on 6 occasions and so the labour cost was Tk. 3000 at the rate Tk 100 per labour for 6days.

They used manures from the 3rd month and throughout the month they used 2 bags of oilcake, one bag of potash and one bag of cargil which cost them around TK6400. Short after 3 months, water or manure is not required. After the 4rth month the *apel kul* appeared in the plants with flowering of beautiful colour in the garden. The fruits that appeared in the plants began to be matured from the middle of the *Poush* to the 1st week of *Magh* (Jan.-Feb). They had a pilot scale harvest of 20 maunds of *kuls* on each *bigha* and they sold the products to the traders of Dhaka at the rate Tk. 2300 per maund. They sold the whole lot to buyer at Tk. 48 000.

The farmers are now grafting the branches for multiplying the saplings and selling them. They have raised 3500 grafts during this season and spent Tk. 38000 for the grafting work. Each is sold at Tk. 25 / 30 and total price (25*3500) Tk. 87500. But there is little or no demand in the market for the grafts and so they have stopped grafting for the time being.

Net profit is (Tk. 135500 - Tk. 104100) = Tk. 31400. The brothers with lofty ideas adopted the cultivation and, although they hired 25 *bighas* of land, they planted trees only on two *bighas* on piloting the ideas. With production and other methods they might have some sort of draw backs which they must have noted and during second time they must rectify them and try to raise the production. So, they are now much encouraged with the success and are now planning for bringing the entire area under cultivation in 2008. They are expecting for producing 30-35 maunds of *apel kul* in each *bigha.*

Lessons Learned

Key lessons learned from this practice are:

- *Apel kul* cultivation is at any stage, either at the small enterprise scale or at the family kitchen garden type is quite suitable for our hard hit population. Though capital, big or small is pretty difficult for small farmers.
- The cultivation is non-traditional and the variety being introduced is new and the production is satisfactory.
- This can support a farmer's family greatly. Also there is potential for generation of employment for people at the farming stage.
- The challenge is the technology of cultivation. Our farmers are illiterate. But agricultural technology has undergone much change due

to advent of tissue culture and biotechnology being introduced by the advanced countries and are producing tremendous amount of crops from a little plot. Now-a-days production does not need much bigger plot. So the farmers are needed to be educated and trained in different packages of technology of production.

- Δ The farmers have invented the production of *apel kul* cultivation in an attempt to replace the cultivation of mango and have found to be prospective. Although the harvests of the whole project are not yet seen by them but the possibility is perhaps much encouraging.
- Δ More over the kul/guava as juice has been introduced in many countries now a days. Even the neighbouring countries India and Myanmar type of guava juice at times appear in our country. So the cultivation has the potential of giving inputs to the industrial units having international market.
- Δ The initiative innovative and has the potential to survive.

Potential for Replication

In this age of economic crisis throughout the world search for non-traditional agric production is wide. So this cultivation of *apel kul* is no doubt prospective and viable. *Kuls* of different varieties are being cultivated traditionally from unknown time at the family level which gets much support from people. A new variety *apel kul* has appeared in the markets which are much bigger than the traditional ones and are sweet to taste, has achieved much market attention during the recent time and are proved to be economically viable within a short time.

The Go-NGO attention to this cultivation is urgently needed to tape the possibility at the benefit of people.

The authority responsible for food security of the population of the country must pay attention to this. Now we in Bangladesh need program based activities for development of the food sector. To feed the vast people, we need exploring all avenues to expand productivity by all possible means. The research community should turn their attention to new dimensions relating to the exploration of non-traditional ones.

CHAPTER 8

COPING WITH WILDLIFE DISTURBANCES

Chapter 8
COPING WITH WILDLIFE DISTURBANCES

Wildlife Disturbances Scenario in Bangladesh

Profiling the Study Areas

This research enterprise has yielded significant ethnographic information on the episodes of good community coping responses related to drought and aridity from different locales of Rajshahi, Nawabgonj, Naogaon, Gaibandha and Nilphamari. The survey areas were 17 villages in 10 unions in 6 upazilas of the five districts. [See Annex XX]

Fog, cold wave, drought and nor'wester found from Naogaon; flood, sand deposition for flood and drought from Gaibandha; flood, drought and fog from Nilphamari; nor'wester, heavy rainfall, hailstorm and extreme heat from Chapai-Nawabganj; and drought, cold wave, flood and hailstorm from Rajshahi. Drought is one of the main and common hazards found from the districts which are observed in *Ashar to Chaitra* (mid June to mid April). Rajshahi, Nawabganj and Naogaon located in Barind tract. But studied areas of Nilfamari and Gaibandha are facing the drought situation due to the land characteristics (sandy soil) of newly formed char land.

Wild Animals Disturbances in Bangladesh

Bangladesh is mainly a flood plain country with a small region of higher land situated in the east and south part. Of the total area of Bangladesh, forest land makes up 17.08% of its geographic surface. According to the Forest Department (FD), there are three categories of forest land in Bangladesh. Forest managed by Forest Department is about 10.30%; unclassified state forest is about 4.95% and village forest almost 1.83% (Forest Department, 2008) [20]

The Hill Forest mainly situated in eastern side of the country and the districts are Chittagong, Cox's Bazar, Rangamati, Khagrachari, Bandarban and Sylhet totalling an area of 6,70,000 hectare which is 4.54% of total landmass of the country and 44% of national forest land. The hill forests are abundant with numerous animal species, among the animals Elephant, monkey, Barking Deer, and Indian Leopard are notables.

On the other hand, Sundarbans situated in the south-west, the world's largest natural mangrove forest in Bangladesh, consists of a total of 6,01,700 hectares which is 4.07% of total land mass of

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the country and 40% of total forest land. It is a unique habitat for a number of wildlife like World renowned Royal Bengal Tigers, deer, monkey and crocodiles.

Food shortage due to deforestation and human activities; constant discomfort for human interference and environmental change the wild animals are disturbed and attack the people and come to the locality searching for food. Every year a good number of people are killed and injured by the elephant and tiger attacks. On the other hand, after 50 years gapping the bamboo flowering cause increase of the rat population of the hilly areas. The rats destroy the crop field, household food storage and seed bank which make the hilly communities vulnerable.

Overview of the Risk Environment

Elephant Attack

Elephants, a protected wildlife species in Bangladesh, often make incursions into villages near the hills, to search for food. They also damage crops, houses and injure humans. The hilly areas of Chittagong are generally supposed to be covered with wild forest infested with different types of animals, but its wildness has been reduced due to the increase of people's interference and ruthless appropriation of natural resources. Beside this, there are some small patches of plains between the hills, where different types of crops have been cultivated since the past and this is an important source of livelihood option to many of the local people.

But felling down the trees in the deep forest resulted in huge food shortage for elephants that forces them to come out in the plain and their occasional interference destroys trees of the gardens, crop fields, properties and lives. Pulling the trees by the trunks, the elephants eat the leaves and soft branches of the trees. Most often it attacks during the flowering period of the mango and jack fruit trees. This is not the end of the spectrum; it also destroys crop fields of the plain land and properties including lives.

Forest officer of Chittagong regions reported that, a herd of 15 wild elephants killed four people and injured 15 others while raging through two villages at Rangunia in 2001. These elephants came from nearby forests. They pulled down a number of bamboo clumps, straw houses, and damaged crops of the field. It was also stated that wild elephants killed nearly 30 people in Chittagong and nearby Cox's Bazar districts in 2001.

The Rat Attack at Bamboo flowering

The maintenance of balance of nature-by-nature itself is observed always. The example is the life cycle of bamboo. A group of plants are seen in nature that grows their off-springs from the roots and not by seeds or branches or leaves or any other part of their body. The example is the banana, bamboo etc. So age of the root is the age of the plants growing in the cluster. The genetic codes of bamboo plants exhibit self-destructing natural process following approximately a 50 years cycle[21]. At first they give out flower, the flower then give fruits, greenish in colour but round in shape, bigger or smaller. Then they die.

This life cycle change of bamboo plants has been observed in 2007 in the Thaikhiangpara West Sallattapipara (Burma border) North Sisong, Thing Daspe, Susong Para, Bakrlai of union and Member colony, Hatimathapara, Bethelpara, New girja Bowm Para and Sadarghat in No.2 Union.

It was at the beginning of August 2007 that the bamboo plants in the above areas begin to flower, as the respondents reported, the flowers (in Bowm language bamboo flowers are called *maopar*; *mao* meaning bamboo and *par* meaning flower) looking white and clustered and after a few days they give out fruits, the fruits looking greenish (fruit in local language is called *maora* meaning bamboo fruit), round in shape, the inner kernel being white and with no seed but with a whitish gap. After the fruits are grown the plants die en-masse naturally and a progeny is finished.

21 Hellen Keller International, April 2008, Needs Assessment Report On Bamboo Flowering, Rat Infestation and Food Scarcity in the Chittagong Hill Tracts, Bangladesh,

Two unions of Ruma Sadar have been infested with rat attacks at the time of bamboo flowering and it has been found that the flowers are very favourite food of rats and the rats, on eating the flowers have their fertility strongly increased for production and consequently the area was flooded over With rats. The flowering process continues for a period: some give flower and others prepare and the ones give flowers give fruits and the others give flowers and so on. On the other hand No. 3 Remakriprasong union gave flowers earlier and then the bamboos were dying. Here too the attacks of rats made the area hell because they not only eat the flowers and fruits of the bamboos but they attack the *jhum* cultivation, especially the rice fields. These, in hundreds and thousands, attack the farmer's land and destroy everything like the attack of pests.

Tiger Attack

The Sundarbans are home to approximately 500 Bengal tigers[22], one of the largest single populations of tigers in one area. These tigers are well-known for the substantial number of people they kill; estimates range from 50-250 people per year (ibid). Tigers are now extremely aggressive because of a state of constant discomfort. This discomfort is due to disappearance of freshwater lakes for drinking, food shortages, human interferences, deforestation etc.

Recently attacks have been on the rise due to the devastation in the swamps of Bangladeshi side caused by Cyclone SIDR which has deprived tigers of traditional food sources (due to the natural upheaval) and has pushed them over towards the more populated Indian side of the swamp.

Profiling Wild Animals Disturbance Prone Study Areas

This research enterprise has given significant ethnographic information on the episodes of good community coping responses related to wild animal disturbances from different locales of Satkhira, Cox's Bazar and Bandarban. The survey areas were 11 villages in 5 unions in 4 upazilas of the three districts. [See Annex XX]

The research shows salinity, arsenic and river bank erosion in Satkhira; flood, flash flood, salinity, cyclone, storm surge and wild animal attacks from Cox's Bazar; and flash flood, wild animal attacks, land slide and earthquakes from Bandarban district. Animal disturbance is the major and commonly found hazard in these districts.

It is a regular event in Cox's Bazar and Bandarban throughout the year. But it is increased during the harvesting period in those areas. Due to the sudden siltation, people cannot always be alert against the move the herd of animals.

In the study areas due to animal disturbances mainly human beings and crops of the fields are destroyed. So the livelihood resources like natural resources, social resources, economic or financial resources, human resources and physical resources all become directly or indirectly vulnerable.

Agriculture, the main source of livelihood, becomes vulnerable due to rat and elephant attacks. The agric practices are totally shattered. The worst impact has been frequently on the crop and fruit gardens, which in turn destroy the main source of livelihood. Consequently the agric dependent people become extremely poor and are struggling for survival. In this way animal disturbance affects in food security and livelihood. Simultaneously, people get injured and some of them even die from elephant attacks.

The tiger mainly attacks people who are working in the forests and sometime they come to the locality in search of foods. In that case, houses and some infrastructures are damaged.

Coping in Wild Animals Disturbance Regions

The research findings suggest that the communities in such areas are trying to cope with the situation with their respective efforts to mitigate the consequences of wild elephant

22 en.wikipedia.org

disturbance. People, in the study areas, attempt to address risk problems *ex ante*. In this chapter we would discuss some cases of relevantly good community practice concerning the risk of wild animal attacks.

Unlike other natural hazards, the absence of any early-warning system for wild animal attacks remains as the challenge for people and professionals in reducing or mitigating the consequences of animal disturbance events.

"Whether sad, angry, distressed, eager, or playful, elephants are this in a big way"

– Joyce Poole

AREAS IN THE LINE OF ELEPHANTS ATTACK

The Précis

Locations		Seasonality	Hazard
Union	Palongkhali Yongsa	Poush to Jyaistha and Bhadra to Kartik	Elephant Attack
Upazila	Ukhia Lama		
District	Cox's Bazaar Bandarban		

Prologue

The elephant has the power to modify the landscape it resides in and passes through. Given its power for destruction, the following discussion is especially worthwhile for anyone concerned about the struggling for lives and encountering elephants, as the only living bulldozers of destruction.

The Initiative

Due to the shrinkage of food availability in the deep forest, the wild animals, especially elephants are forced to come out from the deep forest in search of food in a group. While the elephant hordes are out to move around, sometimes they come across the agric fields, which lie in some pockets between the hills. As a result the crop field is completely destroyed by the elephant horde movement. The consequence enforced the local people to take some preventive measures; fastening tins around the trees and raising buffalos at that time etc.

Earlier people kept away wild elephants by showing flames of fire or by blowing the trumpet or making great sound by firing rockets. But the use of such combustible fire materials were prohibited by the law enforcing agencies in the hilly areas and so the prohibition enforced them to find alternatives. In course of time, one old Shamsul Alam fastened tin sheets with the coconut, mango, and jack fruit trees of his garden and on some occasion he observed tree fastened with the tin sheets were not attacked by the elephant hordes. The practice diffused to the locality and from the year 2006 almost all the families adopt the technique.

Again one Mansur Ali came up with another innovative idea to protect the crop field from wild elephant hordes. Long-term observation of the wild elephant behaviour influenced people to think that the elephants might fear the horns of the buffalos. So on some occasions when wild elephants came in the village he took two buffalos and set them in front of the elephants. Amazingly he saw that the elephants did not raid over, rather they stopped and finally left the field. Afterwards people of the area adopted the technique since 2007.

Goal and Objectives

The goal of using tin and buffalo as shield is to reduce the vulnerability of wild elephant attack. The tin protection initiative aims at making their living comfortable at the time of wild elephant attack to their premises and fruit tree gardens. The aim of the protection by buffalo is to secure safety of their crops in the field.

THE GOOD PRACTICE

Because

- Δ To save human lives and properties in the wilderness , people apply different methods but the ones devised are the most effective and are always followed;
- Δ The ones devised and followed by the people in the areas under study seem to be innova-tive , cost effective, indigenous and beneficial;
- Δ Buffalo and tin methods are able to protect human life and properties effectively;
- Δ Might and fastness ensures wild life; but the method of employing tin sheets against the trees is somewhat intellectually designed experimental result ;
- Δ The methods are already in use in the wild areas of the hill tracts and are found to be effective to save life and properties.

Outcomes and Activities

The preventive measures are the use of tins and buffalos at the time of attacks by hordes of elephants.

Protection by the tin sheets

Usually trees in the gardens, crop fields, properties and lives are being affected by the wild elephants' interference. For the protection of fruit bearing trees, the purchased tin sheets are cut in greater lengths, and then the sheets are fastened at the bottom side of the trees, the sizes being 3 ft long and 3 ft broad. It was observed that elephant feared of catching the trunk of the trees fastened with tin sheets when trying to pull down.

Crop protection by the Buffalos and drum

Similarly buffalos are being used to protect crop fields, properties and lives. People become organized and make four surveillance teams composed of four young members from the labour class who are responsible to observe thirty *kanis* (120 decimals, a local land measuring unit) land. In addition, all the farmers are said to work together at the time of necessity. These workers are protecting possible attack from elephants with use of buffalos.

The elephants generally attack the crops at the harvesting period which are the months *Paush* to *Jyaistha* (mid December to mid June) and *Bhadra* to *Kartik* (mid August to mid November) as multiple crops are grown up in a year. The wild elephants visit this area either in the afternoon or in the evening during the period. If they are not repelled, they destroy everything throughout the night and in the morning they left the place to return to the deep forest. The land owners give 5 drums (one drum is equal to 14 kgs of rice) of paddy for each *kani* of land to the surveillance member team for their job.

As the number of buffalos is small, out of the 54 families of the village, 7 families have their own buffalos. Each team hires two buffalos for one harvesting season at TK 2000 for the purpose with a condition that any loss of buffalos caused by elephants' attack will go to owner side, only they will get the milk of buffalo. The teams, one after another, observe wild elephants' movement whole day and night from the top of the tree so that the team could take proactive measures including preparation. The team is to be vigilant only in hearing, and even if, they fall asleep, they are awakened by the crashing sound and roaring of the elephants hordes. So they are not to be worried about the time of arrival of a horde. The team's main mode of operation is to set buffalos in front of elephant horde and setting themselves behind the buffalos with burning fire and flaming sticks. Finally the team has got success and could force the horde to turn back.

Lessons Learned

Buffalo technique is a self-help socially devised method capable of reducing potential losses. It is really encouraging that buffalo domestication is not only given benefits what we traditionally expect but also it helps save from the attack of wild animals. To drive away animals by employing another animal is an interesting and cost effective way.

Use of tin is also a good example of protecting the trees of the garden that does only require minimum cost to buy the tin.

Both the techniques have some sorts of limitations, tin technique carries risk of injuries of children; similarly buffalo technique carries risk of loss of watcher's lives including buffalos. When elephants become mad and make counter attack, we may apprehend this loss.

These are comparatively eco-friendly simpler methods which reduce the losses of crop field, garden, properties and lives. Although the buffalo technique is effective but it produces a great challenge to reduce risk of losing the watcher's lives.

Potential for Replication

The techniques may perhaps be considered as a replica for other areas where people are encountering attack of wild elephant. Both the methods demand replication in time of elephant attack in places infested with wild elephants.

RAT FLOOD IN CHTS

Trapping Rats or Getting Trapped?

The Précis

Locations		Seasonality	Hazard
Mouza	Remakri Toin	Cycle: Once in 50 Years	Rat Floods
Upazila	Ruma Lama		
District	Bandarban Bandarban		

Prologue

It is found that the bamboo clumps, after every 50 years, give flowers and fruits and then the clump become moribund and extinct. A new generation ensures further continuation of the species. The flowers are white and round shaped. The fruits are also round shaped but have greenish colour. Both the flowers and fruits are favourite food of rats.

Two unions of Ruma Sadar have been infested with the attacks of rats at the time bamboo gives flowers and it has been found that the flowers are very favourite food of rats and the rats, on eating the flowers have their fertility strongly increased for production and consequently the area become over crowded with rats. The attacks of rats turn the area hell because they are not only eating the flowers and fruits of the bamboos but they attack the jhum cultivation, especially the rice fields. Thus food and seed security get vulnerable due to rat attacks and the inhabitants face a grave situation.

The Initiative

Flowering of bamboo begin in the month of August 2007. The *jhum* fields are measured in a '*hari*', 2.5 *haris* being equal to one acre. They have 5 or even 10 haris of *jhum* fields. They plant all together: rice, lentils, *teel*, gourds, potato, pepper, pumpkins, cucumber, *marpha*. They harvest them at different times. They collect the seeds for next cultivation also. But this time they have lost everything and even they could not collect seeds for next sowing due to the attacks of rats.

THE GOOD PRACTICE

- Δ It is not harmful for wild life and do not generate any environmental difficulties;
- Δ Already adopted by the local people.
- Δ Community based primitive and indigenous technology friendly to the environment;
- Δ The strategies can ensure security t the society's agric crops partially without any harm to the environment ;
- Δ The practice is designed by the hilly people themselves from the idea they innovated and its efficacy is, although, limited, needed to be replaced by one ensuring guarantee to their crops in the fields among the hills.
- Δ At least this method of killing the rats may be applied where none is available.

The hilly people take rats as food as they catch them by traps but these rats are so small that they cannot be trapped. So this trap system can protect from rat. This is an indigenous technique and the origin could not be identified.

Ruma Sadar has started flowering in the month of March in the bamboo plants. The farmers were preparing for *jhum* cultivation and devised a special kind of traps for killing rats.

Goal and Objectives

The goal of the initiative is to reduce the vulnerability to the attacks of rats and aim to ensure the safety of the crops and seeds for their food security.

Outcomes and Activities

They collect the necessary materials from the environment of the hills for preparing the new traps. The materials are only bamboo pieces, 5/6 pieces of trees, and some ropes. For killing rats they raise fence around with 2 /3 ft height and they fix up the traps. The fences they make for the purpose are set along the line of the field and

after 1 cubit of one fence they lay another fence and within this space in between they make the traps and on entering the plots the rats are killed. 15-20 traps are left over the space when jhum is cultivated on 2 haris of land. They use the same bamboo for making the traps and the fences (*dai*, a word of Bowm). Beyond the fences two small *achakha* (*achakha* means poles in Bowm) are fixed, with which are fixed triangular frames made of bamboo. Beyond 1.5 ft distance from this pole is fixed another medium size pole of 2-2.5 ft in height. The triangular frame is fixed with the pole

with ropes. The medium size pole has long rope (*gainam*) on one side and small rope (*aluforth*) on the other. These two ropes are connected to a thin and small bamboo (*boikala*). The space in between the space of the fences, 5 /6 long tree pieces are connected to the small and medium size poles with ropes. The expected routes of the rats have two small poles which are connected again from below with ropes. A portion of a piece of smashed bamboo is placed on the path so that when entering the field the thread laid down is exerted tension and the big portion of the tree fall on the rats and they die. The trap they use also for killing fowls, jackals etc.

They themselves prepare the traps and they can prepare one trap within two hours. But as the rats are very small they cannot kill them en masse.

Lessons Learned

To win over the natural barrier has been the struggle since the creation of mankind and thus far they succeeded. To control the impediments to the advantage is inherent to humans. Here in addition, the residents face the obstacle created by the rats for their crops and livelihood and they prepared some preventives by their indigenous knowledge. The measure they apply here is very simple. Laying traps for the prey is very old. Here the elements they employ for the manufacture of the trap are locally available and effective for different preys.

Potential for Replication

Laying poisonous elements for killing the rats pollute the environment. So the trap method is eco- and environment friendly. The places infested with such wild animals destroying the properties of residents can be saved by employing this simple technique of laying bamboo traps.

AREAS IN THE LINE OF TIGER ATTACK

Preventive Measures against Tiger Attacks

The Précis

Units	Location	Seasonality	Hazard
Union	Burigoalini		
Upazila	ShayamNagar	Yearly trends	Tiger Attacks
	Shatkhira in		
District	Sundarbans Range		

Prologue

The Sundarbans is considered to be part of the world's largest delta. The region is well known for its vast stretch of mangrove forest, densely populated with different trees. The Sundarbans has remarkable reserve of wildlife, the man-eater Royal Bengal Tigers being the most famous among them.

The area mentioned above suffers from tiger attacks, which people in other districts cannot think of. Satkhira range of the Sundarbans is the most dangerous range for frequent tiger attacks, the highest frequencies of attacks from 1999 to 2001 accounted to be 56%-63% of the total attacks occurred each year.

In order to collect quality honey, *goran* stocks, *golpata*, oyster shells as well as shrimp many collectors meet sad incidents in this range. Many of them are eaten by the tigers.

The number of attacks increased in the morning, the peak being at midday, followed by second peak in the late afternoon. The largest concentration of attacks took place between 10 to 12 AM and the least being between 9 PM to 3 PM.

People of the age group 15-29 are the least vulnerable, while people of 60+ are much more vulnerable to tiger attacks.

Impact of tiger attacks on family households: More than 68% of the victims suffered from decrease of income and expenditure and around 28% of them lost the ability for income and most of the victims lost working capacity due to fatal injuries and also lost their livestock property. (Source: internet, 27/10/08)

THE GOOD PRACTICE

- Δ It is cost effective for the people who are living in the risk area;
- Δ People can arrange or collect fire materials from the nearest forest;
- Δ It is not harmful for wild life and do not generate any environmental difficulties;
- Δ In these days of hardship of land, food and water, we are to consciously consider the safe-ty of these people living by the forest side and must either ensure the safety of humans or of the forest with its wild animals or both.
- Δ The method now being used has less probability of ensuring safety and some as-pects like worshipping the goddesses are purely psychological heeling and cannot save them and we are to adopt modern safety measures and apply and even then also for any accident we must compensate with.

The Initiative

In order to save one from tiger attacks local people take some spiritual or superstitious measures, such as: taking holy bond from certain *religious* figures in their locality, worshipping the Bonbibi (queen of the forest), Wearing painted Mask etc. The local people, however, do not have any sustainable strategy to protect themselves against tiger attacks. Thus to prevent the attack they make a fire with wood on the road side as well as make a noise or high sound and sometimes use fire sticks to make everybody aware to be careful of the tiger's entry and come in group to repel the tiger from the locality.

Goal and Objectives

The goal of the initiatives is to reduce the vulnerability to the attacks of tiger and the initiative aims at ensuring safe and sound

livelihood and protecting life as well as livestock of the people living in the most high-risk areas in Satkhira range of the Sundarbans.

Outcomes and Activities

The local people and government officials take certain precautions to prevent tiger attack although few of them work. When local people is warned about a tiger coming towards the locality, they make a fire for 20-30 minutes on the road side at risk area with dry leaves and wood which they collect from the nearest forest. In addition, they use fire sticks which make a tiger go away from the locality. Moreover, they start beating the tin or drums to create huge noise or hard sound. As they collect materials for making fire from the forest, there is no financial involvement. So the initiative is not cost intensive.

On the other hand local fishermen will say prayers and perform rituals to the forest goddess, Bonbibi, before setting out on expeditions.

Several victims worshipped Bonbibi, goddess of the Sundarbans; some of them accompanied knives before going to the forest.

Sometimes Fishermen and Bushmen make facial masks to wear on the back of their heads, because tigers always attack from behind. Besides, Government employees wear stiff pads that rise up the back of the neck.

Lessons Learned

- Δ Local people have already adopted these strategies as there is no alternative way;
- Δ Cost involvement in the process is not a crucial;
- Δ Protection in the wild life from the attack of wild animals is crucial ;
- Δ Although sometimes human life as well their livestock may be saved but this is not a dependable mechanism for ensuring safety of life and properties in the forest infested with wild animals.
- Δ In the case of fatality the family of the victim faces serious economic loss and psychological trauma.
- Δ In some cases victim is temporarily or permanently Rrndered disable and incapable of working any more.

Potential for Replication

People should stay close together when walking through the forest, in groups of four or more if possible. From the report of the clients, it appears that Mawalis, Bawalis and fishermen are the most vulnerable; they should form team spirit to work in the forest. At least one member of the team may be vigilant in keeping watch on the possible attack and face boldly together to drive away the tigers.

To prevent tiger attacks in the villages, awareness campaign is essential among the village people in the risk area.

It is difficult to stop tigers from entering the villages around without taking extreme measures, such as: fencing the boundary like the national park of Botswana between village and forest (along the village side of the river) or by raising walls that could prevent tigers from climbing over.

The reality is that the Wild life and forest reserve project must consider the permanent fencing along the boundary; because animal and humans cannot live together. We are to keep in mind that people, poor or rich, will collect forest resources, the pressure will increase more and more with the population growth.

Compensatory Measures and relief

There has been some mentioning within the Forest Department of the need for giving compensation to affected households after a tiger has come out of the Sundarbans, entering a village, and has caused harm by injuring or killing either people or livestock.

In the case of fatality of the victim the family will face serious economic loss and psychological trauma. Therefore compensation level should be the highest.

There is a large role for NGO in relieving the impact of tiger attacks on the families of all victims, inside the forest and out. If a dedicated NGO could focus on improving the lives of those families affected by the loss of their main or sole income earner in especially Shyamnagar Upazila that would be a great step forward from a humanitarian's as well as a conservationist's viewpoint.

CHAPTER 9

Conclusion

Chapter 9
CONCLUSION

Conclusion

The preceding chapters pertain to capturing indigenous knowledge and related diverse coping responses that people generated in their respective attempts to adapt with natural calamities. In conclusion, we would shift our attention from the knowledge of nature to the nature of knowledge to elucidate how indigenous people manage available knowledge to reach solutions to the problems they encounter in everyday life. Focusing on the nature of indigenous knowledge would help organizing the major findings and then analyze them for crystallizing the outcomes of this research. The aim of the discussion is to explore indigenous people's mechanisms of responding to risk situations in order to identify effective approaches for improving and enhancing the visibility of the onshore risk governance processes of which the coping responses form a part.

The study makes the point that immunity from disasters and diseases are two essential elements or critical requirements for agricultural production as well as livelihood stability across the study regions. The tolerance thresholds to these critical events, however, vary from place to place and across different actors. Differences in the endowment bases, access to productive resources and exchange entitlements elicit different tolerance threshold levels for the rural households in Bangladesh. Some social groups are inherently more susceptible to hazards, especially the poor people suffer most from the devastating effects of the natural hazards. The combined effects of various shocks have destabilized their livelihood systems leading to destitution. Inadequate productive resources of poor in the study areas more often expose them to chronic food insecurity. Their agricultural livelihood base significantly suffers erosion resulting from recurrent and over exposure to natural hazards. These calamities have made the farmers vulnerable to crop failures and food scarcities with consequences on the wide-scale food insecurity and malnutrition in the country. Therefore, food security is a central concern of the most rural households in Bangladesh.

Building a disaster resilient community requires the understanding of local concerns and use of local resource and knowledge to build self-reliance and resilience. It also entails adequate policies and an enabling environment. Policy formulation and implementation in a rapidly changing physical and socio-economic environment requires deep understanding of the complexities and diversities.

Apart from external perpetrators, food rights are also violated within the family through discrimination towards women and female children and ignorance about alternative affordable nutrition. Consequently, focussing on increased production at national level should not lose sight of the role of distribution. Again, traditional coping mechanisms of the poorer households seem to be strained by poor access to productive resources, and also by higher population growth in the rural areas. Hence, appropriate policies need to be designed to address the need of the poor people and other disadvantaged groups. However, we will try to provide an overview on the findings of this research in the proceeding discussions. We also attempt to make some remarks based on our observation and experience encountered while conducting extensive field visits for this research.

INDIGENOUS KNOWLEDGE AND COPING RESPONSE

The community people have their own ways of collecting risk information, analyzing risk and taking decisions for managing risk situations through generating coping responses. These

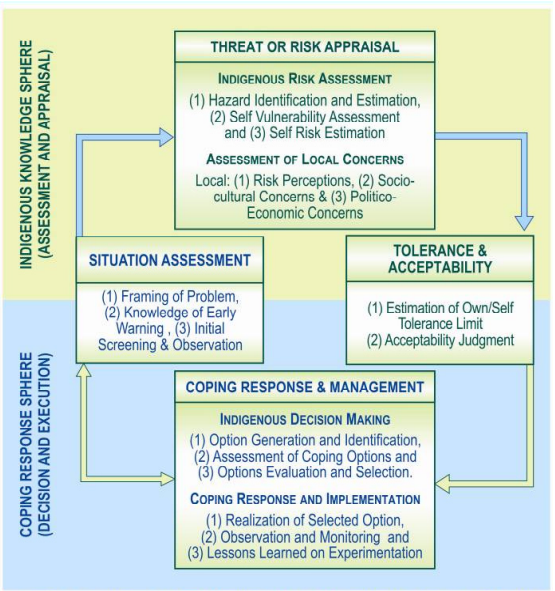

FIGURE 9.1: INDIGENOUS FRAMEWORK FOR GENERATING COPING RESPONSE

conventions, processes or mechanisms comprise of a broad picture of indigenous risk governance including coping practices. The indigenous risk governance looks at how risk-related decision-making unfolds when a range of actors is involved, requiring co-ordination and possibly reconciliation in profusion of roles, perspectives, goals and activities. The problem-solving capacities of individual actors also include the context of risk by taking account of such factors as the historical background, guiding principles, value systems and perceptions. Local risk governance however not only includes a versatile and multi-actor or community based risk coping process but also calls for the consideration of contextual factors such as institutional arrangements and politico-economic culture including different local perceptions of risk.

For wider understanding of coping responses and the complexities, uncertainties and ambiguities of risk situations, we attempt developing an integrative framework that takes into account the local socio-economic and politico-economic processes involved in generating indigenous knowledge and coping responses (see Figure-9.1). The framework has been designed to include enough flexibility in understanding the wide diversity of risk governance strategies employed by the local actors in Bangladesh. We, firstly, discuss a comprehensive risk handling chain of the local people, breaking down its various components into three main phases: 'situation assessment', 'threat appraisal', and 'response and management'. The two intermediate and closely linked stages of risk characterisation and evaluation have been placed between the appraisal and response phases. The local assessors interpret the evidences for characterising risks and evaluate underlying values for judging their own limits of tolerance and levels of acceptability.

RISK PERCEPTION, TOLERANCE AND RESILIENCE

Women and other socially excluded groups constitute the most vulnerable segments of the society and tend to be disproportionately affected by the impacts of disasters and climate change.

Tolerance threshold levels of the households to the natural disaster events, however, vary from place to place and across different actors. Among others, the significant reasons are: social values, attitudes, perceptions, diversity in entitlement and access to resources and so on. Considering such diversities and complexities, it is hard to explore the tolerance threshold levels for different actors under these varied situations. Associated with the diverse nature of risk encountered by different social groups, perceptions on threshold levels are also observed to be diverse among different actors. Different social categories, for instance, the poor, the rich, the women, have different perspectives on upper tolerance limits for crop losses. A general assessment may be included in the following discussion.

The landless, share-croppers and marginal farmers perceive that they live on the edge in each production cycle. They do not have any shock absorbing limits e.g. there are no safe threshold limits for them as they are always at high risk. Hence, they unanimously said that any shock cannot be tolerated even for a single production season. In all field sites, the poor people are not in a position to accept yield losses of any level. Therefore, the upper tolerance limit for them is defined by zero percent yield loss. Transitory food shortage is common even during good seasons. The food and supply and income sources of the poor people are always uncertain and they are one of the most vulnerable groups.

The tolerance threshold level of the women may come next in our discussion. It has generally been recognized that there are differences between men and women in their needs, vulnerabilities, capacities and coping strategies, and so women are more vulnerable to hazards than the males. Roles played by women in the farming systems are also different. Thus, women have different vision of threshold levels since they are very important part of the whole farming system. Additionally, the women are the manager of the household nutrition. On the level of risk tolerance, most of the women expressed opinion which is closer to that of the marginal farmers. Women perceive household food security (HFS) as the availability of food to meet household food needs throughout the year. It is believed that adequate food production is the basis on which the households' build their food security and that should also be sustainable. Hence, household food stocks are very important for women to ensure adequate supply of food to the members of the household. Ensuring continuous supply implies hesitation to accept risk. Thus, women cannot tolerate any level of crop yield loss even for a single season.

The middle or surplus farmers, a few in numbers in the study areas, and can sustain a certain extent of yield losses for approximately a year. Reasons for the differences mainly rest on the differences in possessions, savings (cash, grain stores, durables) and access. Crop failure may not necessarily lead to food shortages or hunger for them, unless consecutive yield losses. These people may have some carryover stock from past harvests. They also have better access to credit and other support systems.

The respondents of this study also reported that accelerated problems for the poor people may sometimes become advantages for some other social groups, especially for the well off people. Higher interest rates, and cheap and bonded labour can be obtained when the poor becomes more poor. Eventually, the money lenders become the owner of the poor peoples' wealth. The situation leads to a complex dilemma since the failure in crops offers alternative opportunities for the wealthier farmers. However, determining the actual risk tolerance limits for different socio-economic groups needs further research.

COPING, ADAPTATION AND RESILIENCE

Individuals and communities have some degrees of autonomy to choose coping pathways. The degree to which they are autonomous is, of course, constrained both by the wider economic and political environment but also by antecedent decisions that partly lock them into particular pathways. The coping strategies, we found in the study areas, are of different types including

immediate, and repeated or regenerative types. Such coping responses are concerned with the immediate, repeated or regenerative in nature and form the basis of dynamic attempts to address long-term issues. They include ways in which households seek to expand the resource base and diversify through flexible land use, petty trade, migration and the provision of services. Key regenerative responses identified in this study are discussed below.

Seasonally Diversified Production Systems

Seasonally alternative farming systems may be considered as an example of regenerative coping that utilises the natural diversity of the landscape and seasonality to cope with climatic adversities and natural disasters. This involves wide varieties of agricultural production including hydroponics when the lowlands are flooded and water logged the regions. However, coping decisions over land use were characterised by both spontaneity in response to immediate pressures and by changes to crops through trial and error.

The households' ability to diversify increases its resilience during seasonal hazards. Of those interviewed in this study, most of the respondents had been able to maintain alternative cropping patterns based on their economic abilities and background. The key constraints for those unable to follow this alternative cropping pattern were lack of access to resources required for production. Thus the land owning households that could accumulate some amount of cash were in a better position to maintain resilient livelihood support systems.

In response to an increase in frequency and intensity of hazard events over the past decades, the proactive households have repeatedly explored different production possibilities and alternatives for transforming patterns of land use. Looking more closely at the profile of these households revealed that well-off households i.e. households with more cash capital tended to cultivate maize, sugar cane, mango, jute, apel kul, and vegetables. Similarly, those households that were lacking in financial resources were more likely to have access to grow *pera, kaon, felon*, *golpata*, banana, *chana/ kherachi*, *bhenda*, *kewra, murta, mele, kalai* and groundnut. The study findings suggest that well-off households were able to better utilise the production alternatives i.e. alternative production for higher economic returns because they had more land and capital including cash and wage labour to work for higher economic returns. Over the years, the marginal land owning farmers have demonstrated that some form of cash capital, or the availability of the productive factors for which the cash is required, have been able to increase their resilience against disasters.

Diversification of Livelihood Activities

Repeated and developed regenerative coping responses have transformed the mode of livelihood activities such as the intent, scale and length of migrations, and adopting petty trade, poultry and livestock raising, and other services. These diverse activities are now consistently incorporated into rural livelihood practices. Most of the respondents had diversified income sources besides subsistence farming, although the majority of these are reliant on the natural resource base. But the benefits of diversification remain inequitably distributed across the communities, reinforcing differences in resilience.

Temporary migration to seek temporary employment based on wage labour in urban or neighbouring areas are quite common among the landless poor, and marginal and sharecropping farmers. People belonging to this category, according to the respondents, regularly use this coping practice. Looking for temporary employments, after disaster, outside the locality for longer, but temporary, periods was considered a last resort by some households during repeated or prolonged extreme situations. Spatial networks to other villages and towns increase access to resources unavailable locally, for example remittances. Some of the households in the study areas had a high dependency on remittances from male members (usually sons) of the households regularly seeking work in urban areas.

We observed a trend among the households across the study areas of investing in duck (especially in water logged and drought prone areas) and poultry rearing. People are also found to have invested in goats, sheep and other cattle husbandry. The indigenous people of different study locales have significantly increased pig rearing as fast growing herds.

Reinforced Social Supports Networks

The move towards a decentralized administrative system of governance in Bangladesh, with formal structures and clear responsibilities at the upazila level, has increased communication channels between the village, local authorities and the extension services. This has served to reinforce locally initiated coping responses and encourage the activities of NGOs that facilitate the transfer of ideas about innovative new technologies. Both GOs and NGOs interventions have reinforced and reorganised the social support networks, to a large extent, formalised the process of reciprocity and have helped sustain these coping practices. This has recaptured social norms and strengthened solidarity and trust within and between the communities through the promotion of equity and sharing of productive assets. The formalisation of these networks has improved knowledge sharing in production, poultry and livestock raising and increased communication among Government agencies, NGOs and rural households.

Increased and repeated utilization of non-cash exchange or barter system by the households created a buffer against the impacts of disasters, and crystallized cooperation in coping and adaptive capacity across the community. However, some of the respondents claimed that these activities have helped maintain solidarity between neighbours, facilitating families sharing food during transitory scarcities. This adaptation has potentially strengthened the village's capacity to cope with future shocks and can be linked to second key component of resilience, the ability to self-organise (Carpenter *et al.* 2001). That self-organisation has strengthened in response to hazards suggests that at the community-level resilience is growing stronger, and that the 'culture' of cooperative action and solidarity are being considered to be important by the respondents. This has developed an enabling environment that the local leaders, in future, may embark on to initiate the establishment of collective projects pursuing common goals.

Informal Institutions and External Support Networks

In this research we found that informal social institutions defined by kinship, neighbourhood or friendship, play vital roles in devising coping strategies and a framework for taking action to respond to natural hazards. These institutions are essentially informal and exclusive types of networks that have developed to facilitate coping actions or daily livelihood activities. Through these social institutions, individuals and household receive and give activities, products or money that has formed the elements of the coping system.

People have also evolved a dependency on complex informal institutions to provide them with the essential networks external to the villages. Many households are found to be mobilizing networks extending outside the village, in some cases following matrilineal networks to other villages, and these networks had been used to initiate work opportunities. These bridged networks have historically provided coping responses, such as migrant work, opportunities to develop more diverse livelihoods and access to technology or access to land in other locations. Maintaining external relationships brought more coping options during times of difficulty. The migrant wage remains an important part of male identity and a regular part of coping. Migrant work is not only an important source of cash but also provide opportunities to disseminate new ideas in the villages. In all the study areas, we found that many people usually go outside their villages and return to their respective village on completion of their job target. These returnees were particularly enthusiastic about the 'modern' farming they have encountered elsewhere and are more likely to adopt new practices and disseminate new ideas.

Technological Change and Innovative Farming Responses

The farmers in the study areas have collectively been developing repeated and specific regenerative farming responses which plan for specific disasters and increased climatic variability. Government extension services and NGOs have promoted and specifically encouraged experimentation with improved varieties through their respective supports and services. Some of the respondents claim to have actively experimenting with new technologies (including both wealthy and poorer households) and have changed to a more disaster resilient and a shorter maturing crop variety, such as, kaon, kalai, chana, pera, maize and groundnuts, as a direct result of extension advice disseminated through GOs and NGOs channels. Using new technologies in response to disasters and extreme climatic variability can be attributed as strategic copings because they change livelihood activities.

These channels have also provided a formal buffer to the risks of individual farming with knowledge transfer to support the farming households to manage problems such as pest infestations, effective use of fertilisers and the application of newly learned skills. Some of the respondents have received formal training from different sources and shared new information amongst the other community members, and information exchange goes well beyond the boundaries of the social groupings and across communities. Active development of agro-forestry and social forestry has been another recent innovation in local farming practice to address natural adversities. The local people are also encouraged and given some specific training on planting, breeding and nurturing economically viable plants in and around the homesteads, which provide valuable sources of food and income. People in all the study areas feel that the planting of individual trees had increased their future possibilities of income and protection of surrounding environment.

Apprising Coping and Adaptation

The central difference between coping and adaptation operates over timescale. Coping is an instantaneous and short-term response to an immediate situation, while adaptation emerges out of complicated and regenerative coping responses when these are repeatedly used to develop adaptations to longer-term or more persistent change. Adaptations can, therefore, be distinguished by their appropriateness of action, and by livelihood progression beyond reactive responses to disasters and climate change impacts. However, the case studies presented in the previous chapter illustrate that the responses to regular risk of disasters have established an alternative cropping system, where consistency has been developed through tactical 'trial and error' farming practice by individual farmers, which has eventually become a more strategic 'proactive' practice by the community people.

Again, certain actions can be both coping and, at the same time, form part of the process of adaptation. This is because people have dynamic livelihood responses and are strategically reactive to anticipated hazard events. This study reveals that the enhancement of social networks for economic migration is used to mobilize strategic supports and, in the sense of longer-term, generation of employment opportunities. Besides, though adaptation is often triggered by the threats of hazard events (e.g. climate change, natural and man-made), such as changes in cropping patterns or creation of informal social support networks, but there are exceptions as well. Some of the observed adaptations found in this study have not been triggered by specific events, instead they are either the result of strategic interventions by government and NGOs programmes, or are products of evolving social transformations and/or the actions of innovative and well-connected individuals.

Al large, it might be noted that adaptations are operative on wider scales than coping. But we have seen that the study households have uneven access to uptake adaptive options resulting differential levels of success across the study population. This is primarily because households have differential access to or exclusion from information, institutions or crucial resources such as skills and cash. Particularly the most vulnerable

households have less resource mobilization capacities as well as lower endowment of human capacities to participate in any forms of reciprocal exchanges within their respective villages and communities. They usually turn to collective support networks, external assistance and/or the traditional authorities at the times of stress.

The Ways forward

Assisting the rural people to manage food shortages that occur due to various reasons implies assisting the poor towards developing livelihood strategies that are both less vulnerable to hazards and more resilient in the face of hazards. It is not enough to concentrate on increasing food supply, or on responding to crisis with food-related interventions. A wider conceptual approach is needed to tackle the deep-seated structural problems of the rural poor. Some implications that are derived from the findings of this study and that might, perhaps, help towards the efforts of making livelihoods in the rural areas more sustainable. At the end of this book, we would try to explore the prospects of the foregoing discussions and results obtained in this study.

We have recommended strategies and potentials for replications of each of the coping strategies presented in the preceding discussions. Programmes may be undertaken to replicate these good coping practices in different areas of rural Bangladesh. This would have positive contribution in ensuring food securities and stabilizing livelihoods of the rural households. Programmes along these lines have to be sought and be encouraged by both governmental and nongovernmental organizations. Besides, increased cooperation between the communities, the public and the government agencies would have multiplied effects to counteract poverty and disasters.

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GLOSSARY

GENERAL GLOSSARY

Capability	A demonstrable capacity to respond to and recover from a particular threat or hazard. Originally a military term, it includes personnel, equipment, training, and such matters as plans, doctrine and the concept of operations.
Capability gap	The gap between the current ability to provide a response and the actual response assessed to be required for a given threat and hazard. Plans should be made to reduce or eliminate this gap, if the risk justifies it.
Consequences	Impact resulting from the occurrence of a particular hazard or threat, measured in terms of the numbers of lives lost, people injured, the scale of damage to property and the disruption to essential services and commodities.
Coping Mechanism	The coping strategies are diverse and dynamic in nature depending upon contextual factors like region, community, social class, ethnic identity, household composition, gender, age and season as well as the likelihoods severity and duration of the potential hazard. Coping may be defined as the manners in which people and organizations use existing resources to achieve various beneficial ends during unusual, abnormal and adverse conditions of a disaster event or process.
Damage	Physical destruction, corruption of information, or loss of beneficial social phenomena (e.g. trust or affiliation).
Disaster	A serious disruption to a community caused by the impact of an event which requires a significant coordinated response by the Government and other entities to help the community to recover from the disruption. Disasters are usually associated with severe damage to infrastructure and utilities, death, injuries and homelessness, and can be widespread or contained within a particular sector or sub sector.
Generic plan	A single plan designed to cope with a wide range of emergencies.
Hazard	An accidental or naturally occurring event or situation with the potential to cause physical (or psychological) harm to members of the community (including loss of life), damage or losses to property, and/or disruption to the environment or to structures (economic, social, political) upon which a community's way of life depends.
Hazard assessment	A component of the risk assessment process in which identified hazards are assessed for future action.
Hazard identification	A process by which potential hazards are identified.
Impact	The scale of the consequences of a hazard or threat expressed in terms of a reduction in human welfare, damage to the environment and loss of security.
Mitigation	The process of implementing measures that eliminate or significantly reduce the risks associated with potential hazards.
Planning assumptions	Descriptions of the types and scales of consequences for which organisations should be prepared to respond. These will be informed by the risk assessment process.

Resilience	The ability of the community, services, area or infrastructure to withstand the consequences of an incident.
Risk	Risk measures the significance of a potential event in terms of likelihood and impact. In the context of the Civil Contingencies Act, the events in question are emergencies.
Risk Assessment	A structured and auditable process of identifying potentially significant events, assessing their likelihood and impacts, and then combining these to provide an overall assessment of risk, as a basis for further decisions and action.
Risk management	The culture, processes and structures that are directed towards the effective management of risks.
Risk rating matrix	Matrix of impact and likelihood for an event, to ascertain the risk.
Risk treatment	A systematic process of deciding which risks can be eliminated or reduced by remedial action and which must be tolerated.
Specific plan	A plan designed to cope with a specific type of emergency, where the generic plan is likely to be insufficient.
Threat	The intent and capacity to cause loss of life or create adverse consequences to human welfare (including property and the supply of essential services and commodities), the environment or security.
Threat assessment	A component of the risk assessment process in which identified threats are assessed for future action.
Vulnerability	The susceptibility of a community, services or infrastructure to damage or harm by a realised hazard or threat.

GLOSSARY OF LOCAL TERM

Achakha	Poles in bowm
Aine buno/ buno kata	The manufacturing process of making charu and pata is locally called aine buno or buno kata.
Akh	Saccharum officinarum (sugarcane)
Aman	A rice crop planted usually in the month of July/ August
Amra	Hog-plum
Apel kul	a variety of palm
Aratdaer	Wholesaler
Baish bondho ghor	14.5 cubits long, 7.5 cubits wide
Barch	A local plant species
Batajal	One kind of net
Batam	Frame for making the roof by 3 in. x 2 in. wood called batam.
Berkata-arbadha	A technique for cultivation of crops in the submerged lands. The cultivation method is called "Berkata-arbadha' in Bagerhat.
Bastagi shak	One kind of vegetables
Beel	Marshy land
Bele	A local variety of fish species
Bhamor	Bhamor means making holes 6/7 inch deep and 1 foot apart in the land and then covering it with peanut seeds in the soil.
Bhenda	One kind of plants that grow 8-10 ft long and have many branches but the branches are little which have much medicinal value. Ricinus communis L. (Euph)
Bhendy	Laddy's finger
Bhetki	Lates calcifer
Bigha	Frame for making the roof by 3 in. x 2 in. wood called batam.
Boal	Wallago attu
Boikala	Small bamboo
Bonbibi	queen of the forest
Borkha	Frame of the roof
Boroi	Zizyphus jujube
Cargil	a crystalline black colored substance like the crystals of urea
Chailya	Dillenia indica L. (Dilleniaceae)
Chanda	A local fish species
Chang	'Chang' is the local name given to the scaffold prepared for drying fishes in the locality.
Chambol	Artocarpus chaplasha Roxb. (Morac.)
Charu	a kind of box, which is made by bamboo and date palm root, it is 1-½ -2 cubit high, and its width is 1 ½ to 2 cubits
Chatai	Bamboo made mat
China/ Kherachhi	It resembles the small crystalline round shaped mustard seeds. This is being used as auxiliary to rice and is mixed in the proportion of 3:1 i.e. the ratio is 250 grams of China with 750 grams of rice.

Chita	grains having no inner substance
Chalti nadi	Current River
Choka	The unit of soil cutting is called a 'choka'. One choka is equivalent to 4 cubic cubits i.e. 4 sq. cubits to one cubit deep.
Chora	Creep
Chobbish bondho ghor	16 cubits long, 8 cubits wide
Chholashak	Leaves of legume
Chuine sheola	One kind of weeds like lichen, moss and algae (it's a kind of aquatic plants which look greenish in color, and depending on the depth of water, they grow in length 5 ft to 15/20 ft).
Dai	A word of Bowm
Dao	knife
Dheki	a wooden device especially for husking rice
Doazara	Local name of bamboo fence used in Kakara, Chakoria, Cox's Bazar
Dulbergia	A local plant species
Dumur	Ficus hispida L f.(Moraceae)
Ekush bondho ghor	14 cubits long, 7 cubits wide
Etcha	Shrimp
Felon	A kind of crop born by a kind of bean like creepers that grow one foot or one and a half feet in length
Gajar	A local fish species
Golda	Palaemon carinus
Golpata	A big leaf mangrove plant
Gher	waterlogged land besiegements
Ghones	The tide that comes during the full moon and new moon time in every month is called in local language 'ghone' which is occurred two times in a month at every 15 days break.
Ghuchi	A ball shaped moulds is prepared from the cow dung which is used as fuel
Gopalbhog	A variety mango
Goroom goroom	Imitation sound type created
Gola	Grannary
Gur	Molasses
Haor	Moribund Delta
Hari	Pot made by soil
Hari	2.5 haris being equal to one acre
Hatcha	Pulling net
Hati	The word 'Hati' is not available in Bengali dictionary and is perhaps derived from other language. But the meaning can be constructed from the objective of the action and arrangements. Since the houses are usually swept away by the water waves, the people of this community have adopted this mechanism called 'Hati' to protect their properties.
Hizle	Semecarpus sum-panduriformis Wall. (Anacardiaceae) Barringtonia acutangula (L.) Gaertn. (Lecythidaceae)
Horina	Panicovia rubiginosa

Jal	Net
Jinge	Luffa acutangula Roxb. (Cucurbita.)
Jhiri	Fountain
Kachu	arum of any type
Kaon	a kind of corn, like rice, belongs to Gramin family which is much smaller than rice and is like mustard seeds in size
Kalmilota	Ipomoea alba L. (Convolvulaceae) (I. bonanox L.)
Kamli	A local herb species
Kandi	A technique for cultivation of crops in the submerged lands. The cultivation method is called 'Kandi' in Pirojpur.
kani	2 acres
Kani	Unit of land measurement (1 Kani = 40 decimals in Cox's Bazar)
Karala	Momordica charantea L. (Cucurbita)
Kashban	A kind of tall grass bearing white flowers with scenic beauty grown on the char
Katha	Unit of land measurement
Kewra	known as screw-pine plant (Sonneratia apetala), locally known as Kewra
Khal	Canal
Khania	A hole is dug in the fifth step of salt cultivation at about 1 or 1.5 ft deep in order to store the water that could not be discharged adequately.
Kharif	The wet season (typically March to October) characterized by monsoon rain and high temperatures.
Khurong	a kind of local contrivance
Koi	Anabas testudineus
kol beri	Two rings of 4 ft long and 1.5 inches width which is used for making mele mat
Komar deya	komar deya, a Bengali term, meaning 'an artificial shelter erected by heaping straws or branches of trees in a stagnant or standing water either in a water body (beel) or in an area of a river where water is relatively standing.
Kot System	'Kot' is a conventional system of taking lease a plot of land for a period of some years on payment of money at a certain rate, decided through negotiation.
Kukrimukri	Leaf-disease
Kuthi	Kuthi is prepared with clayey mud, stubs and the rice bran.
Lakhkha	Lakhkha involves the rearing a kind of insects, very small and do not have visible movement and live in colony on the trees where the insects love to stay, spread their offspring and extract fluid from the tender branches of the trees and develop and produce resins in their body, which the farmers extract from the insects by a special process. The extracts are known as lac or shellac and popularly as resins which are very useful in painting works and in many other works.
Lalmi kathoa	A local plant species
Lalshak	Amaranthus tricolor L. (Amarantha.) (A. gangeticus L.)
Lokasamaj	A local NGO
La-parong	One kind of bamboo pot
Lona dhora	the withering of the leaves

Macha	the shed/roof
Mahogany	Swietenia mahagoni (L.) jacq. (Meliaceae)
Maita oil or pora oil	A special type of oil
Mele/ patra	Reed
Monga	semi famine situation
Morok	Disease
Mrigel	Cirrhina mrigala
Murta (BET)	Calamus viminalis Willd. (Palmae)
Mushuri kalai	It is a bushy annual plant grown for its lens-shaped seeds.
Neem	Azadirachta indica A. Juss.
Nola	A local fish species
Pala	To make the Gola stronger poles are set vertically inside the Gola, which locally are called pala.
Palmyra	A local fish species
Palong	Spinach
Pata	one type of fence which is used for catching fish
Pataton	Wooden platform
Pati	Mat
Patshak	Jute leaf
Pera	Pera is a kind of crop grown on the sandy soil; grinded grain is eaten like flour with molasses or salt and pepper together.
Pith beri	Back ring 3 ft long and 1 inches flat.which is used for making mele mat
Puti	Barbus stigma, B. puntio, B. sophore
Puishak	One kind of vegetables (leaf of jute)
Pusher bari	The pattern of this house is such that the plinths are high, the roofs are relatively low having small slopes and the houses are surrounded by walls on all sides. The house inside the walls is made very strong to act as the core house against cyclones and water surges. Besides, people of the area plant sufficient trees so that these trees can withstand the fastest speed of winds and water surges. These types of houses are called 'Pusher Bari' in Cox's Bazar areas.
Sako	Sako is a traditional barrier overcoming mechanism both in the hills and plane lands, the idea of which taught people of constructing the so-called permanent bridges on greater barriers.
Sech Kaj	Evacuating/ expelling the standing water from the marshy land to make the land suitable for cultivation. It is called sech kaj in Jessore.
Shishoo	A local plant species
Shol	Ophiocephalus striatus
Shitol beri	Cold ring 4 ft long and 1.5 inches flat which is used for making mele mat
Shitol pati	One kind of mat
Sidol	Dry fish
sotero bondho ghor	9 cubits long, 8 cubits wide
Rabi	The dry season, November to February. Crops grown are boro, wheat, potato, pulses and oilseeds.

Rakkha gola	In Bengali, the word 'Rakkha' means to protect, and 'gola' means a container of food. In addition, the 'rakkha gola' also indicate distinct operational procedure for disbursing and recovery of paddy.
Ranu/ Renu	young spawns of prawn
Rui	Labeo rohita
Segun	Tectona grandis L f. (Verbenaceae)
Taki	Ophiocephalus
Talla bamboo	One kind of bamboo
Telapia	Tilapia mossambica
Tengra	Mystus vitatus
Pairshya	A local fish species
Vehr	The place where mud is collected from becomes a ditch which is used as factory of manufacturing bio-fertilizers and storage of the same.

ANNEXURE

ANNEX I

THE STUDY DESIGN

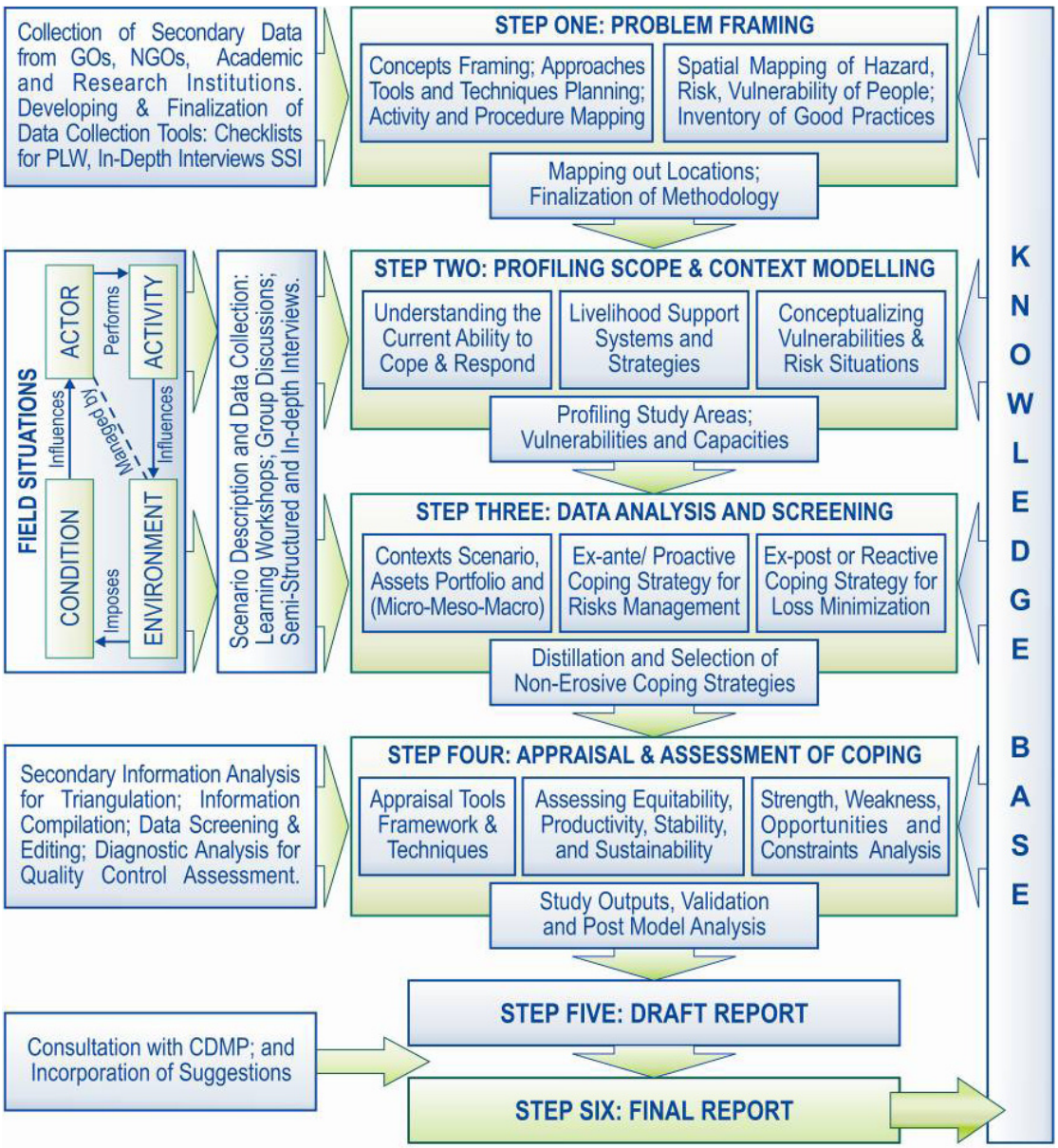

Figure 2.1: The Operational Framework– Field Situations, Research Activities and Methodology

Sampling and Respondents Selection

This research was largely founded upon qualitative data collection methods, in which most of the source selection was done deliberately according to specified characteristics rather than randomly from the population, as a whole. The research made use of multistage cluster sampling– a design in which a sampling unit consists of a group or 'cluster' of elements (or observation units) – in order to select the respondent for this investigation. The target population was widely distributed geographically and occurred in natural and social clusters such as disability, sex, and relations types. Based on the list of Unions and Upazilas of the selected districts, the target population was divided into non-overlapping groups of clusters i.e. primary sampling units (Union and Upazila) and secondary sampling units (occupational groups, ethnic or indigenous and religious minorities. Respondents from the selected sample clusters were selected for data collection.

The population of the selected clusters were again divided into non-overlapping homogeneous groups of different strata i.e. primary sampling strata (most vulnerable categories), secondary sampling stratum (male and female), and tertiary sampling strata (different key actors like local government leaders, local administration, GO, NGOs and civil society representatives). Respondents were selected randomly of observation units within all of the strata.

Framing District Level Activities

The research team approached each selected district through a set of research tools to develop baseline mapping of the onshore coping strategies available at the local vicinity with the district territory. This was primarily done before hand through extensive review of the secondary sources i.e., prior to approach the research sites empirically, the hazard, vulnerability and coping response mapping were done. These mappings were shared with CDMP and after incorporating their expert opinion on the initially selected research sites the research team proceeded further to conduct the fieldwork in each districts. These mappings of hazards, vulnerabilities and coping responses guided the district level fieldwork and activities planning as significant points of reference. Yet these frames of references were not the restricting or limiting factors, instead, these frames provided the research team with freedom of departure to conduct fieldwork in each selected districts.

At the district level, the investigation started with validating, reconfirming and updating the existing mapping or frame of reference from multiple primary sources selected purposively from among respondent belonging to different stakeholders including DRRO, PIO, social welfare officer, disaster management personnel, and representative of CPP, LGI and NGOs. In each district, at the beginning phase of fieldwork, the research team applied PLW/GD and KII as tools to identify the potential coping strategy and their grounded locations in terms of Upazila and Union names. A brief initial screening has been done to identify and select the Primary Sampling Units (PSU) i.e. Unions for exploring the detail facets of each coping strategies. In each field site i.e. unions, we collected general socio economic data and information on crop and livestock production, perceptions, constraints, off-farm employment, access to wild foods, migration, etc.

Activities at Research Sites

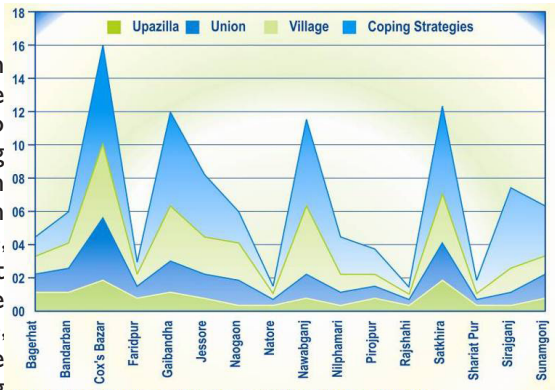

Figure 2.1: Overview of Findings at Different Research Sites

Group discussions were conducted, at each research sites i.e. Union, with community people to explore the technical and human resources available in order to have a general understanding of the factors contributing to vulnerability and people's capacity to deal with seasonal stresses and hazards. The participants in such group discussions included cross-sectional people, representing UDMC personnel, elders, different categories of farmers including young farmers, and the most vulnerable categories e.g. women, disable people, excluded and indigenous groups, in order to stimulate discussions and develop a broad picture of local coping activities. Local people's perception and attitudes towards hazards and disasters within their local environment were also unveiled in these discussions. The good community practices related to coping had been captured through understanding the disaster risks situation at the household level and corresponding coping strategies at the household and the community level. Semi-structured interviews were conducted at this level with different actors. Finally, the findings had been confirmed and validated in group discussions conducted at the Union level and this had been achieved through analyzing the different information gathered together with the community people.

Table 1.2.: The Salient Features of the Fieldwork and Research Activities

SELECTION OF DISTRICTS			TOOLS, TECHNIQUES & ACTIVITIES				COVERAGE SCENARIO			FINDINGS
Names	Source*	Main Hazard Focus	NGOV	SDW/ GD	SSI	KII	Upazila	Union	Village	CSSI
Bagerhat	CDMP	CYL, SAL, WLI,	02	08	21	18	03	03	03	03
Bandarban	CDMP	FFL, WAS	04	12	30	24	03	04	04	05
Cox's Bazar	CDMP	CYL, SAL, FFL, WAI	03	34	88	61	05	10	12	16
Faridpur	CDMP	FLD, RBE,	02	06	14	13	02	02	02	02
Gaibandha	CDMP	FLD, DRT	02	32	67	54	03	05	09	15
Jessore	CDMP	WLG	02	22	46	37	02	04	06	10
Naogaon	CDMP	DRT	03	12	36	20	01	04	06	05
Natore	SLR	FLD	01	02	07	08	01	01	01	01
Nawabganj	CDMP	DRT	02	30	69	49	02	04	11	14
Nilphamari	CDMP	DRT	02	14	25	23	01	02	03	06
Pirojpur	CDMP	FLD, CYL, WLG	02	10	18	19	02	02	02	04
Rajshahi	SLR	DRT	03	03	07	08	01	01	01	01
Satkhira	CDMP	SAL, ARC, WLG, WAI	04	30	64	55	05	06	08	14
Shariatpur	CDMP	FLD, RBE	01	06	09	11	01	01	01	02
Sirajganj	CDMP	FLD, RBE	02	28	42	44	01	02	04	13
Sunamgonj	CDMP	FLD, FFL	02	18	33	31	02	04	03	08
TOTAL			37	267	576	475	35	55	76	119

ABBREVIATIONS:

HAZARDS: [CYL – Cyclone; SAL – Salinity; FFL – Flash Flood; FLD – Flood; WAI – Wild Animal Invasion; RBE – Riverbank Erosion; WLG – Water Logging, DRT – Drought; ARC – Arsenic Contamination]. METHODOLOGY: [SLR – Secondary Literature Reviewed; SDW – Scenario Development Workshop; KII – Key Informant Interview; SSI – Semi-Structured Interview (including In-Depth Interview & Open Ended Discussions)]. OTHERS: [CDMP – Comprehensive Disaster Management Programme; NGOV – Number of NGOs being Visited; CSSI – Coping Strategies Selected for Investigation and Case Study].

Notes: * 14 districts were selected in consultation with CDMP based on hazard and agroecological diversity. Besides, Natore and Rajshahi districts were included to investigate 02 preselected coping strategies found during the secondary literature review.

Data Collection Tools and Techniques

Different tools and techniques along with the respective contexts of their application have been discussed in the subsequent paragraphs. The number of interactions made with different actors and the number of respondents involved in each exercise have been dependent upon local contingencies, dynamics and context. The salient statistical features related to the use of these tools and techniques at different research sites are summarized in table 1.2 and figure 1.7.

Group Discussions and Learning Workshops

Group Discussions (GDs included 6 or more participants) and Scenario Development Workshop (SDWs involved 12 to 20 participants) played significant role in the data collection as well as validation processes during the fieldwork of this research. The participants were selected through multistage cluster sampling and stratified random sampling as discussed earlier. The GDs and SDWs provided the context of applying other tools for developing consensus and for getting an indication of how pervasive the coping response in the local context. Identifying the potential coping strategies available at the vicinity and collecting information regarding coping, hazard, social and vulnerability profile remained as the thematic issues of discussion. Besides, information on local patterns and processes of coping, including respective hazard responses, prices and marketing of local produce etc. were also explored in these discussion sessions. The SWOC analysis was done in such joint interview sessions for each coping response and good community practice.

Semi-Structured and In-Depth Interviews

Semi-structured interviews, in-depth and open-ended discussions were carried out with selected respondents. These interviews collected qualitative data to reflect on the attitudes, beliefs, knowledge and perceptions of the community people at the research sites where selection was done purposively according to specified characteristics and contextual requirement, in most of the cases, after screening and classifying the target population through multistage cluster and stratified sampling based on gender, age and groups belonging to different socio-economic statuses.

The semi-structured and in-depth interviews collected information on farm output, harvests, income, sources of food and income during harvest failures or hazard exposure based on past hazard experiences, seasonal changes in farming activities, livestock fodder, general socio-economic information etc.

Key Informant Interviews (KII)

Key informants were interviewed to uncover information on problems, hazards, perceptions, feelings, opinions and thoughts. Reflective, interpretative and decisional questions related to each coping response were discussed with the key informants. Key informants included Upazila and Union level government and local government personnel, staff of the NGOs operating in the area and any other agencies being stationed at the local level.

Other PRA Tools

In addition to aforesaid strategies, various PRA tools were employed to collect data from primary sources. Some of these included problem and solution matrix, seasonal calendars and direct observations. The information areas explored through applying PRA tools included different activities, problems and opportunities which occured during different times of the year and which had an effects on people's

lives and farm activities, including rainfall, labor supply and demand, food availability, farm operations, crops harvested, pest and diseases, seasonal price movements, and so on. It would, however, be worth mentioning that all these tools had not been used in each field sites, instead, tools were selected and adapted according to the information need and type of coping strategies selected as good community practices.

Data Analysis and Screening

Data Processing

The research design including devised strategies and tools to collect data, as outlined above, might perhaps be characterized as participatory research largely founded upon descriptive and qualitative data. The nature of qualitative data captured in this research, required a context specific analysis along with a less structured approach. Therefore, the recorded outcomes of this research were rather unstructured in nature, while the analysis of the collected qualitative data was not mere simple tasks or straight-forward process. Screening, content analysis and narrative analysis were engaged as approaches to interpret the collected data and to invoke meanings of the materials assembled. The recorded findings of the participatory methods, as deployed in this research, had to be categorized to generate meaning as well as to make sense of qualitative findings.

The initial screening process had been organized and sorted out primary data according to its components and the topics of inquiry that allowed the research team to "examine, compare, conceptualize and categorize data[1]". This was mostly done during our stay in the field or else, in some cases, immediately after the fieldwork i.e. after the interviews and focus group discussions had been transcribed from audio recording. Early screening was, so to speak, preferred to maximize the advantage of respective contexts to categorize data and to perceive the social reality in terms of those contextual categories. The research team explored the possible linkages and relations between different categories of data. Content analysis during screening and sorting were performed as mechanisms to categorize, organize and record primary qualitative data for further analysis and interpretation.

Different models of narrative analysis[2] were engaged to analyze qualitative data in this research. We considered narrative analysis as complementary to semi-structured interviews, allowing the uninterrupted flow of information. We considered the narrative analysis as a truly participatory and empowering research process, in-sofar as, it gave respondents the space to articulate their own viewpoints without any structure restricting their expressions on a particular subject. Notes and transcription of semi-structured interviews were analyzed to interpret the findings of an activity process concerning coping responses.

Monitoring and Quality Control

The research team emphasized the need of achieving and maintaining the highest possible level of quality throughout the performance of the research activities. All collected, accepted and analyzed data in this project had undergone specific quality control assessment. All data were critically assessed during and after

1 Strauss and Corbin, Basics of Qualitative Research: Grounded Theory Procedures and Techniques, p. 61

2 Four models of narrative analysis can be distinguished: thematic analysis (emphasis on what is said compared to how it is said), structural analysis (emphasis on the way a story is told), interactional analysis (emphasis on the dialogue) and performative analysis (emphasis on performance such as gestures used). See Riessman for details.

collection to ensure the quality of the data. These assessments included independent performance audits, data processing audits, as well as external review of the tool and templates used to collect the data.

All data reporting had extensively been reviewed to identify all problematic and missing data points. At large, the data accepted for processing had passed through extensive screening process for quality assurance based on interpretative and diagnostic analysis on the following criteria, e.g. precision, accuracy, representativeness, completeness and comparability. Along this line of commitment to capture quality data, the research team had recollected the primary data by revisiting the research sites of Naogaon and Nawabganj districts.

Methods of Data Analysis

Analysis of Interviews

The in-depth, semi-structured and open-ended interviews were analyzed by clustering them in terms of each question asked. Answers from different respondents were grouped together. Variations in individual characteristics were the primary focus of the study and hence the statements of individual respondents were analyzed first by using data so collected. Then cross-case analysis was done by showing variations in answers to common questions to represent individual traits.

Analysis of Observations

The analysis of overt and covert observations involves systematic processes of six consecutive steps. The first step includes a chronological description of observations, over time to represent the study from the beginning to the end. The second step captures the critical incidents or major events in order of importance that we observed during the fieldwork. The third step prepared scenario description of various places, sites, settings or locations before doing cross-setting pattern analysis. In the fourth step, we placed the human and cultural components into the various settings developed in the earlier step. Capturing the important local processes at work (e.g. decision makings communication, segregation etc.) was done in the fifth step. The final step involves the unfolding of key issues observed on the ground, such as how did participants or respondents bring changes into their coping efforts, strategies and behaviour, and so on.

Analysis and Construction of Case Studies

The analysis of case data and constructing case studies involve processes of four consecutive steps. In the first step, we assembled the raw data consisting of all the pieces information collected about the coping response for which a case study was prepared. The second step initiated with the construction of case record through condensing the raw data by organizing, classifying and editing into a manageable and accessible package. In the fourth step, we analyzed and appraised the case study of the coping strategy in terms of its context. Final step included the writing of narrative descriptions along with its thematic presentations.

ANNEX II

CHAPTER TWO

Table 2.1: Costs of Sotero Bondho Ghor (9 Hands Long House) as Flood Resilient Housing Structure

Name of item	Unit	Unit price	Total price
8 feet long wood pillar	10	496	4960
8 feet long bamboo pillar(1 bamboo=2pillar)	3	120	360
8 feet long Ruya	16	178	2848
18 feet long Bagha	10	405	4050
18 feet long Paiyr	5	405	2025
18 feet long Bailsha	2	405	810
18 feet long Doyur	6	405	2430
11 feet long Lora	22	180	3960
18 feet long Tokta for pataton	14	405	5670
8 feet long Tin	16	400	6400
7 feet long Tin	26	320	8320
Cost of six window			
12 feet long 1 feet wide wood	2	3980	7960
3 feet long 1 feet wide wood	12	200	2400
Cost of one door			
27 feet long wood for frame	1	4250	4250
6 feet long, 1.5 feet wide wood	1	5000	5000
Carpenter, 2person/ per day taka(2*200)=400	20 days	400	8000
2.5" tarkata	2kg	120	240
2" tarkata	2kg	120	240
1.5" tarkata	0.5kg	120	60
1" tarkata	1kg	120	120
Dala	4	100	400
Gojal	3kg	158	474
Screw	2kg	125	250
Jute rope	3kg	25	75
Nylon rope	3kg	50	150
Total			71452

Table 2.2: Cost for Making Scaffold of Raising Plinth of the House

Name of item	Amount	Cost per unit	Total cost
Bamboo	2 pcs	50	100
Binding threads (jute ropes)	1 kg	400	40
Laborer for earth filling	6 person	120	720
Laborer for prepare the platform	6 person	100	100
Total			960

Table 2.3: Cost for Making a Gola of 6-7 ft in Height and 5-6 Feet in Breadth

Gola in Balidha			
Name of item	Quantity	Unit price	Total
Bricks	2000	3500	7000
Sands	120 cft	10	1200
Cement	5 bags	350	1750
Bamboo(mat and poles)	30	120	3600
Thin bamboo used under the roof)	10	40	400
Tin sheets	16 pieces (8 x 9)	4500 for 8 pieces	9000
Total			22 9 50
Gola in Kakara			
Name of item	Quantity	Unit price	Total
Bricks	180	4 per bricks	720
Sands	7 sacs	75 per sacs	525
Cement	4 bags	350 per bag	1400
Wood	29 sq. ft.	355	10295
Bamboo used for doazara	70	100	7000
Tin sheets	73 sq. ft.	175	12775
Iron (rod)	7.5 kg	55	412
Salt	10 kg	5	50
Matir tel	5 litters	85	425
Pesticide	3 Ounces	1 bottle	354
Screw	7.5 kgs	120	900
Labor Cost for making Doazara	-	-	1050
Labor Cost for total preparation	-	-	17000
Total			52906

Table 2.4: Expenditure for Making Fences & Scaffold for Producing Vegetables in a Plot of 10 Katha Lands

Name of item	Quantity	Unit price	Total amount
Labor	12	80	960
Seeds	2 kgs	150	300
soil cutting by spade	1	140	140
weeding	1	30	30
Bamboo	6	80	480
Manure (chemical phosphate)	5kgs	409	200
Insecticides	1 bottle	200	200
Total			2310

Table 2.5: Total Expenditure for *China* Cultivation

Name of item	Quantity	Unit price	Total Price
Ploughing the land	3 times	100	300
Urea	15 kgs	7	105
Phosphate	10 kgs	17	170
Potash	5 kgs	30	150
Seeds	2 kgs	20	40
Seeds sowing	1 persons	100	100
Irrigation	1 time	360	360
Weeding	6 persons	100	600
2nd –weeding	4 persons	100	400
Gypsum	5 kgs	15	75
Harvesting crops	6 persons	100	600
Thrashing the crop	3 persons	100	300
Total			3200

Table 2.6: Total Expenditure for Maize Cultivation in One *Bigha* Land

Name of item	Beer Shuvogachha			Rasulpur			Nejampur Purbopara		
	Unit	Price per unit	Total	Unit	Price per unit	Total	Unit	Price per unit	Total
Land contract	1 bigha	3000	3000	1 bigha	2000	2000	1 bigha	Self	Self
Potash fertilizer	15 kg	20	300	15	20	300	2	27	54
Phosphate	15 kg	22	330	15	22	330	6	28	168
Trilling land	2 times	250	500	2 times	200	400	2 times	200	400
Corn seed	2 kg	220	440	2 kgs	220	440	2 kgs	70	140
Urea	25 kg	6	150	25 kgs	6	150	10 kgs	10	100
Irrigation	Once	2 times	3 times	350	300	80	350	900	320
Cow dung	-	-		-	-	70	3	-	210
Pesticide	Once	200	200	Once	200	200	Once	90	90
Gypsum	-	-	-	-	-		2 kg	20	40
Spray machine rent	Once	50	50	Once	50	50	self	00	00
Laborer	19 people	100	1900	22 people	100	2200	3 people	300	300
		Total	7220		Total	6940		Total	1822

Table 2.7: Total Cost of *Kaon* Cultivation for One *Bigha* Plot

Name of item	Unit	Unit Price in Taka	Price in Taka
Seeds	1 kg	20	20
Urea	20 kgs	6	120
Irrigation	4 hrs	105	420
Labor	10 persons	120	1200
		Total	1760

Table 2.8: The Cost of Producing *Felon* in 5 *Kani* (2 Acres) of Land

Name of item	Amount	Cost per unit	Total cost
Seed	45	45	45X45=2025
Labor for sowing	25	200	25X200=5000
Irrigation	2 times	2000	2X2000=4000
Urea fertilizer	100 Kg (2 sacs)	800 (1 sac)	800X2=1600
Women labor for collecting harvest	20	100	20X100=2000
Seed storage	45 kg	-	195
		Total	14820

Table 2.9: Cost of *Pera* Cultivation in One *Bigha* Land

Name of item	Unit	Unit price	Total price
Seeds	10 kg	20	200
Uria	20 kg	6	120
Irrigation	2 times	210	420
Labors	10 persons	120	1200
Ploughing cost	5 times	100	500
		Total	1940

Table 2.10: Raising Plinth of the Tube Well

Name of item	Unit	Unit price	Total price
Head of tube well	1	1400	1400
Plastic pipe	95 ft	12	240
GI pipe (4 in dia)	3 ft	80	240
GI pipe 5ft	5ft	80	400
Bricks	600	3.5	2100
Cement	3 bags	270	810
Labor for boring	2 Persons	150	300
2 labors for 3 days 200 for concrete work of the base of the tube well	3 Persons	200	600
labor for carrying water	1 Person	100	100
Tools, wrench screw diver etc	-	-	400
Carrying cost	-	-	500
		Total	8090

Table 2.11: Cost for Making Flat Form for Preserving Traditional Fuel

Name of item	Unit	Unit Price	Total Price
Big bamboos	2 no.s of 25 cubits long	150	300
Small bambos	4no.s of 15 cubits long	60	240
Jute ropes	1 kg	80	80
Labor	1 person	120	120
		Total	740

Table 2.12: The Cost of Producing *Masuri* Kalaiin One *Bigha* Land

Name of item	Amount	Cost per unit	Total cost
Ploughing	3 times	100	300
Urea fertilizer	20 Kg	7	140
Phosphate fertilizer	10 Kg	17	170
Labour for sowing	1 person	100	100
Seed	5 Kg	100	500
Labour for weeding	5 persons	100	500
Gypsum fertilizer	10 Kg	15	150
Urea fertilizer	5 Kg	7	35
Labour for harvesting	5 persons	100	500
		Total	2395

Table 2.13: Total Expenditure of Groundnut Cultivation in 1 *Bigha* land

Name of item		Unit		Unit Price (Tk)		Total	
Shuvogachha	kakara	Shuvogachha	kakara	Shuvogachha	kakara	Shuvogachha	kakara
Plowing	Labor for seed sowing	1 time	4 persons	300	200	300	800
Labor for Bhamor	Irrigation	2 persons	2 times	100	330	200	660
Seeds	Fertilizer	5 Kg	41 kg	100	16	500	656
Labor for peeling seeds	Labor for crop guard	3 persons	1 person	100	3000	300	3000
Labor for sowing seeds	Labor for picking nuts	4 persons	3 persons	100	100	400	300
Diazenon	-	200 ml gm	-	70	-	140	-
Labor for spray	-	1 person	-	100	-	100	-
Machine rent for pesticide spry	-	1 machine	-	50	-	50	-
Labor for picking nuts	-	4 persons	-	100	-	400	-
Labor for cutting nuts	-	3 persons	-	100	-	300	-
					Total	2690	5416

Table 2.14: The Cost of Producing Sugarcane in One *Bigha* Land

Name of item	Unit	Unit price	Total price
Ploughing	4 times	100	400
Potash	10kgs	18	180
TSP	15kgs	22	330
Sugarcane for sowing	600 pieces	7	4200
labor for sowing	4 persons	100	400
Weeding	5 persons	100	500
Irrigation	2 times	250	500
Urea	30 kgs	6	180
labor for taking out grey leaves	5 persons	100	500
insecticides (Furadone)	1 kg	250	250
insecticides (Diazinon)	1 kg	250	250
labor for spray	1 person	100	100
		Total	7790

Table 2.15: The Cost of Producing Onion in One *Bigha* Land

Name of item	Unit	Unit price	Total price
Ploughing	2 times	200	400
Leveling	2 times	100	200
Seeds	0.75 kg	1200	900
Urea fertilizer	17 kgs	8	136
Potash	5 kgs	40	200
TSP	10kgs	17	170
Manuring	1 person	100	100
Weeding	1 persons	100	100
Irrigation	2 times	125	250
Harvesting	3 persons	100	500
		Total	2956

Table 2.16: Total Production Cost of Garlic Cultivation in 1 *Bigha* Land

Name of item	Unit	Unit price	Total price
Labor for cleaning the land	6 persons	100	600
Dep manure	70 kgs	40	2800
Potash	50 kgs	30	1500
Uria	30 kgs	14	420
Insecticides	2 times	155	310
Seeds	3 maunds	2500	7500
Seed processing	3 maunds	160	480
Labor for sowing seeds	25 persons	100	2500
Labor for spreading manure	1 persons	100	100
Irrigation	4 times	230	920

Name of item	Unit	Unit price	Total price
Labor for harvesting	15 persons	100	1500
Garlic processing	8 persons	100	800
Labor for cleaning the garlic	20 maunds	50	1000
		Total	20430

CHAPTER THREE

Table 3.1: Expenditure of Housing Pattern of Hilly Areas

Expenditure of Plastering House			
Equipment	Quantity	Unit Price	Total
Cement	1 Sac	75	350
Sand	8 CFT	10	80
Iron (Rod)	30 Kg	70	2100
Gi Wire	40 Kg	80	3200
Labor for nail inserted	2 persons (1 days)	150	300
Labor for coiling wire	2 persons (3 days)	150	900
Labor for Plastering (Head)	1 persons (5 days)	220	1100
Labor for Plastering	2 persons (5 days)	150	1500
		Total	9530
Expenditure of Polythene Build House			
Polythene	10.30 meter	400	4120
Pins	2 Kg	80	160
		Total	4280

Table 3.2: Expenditure of Duck Rearing (1000 Ducks)

Items	Equipment	Quantity	Unit Price	Total
Ist month	Duck Baby	1000 baby	15	15000
	Poultry Feed	10 bags	1240	12400
	Vitamin AD	1 file (large)	400	400
	Multivitamins	1 file	240	240
	Calcium tabs	6 file	40	240
	Vitamin B plus	1 bottle	100	100
2nd Month	Rice barn	30 mound	150	4500
	Rice	180 kg	20	3600
	Broken Rice	180 kg	15	2700
3rd Month	Rice barn	30 mound	150	4500
	Rice	180 kg	20	3600
	Broken Rice	180 kg	15	2700
Other materials	Labor for duck feeding	2 persons	1000	6000
	1 person (absence of care taker)	1 person	3500	3500
	Plastic dish	50 unit	38	1900
	Water pot	30 unit	22	660
			Total	62040

Table 3.3: The Estimated Expenditure of the Project of Crop Saving Embankment (3.544 km)

Materials	Total
Earth cutting (13549.54 CM)	787201
Irrigation work	3377
Two sides of the dam covering with Poles and Chatai	63000
Carpeting by turf	86514
To cover with Binna grass	23101
Salary if the supervisor	8106
Total	939799

CHAPTER FOUR

Table 4.1: Cost and Production for Floating Agriculture in 3 Beds of 10 Meters Long (2 Meter Width & 1 Meter Thick)

Production Cost			
Materials	Unit	Unit Price	Total Price
Labor for bed preparation	6	100	600
Bamboo	3	50	150
Seeds and saplings	3 bed	40	120
Maintenance	3 bed	20	60
Total			930
Products			
Lady's finger	90 kgs	10	900
Red vegetables	60 kgs	8	480
Kalmilota	150	7	1050
Bio-fertilizers	1500	0.2	300
		Total	2730

Table 4.2: Cost and Benefits of Fish Collection

Total cost and annual income from one komar			
Total expenditure for raising a komar			
Materials	Quantity	Unit price	Total
Branches and leaves of trees	10 bundles	40	400
Bamboo poles	5	40	200
Nylon ropes	100 gms	10	15
Labor for construction and catching fishes	7	100	700
		Total	1315
Annual income			

Time	Frequency in a month and total catches	Sales Proceeds	Expenses	Net income
One year	2x12	500x24= 12000	1315	10685
Total cost of 5 charu from a 45-50 ft long bamboo				
Expenditure for 5 charu made from a 45-50 ft long bamboo				
Materials		Unit	Unit Price	Total (Tk.)
Bamboo		1 piece (45-50 ft long)	120	120
Root (Date palm)		75 pieces	75	75
Labor		1.5 days	80	80
Total				315
Expenditure for 100 feet "pata"				
Bamboo		1 piece (50-55 ft long)	120	2400
Bamboo for tying the fence in order to keep the frame strong		16 piece (50-55 ft long)	120	1920
Labor		4 persons for 3 days	70	840
Labor cost for placing pata		3 persons in a day	70	210
10 "charu" are placed in 100 feet pata		10 charus	100	1000
			Total	6370

Table 4.3: Total Cost of *Kandi* Cultivation in One *Bigha* Land

Fixed costs of Kadi Method per bigha land			
Materials	Unit	Unit Price in (for 1 row)	Total in (for 4 row)
Labors For converting plain land as plots	50 persons	140	7000*4 days = 28000
Water hyacinths (Kachuripana)	20 boats (30 maunds capacity)	300	6000
Powder of Coir	8 boats (20 maunds capacity)	800	3200
Boat(rent for Topapana)	8 boats (20 maunds capacity)	350	2800
Labors for setting water hyacinths, coconut coir powder, small hyacinths	20 persons	140	280*2 days = 5600
Labors for sowing seeds and other related works	10	140	1400
Urea	60 kg	7	420
Insecticides	4	125	500
		Total	87880
Necessary Costs of Crop Cultivation			

Month	For 1 bigha				
	Materials	Unit	Unit price (Tk.)	Cost for 1 row	Total (Tk.) for 4 row(1 bigha)
Ashwin	Labor and materials (making of flat form)	1 plot	1600	4000	16000
	Saplings of cucumber	150	2	300	1200
	Karalla saplings	150	2	300	1200
	Seeds of red vegetables	0.25 kg	400	100	400
	Bit copi seeds	0.2 kg	7000	1400	5600
Agrahayan	sugar cane saplings	120	5	620	2480
	Depsar	2 kg	35	70	280
	Cow dung (half of a small boat which contains about 10 maunds)	5 maund	400	200	800
				Total	27960

Total Earning					
Month	Per bigha				
	Sale materials	Quantity	Unit price	Income from 1 row	Total income from 4 row
Katrik	Bitcopi saplings	90% of the total bitcopi saplings	1.5	5500	22000
	Bitcopi	160 hali	25	4000	16000
Agrahayan – poush	Red vegetables	50 hands full	10	500	2000
	Cucumber	500 kg	12	6000	24000
Magh	Bitcopi	100 hali	25	2500	10000
Falgun-Boishakh	Karalla	240 kg	25	6000	24000
Ashar	-	300	10	3000	12000
				Total	110000

Table 4.4: Total Cost and Selling Price of *Mele* (Reed) Cultivation and Mat Weaving

The approximate cost for weaving a pati in Dobra Deulbari		
Production	Numbers	Expenses in Taka
1 patra	1 pon (80 patra)	50
color	1 pack	30
chopper	1	20
Labor	5	300
Total		930
The approximate cost for weaving a pati in Assasuni		
Production	Numbers	Expenses in Taka

Bamboo	1	100
Tau	1	30
Wooden bau	1	40
Mele	1 Bundle	25
Jute thread and rope	-	10
Labor	2 Persons	
	Total	400

Table 4.5: Total Expenditure for Dewatering

Elements			**Unit Price**	**Total Cost**
Purchase of materials for the work of dehydrating the boggy land covering 1072 acres	Wooden planks and logs	Different type and size	40000	40000
	Wood	6' x 1.5' x 1.5 " 150 logs (rain tree)	8000	120000
	Polythene Cloth	7c x 8c no. 37	60	2220
	Bamboo	20'-22' no. 52	120	6240
	Rope	1 kg bundle	55	55
Transportation Cost	Pump machine	Both Way	-	1840.00
	Wood	Both Way	-	1270.00
Rent of Pump machine		46 pumps worked for 15 days	500	345000.00
		20 pumps worked for 3 days	500	30000.00
		7 pumps worked for 2 days	500	7000.00
Cost of diesel		46 pumps worked for 15 days	-	5683.50
		20 pumps worked for 3 days	-	1136.70
		7 pumps worked for 2 days	-	757.80
			Total	**561203.00**

CHAPTER FIVE

Table 5.1: Cost for *Keora* Cultivation in One *Bigha* Plot

Items	Unit	Unit Price	Total Price
Seeds	1 kg	20	20
Urea	20 kgs	6	120
Irrigation	4 hrs	105	420
Labor	10 persons	100	1200
		Total	1760

Table 5.2: The Cost of Producing Ring Well Tube Well in One *Bigha* Land

Name of the Equipment	Amount	Unit Price	Total
Cement Ring	20	125	2500
Tube well	1 piece	4000	4000
A cover	1 piece	200	200
Plastic pipe for air circulation	3 ft with a hole at the end	18	54
Communication pipe	20 ft long	25	500
Cement	1 bag	350	350
Brick concrete for the platform	10 bags	30	300
Sands	5/6 baskets	20	60
		Total	7964

Table 5.3: Total Expenditure and Benefit of Shrimp Cultivation in One *Bigha* Plot

The preparation cost			
Materials	Quantity	Unit price	Total price
Lime	7 kgs	8	56
Ureas	4 kgs	17	68
Phosphate	6 kgs	150	900
Ploughing with power-tiller-in 1 bigha	-		300
Cow-dung	50 square feet	12	600
Total			1924

The approximate total costs			
Materials	Quantity	Unit price per 1000	Total price
Young prawns	9500 prawns	700	6650
Land preparation			1924
Total			8274

Total production and selling price			
Materials	Quantity	Unit Price	Total Price
Shrimp	120 kg	320	38400

Table 5.4: The Total Expense (Approximate) for Nursing Prawn *Ranu*

Name of the Equipment	Total
Cost for preparing the foundation	90000
Cost for digging the tanks	240
Cost for making the house	781
Pipe of 1.5 in diameter	240
Pipe of 5 in diameter	1750
Shallow machine	12000
Bamboo poles	770
Bamboo for roof and paling	6000
Prawn renus	360000
Labor for nursing	16000
Spoon-1	20
One sieve	15
Total	487816

Table 5.5: Total Cost of Salt Production in One Kani Land

Equipment	Quantity	Unit Price	Total Price
Land	6 month	3000	9000
Labor for cultivation	1 person for a season-6 months	13000	13000
Polythene	1 piece	700	700
Diesel	6 time	23	138
Machine	1 season-6 time	400	400
		Total	23235

CHAPTER SIX

Table 6.1: Total Cost for Making a *Pusher Bari*

Materials	Unit	Unit price	Total price
Tree poles	26	-	3000
Borkha (frame of roof)	21	-	2100
Bamboo(for fences)	300 (8/9 cubits long)	-	4500
Nails	2 kgs	250	500
Wires-24 (for tying)	2 kgs	200	400
C.I. sheets	7 bundles (each of 72ft)/ 2 karas	2500	17500/ 4000
Laborers	12	20	2400
Saplings of different species	450/ 500	2	1000
		Total	42400/28900

CHAPTER SEVEN

Table 7.1: Expenditure of Fish Cultivation in 10 *Katha* Pond

Item	Unit	Cost per unit	Total cost
Insecticides for killing harmful insects	1 bottle	50	50
Lime	20 kgs	8	160
Young fish	12 kgs	130	1560
Uria	2.5 kgs	6	15
Cow-dung	12 kgs in a month	-	-
Poultry litres	50 kgs		1200
Oilcake	2.5 kgs	30	75
Vitamin	1 bottle (500 ml)	400	400
		Total	3445

Table 7.2: Costs and Benefits of Mango Cultivation in one *Bigha* Land

Cost for Plantation			
Product	Amount	Unit Price	Total Price
Mango sapling	14	50	700
Labor	12 persons	80	960
Cane(used for the fence)	5	70	350
Mud and trolley rent	1.5 trolley	80	120
Fertilizer	2 Kg	200	400
Insecticide	1 liter	150	150
irrigation	10 persons	80	800
Pond rent	-	-	600
Total			4080
Maintenance Costs for Mango Plants			
Time	Unit (Month)	Cost	Total Taka
The first four years (4th year is the first fruit bearing year)	48	800	38400
Fifth	7	800	5600
Sixth	5	800	4000
Seventh	3	800	2400
Eighth	2	800	1600
Total			52000
The Cost of Growing Paddy in the Same Plot			
Items	Amount	Unit price	Total (Tk. for a season)
Labor	25 persons	60	1500
Seed	6 Kg	20	120
Sack	6 Bags	40	240
Processing	12 maunds	10	120

Fertilizer	10 Kg	6	60
insecticide	250 ml	180	45
Total			2085
Income (from the Mango variety Gopalbhog)			
The year in which the trees start bearing fruits	Amount (Maund)	Unit price (Taka)	Total price
1st	1	2500	2500
2nd	1.5	2500	3750
3rd	2.5	2500	6250
4th	3.5	2500	8750
5th	4	2500	10000
6th	5	2500	12500
7th	6	2500	15000
8th	7	2500	17500

Table 7.3: Costs and Benefits of Different *Lakhkha* Cultivation

Cos t of Lakkha Cultivation									
One time Lakhkha cultivation in a year					Twice cultivation of Lakhkha in a year				
Price of Lakhkha		Cost		Benefit	Price of Lakhkha		Cost		Benefit
		Unit	Price (Tk.)				Unit	Price (Tk.)	
Unit	Price	Lakhkha seeds	5*8= 40	-	Unit	Price	Lakhkha seeds	5*8=40	-
200	1000	Pesticides used in rainy season	30	-	200	800	Pesticides used in rainy season	30	-
					Plus the baroi fruits of half of the branches which is not sold				
Total	1000	-	70	930		800	-	70	730