Indigenous Knowledge and Prospects of Sustainable Agriculture in Bangladesh: An Anthropological Investigation

Thesis submitted by:
Dwijendra Lal Mallick
Ph. D Candidate
Department of Anthropology
The University of Dhaka

May 2007

Submitted to:
Department of Anthropology
The University of Dhaka
Bangladesh

Indigenous Knowledge and Prospects of Sustainable Agriculture in Bangladesh: An Anthropological Investigation

Thesis submitted by:

Dwijendra Lal Mallick

Ph. D Candidate

Department of Anthropology

The University of Dhaka

May 2007

Submitted to:

The Department of Anthropology

University of Dhaka

Bangladesh

Indigenous Knowledge and Prospects of Sustainable Agriculture in Bangladesh: An Anthropological Investigation

Thesis prepared and submitted for the Degree of Doctor of Philosophy to the Department of Anthropology, The University of Dhaka, Bangladesh

Supervised by:

Professor Shahed Hassan
Department of Anthropology
The University of Dhaka
Dhaka, Bangladesh

Submitted by:

Dwijendra Lal Mallick
Ph. D Candidate
Registration no. _____
Department of Anthropology
The University of Dhaka

Declaration

I, do hereby, declare that the doctoral dissertation entitled, "*Indigenous Knowledge and Prospects of Sustainable Agriculture in Bangladesh: An Anthropological Investigation*" is an original research work done by me under the direct supervision of Professor Shahed Hassan, Department of Anthropology, the University of Dhaka. Professor Hassan has approved the contents and presentation of findings of my dissertation. I do hereby also declare that this is my own work and that, to the best of my knowledge, it does not contain any unacknowledged material.

Dhaka
May 2007

Dwijendra Lal Mallick
Ph. D Candidate
Registration No. 57/2006-7 (Re-ad.)
Department of Anthropology
The University of Dhaka

Abstract

Bangladesh has made laudable progress in agricultural development in the last two decades, but the growth of the sector is associated with a number of agro-ecological (degradation of soil fertility, loss of productivity and biodiversity) and socio-economic problems (such as high external input cost and decrease of real benefits from agriculture, commercialization of agriculture and reduction of natural resources based livelihood options, growing social inequity etc.), which again threatens the sustainability of the sector. Since agriculture is the mainstay for majority population in Bangladesh, the sector has to be developed in a sustainable way to enhance productivity and diversity in agriculture, which may provide with more employment, food and nutrition to the majority poor and marginal farmers. Indigenous knowledge is local people's knowledge, their beliefs, values and practices that they have developed over time and continue to develop. It is based on experience and gives sustainable options for resources management and livelihoods. Effective application of indigenous knowledge (IK) and local resources in farming practices as well as blending of IK with modern knowledge may help to address many of the problems of today's agriculture and contribute to the sustainable development of the sector.

Chambers has expressed his interest in local and indigenous knowledge for rural development and natural resources management from early 1980s. Currently, there has been growing consensus among the development thinkers, academics and development practitioners that due respect should be given to IK while planning and implementing development programmes. Bangladesh had richness in indigenous and local knowledge in the past, but the modernization of agriculture and often top-down technology diffusion has destructed the traditional and local knowledge base in the recent decades. Still many poor and marginal farmers use their own knowledge and local resources for agricultural practices, their livelihood and subsistence. Anthropological research has vast experience and much to offer to understand the context of local people, their knowledge and practices in agriculture. This study, in South-central floodplain ecosystem of Bangladesh, tries to explore the uses and usefulness of IK in agriculture considering the socio-economic and environmental issues and concerns. The study used mainly participant observation and few participatory research tools to understand local farming practices, problems in agriculture, uses of local and external knowledge and farmer's innovativeness in new knowledge generation.

The study found that in the past, agricultural practices in the floodplain villages were mainly based on local inputs, indigenous knowledge and practices. Farmers developed their cropping patterns and farming practices considering the hydrological patterns, seasonality and local resources. Much of the local knowledge and indigenous practices (in terms of cropping and local species, integration among the sub-sectors) have been lost in the recent years due to mainly HYV crop mono-cultivation, but still the involved and innovative farmers are using many of their IK for soil conservation and classification of soil for appropriate crops, crop rotation and inter-cropping, growing of local varieties of crops, pest control, irrigation and drought management, agro-forestry and home gardening, seeds preservation and storage of grains, natural resources conservation,

veterinary medicine and human health seeking. However, the level of application of IK, interests for IK and innovation for blending of IK and modern knowledge (MK) differ across social categories of the farmers (poor, marginal and rich) and their age, gender, education and awareness about problems of agriculture and good practices.

The field observation says that the marginal and self-sufficient groups of farmers have great interest for IK. They are very active and innovative to integrate the IK and MK for good practices since they have long term stake in agriculture for their food and livelihood. Hence, a knowledge continuum between local and external knowledge is evident. Women and elderly people in farming community play a key role in use and promotion of IK in environmentally sound and socially appropriate agricultural practices and resources conservation. Further, there has been a reversal towards ecological farming with the increasing use of IK and local low cost inputs (such as green and compost manure, use of surface and rain water for irrigation, pest control with local herbs and techniques etc.,) as well as by avoiding harmful practices (such as HYV rice mono-cropping, excessive use of chemical and non-renewable external inputs) in agriculture in the study villages. But still this is limited among few farmers. Appropriate policy and institutional arrangement, wider awareness about importance of IK in agriculture, collective actions and participatory action research by involving the farmers, scientists and key actors may enhance the emerging knowledge continuum and contribute to the sustainable development of agriculture and livelihoods of the rural people. A balanced outlook about life and nature as well as a worthy purpose of farming and living may also promote good practices in resource management and agriculture.

Acknowledgement

First of all, I would like to express my sincere gratefulness to Professor Shahed Hassan, the Department of Anthropology of University of Dhaka for his kind supervision of my research work on *Application of Indigenous Knowledge and Prospects of Sustainable Agriculture in Bangladesh*. I would also like to take the great privilege to acknowledge his prudent guidance and insightful suggestions in every stage of my study from the very beginning to the completion of my dissertation including; the development of concept paper and analytical framework; developing approach and appropriate tools for fieldwork; literature review; collection of field information using mainly qualitative approach; analysis of information and presentation of the findings in the final report. Besides scientific directions to my study and academic support, Professor Hassan has been an immense source of inspiration for me to complete the study.

I would like to remember the motivation and encouragement that I received from Professor Paul Sillitoe of the University of Durham, UK (while I worked with him on indigenous knowledge and development issues in Bangladesh) to carry out research on local knowledge systems. I would also like to express my sincere gratitude to Professor Zahidul Islam, the former Chairman of the Department of Anthropology and Dr. Ahsan Ali, Chainman of the Department for their guidance and academic supports to complete my study. Mr. Siafur Rashid, Associate Professor of the Department of Anthropology of the University of Dhaka encouraged me to undertake the study. I am very grateful to all of them for their inspiration and supports.

I would like to acknowledge with thanks the valuable institutional supports that I received from Bangladesh Centre for Advanced Studies (BCAS) and the personal inspiration from Dr. Atiq Rahman, Executive Director of BCAS to undertake and complete the research on the topics. The Research Initiatives, Bangladesh (RIB) has supported my study to carry out field data collection and without their kind support, I would not be able to complete my fieldwork. I am very grateful to RIB for their kind support to me as a young researcher. Mr. Sukanta Sen of the Bangladesh Resources Centre for Indigenous Knowledge (BARCIK) very often inspired and supported me with information on IK and agriculture from their research centre. I am very grateful to him for his kind support to my study.

I also received valuable support from Mr. Abdul Karim, Mr. Anil Roy, Mr. Bidhan Chandra Tikadar and Mr. Tofayal Ahmed, my colleagues of BCAS in Gopalganj, who assisted me to build rapport with the farmers and community people in the study villages as well as in organizing fieldwork in different times to learn about current agricultural practices and uses of IKs in the floodplain villages. I am also very grateful to the villagers and few innovative farmers in *Talbari* and *Champatapara* in Gopalganj district, who shared their long experiences and gave valuable information on various issues of local agricultural practices, uses of IK and modern knowledge in agriculture in the context of agro-ecological changes, livelihoods and social change. Without the cooperation of the farmers, my study could not be accomplished. Finally, Rosy – my wife has been an immense source of inspiration for me to complete the study. I acknowledge with utmost thankfulness the continuous and valued supports that I received from her for my study.

Table of Contents

List of Tables and Figures

List of Abbreviations

ANRP	Agricultural and Natural Resources Programme
BADC	Bangladesh Agricultural Development Corporation
BARC	Bangladesh Agricultural Research Council
BARCIK	Bangladesh Resources Centre for Indigenous Knowledge
BCAS	Bangladesh Centre for Advanced Studies
BFFA	Beyond Farmer First Approach
BMPs	Best Management Practices
BRRI	Bangladesh Rice Research Institute
CIKARD	Centre for Indigenous Knowledge for Agriculture and Rural Development
DAE	Department of Agricultural Extension
DFID	Department for International Development
DTW	Deep Tube Well
EAP	Ecological Agricultural Programme
FAO	Food and Agricultural Organization
FFS	Farmer Field Schools
FFM	Farmers First Movement
FGD	Focus Group Discussion
GDP	Gross Domestic Products
GoB	Government of Bangladesh
GR	Green Revolution
HEI	High External Input
HYV	High Yielding Variety
IDRC	International Development Research Centre
IRRI	International Rice Research Institute
LEI	Low External Input
IIED	International Institute for Environment and Development
IIRR	International Institute of Rural Reconstruction
IK	Indigenous Knowledge
IKDM	Indigenous Knowledge and Development Monitor
IPM	Integrated Pest Management
ITK	Indigenous Technology and Knowledge
IT	Intermediate Technology
IUCN	The World Conservation Union
LISA	Low Input Sustainable Agriculture
LK	Local Knowledge
LLP	Low Lift Pump
MDGs	Millennium Development Goals
MK	Modern Knowledge
MoA	Ministry of Agriculture
MV	Modern Variety
NAP	National Agricultural Policy
NGO	Non-Government Organization
NRM	Natural Resources Management
NRSP	Natural Resources Systems Programme

PAR	Participatory Action Research
PR	Participatory Research
PRA	Participatory Rural Appraisal
REPPIKA	Regional Program for Promotion of Indigenous Knowledge in Asia
RIB	Research Initiatives, Bangladesh
RRA	Rapid Rural Appraisal
SA	Sustainable Agriculture
SAN	Sustainable Agriculture Network
SARD	Sustainable Agriculture and Rural Development
SAREP	Sustainable Agriculture Research and Education Programme
SD	Sustainable Development
SEHD	Society for Environment and Human Development
SPO	Systematic Participatory Observation
STW	Shallow Tube Well
TWN	Third World Network
UNCED	United Nations Conference on Environment and Development
UNDP	United Nations Development Programme
WCED	World Commission on Environment and Development
WEHAB	Water, Energy, Health, Agriculture and Biodiversity
WRI	World Resources Institute
WSSD	World Summit on Sustainable Development

Summary of the Findings

1. Background and Rationale of the Study

Bangladesh made laudable progress in agricultural productivity in the last 2-3 decades, but the growth in agriculture has been associated with a number of social, economic and ecological problems such as degradation of soil fertility and productivity of land, loss of biodiversity, pollution of water and land, health hazards, low economic return from crop cultivation, rapid changes in social and cultural patterns and growing inequity in the society. These problems threaten the sustainability of the sector. On the other hand, consensus has been built about the importance of local and indigenous knowledge in resources management, conservation, livelihood promotion and sustainable development. Indigenous knowledge is local, experimental and informal knowledge, which gives appropriate options for livelihood promotion and resources conservation in the local contexts. Effective use of the wealth of IK may help to address many of the ecological, economic and social problems of agriculture and livelihoods in rural Bangladesh.

Indigenous knowledge generally refers to the unique, traditional and local knowledge existing within and developed around the specific socio-economic condition of people to a particular geographic area. It is more than technology and practices and it includes: information, beliefs, practices, tools, materials, bio-resources, experiments, education and traditional communication. In every geographic locality, people have their own local and indigenous knowledge and practices in relation to their production systems (agriculture, fisheries, forestry etc.) and livelihood activities. Like all other knowledge and wisdom, IK originates from human practices based on the simple process of trail and error. It entails many insights, perceptions, behavior and traditional institutions related to the nature and environment including solar cycle, astrology, and meteorological and geological conditions. The folk-wisdom is usually integrated with belief systems and cultural norms, which are expressed in traditions and myths, through traditional methods of communication i.e., through songs and proverbs.

The indigenous knowledge is local, experimental and informal. It is transmitted through oral tradition and practices. IK is different from western scientific knowledge in many respects (contents, methods and uses), but it is based on popular science i.e. logical understanding and causality. It has its own dynamics and always takes new ideas and experiences from other through trial and error. People also modify and improve their local and technical knowledge to increase its efficacy and usefulness in the context of time and their own situation. Hence, it is felt that the livelihood patterns based on IK does not over exploit natural resources bases and help re-generate for future use and subsistence. Local knowledge and IK can give long term solution to problems, which are economically productive, ecologically sound and socially acceptable and equitable. Incorporation of IK may promote sectoral development such as agriculture, fisheries, forestry etc., and allow better utilization of local resources as well as sustainable management of natural recourses and eco-systems. The utilization and promotion of IK may enhance local capacity, help understand local concerns and priority and find better

solution of the problems. Thus, effective utilization of IK can empower local communities and may help them to achieve self-sufficiency as well as living in harmony with nature.

Chambers expressed his interest in local and indigenous knowledge for rural development from early 1980s.The main argument behind this is that farmers have an intricate and detailed knowledge of the environment from which they gain their livelihoods that they both experiment and innovate and such indigenous knowledge should not be viewed, as a constraint to development but can be a positive resource for rural and social development in promoting participation and empowerment. Warren and Cashman strongly feel that indigenous knowledge can play a key role in the design of sustainable agricultural systems, increasing the likelihood that rural people will accept, develop and maintain through innovations and interventions. Currently, there has been growing consensus among the development practitioners and academics that due respect should be given to indigenous knowledge while planning and implementing development programmes for different sectors such as agriculture, fisheries, forestry etc.

There has been growing interest about IK in Bangladesh, but very few studies have been conducted on IK and it's uses. There is a huge knowledge gap in use of IK in agriculture. The existing literature does give social perspectives of uses of IK. This study, with an anthropological approach, tries to examine the uses (current and past), further application and usefulness of potential IKs in agriculture in relation to achieving sustainability of the sector. In fact, the common people of rural Bangladesh, particularly, farmers, fishers and women possess richness of local and indigenous knowledge for crop cultivation, vegetable growing, home gardening, fishing and fish farming, poultry and livestock raring, healthcare and environment management. But the growing technological interventions in the recent decades and modernization of agriculture with external inputs, supported by the agricultural extension division and market forces, affected the traditional and local knowledge base in rural Bangladesh in general and farming in particular. Today, farmers very often use external technologies and high cost inputs in farming such as HYV seeds, chemical fertilizers and pesticides, ground water extraction technologies etc. But still some of the poor and marginal farmers have not abandoned their own knowledge and traditional practices. It is assumed that the resources poor farmers in rural Bangladesh could not adopt the modern technological inputs in their farms due to financial crisis as well as their marginalized position in market and knowledge diffusion process. The farming practices of the poor, with low external inputs, though give relatively low yields, but are diverse in nature, environment friendly and sustainable. These local practices and indigenous knowledge may be extremely useful for developing strategies and options for sustainable agriculture in Bangladesh.

This study has been designed to assess the uses and usefulness of IKs in floodplain agriculture considering the socio-economic and environmental contexts and concerns of the farmers in the selected villages. The study further examines how the useful IKs could be integrated in present day agriculture to address the key problems of agriculture for achieving sustainability in the sector. The study specifically focuses on the following issues and questions:

- what are the local and indigenous knowledge that the farmers practised in the past?
- to what extent the farmers, particularly poor and marginal farmers, are using the local and indigenous knowledge in their various farming practices at present?
- how do socio-economic conditions (i.e. wealth categories of the farmers) and personal attributes (such as age, education and gender) of the farmers as well as their institutional links influence the use of IKs in agriculture?; and
- how the existing indigenous and local knowledge can be effectively integrated with present day agricultural practices to make the sector sustainable?

The study required a wholistic and participatory approach to understand the strengths, weakness and usefulness of indigenous knowledge and practices in agriculture. The study collected both primary and secondary information to document the use of IK in agriculture and assess the interests and perceptions of farmers about indigenous knowledge considering their social categories and personal attributes such as age, education, gender and their involvement in agricultural practices etc. The study employed mainly systematic and participant observation to collect primary information and gain insight about application of IK and modern knowledge in agriculture. The study also used household census, limited scale of sample survey and few tools of participatory research to understand local farming practices, uses of inputs, productivity, cost-benefits, problems of agriculture, uses of IK in the past and present, farmer's interests and innovativeness in relation to the use of IK and modern knowledge in agricultural practices in floodplain villages.

2. Nature of Anthropological Approach and Methods for the Study

The chapter two gives a glimpse on the nature of anthropological studies, changing focus of discipline and contribution of the key classical anthropologists to the development specific approaches of anthropology to look at people, society, culture and ecology. Anthropology has been comparatively a recent social science and as a formal discipline, it has a history of origin and development of about 150-200 years. Anthropology got a solid and independent basis in the second half of the 19th century only when scholars could collect reliable information about various backward and isolated communities through participant observation. In fact, the historical development and evolution of anthropology as a social science has its roots in the study and research of pre-industrial and primitive societies. The classical anthropologists studied mainly small and isolated indigenous communities and tried to find a trend of historical evolution of human society and culture. But in the recent years, there has been a significant shift in the focus of anthropological studies from historical and cultural aspects to more contemporary issues and concerns of present day society.

The historical development and evolution of anthropology as a social science has its roots in the study and research of pre-industrial and primitive societies by western people. Anthropology is the discipline, which owes its origin in the study of colonized societies by the dominant Europeans and the study of culture of vanishing Red Indians by white

Americans. Therefore, the discipline is sometimes termed as the outcome of the study of other culture. However, it is also viewed that anthropology bridges the gaps between sciences and humanities by studying both the origin and evolution of human beings as well as the evolution of human culture. Referring to the positive depiction of the scope of anthropology by Carpo, Alam N., maintains that it is one of the humanities, so anthropologists share some of the insights of philosophers, literacy, art critics, translators and historians. Again anthropology is a science and it shares a great deal with sociology, psychology, political science, economics, linguistics, geography, paleontology and biology. Over the years, the discipline has prepared its academic grounding and defined the subject matters, developed the theoretical perspectives and methodologies.

The broad range of anthropological interest has led to specialization within the field. The main areas of the study within the discipline are: cultural anthropology, physical anthropology and archaeological anthropology. Cultural anthropology has been again subdivided into: pre-historic archaeology, anthropological linguistics, ethnology and social anthropology. Many anthropologists worked covering the issues under cultural anthropology, which studies learnt human behavior, rather than genetic behavior that is typical of a particular human group. Cultural anthropologists attempt to understand culture in its general sense studying its origins, development and diversity as it changes through time and spaces among people. Cultural ecology or ecological anthropology has been again a subfield of anthropology, which studies the complex relationships of human beings with the nature and environment as well the dynamics of society and environment. It studies the interrelationships of between natural and human systems in the local cultural context. Anthropological knowledge has the potential to inform and instruct people about how to construct sustainable way of life. It also tries to explore how people adapt with the change in nature, ecosystems and social system.

Anthropology as a social science is rooted in empiricism. Investigations of anthropology are based on participatory and systematic methods. Anthropologists gain practical experiences with particular people and society through participating in fieldwork. They look at the variations, diversity and covariance between elements. The anthropologists also try to discover connections and unity in a social system. Many academicians and development thinkers have emphasized on the importance of anthropological approaches to improve local development planning, sectoral development (agriculture, fisheries, forestry, health etc.), resources management and livelihoods studies, which focuses on indigenous knowledge and local practices.

Anthropologists can make important contribution to local and regional development planning by using their comprehensive and participatory approaches with insight (deep understanding and thorough analysis), intuition (capacity of assumption with accuracy) and empathy (quality of understanding others concerns from their perspectives and expression) as well as by exploring the local and indigenous knowledge systems to integrate those in the development process. Because, they have vast experiences to identify local criteria, methods and tools relevant to local situation to capture people's perspectives and knowledge. Sillitoe (2001) called upon the anthropologists to facilitate greater uses of local knowledge in development.

The chapter two also analyzes the status of anthropological studies in Bangladesh and identified research needs in IK, agriculture and livelihoods. Anthropology as both academic pursuit and practical research practice has been very new in Bangladesh. Few public universities including Dhaka, Jahangirnagar, Chittagong, and Rajshahi universities have started teaching of anthropology in the latter part of the last century. Clade Lev - Strauss, Pierre Bessaignet, Hans E Kauffmann and LG Loffler made important initial contributions to anthropological studies in Bangladesh in the second half of the last century. They studied kinship, culture and social systems of the ethnic people in Bangladesh. Few Bangladeshi academics and researchers also conducted limited villages studies focusing on family, culture and traditional organizations by using anthropological approach. Mukherjee, Chowdhury, Arefeen, Hassan, Islam and Alam are pioneers among the Bangladeshi anthropologists.

But research by following anthropological approaches in the country has been very few in number. It is criticized that until recently, anthropologists have not been active partners in the process of agricultural research and development. The involvement of social scientists in the development process is largely because of a growing concerns among natural scientists and administrators to become socially informed. There is recognition that, too often agricultural research and development has failed or did not fulfill its potential objectives, because it was socially uniformed and ill conceived. This realization, by default, has led to increasing attention on identifying socio-cultural variables in project design. In turn, this has resulted in the recruitment of social scientists in research and project teams to make use of the applied potentials of social science. This newfound recognition of the uses of anthropology and rural sociology, in terms of their place in the multidisciplinary research and development programme, has gained much importance in the recent decades. Sillitoe, Barr and Dixon worked in Bangladesh in the late 1990s on how to incorporate farmer's and fisher's knowledge into natural resources management and research systems. They worked with a number of local researchers in Bangladesh and examined the methodological issues for incorporating IK in natural resources management and local development process. However, they found that there were considerable intellectual difficulties and practical problems in integrating scientific knowledge and IK in Bangladesh.

The study takes a cultural ecological approach and tries to investigate human adaptation and behavior to environment and nature with a particular focus on knowledge exchange and innovation by local people. The study also undertook a review of literature to gain greater understanding about sustainable development issues, debates and components of sustainable agriculture, concept of IK and importance of IK in development in general and sustainable agriculture in particular. The literature review also focuses on anthropological approaches, contributions of classic anthropologists in developing a different approach to understand society, culture and role of IK in development. Besides the review and consultations (with academics, researchers and knowledgeable farmers), the study also followed systematic participant observation to assess the strength and usefulness of IK in agriculture. The study further employed a number of relevant tools of Participatory Research along with limited scale of household census and sample survey.

3. Local Knowledge in Rural Development and Practices of IK in Agriculture of Bangladesh

The chapter three focuses on the local and indigenous knowledge in rural development in general and practices of IK in agriculture in particular. The chapter is based on published literature and describes the position of IK in knowledge systems, crisis of modern knowledge and importance of IK in addressing the problems within the sustainable development framework. It is felt that IK is vast source and important part of knowledge system. Indigenous knowledge is the knowledge that people in a given community developed over time and continue to develop. IK is based on experience and often tested over long time. It is adapted to local culture and environment. It has its own dynamic to adapt and improve in the changing situation. IK is different from western scientific and modern knowledge, but there have many overlaps between IK and modern knowledge. IK is different from western scientific knowledge in three respects: subject of investigation, methods and context of knowledge generation and uses. IK is generated in the local context to address local problems while western scientific knowledge is developed following standard methods and theories to give generic solution to macro-level problems. On the other hand, IK is functional and it is developed through trial and error in the social laboratory. IK is wholistic and it covers all aspects of life in local contexts. It minimizes risks and give sustainable basis for resources management and livelihood promotion. IK based production and livelihood systems do not over exploit natural resources and it is cost effective. It gives long term solutions to problems considering local resources and potentials in human and natural systems.

Warren and Cashman examined the possibility of integration of IK in sustainable agriculture and rural development in the early 1990s. They tried to explore how it functions. It is felt that farmers have their own sophisticated ways to look at their world and the knowledge that they have acquired and developed over many centuries. They point out that many of the technological solutions that had been proposed to address problems in rural communities failed in the field, because the process did not take into account the local culture, society's preference, skills and knowledge. Success in rural development and agricultural development are more likely to be achieved when local people are involved in the planning and implementation process and their knowledge are valued.

The crisis of modern knowledge was felt much earlier and that was reflected in various writings and thoughts of social scientists, academics and development practitioners from the early 1980s. The notion of indigenous knowledge was felt influential in agricultural development that was manifested in the Farmer First Movement. Chambers, a great thinker of the farmer first approach, criticized the professional development practitioners as outsiders and sought to reverse its ideological underpinning emphasizing on learning from people. In his classical work, "*Rural Development-Putting the Last First*" Chambers seriously criticized the mechanical introduction of western knowledge in the development process in developing countries. Chambers, through his long participatory research experienced in developing countries including Bangladesh, emphasized on the importance of local knowledge, experience, experiments and priorities of local and rural people for their development. But he did not totally ignored the essence of modern technological

knowledge and feels that the two types of knowledge complement each other and together they may achieve advancements, which neither could do alone.

The farmer first approach was criticized in a number of ways. One of the criticisms was that it oversimplified the local knowledge. The criticisms came mainly from the Beyond Farmer First Approach. They held that the FF movement failed to grasp the dynamics of local and indigenous knowledge. Knowledge is seen as a ready store for extraction and incorporation by the FFM. Thompson (who led the Beyond Farmer First movement) says that the impacts of FF approach has been felt through the works of many NGOs and growing number of universities, national and international agricultural research institutes, but the approach fails to some extend to consider the socio-cultural, political and economic dimensions of knowledge creation and innovation, the uses and transmissions of knowledge to rural communities. Further, Mazzucato suggests to bridging gap between scientists and local people by following cognitive anthropological approach. Cognitive anthropology studies indigenous economies valuing people's economic reasoning, their notions of wealth, labor, and capital, and their view of how these can best be managed, invested and presented. This type of analysis can be taken as one step further by examining local classifications of such economics terms as benefits, costs, insurance, interest, security and risk, in order to determine whether these are locally meaningful concepts.

The people of rural Bangladesh use various local and indigenous knowledge and skills for agricultural practices. The farmers use local knowledge for selecting crops, preserving seeds and soil, pest control, gardening, poultry and cattle raising. They also use their various local knowledge and local materials for livestock raring and veterinary medicine. It was found that small-scale fishing is organized mainly with local fishing gears and crafts that helped to conserve fisheries as well as gave long term livelihood support for the fisher folk. Indigenous and local knowledge are being often used for rural health seeking for ages. People in the rural setting, very often use their localized knowledge for weather forecasting and disaster management like flood, cyclone, droughts and riverbank erosion in Bangladesh.

Women possess wealth of indigenous knowledge and they use those in their everyday activities including home gardening, food collection and preparation, nutrition management, health seeking with local herbs, agro-forestry, integration of crops with poultry and livestock, seed preservation and storage of grains. Elderly men also possess and use IK. But men and women often have different skills and different knowledge of local conditions and everyday life. The knowledge and skills, the womenfolk possess, sometime differ. Women also contribute greatly to natural resources management and conservation of bio-resources around home and homestead. Both IK and intellectual property rights (IPR) of the women and farmers are affected by the technology and knowledge diffusion of the agricultural extension, media campaign and emerging market forces in Bangladesh.

4. Key Features of Sustainable Agriculture and the Challenges of Agriculture in Bangladesh

The chapter four discusses wide ranging issues, which cover elements of sustainable development; sustainable agriculture and livelihoods; agricultural development in Bangladesh; national agricultural policy and strategies; and emerging good practices. Agriculture is defined primarily as cultivation of land for production of crops, but currently the scope of agriculture has been widened. Any applied activity through proper utilization of natural resources, which relates to the production, development, preservation, processing, marketing and extension of not only crops but also other agricultural commodities such as fish, meat, eggs and forest products are accepted within the purview of agriculture. Crop production, animal husbandry, fisheries, forestry etc., are integral components of agriculture, but again crops undoubtedly constitute the largest and most important sector in Bangladesh agriculture.

An unprecedented scale of agricultural expansion and intensification with modern seeds varieties, chemical inputs, and agricultural technologies has raised many ecological, economic and social concerns locally, nationally and globally. There are growing concerns about productive capacity of the agro-ecological systems e.g., can the agro-ecosystems withstand the stresses (such as erosion, depletion of soil nutrient and fertility, pollution of land and water, destruction of bio-resources and over exploitation of natural resources) imposed by rapid and in many cases unwise intensification of agriculture? There is also concern about the negative impacts on other ecosystems- impacts that are often accentuated by intensification of agriculture. The harmful effects of increased soil erosion on downstream fisheries and wetlands and the damage to both aquatic resources and human health from chemical fertilizer and pesticide residues in products and the agro-ecosystems are felt badly.

Many environmentalists and social scientists have expressed a number of ecological and economic concerns (soil degradation, loss of productivity, high economic cost with low real benefits) as well as social concerns such as the growing inequity, dislocation of marginal and poor from their tradition occupations and destruction of rural livelihood, rapid social and cultural changes in society. Hence, the questions of sustainability of the agriculture are raised. It is difficult to define sustainable agriculture. However, the discourse on sustainable development, which started during the WCED in 1987 and elaborated in UNCED in 1992, gave important basis for understanding key elements of sustainable agriculture. The Agenda 21 and the WSSD plan of implementation put emphasis on natural resources conservation, environment management and development of agriculture in a sustainable way. The World Resources Institute, IIED and SAREP have developed own analysis about the process and key elements of sustainable agriculture.

The IIED suggests to reducing use of external inputs in agriculture and increasing community participation and local inputs for sustaining agriculture. The SAREP of the University of California, USA points out that a sustainable agricultural system should integrate three goals: environmental health; economic profitability and social equity. A

system perspective is important for sustaining agriculture, where individual farmers, community people and local ecosystems may have different interactions for long. Sustainable Agriculture Research Education Programme approach has identified the following elements of agriculture: mainlining diversity; land and soil management; efficient use of inputs (local inputs instead of external and non-renewable inputs); best management practices (BMP); economic and social cost-benefits; and farmers goal and life style choices.

This study considers four key components of sustainable agriculture, which include: economic elements i.e., augmenting productivity, economically beneficial and stable for long time; social aspects (livelihood support for farm families, socially responsible and equitable and culturally adaptive); environmental concerns (conservation of land, water and all natural and bio-resources, use less harmful and more renewable energy and resources, reducing pollution impacts to ecosystems and human health); and knowledge and technological considerations i.e., information and awareness, promotion of local knowledge and low cost inputs and appropriate technologies. A sustainable agricultural system should be based on local resources and knowledge and must be environmentally non-degrading, technically appropriate, economically viable, and socially equitable and acceptable

Bangladesh is experiencing medium moderately good economic growth with industrialization and expansion of trade, business and service sectors. But still the country is considered an agrarian one. Agriculture is the mainstay of majority people of the country. Agriculture contributes over a quarter of country's GDP, provides about two-thirds of employment and brings about a quarter of export earning. More than 65% of the rural population of Bangladesh directly and indirectly depends on agriculture for their livelihoods and the sector has to feed the country's over 150 million people. Agriculture grew on an average at 2.3 percent annually during the latter half of the 1990s. The main drives came from crops sub-sector, which accounted for 58 percent of total agricultural value added and it grew at 2.2 percent annually over the last decade. But the non-crop sub-sectors of agriculture such as poultry, livestock and fishes also have lot of dynamisms and significantly contributed to people's livelihoods and the economy. The crops contribute to the major share in agricultural outputs in Bangladesh while the other sub-sectors such as fisheries, livestock, poultry, forestry etc., also contributed to the growth of the sector. Despite this growth, Bangladesh agriculture has to increase the productivity by intensification and diversification of agricultural productivity and the sector has to produce the required food to feed the growing population.

The major challenges of Bangladesh agriculture are to achieve self-sufficiency in food production, reduce rural poverty and foster economic development. The government has therefore attached highest priority to this sector to enable the country to meet these challenges and to make this sector commercially profitable, ecologically sound and socially responsive. The Ministry of Agriculture, in a recent policy document has identified a number of constraints, which are the following: agriculture is dependent on the whims of nature and is risky; availability of cultivable land is decreasing; widespread poverty among the population engaged in agriculture; lack of required capital for

agricultural activities; inadequacy of appropriate technology considering farmers socio-economic conditions; uncertainty of fair price of agricultural commodities due to underdeveloped marketing system; agricultural commodities are rapidly perishable and post harvest losses are too high; and limited knowledge of common people about the nutritional value of agricultural products and commodities including vegetables and fruits. However, the country has seen some progressive shift in policy and strategies of agriculture. The aims of the National Agricultural Policy of Bangladesh are to increase agricultural productivity, food production, income and welfare of the farmers through promotion of appropriate farming practices considering economic, social and environmental issues. The policy and strategies also put emphasis on use of local inputs and consider local people's need, priorities and knowledge while implementing sectoral programmes and action. But there is problem in implementation of those policy and strategies. The local and regional government agencies and institutes are not adequate aware of the changes in policy and not motivated to take required action at the local level.

Besides the government initiatives, few NGOs and research organizations are taking limited efforts in agriculture sector to address the current problems and enhance sustainability of the sector. UBINIG (a research and right based NGO) undertook an innovative initiative to revive the traditional farming practices, known as Nayakrishi Andolon. They are working in three districts including Tangail, Pabna and Cox's Bazar. *Nayakrishi* means new agriculture. It is an initiative of the peasants, motivated and organized by UBINIG, to produce healthy food, healthy environment and happy life for the rural people. PROSHIKA (a leading NGO) has also been engaged in popularizing alternative agricultural methods, which is productive, equitable, conductive to bio-diversity and ecology. They call it Ecological Agricultural Programme. The main objective of ecological agriculture is to develop farmer's understanding of the causes of agro-ecosystem degradation and a scientific explanation of the adverse effects they experience. The group members are provided with appropriate training along with financial and technical support. The groups can collectively implement the projects or individual members can do it through their groups. The farmers use local organic manure instead of chemical fertilizer. They also integrate crops with other sub-sectors such as cattle raising, poultry and vegetable growing.

However, a recent study finds that there have been mounting concerns regarding excessive use of chemical inputs and their severe negative impacts on ecology and human health. This consequently increased NGOs initiatives for ecological farming, but the success is vary minimal. The numbers of farmers adopting ecological farming is not great. Few farmers have adopted this approach on their homestead-based farming, which is less controlled by market forces. The study identified several reasons regarding – why the farmers are not widely practicing eco-farming here. The major facts behind this are: lack of organic manure; low yields and lack of premium for organic products; contradictory approaches and message from the NGOs, government extension services, media and actors; and wider promotion of HYV seeds and external input for farming. They also suggested to enhancement of learning by doing; widening the target groups; improvement of coordination among the actors; and advocacy to promote ecological farming.

5. Farming Practices and Application of IK in Floodplain Villages

The chapter five focuses on floodplain ecosystem, population and social dynamics in the study villages, interface between human and natural systems, agricultural practices in the study villages, use of inputs and cost-benefits, problems of agriculture, use of IK and MK in agriculture and farmer's interest for application of IK for addressing the current and emerging problems in agriculture. Floodplain occupies over 65% of the country's land surface. Floodplain has diversity and complexity in physical conditions in terms of soil and land formation, hydrology and climate. Floodplains as wetland ecosystems provide important livelihood and resource supports (such as food, water, fish, nutrition etc.,), eco-systemic services and navigation facilities to the local people. Floodplains are treated as the large and last remaining habitats for numerous rare and endangered species such as plants, birds and animals in the country. But the major floodplains in Bangladesh have been subject to rapid degradation due to population pressure, massive withdrawal of water for irrigation, obstruction of water flow by construction of roads, culverts and other anthropogenic causes.

The study villages are located in a major floodplain called *Kalatali Beel* in the south central Bangladesh in Gopalganj district. There was richness of aquatic flora and fauna in the past, but the resources base has been greatly depleted in the floodplain in the recent decades due to many human interventions and natural factors. The land formation of floodplains has many interfaces with hydrological system. The landscape of the study villages is not flat. It has high land (normally flood free), medium land (flooded up to 3-5 feet) and low land (flooded up to 5-10 feet) during monsoon. About 50% land is medium land and 30% are low land in the village while about 20% land is high land in the study villages called *Talbari* and *Chamtapara*. The study villages are moderately populated. People settled in the lower Ganges floodplain villages about 300 years ago and they experienced many changes in physical environment, political system and social environment. Despite those changes, agriculture remains the major occupation for majority people in the villages. But most of them are poor and marginal farmers. Next to agriculture, they are also engaged in wage earning, fishing and small business.

The villagers are classified into different social categories. According to the local people, about 60% people of the study villages are poor while 35% are marginal and medium farmers and only 5% of them are rich. The household census reveals that 40% of the villagers are functionally landless and another 18% of them are also land-poor farmers who have land between 50-100 decimal. About 22% of the villagers are marginal farmers having land between 100-250 decimal. About 15% of them are medium farmers having land between 250-500 decimal and only 5% families are comparatively wealthy, who own land 5-7 acres. Literacy rate is low in the villages. The census data shows that 35% of farmers are illiterate and the rest 65% got some sot of education. About 30% of the farmers attained primary education only while 26% of them got secondary education. About 9% of the farmers received higher education.

The farmers cultivate various crops of both traditional and modern varieties on different types of lands. They grow various crops on the medium and high land. *Boro* paddy (dry season rice) is grown on the low land. Lots of vegetable and fruits are grown in the

homesteads. Most of the farmers are very experienced and involved in agriculture. Homestead and high land has greater crop diversity and intensity. Both the marginal and medium farmers grow at least 2-3 crops on the high and medium land. They also practice intercrops, multi-crops and maintain crop rotation in different seasons of the year. The marginal and medium farmers have practice of higher crop diversity and intensity on their various lands. During winter season, various *Rabi* crops such as oil seeds (Mustard), lentil (*Masur, Kalai, Mug* etc.) and lots of winter vegetable are grown on both high and medium land. Medium and high land has greater level of crop diversity and intensity in the study villages. HYV rice is grown on medium and low land during *Kharip-1* season in summer while local *Aus, Aman* and limited modern variety of *Aman* are cultivated on medium and low land during *Kharip-2* in Monsoon and Autumn season. Farmers produce lots of vegetables on their homesteads round the year as well as on floating gardens in the floodplain during rainy season.

The farmer of all categories use different types of inputs such as local, family and low cost as well as external and high inputs, modern knowledge and technology. The survey results reveal that the poor and marginal farmers use various low cost local inputs and knowledge (including local seeds, green and composed manure, surface water and local herbs and indigenous techniques) in their farming practices (such as crop cultivation, vegetable and fruits growing and agroforestry, poultry and livestock, fisheries etc). On the other hand, the rich farmers take high level of external inputs such as HYV seeds, chemical fertilizer and pesticides, ground water by STW for irrigation, which are available in the markets and in formal government agencies.

The marginal and poor farmers use seeds from both of their own sources and market, NGOs and neighbors. The marginal and self-sufficient farmers take greater amount of local inputs and family inputs and they value most the indigenous knowledge in farming practices compared to both of the rich and poor farmers in the study villages. They practice learning by doing in the field and initiate good farming practices through lots of trial and errors. The poor also take various local inputs and apply indigenous knowledge and techniques in farming, vegetable growing, home gardening, agroforestry and fish culture. But they are very often guided by the interest of gaining quick economic returns from HYV crop cultivation and mono cropping, which are largely dependent on external purchased inputs. Sometimes, they also do it unconsciously. So, the poorest farmers do not use most of the IK and they are not isolated from market and external forces in the study villages. It is the marginal and self-sufficient groups of farmer those who use IK to larger extend, because of their own understanding of the problems in agriculture and the potentials of IK to address the problems.

The farmers are facing three key problems in agriculture. These are: decrease of soil fertility and farm productivity; decrease of economic return and net benefits from agriculture; and environmental degradation in the locality. The survey results show that loss of soil fertility and decrease of productivity; increase of inputs costs (for seeds, fertilizers, water, pesticides and labour costs) and decrease of net economic benefits from crop farming are common in the villages. They also reported the excessive use of chemical fertilizers and pesticides and associated health risks and its impacts on

ecosystem and local bio-resources, particularly on open water fisheries as major problem in the local agro-ecological system. Over extraction of ground water during dry season drew down the ground water level making many of the hand tube wells inoperative in the dry season. Many of them have also reported the loss of local crops and biodiversity as a major problem in agriculture.

In the past, agricultural practices were mainly based on local inputs and indigenous knowledge. Farmers developed localized methods of ploughing land with cows; soil conservation with crop rotation, inter cropping, mixed cropping; increase of soil fertility by burning crop residues in the field, use of green manure, pest control by using local techniques and organic materials such as herb and ash; use of surface water and rain water, drought management by local techniques (pulling rope on young plants); agro-forestry and integration of agriculture with livestock and poultry. They were self-sufficient in undertaking agricultural activities with their own resources and efforts. However, they would sometimes take inputs, new ideas and material assistances from relatives and fellow farmers. The innovative farmers were also keen to know from farmers of the neighboring villages. They would introduce new varieties of crops and techniques of cultivation suitable to their own situations and context considering land types, flood, water availability and seasonal variation across the year.

It was also learnt that all the agricultural and livelihood activities in the locality were mostly dependent on indigenous knowledge and local inputs in the 30-40 years ago. In the late 1960s and early 1970s, external and modern knowledge as well as many external inputs were introduced by different agencies (BADC and NGOs). Many of the IKs and local indigenous practices were replaced by the emergence of MKs and external inputs, which gave quick results in the initial stage. In the 1990s, (after 20 years Green Revolution), there has been a slow change in the mind sets of the local farmers and many of them have become interested to the good local practices and indigenous knowledge for soil conservation, pest control, irrigation and drought management, crops and species conservation through intercropping, multi-cropping, agro-forestry and integration of sub-sectors of agriculture.

Though the use and application of local inputs and IK has decreased in the last decades, but presently many farmers, mainly the self-sufficient and marginal groups as well as few poor farmers are increasingly applying various IKs and local inputs (such as local crops and seeds varieties, green and compost manures, herbal pest control, rain and surface water for irrigation and drought management) in farming practices. There are practices of multi-crop, inter crops and crop rotation and cultivation of local varieties of crops (Aus, Aman, jute, *kaun, china,* sugarcane, mustard, *til tisi*, groundnuts); mulching for soil conservation, uses of green manures (*Dhaincha, sola,* jute etc.), compost and organic manures (cow dung, crop residues, water hyacinth, aquatic flora etc.); local techniques for pest (birds sitting, *Alor Phad.* and predators) and weed controls. But the level of uses and interest for IK and blending of IK and MK differ across the wealth categories. The level of awareness about IK, good practices and their world views (purpose of agriculture and living; relation between human and natural systems), orientation about ecological good practices and connection with external world very often influence the use of IK and MK in agriculture.

The field observation says that the medium and marginal farmers apply IK to great extent in their farming practices and in terms of taking local low cost inputs in agriculture, because they have long term stake in agriculture and try to promote good practices. They are very innovative and often try to modify and improve IKs in their own needs and local contexts. They also adapt the MKs and external knowledge in the context of local situation and their needs and thus contribute to generation of new knowledge. Women play a very key role in agriculture in the study villages. Women from poor farming families preserve seeds and participate in planting of crops and post harvesting activities. They suggest for appropriate crop rotation and mixed cropping. They organize home gardening and vegetable growing in home and in the field. They prepare food and collect the vegetable and other elements of food from home and natural resources bases in the floodplain (small fish and aquatic vegetable for household consumption). They conserve bio-resources (fruits, herbs and vegetables) and collect herbal plants and use those widely for human health seeking and veterinary medicines.

The age differences and personal experiences sometimes influence the use of IK and MK. Elderly people very often prefer the use of local inputs (own seeds, local crops, compost manures and local pest management) and local knowledge while the young people generally prefer external inputs (HYV seeds and chemical fertilizers and pesticides) and modern knowledge in their farming practices. However, there are young farmers who use both MK and IK in crop cultivation and take inputs from other sub-sectors (poultry and cattle). There are also innovative young farmers (those who are very involved in agriculture) are aware of the current and emerging problems in agriculture (such as loss of soil fertility and productivity and ecological destruction) are again interested for both IK and MK. Formal education sometimes creates barriers towards the use of IK. But most of the farmers are illiterate in the study villages while few of them got primary education. Again, it is the out look and worldviews of the farmers that determines the use of IK and MK. Proper orientation about agriculture, ecology and society as well as good food and nutrition for farm families, consumers and the communities can promote use of IK and good practices in agriculture.

But there is limited awareness about the use and usefulness of IK among the farmers, particularly among the involved and innovative farmers. The poor and marginal groups have some interest for the IK and local input, but they have resources constraints. They don't have adequate access to natural and common resources, which gives important basis for ecological farming with local knowledge and inputs. Hence, there is need for awareness, policy measures and institutional support for the poor and marginal farmers for promoting good practices. Demonstration of good practices at the farm level by showing the usefulness and efficacy of IKs can encourage farmers towards good practices. The agricultural extension department at the Upazila, development NGOs and media can play effective role in this areas.

A dynamic and growing agricultural system requires meaningful interactions among the farmers and scientists. This is needed for establishing effective links between micro and macro process. Farmers must have the critical understanding and awareness about the

problems and prospects of the agro-ecological systems and only then they will engage their knowledge, inputs and resources to find appropriate solutions. The local knowledge and resources may not give solution to their every problem and the farmer have to acquire new ideas, information and support from the external sources such extension services, research organizations, NGOs and market places, but they must have adequate understanding of the suitability of the external knowledge and inputs. Hence, there is a strong need for knowledge continuum between the farmer and external world. Participatory action research may facilitate an effective knowledge continuum between farmers, scientists, policy people and development actors.

6. Conclusion and Recommendations

Sustainable development seeks to respond to a set of key requirements including: a) integration of resources conservation and development with continuous growth; b) satisfying basic human needs (food and nutrition, fiber, fodders, shelter, health etc.,) and c); promotion of social justice, self-determination and culture diversity. For sustaining growth and development in any sector, maximization of internal inputs and renewable resources is essential to avoid the costly external and non-renewable inputs. This is equally true for agricultural sector to make the agro-ecological system sustainable. A sustainable production system should meet at least three sets of goals and imperatives. These are: **economic goal** (increase productivity and meeting basic needs of the farming communities using local and necessary external resources in an efficient and cost-effective way); **environmental imperatives** (conservation and optimal uses of natural resources) and **social goals** i.e., maintaining farm family welfare, food security, poverty reduction, social progress, participation and knowledge generation, social justice, cultural diversity and happiness.

Sustainable agriculture and rural livelihood largely depends on the level of integration of natural, human and social sub-systems, where knowledge of farmers, worthy purpose of farming and living; and wise and efficient uses of resources can play important role. An agricultural system becomes sustainable, when it protects and renews the natural resources up on which all the agricultural and most of the livelihood activities are organized. The agricultural and livelihood systems could be made sustainable, when the farmers are aware of the problems, potentials and can undertake measures to improve the situation consciously and effectively with their knowledge and resources optimizing the uses of local resources and inputs and minimizing the adverse impacts of external inputs on natural resources, human systems and social systems. Such efforts many not de-link the farmers from the external world and scientific innovation. The farmers would adopt the external knowledge in their local context. They might use all resources and inputs efficiently considering the carrying capacity of the nature and long-term productivity of land, water, and forest for supporting the livelihoods of the farming community.

All the popular wisdom, traditional knowledge, local practices, beliefs, the local resources bases, equipment and various local techniques for resources management, enhancement of livelihoods, health seeking etc., could be treated as indigenous

knowledge. These are developed through long practice and give sustainable options for resources management, agriculture and livelihood options considering the various risks, stakes and challenges of the local people. The field observation and farmers views reveals that IKs can help to address many of the problems in recourse management, agriculture and livelihoods of local communities through promoting good practices and integration of the human and social systems with natural systems. It is strongly felt that the agricultural systems based on IK, local renewable inputs with necessary limited external supports and an effective knowledge continuum obviously can help to achieving sustainability of the sector through:

a. greater integration of human, social and natural systems;
b. protection and renewal of the local natural resources base for healthy and productive land, water and ecosystems;
c. optimization of using on-farm organic inputs maintaining cycles between biological and natural resources and reduction of uses of non-organic inputs avoiding the adverse impacts on ecosystems and human health; and
d. ensuring equity by providing employment, adequate income, food and nutrition for farm families and local communities for supporting their livelihoods.

Knowledge and understanding of specific the issue in relation to agriculture and farm management and the mode of thinking of the farmers, extension workers and the scientists may differ in many ways, but participatory action research and continuous interaction among the farmers, researchers and relevant actors can help to have better understanding of the farming systems, the problems and enhance co-learning leading to more productive, dynamic and sustainable agricultural systems. It was noticed that the poor and marginal farmers sometimes lack proper understanding of the farming systems and the problems and they need appropriate information and sometime orientation about the dynamics of the systems as well as greater access to local resources base, which can help them to take right decision at farm level and initiate good practices. Critical awareness and understanding of the problems and prospects of agriculture may give part of solution by engaging the farmers and the key actors in collective action and reflection for promotion of good practices, where poor and marginal farmers must play a key central role in exchange, innovation and knowledge generation.

Recommendations

The public policies and programmes in Bangladesh very often favour the large farmers, who are small in number but can influence the decision making at local and national levels. The national policy and programmes should redirect their focus on the marginal and small farmers, who are large in number. The programmes based on local needs and priorities utilizing local and indigenous knowledge can best help the small farmers and poor rural communities. Fortunately, the present National Agricultural Policy of Bangladesh suggests to promote IK in agriculture, but the country needs a national strategy and practical programmes to enhance the application of IKs and good practices for promotion of ecologically sound and socially appropriate farming.

It is also felt that the worthy goal of farmers for farming and living can promote good practices at farming and livelihood activities, where farmers may use their conventional wisdom, skills and IKs to integrate human and social systems with natural and biological systems without harming the nature and ecosystems. A good sense of live on earth and re-orientation of farmers about how to best integrate the human and social systems with natural systems considering it carrying capacity can help develop good practices as well as generation of new knowledge in the area of agriculture, natural resources management and livelihoods. Participatory action research can enhance such knowledge generation and effective knowledge continuum. The study further puts forward the following recommendations in relation to policy, programmes, local actions and research in the areas of IK, agriculture, natural resources management and promotion of livelihoods of the rural people.

Recommendations for Policy and Institutions:

- Increasing the understanding, awareness and interest of people both in policy and programmes at various local levels as well as the farmers and rural communities (who are the ultimate users of the local knowledge) about IKs;
- Sensitization and engagement of the people in policy and programme about the uses and usefulness of IKs in the context of sustainable agriculture and achieving livelihoods from agriculture;
- Building new institutions and bring about necessary shift in existing institutions at different levels is required towards working for sustainable agricultural development and promotion of livelihoods of the poor and the marginal groups (because the existing formal government institutes work for the large farmers and promotion of commercial production systems);
- Improve legal framework and incentives (economic, social, property right etc.) to stop harmful practices and encourage good practices, organic farming and integration of natural and biological cycles;

Recommendations for further research and collective actions:

- Preparing inventories of IKs used in different agro-ecological systems and improve the potential IKs though facilitating the continuous applications of IKs in farming, so that the IKs can contribute to addressing the problems in agriculture and rural livelihoods;
- Initiating more participatory and action research for promotion and effective application of IKs in agriculture for achieving its sustainability;
- Initiate more on-farm research involving farmers and community people where the scientists, trained in the formal institutes, can play more facilitating role in identifying issues and develop methodology for the farmers to act meaningfully in the process of agricultural development, enhancement of livelihoods and generation of knowledge;
- More academic as well as action research on – how to blend IK and MKs i.e., improve potential IKs in the current contexts, needs, priorities and adopting MKs to the local situation;

- Research is needed on how the human, natural and social systems can be integrated meaningfully in the dynamically changing agro-ecological systems, which have many interfaces with the social, economic and political systems; and
- Improve methods and approach to initiate more effective participatory action research, where farmers and local people can be the key players in the research and contribute to the generation of knowledge generation and thereby the local community can get benefits from new knowledge by improving their productions and livelihood systems.
- Collective action with poor and marginal farmers at farm levels; and
- Promotion of good sense of live, living and farming.

Chapter-1: Background and Rationale of the Study

1.1 Introduction

Nature of the Problems studied

Agriculture is the mainstay for the majority people in Bangladesh. It contributes over a quarter of country's Gross Domestic Product (GDP). It provides about two-thirds of employment and brings about a quarter of export earning. More than 65% of the rural population of Bangladesh directly and indirectly depends on agriculture (crops, poultry, livestock, home gardening, agro-forestry, fisheries etc.) and related activities for their livelihood. Further, it has to feed the country's about over 150 million people. So, the sector has to be developed in a sustainable way to enhance productivity and employment opportunities for the large poor and marginal farmers through intensification and diversification in production of the sector (Mandal, 2002). However, the growing population has increased demand for food and there has been a trend of over exploitation of agricultural resources in an unsustainable manner in the last 3-4 decades. All the post independence governments in Bangladesh were committed to increase food production. They encouraged the uses of modern agricultural inputs such HYV seeds, irrigation, chemical fertilizer and pesticide. Farmers, mainly the large farmers were very active to take the immediate benefits of the so-called "Green Revolution". All those efforts increased food production in the country considerably and the country has achieved some sot of autarchy in rice production in the recent years. But the sector, despite this growth and success, has been associated with a number of problems in relation to loss of productivity, economic cost-benefit, environmental degradation and social problems. These include the following:

- Dependency on high cost external inputs such as HYV seeds, chemical fertilizers, pesticides and irrigation technology;
- Degradation of soil nutrient and fertility due to mono-cropping and excessive uses of agro-chemicals (fertilizers and pesticides);
- Loss of farm productivity (as a result, many farmers have already experienced the effect of the law of diminishing return i.e., net benefits has decreased from farm production considering increased inputs costs);
- Ecological problems: loss of species and biodiversity, pollution of water and soil and destruction of habitats;
- Serious threats to human health due to indiscriminate uses of chemical fertilizer and pesticides in crops, fruits and vegetable production;
- Lack of knowledge about good practices and appropriate farm management; and
- Rapid changes in livelihood and social systems resulting in increased social inequity and poverty (Akash, 1998 and Gregow, 1998).

Hence, the question of sustainability of agriculture in Bangladesh arises and there is an urgent need to look into the issue considering the economic, social and environmental aspects of agriculture as well as livelihoods of people. We must explore - how the sector could be made more productive, economically cost-effective, socially appropriate and environmentally sound by applying both local knowledge and modern knowledge

through better management of farms without using much high-cost external inputs as well as by avoiding the harmful practices.

Concept of Sustainable Agriculture

Sustainable agriculture means the utilization and management of agricultural productivity and resources including land, soil fertility, water, crops, plants, biodiversity and the eco-systems in an environmentally sound and socially and culturally acceptable way to ensure the attainment and continued satisfaction of human needs - such as food, fodder, water, shelter, health, fuel etc., for the present and the future generations. Sustainable agricultural system must provide a fair and reasonably secure living for farm families; it should benefit rather than harm the natural environment and must at least maintain basic natural resources such as healthy soil, clean water, biodiversity and clean air. Sustainable agricultural system should support viable rural communities and fair treatment of all involved in the food system, from farm workers to consumers (CIKARD, 1998). According to the Sustainable Agriculture Network and SAREP, sustainable agriculture refers to a system that:

- achieves the integration of natural and biological cycles;
- protects and renews soil fertility and natural resources;
- optimizes the use and management of on-farm resources;
- reduces the use of non-renewable resources and purchased external inputs;
- provides adequate and dependable farm income;
- promotes opportunities for farming families and communities; and
- minimizes adverse impacts on human health and ecosystems.

In the light of the above discussion, it is obvious that all the environmental, technological, social and economic aspects such as productivity of land and soil, maintenance of bio-diversity and eco-systems, farmer's knowledge, technology generation and farmers innovation, cost-benefits, livelihood support from farm products and their participation in the process are very important to achieving sustainability of the sector and its sub-sectors such as crop, agro-forestry, livestock, poultry, fisheries etc. Most importantly, sustainable agricultural systems must provide food security and nutrition and reasonably secure living for farm families. These are to be guided by a set of worthy purpose of the farmers for production, enhancement of natural resources and promotion of livelihoods. Hence, this study considers the following key elements of agricultural system that may help to sustain the productivity, stability, conservation of the natural resources and ensuring food, nutrition and well being of the farming community for long time:

- an agricultural system should be economically productive and profitable considering input, output and various benefits of farm production;
- it should be environmentally sound (not harming the national resources base, bio-diversity, physical environment and ecosystems);
- agricultural system should be knowledge based practices (farmers should have adequate knowledge and information about the farming systems and associated problems and possible solutions by integrating both local and external knowledge) and technologically sound; and

- finally, the system should be socially and culturally acceptable and equitable by supporting the livelihoods of the farm families and local communities.

Growing Importance of Indigenous Knowledge (IK)

Chambers expressed his interest in local and indigenous knowledge for rural development from early 1980s.The main argument behind this is that farmers have an intricate and detailed knowledge of the environment from which they gain their livelihoods that they both experiment and innovate and such indigenous knowledge should not be viewed, as a constraint to development but can be a positive resource for rural and social development in promoting participation and empowerment (Chambers, 1983 and Sillitoe, 1998). Warren and Cashman (1991) strongly feel that indigenous knowledge can play a key role in the design of sustainable agricultural systems, increasing the likelihood that rural people will accept, develop and maintain through innovations and interventions (IIED Gatekeeper Series No. 10: Briefing paper on Key Sustainability issues in Agricultural Development).

Currently, there has been growing consensus among the development practitioners and academics that due respect should be given to indigenous knowledge while planning and implementing development programmes for different sectors such as agriculture, fisheries, forestry etc., for a country and a region. Many development practitioners have shown their increasing interest in IK and its contribution to sustainable resources management and development of agriculture. There are two basic reasons for why it is so important to consider IK when carrying out research for natural resources management and development. Firstly, incorporating IK into development process can contribute to local empowerment and sustainable development of agriculture, fisheries, forestry and other sectors by increasing self-sufficiency and strengthening self-determination. Secondly, exploring and utilization of IK in research, development and resources management plan gives it legitimacy and credibility in the eyes of both local people and outsiders by increasing cultural pride and thus motivate to solve local problems with local ingenuity and resources.

Local capacity building is a crucial aspect of sustainable development. IK empowers people and gives them sustainable basis for resources management and rural livelihoods for long term (Grenier, 1998 and IIED, 1998). Utilization of IK promotes integration of natural, biological and human systems and thus can protect nature and conserve resources. It can also help to increase long-term livelihood resilience by providing employment for the farming community, food security and nutrition for them as well as reduce various risks and adverse impacts on human health. So, it is felt that effective application of IK in agriculture may help to address many of the environmental and social problems of the sector.

1.2 Review of Literature and Identifying the Knowledge Gaps

In the initial stage of my literature searching, I found a serious lack of written materials on indigenous knowledge in Bangladesh. But recently I found few important books, articles, reports and papers focusing on the uses of indigenous knowledge in agricultural systems and natural resources management. First of all, I would like to focus briefly on the works of few scholars and development thinkers who made important contribution to the discourse of IK in development.

Chambers, in his pioneering work entitled *Rural Development- Putting Last First*, mentions that rural people's knowledge is an enormous and underutilized resource in many developing countries. The small farmer's expertise represents the single largest knowledge resources not yet mobilized in development enterprise. Referring to Brokensha, Warren and Warner, he maintains that indigenous knowledge systems should be regarded as part of national resources although so far nearly all nations have virtually ignored these national assets (1983). In the context of growing problem in large scale agriculture based on high cost external inputs, Chambers and others have noted that the resources poor farm families in the developing countries maintained a complex, diverse and risk-prone agriculture. The experiences and knowledge of those poor farmers are highly useful in searching sustainable options for rural development and agricultural development. The experiences of the poor and marginal farmers, their ideas, knowledge, innovation, adaptive strategies and their own agendas are very important and should get priority in the development of the sector (Chambers *et al*, 1991). He also argued that the farmers have the capacity to experiment, adapt and innovation so that the farmer's agenda should be put first in the research and development, particularly in agriculture, natural resources management and rural development. The local knowledge systems can be linked with the scientific knowledge and thus effective blending of both knowledge systems can help to achieve sustainable development.

Warren and Cashman (1991) examined the possibilities of integration of IK into agriculture and rural development. They felt that the farmers of any location have their particular way to look at their own world and problems and hence farmer's knowledge is very crucial for sustainable development of agriculture, because IK and local knowledge is embedded in society and culture. However, he also maintains that IK is often contrasted with "scientific" western, modern or international knowledge that are developed by university, research institutes and private organizations using formal scientific approaches (Warren, 1983 and Warren and Cashman, 1991). But Agrawal (1995) gives different views and he feels that in reality there is lots of overlaps between IK and modern knowledge (MK), because it changes over time and situation and adapts to increase its efficacy.

Thompson (1993) criticizes the approach of the Farmer First approach led by Chambers and others. He assumes that rural people's knowledge does not represent an easy definable body or stock of knowledge ready for extraction and incorporation. The rural people's knowledge like scientific knowledge is fragmentary, partial and provisional in nature. Knowledge is embedded in and emerges out of a multi-dimensional universe, in which

diverse cultural, economic, environmental and socio-political factors interact and influence one another. So, IK research should consider the political dimensions of knowledge generation and utilization of various knowledge. In this regard, Titilola (1994) finds great importance of local knowledge systems in the context of African development. He tries to establish links of IK with external knowledge and emphasizes on re-conceptualization of the conventional development theories and practices and expects that this would make it possible to utilize the positive aspects of local knowledge systems developed among the tropical and subtropical agricultural communities.

Paul Sillitoe has vast experience of exploring potentials of IK in Africa and Asia. To him indigenous knowledge generally refers to the unique, traditional and local knowledge existing within and developed around the specific socio-economic condition of people to a particular geographic area. In every geographic locality, people have their own local and indigenous knowledge and practices in relation to their production systems (agriculture, fisheries, forestry etc.) and livelihood activities. Integration of IK in development process can help true grassroots development and conserve natural resources (Sillitoe, 1998). He also finds a knowledge continuum, where both the local people and external scientists may exchange and learn from each other. Participatory action research involving multi-disciplinary people can facilitate such effective exchange, co-learning and knowledge generation.

In a recent work called "*Working with Indigenous Knowledge: A Guide for Researchers*", Grenier synthesized the experience of IDRC on IK and development across the developing countries and reports that new knowledge is continually added to IK and such knowledge systems always do innovate within and also internalize, use and adapt external knowledge and technologies to suit in the local situation. One of the key features of IK is that it is holistic and it covers all aspects of lives giving the basis for sustainable livelihoods of poor and marginal people, who mainly produce for subsistence. IK system minimizes risks. It can give a basis for self-sufficiency and self-determination for at least three reasons: people are familiar with IK; they can understand the uses of IKs effectively; and it draws local resources and it is cost-effective. New knowledge is continually added to IK and local knowledge systems and such knowledge systems always do innovate within and also internalize, use and adapt external knowledge and technologies to suit in the local situation (Grenier, 1998).

In Bangladesh, the Bangladesh Agricultural Research Council (BARC) undertook one of the earliest extensive works on indigenous technical knowledge and published a book entitled, "*Indigenous Agricultural Tools and Equipment of Bangladesh*". It describes the various agricultural tools and traditional appliances that had been used, and still are being used in many parts of the country. The book provides a detailed description of the equipment and gives local names, size, the mode of operation, and the materials from which they are made. But one of the limitations of the book is that it does not provide necessary analysis of the socio-economic and cultural contexts of the of indigenous agricultural technologies.

Chowdhury and Elias (1996) have completed another extensive works on indigenous technical knowledge. In the nation-wide study, they reported on indigenous knowledge relating to cropping, home gardening, seed preservation, pest control and so on. They documented about two hundred different indigenous techniques and practices used in agriculture, livestock, fisheries and human healthcare. Chadwick and Mallick (1998) provides a synthesis of previous work in the field of indigenous knowledge and techniques in water resources management in Bangladesh. The study adopted a regional perspective on resource management and it reviews related issues by exploring the strengths and usefulness of indigenous knowledge for improved maintenance of local ecosystems as well as production systems.

Bangladesh Resources Centre for Indigenous Knowledge (BARCIK) published an important book in 2000 entitled "*Indigenous Knowledge Development in Bangladesh: Present and Future*". Edited by Sillitoe, the book is an important contribution to the field of IK and sustainable development in Bangladesh. Divided into five sections, the book contains valuable information on agriculture and livelihood issues of the rural people. The book is based on a workshop findings on "*State of Indigenous Knowledge in Bangladesh*", held in Dhaka in 1998. Further, the *Grassroots Voice*, a journal of indigenous knowledge and development, published regularly by BARCIK, provides insights of different aspects of IK and practices, local and indigenous knowledge in different sectors including agriculture, fisheries, forest, rural health seeking etc.

Folkways demonstrate vast resources of IK in Bangladesh. Khan (1987) in his work has documented wealth of folklores in relation to farming, fishing, rain, floods, water management and rural livelihoods. The *Khanar Bachan* (verse of Khana, a wise lady of the medieval age) remains another source of popular wisdom in Bangladesh, which gives predictions about weather, rainfall and crop cultivation.

Rationale of the Study and the Research Question

Despite some progress in the filed of IK studies in Bangladesh, still there has been lack of practical research and academic efforts, particularly in the field of social sciences to examine economic, social, cultural and livelihood aspects of local and indigenous knowledge. There is a great need to explore the strengths of IKs and their application, which are gradually being disappearing by the diffusion of modern and technical knowledge and the emerging market forces. It is argued that application of potential IKs in agriculture can help to address the current and emerging problems of the sector that may ultimately contribute to achieving sustainability of the sector in the long run. There is also need for practical research, particularly in the field of social sciences to examine socio-economic and livelihood aspects of local and indigenous knowledge focusing on the possibility of application of potential IKs in agriculture to address the current and emerging problems of the sector.

Anthropological research has vast experience and much to offer to understand local people, their knowledge, livelihoods and resources use patterns in their perspectives as well as to examine the potentials of local and indigenous knowledge that could be

integrated into local development, natural resources management, agriculture and enhancement of livelihoods. The study raises the question whether the application of local and indigenous knowledge in agriculture can address some of the major problems (ecological, economic and social problems) of agriculture and help to achieve sustainability of the sector in Bangladesh? The study has been designed to examine the uses, application and usefulness of potential IKs in agriculture in relation to achieving sustainability of the sector considering the ecological, economic, social and ecological issues.

1.3 Conceptual Framework of the Study

Indigenous knowledge generally refers to the unique, traditional and local knowledge existing within and developed around the specific socio-economic condition of people to a particular geographic area. The IK is more than technology and practices and it includes: information, beliefs, practices, tools, materials, bio-resources, experiments, education and traditional communication. In every geographic locality, people have their own local and indigenous knowledge and practices in relation to their production systems (agriculture, fisheries, forestry etc.) and livelihood activities. Like all other knowledge and wisdom, IK originates from human practices based on the simple process of trail and error. It entails many insights, perceptions, behavior and traditional institutions related to the nature and environment including solar cycle, astrology, and meteorological and geological conditions. The folk-wisdom is usually integrated with belief systems and cultural norms, which are expressed in traditions and myths, through traditional methods of communication i.e., through songs and proverbs (Sillitoe, 1998, Warren and Cashman, 1991).

The indigenous knowledge is local, experimental and informal. It is transmitted through oral tradition and practices. IK is different from western scientific knowledge in many respects (contents, methods and uses), but it is based on popular science i.e. logical understanding and causality. It has its own dynamics and always takes new ideas and experiences from other through trial and error. People also modify and improve their local and technical knowledge to increase its efficacy and usefulness in the context of time and their own situation. Hence, it is felt that the livelihood patterns based on IK does not over exploit natural resources bases and help re-generate for future use and subsistence. Local knowledge and IK can give long term solution to problems, which are economically productive, ecologically sound and socially acceptable and equitable. Incorporation of IK may promote sectoral development such as agriculture, fisheries, forestry etc., and allow better utilization of local resources as well as sustainable management of natural recourses and eco-systems. The utilization and promotion of IK may enhance local capacity, help understand local concerns and priority and find better solution of the problems. Thus, effective utilization of IK can empower local communities and may help them to achieve self-sufficiency as well as living in harmony with nature.

Bangladesh is predominantly a rural and agrarian country with agriculture being the main stay of majority population. Industrial development is slow while trade and business is

growing fast. The economy is increasingly being connected with external world in the recent decades in many ways. In such a traditional but slowly growing society, majority farmers have relied on local resources and indigenous knowledge for agriculture and rural livelihoods for generations. Various kind of local and indigenous knowledge has been developed and improved to meet the needs priorities of the changing society and ecology. The common people of rural Bangladesh, particularly, farmers, fishers and women possess richness of local and indigenous knowledge and techniques for farming, fishing, healthcare and environment management. At the same time, the technological intervention and modernization of agriculture, supported by the agricultural extension division and private sector, affected the traditional and local knowledge base in rural Bangladesh in general and farming in particular. Today, the farmers are forced to use modern technologies, external agricultural inputs (such as HYV seeds, chemical fertilizers and pesticides, ground water extraction technologies etc.) by the emerging market forces and widespread extension services. But still many of the poor and marginal farmers have not abandoned their own knowledge and traditional practices (Chowdhury, 2000; and Barr *et al,* 1996).

The local knowledge is important to find the better options for sustainable resources management, agricultural development and livelihood promotion. But the local knowledge base is disappearing quickly due to expansion of Green Revolution technologies, modernization of agriculture and emerging market forces. The central planning by bureaucrats and professionals with external knowledge ignored the local knowledge and the needs of the farmers and local community, which also caused to loss of the wealth of indigenous knowledge in Bangladesh. The process of diffusion of modern and external knowledge started in late 1960s and 1970s and that process destructed the local knowledge and agro-ecology in 1980s. Again, the country saw a reversal to the IK and use of local inputs for agriculture in mid 1990s. But still modern technological knowledge and external inputs dominate the agriculture in Bangladesh.

However, it is assumed that many of the resources poor farmers in rural Bangladesh could not adopt the modern technological inputs (YHV seeds, chemical fertilizer, pesticides and modern irrigation technologies) in their farms due to financial crisis as well as their marginalized position in market and knowledge diffusion process. The farming practices of the poor, with low external inputs, though give relatively low yields, but are diverse in nature, environment friendly and sustainable. Very recently, attention is being paid to the wisdom of poor farmers and the local knowledge systems in many parts of the world, because the local knowledge provides a basis for identifying ecologically sustainable options for resources uses and development of agriculture. Thus, farmer's own knowledge and local technologies have a great potential if the wealth of potential local knowledge could be identified and applied in the current agricultural practices as well as integrated with the modern and scientific knowledge systems effectively and meaningfully.

1.4 The Purpose of the Study

The process of the modernization of agriculture and the technological diffusion in the last four decades backed by the market forces and growing commercial interests of rich farmers have increased farm productivity significantly, but the process has deteriorated the agro-ecological systems in Bangladesh. It has destructed environment and decreased the net farm productivity considering the economic cost-benefits and livelihood stress. The current process of technological diffusion and external inputs (such as HYV seeds, chemical fertilizers and pesticides) based agricultural practices are also destroying the local knowledge systems, which were developed and utilized through generations and IK gave the basis for sustainable use of resources for promotion of livelihoods. So, there is an urgent need to explore the strengths and usefulness of local and indigenous knowledge for finding appropriate options of sustainable development of agriculture.

In the above context, the main purpose of the study was to assess the uses and usefulness of IKs in floodplain agriculture considering the socio-economic and environmental contexts and concerns of the farmers in the selected villages. The study further examines how the useful IKs could be integrated in present day agriculture to address the key problems of agriculture for achieving sustainability in the sector. The study specifically focuses on the following issues and questions:

- What are the local and indigenous knowledge that the farmers practiced in the past (20-30 years ago)?
- To what extent the farmers, particularly poor and marginal farmers, are using the local and indigenous knowledge in their various farming practices at present?
- How do socio-economic conditions (i.e. wealth categories of the farmers) and personal attributes (such as age, education and gender) of the farmers as well as their institutional links influence the use of IKs in agriculture?; and
- How the existing indigenous and local knowledge can be effectively integrated with present day agricultural practices to make the sector sustainable?

1.5 Approach and Methods of the Study

It is obvious that the local knowledge of farmers can provide a good basis for identifying socially and ecologically sustainable options for resources uses and development of agriculture. An anthropological research has much potential to investigate and understand the strengths, local context and use of indigenous knowledge in agriculture. Anthropology has been comparatively a recent social science, which has a history of origin and development of about 200 years. The western academics and scientists mainly from United Kingdom, USA and France contributed to the growth of the discipline and its approaches. All the classical anthropologists studied mainly small and isolated indigenous communities and tried to find a trend of historical evolution of human society and culture. In the recent years, there has been a significant shift in the focus of anthropological studies from historical and cultural aspects to more contemporary issues and concerns of present day society.

The study on IK in agriculture requires a participatory and wholistic approach to understand the strengths and usefulness of indigenous and local knowledge in agriculture. The study tries to understand those issues by using both primary information (collected through systematic and participatory observation) and secondary information. Primarily, the study has identified the different kinds of IK (through literature review and fieldwork) that were in use in the past as well as are being used in present day agriculture. Then the IKs were classified according to their uses and usefulness in different agricultural sub-sectors including crops, livestock, fisheries, natural resources and biodiversity. Finally, farmer's interests and knowledge about indigenous knowledge considering the social categories and personal attributes such as age, education, gender and their involvement in agricultural practices etc., have been assessed. The study employed mainly systematic and participant observation to collect primary information and gaining insight about the selected issues. The study has also employed limited scale of sample survey (on socio-economic conditions of farmers, farm productivity, knowledge transfer, uses and usefulness of the IKs) and a number of tools of participatory research (PR) to understand farming practices, inputs use, productivity, cost-benefits, problems in agriculture, uses of IK and MK in agriculture, farmer's interests and innovativeness in relation to the use of IKs in agricultural practices at local level.

1.6 Summary of the Chapter

This introductory chapter gives background, contexts and rationale of the study with the purpose and research question, analytical framework and some reflection on the methodology of the study. Bangladesh made laudable progress in agricultural productivity in the last 2-3 decades, but the growth in agriculture has been associated with a number of social, economic and ecological problems such as degradation of soil fertility and productivity of land, loss of biodiversity, pollution of water and land, health hazards, low economic return from crop cultivation, rapid changes in social and cultural patterns and growing inequity in the society. These problems threaten the sustainability of the sector. On the other hand, consensus has been built about the importance of local and indigenous knowledge in resources management, conservation, livelihood promotion and sustainable development. Indigenous knowledge is local, experimental and informal knowledge, which gives appropriate options for livelihood promotion and resources conservation in the local contexts. Effective use of the wealth of IK may help to address many of the ecological, economic and social problems of agriculture and livelihoods in rural Bangladesh.

In Bangladesh, very few social studies have been conducted on IK and its application. There is a huge knowledge gap in IK for agriculture, particularly from social sciences perspectives. This study, with an anthropological approach, tries to examine the uses (current and past), further application and usefulness of potential IKs in agriculture in relation to achieving sustainability of the sector. In fact, the common people of rural Bangladesh, particularly, farmers, fishers and women possess richness of local and indigenous knowledge for crop cultivation, vegetable growing, home gardening, fishing and fish farming, poultry and livestock raring, healthcare and environment management.

But the growing technological interventions in the recent decades and modernization of agriculture with external inputs, supported by the agricultural extension division and market forces, affected the traditional and local knowledge base in rural Bangladesh in general and farming in particular. Today, farmers very often use external technologies and high cost inputs in farming such as HYV seeds, chemical fertilizers and pesticides, ground water extraction technologies etc. But still some of the poor and marginal farmers have not abandoned their own knowledge and traditional practices. It is assumed that the resources poor farmers in rural Bangladesh could not adopt the modern technological inputs in their farms due to financial crisis as well as their marginalized position in market and knowledge diffusion process. The farming practices of the poor, with low external inputs, though give relatively low yields, but are diverse in nature, environment friendly and sustainable. These local practices and indigenous knowledge may be extremely useful for developing strategies and options for sustainable agriculture in Bangladesh.

The study required a wholistic and participatory approach to understand the strengths, weakness and usefulness of indigenous knowledge and practices in agriculture. The study collected both primary and secondary information to document the use of IK in agriculture and assess the interests and perceptions of farmers about indigenous knowledge considering their social categories and personal attributes such as age, education, gender and their involvement in agricultural practices etc. The study employed mainly systematic and participant observation to collect primary information and gain insight about application of IK and modern knowledge in agriculture. The study also used household census, limited scale of sample survey and few tools of participatory research to understand local farming practices, uses of inputs, productivity, cost-benefits, problems of agriculture, uses of IK in the past and present, farmer's interests and innovativeness in relation to the use of IK and modern knowledge in agricultural practices in floodplain villages.

Chapter-2: Nature of Anthropological Studies and Methods for the Study

2.1 Anthropology- a recent Social Science

Anthropology has been comparatively a recent social science and as a formal discipline, it has a history of origin and development of about 150-200 years. Anthropology got a solid and independent basis in the second half of the 19th century only when scholars could collect reliable information about various backward and isolated communities and races through participant observation. The natural historians, travelers, social philosophers, western academics and scientists mainly from UK, USA, Germany and France contributed to the growth of anthropology and its approaches. All the classical anthropologists studied mainly small and isolated indigenous communities and tried to find a trend of historical evolution of human society and culture. In the recent years, there has been a significant shift in the focus of anthropological studies from historical and cultural aspects to more contemporary issues and concerns of present day society.

The historical development and evolution of anthropology as a social science has its roots in the study and research of pre-industrial and primitive societies by western people. Anthropology is the discipline, which owes its origin in the study of colonized societies by the dominant Europeans and the study of culture of vanishing Red Indians by white Americans. Therefore, the discipline is sometimes termed as the outcome of the study of other culture. However, it is also viewed that anthropology bridges the gaps between sciences and humanities by studying both the origin and evolution of human beings as well as the evolution of human culture. Referring to the positive depiction of the scope of anthropology by Carpo, Alam N., maintains that it is one of the humanities, so anthropologists share some of the insights of philosophers, literacy, art critics, translators and historians. Again anthropology is a science and it shares a great deal with sociology, psychology, political science, economics, linguistics, geography, paleontology and biology. Over the years, the discipline has prepared its academic grounding and defined the subject matters, developed the theoretical perspectives and methodologies. The emphasis and focus of the discipline may vary significantly in different parts of the world (Alam, 2006).

Over the globe, anthropology was inconsistent in terms of its subject matters, focus, theoretical perspectives, scope and area of specialization as well as difference in opinions as to what the discipline should be. No common ground for discussion was constructed in the earlier days. Primitive culture, savage, tribes, lineages, clans, under developed society etc., were subjects of interest for many of the early anthropologists. However, social anthropology has to a large extent developed independently in England and gradually institutionalized in Europe and America. Still the contemporary phase of anthropology is fragile, tentative, often arbitrary and vulnerable to and expanded to many changes, shifts, divergences and discontinuities (Jalal, 2006). But Alam argues that though anthropological discourages until recently are out come of the study of other culture, social and economic systems and acculturation in a niche of unequal relationship often characterized as the ruler and the ruled and also the dominant and dominated societies,

the discipline has achieved certain uniqueness of approach of studying and viewing life, the world, the people and the societies. In the recent years since early 1960s, the discipline has been undergoing sea of changes and it is currently expanding its boundary and adapting to the changes by incorporating various issues within its domain of teaching and research in a critical and dynamic way (ibid). According to Whilte (1967) the conventional definition of anthropology is that it is the "science of man" but obviously no single worker can perform the grandiose undertaking of studying mankind in its entirety. The study of man must be carried out by a number of specialists acting in concert and combining to pool their conclusions...like so many modern sciences, anthropology is the melting pot: its horizons have grown wide but also cloudy. White categories the broad areas of anthropology into four sub-fields: physical anthropology; cultural anthropology; social anthropology and applied anthropology.

The broad range of anthropological interest has led to specialization within the field. The main areas of the study within the discipline are: cultural anthropology, physical anthropology and archaeological anthropology. Keesing and Keesing (1968) have shown two major divisions of anthropology with a number of sub-fields. The two major fields are: physical anthropology and cultural anthropology. Cultural anthropology has been again subdivided into: pre-historic archaeology, anthropological linguistics, ethnology and social anthropology. Many anthropologists worked covering the issues under cultural anthropology, which studies learnt human behavior, rather than genetic behavior that is typical of a particular human group. Cultural anthropologists attempt to understand culture in its general sense studying its origins, development and diversity as it changes through time and spaces among people. Cultural ecology or ecological anthropology has been again a subfield of anthropology, which studies the complex relationships of human beings with the nature and environment as well the dynamics of society and environment.

Ecological anthropology studies the interrelationships of between natural and human systems in the local cultural context. It is particularly relevant to contemporary concerns with the state of the general environment. Anthropological knowledge has the potential to inform and instruct people about how to construct sustainable way of life. It also studies how local people's customs, values, behavior, practices, traditional knowledge and various institutions determine to engage people in environment management and conservation of nature. Ecological anthropology also tries to explore how people adapt with the change in nature and ecosystems as well as gain their livelihoods by utilizing their knowledge and technology in the dynamic social system.

Changing Focus of Anthropology

Anthropology, though a young science in research and academic practices, has experienced significant changes in its focus and approaches of study. Islam and Shafie (2006), in their recent article, examine the changing premises of anthropology and its approaches to study the contemporary issues in an increasingly globalized world. They also explore the "*Roots and various Routes*" of the discipline. To them, anthropology today is much concerned about the ideological representations of rootedness as these are on the move following diverse routes. The premise of classical anthropology have

developed transnational and post-colonial perspectives to look at globalization within evolutionary frame of reference that we are local but we are also global. For instance, the discrete cultures were geographically bounded and localized before, but now in the global age it started flowing around the world. Referring to Hannerz, they feel that culture today flows across the world, filtered through states, market, movement and everyday life. Globalization as pervasive process is dismantling our old categories of places, locality, culture and society; and it has transformed the contemporary world reflecting hybridity, translocality, movement and rhizomes (Islam and Shafie, 2006). To them, the investigation of anthropology started as an extension of natural history and gradually many anthropologists were engaged in the study of so-called primitive man of savage culture and society. Of the late, its subject matters focus on the comparative study of human life world. Anthropological investigation intends to explain human behavior and the context in which the behavior of people is embedded.

Thus the discipline as an articulated system of knowledge explores – how people through their collective and separate activities reproduce and modify the realities of their past and present lives. The methodological virtue of anthropological fieldwork is that it gives us an opportunity to transcend received theories, knowledge and wisdom and allow us to learn from the valid sources i.e., people speaking and acting in living society. Thus anthropology appears to be the discipline to explain to us - how did we get here and where are we now and what are the possible routes to move forward? Anthropologists may be uniquely positioned to speak with knowledge and insight gained through empiricism, rationalism and humanism. An anthropological lens may focus on human society and culture historically and cross-culturally. Anthropology studies diversity in society and culture as well as unity in diversity (i.e., the patterns of regularities and order; divergences and convergences in social process) to understand and facilitate the social transformation towards development.

The major anthropological schools of thoughts that got distinctions include: evolution school; historical particularism; functionalism, structural functionalism; comparative analysis school and cultural relativity. It is viewed that American anthropology contributed to more on cultural anthropological tradition, while European anthropology contributed to the development of methods and research in social anthropology. Levi – Strauss, a French anthropologist contributed to the structural functionalism while Lesli White another prominent anthropologist contributed to the new evolutionism paradigm of anthropology and puts more emphasis on cultural-materialistic perspectives in the context of social, political and technological changes.

The foundation of anthropology in South Asia has been laid by ethnographic report of colonial power. Beteille and Revers contributed to the development of Indian Anthropology in the middle of the last century. Fieldwork using participant observation has been one of the centerpieces of anthropological studies here. Village studies, kinship and caste system were the main focuses of anthropological studies in South Asia and Bangladesh and those studies fall mainly under social and cultural tradition of anthropological investigation.

Anthropology as a social science is rooted in empiricism. Investigations of anthropology are based on participatory and systematic methods. Anthropologists gain practical experiences with particular people through participating in fieldwork. For an anthropologist fieldwork is a kind of vision quest and it is not only sources of information but also core experience of a researcher. An anthropologist in the field, though he may be concerned with methodological rigor, is in an intense situation, where all his insight (i.e., deeper understanding and thorough analysis), intuition (capacity of assumption with accuracy) and empathy (understanding of others concerns from their perspectives and expression) must be brought to bear. Anthropological investigation is particular to some society and issues at micro-level, which considers it's past and present. It is empirical and functional in nature to find pragmatic solutions to particular problems. Thus anthropology is regarded as a wholistic study of society and mankind and the very approach and method of anthropology has set it apart from other social and behavioral sciences. It gives us a broad view of time, places and circumstances. It brings into focus the long-range workings of human society and it projects in their broadest perspective, the possibilities of man. It is in search of man's future as well as the past that we turn to anthropology today. Anthropology takes both a comparative and wholistic approach and examines the bio-physical, social and cultural aspects of mankind. This makes anthropology in some respects a synthesizing field of knowledge and provides a total and composite view of mankind (Berreman et al, 1987, Keesing and Keesing, 1968). It studies diversity in the society, culture and human behavior and at the same time tries to understand the unity and harmony in diversity of the society.

Anthropology looks at the variations, diversity and covariance between elements. The anthropologists try to discover connections and unity in a social system and allow pluralism in approach and issues in study. One should learn from each other and allow other to think and explain differently. At the same time, one should not be too narrow and too broad in taking issues and approach of studying rather s/he should have specificity and focus on some areas with connectivity that could be explained under any thought frame. Hence, modern anthropological investigation takes place multiple approaches combining both qualitative and quantitative information for understanding contemporary world.

2.2 The Contribution of major Classical Anthropologists

This section briefly deals with the lives and careers of the early and classical anthropologists and gives a synthesis of the contributions of the classical anthropologists to the development of anthropological approaches and thoughts. Henry Schoolcraft, H Morgan, EB Tylor, James Frazer, B. Malinowski, Radcliffe Brown and Franz Boas are treated as major classical anthropologists, who made great contribution to the development of methods for anthropological studies. They are the prominent personalities in anthropology, who founded the discipline and developed its approach and scope of studies with diversity of issues. Their works, concepts, methods and contribution have led the development of anthropology as a new discipline in the 19th and early 20th

centuries. Their works and approaches have demonstrated both the unity and diversity of issues covering all the social, economic, cultural, historical, ethnological and ecological aspects of human societies (Rahman, 1989). The works of Levi Strauss, Marvine Harris also have contributed significantly to the development of anthropology in the 20th century. The following sections give brief reflection on the works and approach of the key personalities of the classical anthropologists.

a. Applied Anthropological Approach: Henry Schoolcraft (1793-1864) has been known as the first American Social Anthropologist. He worked very closely with American Indian and generally developed an immense interest in knowing the Indian people, their lives and culture, which subsequently made him first American social anthropologist and first genuine field anthropologist in the world. Schoolcraft learnt the native language carefully and stayed with the Indian Community for about 20 years and conducted field research. A few modern anthropologists have conducted fieldwork for such long period. Schoolcraft not only recorded the facts of socio-cultural life of Indians but also discovered the problems of the local people (without any formal training in such discipline) and fought for Indian people, which made him not only an applied anthropologist but also a social worker. Schoolcraft also worked on totemism and clan organization, magical beliefs and practices by Indians, their rituals and taboos.

b. Social Anthropological Approach: Lewis Henry Morgan (1818-1881) is said to be the farther of American anthropology, who did a lot to shape the growth of anthropology. He was influenced by the thoughts and works of Karl Marx and Frederic Engles, particularly by their materialist conception of history. This was reflected in Morgan's Ancient Society. Again Marx and Engle appraised Morgan's treatment of primitive communism and technological determinism in interpreting social transformation. According to Morgan, human progress passed from savagery to civilization through barbarism. He suggests each of period has a distinct culture and exhibits a mode of life more or less special and particular to itself. However, many historians and social anthropologist did not accept Morgan's periodization of history and unilateral evolutionary idea of social development. However, in social science tradition, Morgan is also known as Darwin of social anthropology.

Morgan was born in a village of New York on 21 November 1818. He took his graduate degree from the Union College and studied law. He took the career of legal practice in 1844. He married in 1851 and settled in Rochester in New York where he soon became associated with enlightened circle. He was interested in public matters and thus was able to serve once in New York State Assembly and once in the Senate. The Ancient Society of Morgan is his master price and widely discussed book. His other anthropological works include: Systems of Consanguinity and Affinity of Human Family (1870), Houses and Life of the American Aborigines (1881). The Ancient Society was first published in 1877. He was deeply influenced by Schoolcraft, who is treated as the first American social anthropologist. Morgan joined the young men's club, which was transformed into an Indian Society. The society was interested in studying the Indians. Morgan and a few of his society members took it seriously. He was interested to prove the Asiatic origin of

the American Indians through the comparative study of classificatory kin terms of Indian and Tamils of South India.

Morgan studied kinship. His theory of kinship was, in fact, a technique of studying the forms of marriage, family, property and other related social organizations. To Morgan, social relationships are of two kinds based on consanguinity (blood relation) and by affinity or by marriage. Morgan's treatment of kinship organization still deserves attention of most of the modern anthropologists. Morgan also talked about the transformation of kinship-based society to territorial organization. According to Morgan, through this transformation there appeared the "growth of the idea of government in human mind". Morgan thought that the human history could be divided into two broad categories such as ancient or primitive society and modern or civil society. In primitive society, a person's status and roles in social life were determined by his personal relationship to other members of the society. A person's role and position are largely determined and regulated by ties of kinship and personal ties. But status of person in Civitas is determined by his place of residence, dame, township, state and by his relationship to property. Hence, Morgan is regarded as one of the founding fathers of social anthropology.

c. Cultural Anthropological Approach: If Morgan is treated, as farther of American anthropology, then EB Tylor should be regarded as the founder of British cultural anthropology. He emphasized on the study of human culture instead of physical evolution. Tylor, the most eminent British anthropologist was born on 2 October in 1832. Tylor did not receive formal education from any university but he occupied many important positions at the University of Oxford. He had a critical mind and a systematic approach to look at society and people. He was a devoted academician. He became Fellow of the Royal Society. The University of Oxford conferred on him the degree of Doctor of Civil Laws in 1875.

Tylor's visit to America and his archaeological expedition to Mexico played a vital role in shaping his mode of thinking and career of life. He was greatly influenced by the thinking and works of Spencer and Darwin. Tylor worked at a time when anthropology was taking a shape of a scientific discipline dealing with man and his culture. In that formative stage, there was a great need of defining the subjects and its concepts. Tylor worked on defining the concept, scope and approach anthropology. He also worked on culture and religion. His definitions of anthropology, culture and religion are widely quoted.

According to Tylor, social anthropology is history and something more than that. He made the first attempt to define the field of investigation of anthropology. Tylor thought that anthropology could be the mirror of society and it should reflect the contemporary society and culture. He also felt, "Anthropology by revealing the impulses behind folk ways, provided a critical apparatus for testing the validity of contemporary behavior". Tylor also mentioned the scope of the area of anthropology, which should cover the study of men's body and soul as well as his physical and cultural environment. Tylor gave a very comprehensive definition of culture, which is very appropriate in the context of

anthropological investigation. According to Tylor, culture is a complex whole, which includes knowledge, belief, art, morals, law, custom and any other capabilities and habits acquired by man as a member of society. Tylor gave a short but very meaningful definition of religion. His definition of religion, "the belief in spiritual being" is widely quoted, because the belief in supernatural entity is almost universal. His voice was strong enough to advocate the psycho-physical unity of all mankind.

d. Historical and Cultural Approach: Sir James Frazer had undertook a bit different approach to study human society and cultural. He was born at Glasgow, Scotland in January 1854. He had interest in classical literature and philosophy. He also studied law. Frazer is known as an arm-chair anthropologist since he did not make any field work for his investigation and studies in anthropology. But he was a very good library researcher and he spent most of his time in library to collect materials for his masterpiece writings such as "Golden Bough", "Totemism and Exogamy", "The Belief in Immortality and the Worship of the Dead", "The Worship of Nature and the Folklore in the Old Testament".

The book "Primitive Culture" of Tylor influenced Frazer significantly and it stimulated Frazer's interest in anthropology. Frazer was invited by his friend Robertson Smith to write articles on totem and Taboo for the Encyclopedia Britannia. This was an opportunity for him to contribute to anthropological study. His articles on "Taboo and Totemism" for the Encyclopedia Britannia were published in 1888, where he explains the social origin of taboo and totem and tries to prove that taboo played a key role in formulating modern laws and morality.

The "Golden Bough" was published in 1900 in three volumes. He made efforts to explain the long evolution by which the thoughts of human kind have passed through successive stages of magic, religion and science. The work is treated as an epic of humanity, which started from magic and attained to the stage of science in its mature stage. Frazer assumes that human thought will meet its death at this scientific stage. Frazer emphasized much on myths, stories, belief and ideas of primitive people than on their ordinary life, and one of the criticisms against Frazer is that he covered a wide range of anthropological and quasi-anthropological topics and sub-topics on the basis of library work (which is not a true anthropological approach) and many of his works generated speculations, which are perhaps not true facts.

Frazer's "Totemism and Exogamy" was published in 1910 and the main argument in it was that after totem had become hereditary, exogamy developed as a means for preventing in breeding. The "Worship of Nature" of Frazer was published in 1926. He puts forward the thought that religion is based on the human personification of nature. Ideas expressed by Frazer in his "Worship of Nature" are getting greater familiarity in the today's world. He became an esteemed Fellow of the British Royal Academy in 1914.

e. School of Functionalism: B. Malinowski is known as a prominent personality of the functionalist school. He was born in Cracow, Poland in 1884. Malinowski entered the University at Cracow and received his Ph.D. degree in physics and mathematics. He began to develop a career in physical science, but suddenly he got sick and during his

knowledge of the native civilization so that the whites may establish good harmonious relation. In 1937, Brown was appointed to the first established chair in social anthropology at Oxford. Here, he argued and made a distinction between historical and sociological studies and claimed that sociological studies are more important in anthropology. Brown expected that one should make intensive studies of single culture observing the data, formulating hypothesis and testing those by further fieldwork and direct observation. Brown also says that a social anthropologist gains data by observing the magnitudes of actions and interactions occurring between individuals and groups in a social system. The actions and interactions form an integral whole and none could be understood in isolation from others. Brown emphasized on comparative method to explore institutions of present day societies in terms of their similarities and dissimilarities in structures and functions.

According to Brown, the structure of an organism consists of the ordered arrangements of its parts and the function of the parts is to inter-relate the structure of an organism. Thus social function is the interconnection between the social structure and social life. Brown and his followers are known as "Structural functionalists", mainly to distinguish them from functionalism of Malinowski. Brown says that social systems are made up of normatively guided social relationships through which members of a society occupy particular statuses, pursue diverse interests and express values and sentiments. For a social system to exist, members must in some measure share moral, aesthetic and economic interests or values. At any given time, a social system reveals both organization and structure. Brown shows how norms and rituals contribute to structural continuity and social solidarity. Brown brought new current in anthropological thought, having powerful effect on British and American anthropology.

Table-1: Brief Life sketches and the Key Contributions of the Classical Anthropologists

Names, Lifetime and places of work	Major Contributions
Henry Schoolcraft was born in America in 1793 and he died in 1864. He is known as the first American social and applied anthropologist	He worked very closely with American India and developed an immense interest in knowing the Indian peoples and cultures by undertaking long empirical and applied field research, which subsequently made him first American social and applied anthropologist. Schoolcraft worked on Totemism, clan organization, magical beliefs and practices, rituals and taboos of Indians.
Lewis H Morgan (1818-1881), was born in a village near New York city in America, is regarded as the farther of American anthropology	Morgan did a lot to shape the growth of anthropology. He studied kinship, forms of marriage, family, property and social organizations. To Morgan, social relationships are of two kinds based on consanguinity (blood relation) and by affinity or by marriage. Morgan's treatment of kinship organization deserves attention of most of the modern anthropologists. Morgan is also known as social Darwin. The materialistic concept of history was depicted in his Ancient Society.
EB Tylor (1832-1917) was born in Britain and he is regarded as the foundered of British cultural anthropology	Tylor emphasized on the study of human culture instead of physical evolution. Though he did not receive formal education from any university but he occupied many important positions at the University of Oxford. He had a critical mind and a systematic approach to look at society and people. Tylor defined anthropology and its scope, religion and culture.
Sir James Frazer (1854-1941) was born in Scotland, but he studied	Frazer did not make any fieldwork for his studies in anthropology and he is known as armchair anthropologist. He was a very good library researcher and he spent most of his time in library to collect materials for his

and worked mainly in UK	masterpiece writings such as Golden Bough, Totemism and Exogamy, the Worship of Nature and the Folklore in the Old Testament
B Malinowski (1884-1942) was born in Poland, but he spent most of his research and academic time in UK, Australia and USA	Malinowski contributed to methods of anthropology as well as theory of functionalism. His views on family, culture and kinship are very important. His major works are: The Family Among the Australian Aborigines (1913); Crime and Custom in Savage Societies (1926); The Sexual Life of Savages in Northwestern Malaysian (1929); Sex and Repression in Savage Society (1927); A Scientific Theory of Culture and Other Essays (1944).
Radcliffe–Brown (1818-1955) was born in England, but he also worked in Australia, South Africa and USA. He conducted field research in Andaman Islands in 1906-1908	Brown is known as structural functionalist. To him, the structure of an organism consists of the ordered arrangements of its parts and the function of the parts is to inter-relate the structure of an organism. Thus social function is the interconnection between the social structure and social life. The actions and interactions form an integral whole and none could be understood in isolation. Brown emphasizes on comparative method to explore institutions in terms of their similarity and dissimilarities in structures and functions.
Franz Boas (1858 –1942) was born in Germany, but he spent much of his time in America for teaching and studying	Boas stood for radical linguistic and cultural relativity, which placed him among the most modern anthropologists. He had a long experience of field research and collected much ethnographic data and recorded the real experience of his fieldwork. To Boas, race is a physical phenomenon and it is an inherited biological feature, not related to culture, which is learned. To him, culture itself is enough to account for difference in behavior and there is no basis to judge one culture or race superior to another culture or race.

Sources: White, 1967 and Rahman 1989

g. Cultural Relativity: Franz Boas had a different outlook to examine the human society and it culture. He was born in Germany in 1858. He was specialized in physics and mathematics first, then he was interested in physical and cultural geography. In 1883, Boas began his anthropological career with a trip to Baffinland, a crucial experience for him and for anthropology. He wrote his doctoral dissertation on the color of seawater in 1881. It is viewed that during his first expedition, he discovered that the Eskimo had a different set of color categories. Boas wrote, "I had seen that they enjoyed life and hard life we do; that nature is beautiful to them; that feelings of friendship also root in the Eskimo hearts ... based on human nature, like ours".

Boas went to Baffin land primarily as a geographer, looking for the effect of culture of set of people on their physical environment, but gradually he become more interested about the importance of social tradition as a determinant of culture and personality. His realization of power and impact of social tradition in shaping human lives turned his interests from geography to ethnology and marked the beginning of his career as an anthropologist.

Boas spent much of his time in America, where he held many key positions in different universities and scientific societies. Boas is known as a famous American anthropologist and a great teacher who trained many anthropologists. Few of them are Alfred Krober, Alexander Golden Wiser, Robert Lowie, Paul Radin, Edward Sapir, Margaret Mead, Ruth Benedict and E. Adamson. Boas was President of the New York Academy of Science (1910) and President of the American Association for the Advancement of Science (1931). Boas founded the American Folklore Society and revitalized the

American Ethnological Society in 1900. Boas contributed to more than six hundred research articles in professional and scientific journals, but he wrote comparatively few books. His great book, "The Mind of Primitive Man" appeared in 1911. He wrote another book named "Primitive Art" in 1927, which was followed by his "Anthropology and Modern Life" in 1928. The "General Anthropology" and a revised edition of the "Primitive Man" of Boas appeared in 1938. The selected important papers of Boas were published in 1940 under the caption of "Race, Language and Culture".

Boas stood for radical linguistic and cultural relativity, which placed him among the most modern anthropologists. He had a long experience of field research and thus collected much ethnographic data and recorded the real experience of his fieldwork. Boas attempted to discover the relationship of physical and cultural development. According to Boas, race is a physical phenomenon and it is an inherited biological feature, not related to culture, which is learned. To him, culture itself is enough to account for difference in behavior and there is no basis to judge one culture or race superior to another culture or race. The thoughts and ideas of Boas about human society changed over his lifetime. We see him first to stand for evolutionism and look for general law of evolution. He then gave up his ideas of evolution and stood for historical particularism. Finally, he sees individualism as both an effect and cause of social change. He begins to notice the influence of culture on human personality and also suggests that individuals respond to culture in different ways.

Boas changed his mind because he thought social psychological phenomena and social reality are so complicated and diversified that alternative theoretical ideas may be developed on any society at any given time. There is always difference between an ideal type (theoretical framework) and the social reality. Thus, Boas was dynamic in his thoughts and he did accept the reality even when it went against his own ideas. The previous sections on the various approaches of anthropology have been developed mainly based on the works of White (1967) and Rahman (1989).

2.3 Importance of Anthropological Approaches to the Studies of Indigenous Knowledge and Sustainable Development

The main feature of anthropological approach is holistic, empirical and participatory. Very often anthropological studies are conducted at micro-level. Participant observation has a key position in anthropological investigation. It is treated as an important corner stone of anthropological fieldwork. In participant observation, the researchers directly participate in fieldwork and became part in a different society and culture. The researcher becomes a participant in the context being observed. So, it is not merely a tool of data collection from the field, rather a process of action and reflection. Many anthropological investigations use systematic and participatory observation instead of participant observation. In systematic participatory observation, researcher tries to observe closely certain things, specific situation, issues or behavior of people rather than trying to immerse in the whole context. Hence, systematic and participatory observation has many relative advantages and scientific rigor than that of participant observation.

Farrington and Martin (1986) have focused on concerns of current anthropology and tried to find links with the participatory approach to development, where local knowledge is an integral part of planning and implementation. This is an emerging area of expertise, in the process of establishing a place for itself within development practice. It has recently become popular beyond anthropology to point out that indigenous peoples have their own effective 'science' and resource use practices and that to assist them we need to understand something about their knowledge and management systems. There is a growing acknowledgement that effective development assistance benefits from some understanding of local knowledge and practices, as some anthropologists have argued for decades.

Many researchers, academics and development thinkers have emphasized on usefulness and importance of anthropological approaches and methods for local development planning, sectoral development, livelihoods and the studies, which focuses on IK. Sillitoe (2001) in his article discusses the emerging shift in development praxis in details and urges the anthropologists to take of the new opportunities and challenges of using their professional skills to facilitate integration of local knowledge in development process. He elaborates saying that the indigenous knowledge approach has emerged over the last decade with these paradigmatic shifts which, paying more attention to 'grassroots' perspectives, not only afford anthropology a chance to become meaningfully involved in development, but also recommend it as the intellectual home of participatory development, affording it disciplinary pedigree and coherence. This relates to the need to draw together the academic and development strands that have contributed in varying extents to local knowledge research to build on their combined strengths to further development and modifying established practices.

Local knowledge research sets out explicitly to make connections between other peoples' understandings and practices and those of scientific researchers and development workers, notably in the natural resources sector (ibid). By furthering our understanding of agricultural, forestry and fishing regimes, it aims to contribute in the long term to gainful development and positive change, promoting culturally appropriate and environmentally sustainable adaptations acceptable to people as they increasingly commercially exploit their natural resources. It has grown rapidly since with a proliferation of conferences, symposia, edited volumes and technical reports, and the establishment of an international network with a quarterly newsletter. A deal of this work has recently appeared under the auspices of the Intermediate Technology Movement and bears the stamp of its robust concern for addressing practical issues in appropriate contexts, technically, culturally and environmentally. It is difficult as a consequence to define the intellectual stance of local knowledge studies, which are currently very heterogeneous in their approaches, reflecting a healthy interest in any academic paradigm if relevant to enquiries and pertinent to developmental problems in any region, although the majority has affinity to ethnographic accounts of production systems. The result is that local knowledge research currently lacks paradigmatic or methodological coherence, indeed it is caught in a battle of perspectives as practitioners tussle in arguments characterized as right versus left, natural versus social science, hard versus soft systems and so on.

Now a days, many anthropologists study the contemporary social and economic issues of present day society, which are very complex and these deserve multiplicity in approaches, methods and analysis. Anthropologists like other social scientists should have an open mind and adaptive attitudes (should not be guided by any dogma) while selecting topics of study and approaches for investigation. In fact, there have been many significant shifts in topics, paradigms, methods and approaches in anthropological investigation in the recent time. The tradition and local practices, which were often regarded as the opposite of and even obstacle to modernization, may become a crucial part of the true development process. Much of the new and emerging development thinking considers development being achieved through traditional institutions. Thus, the development planning must be empirically grounded to the people at the grassroots and this has been termed as "development from below". There should be a more realistic appreciation of village life world and it can provide us with useful perspective and point of departure. Anthropological approach has much to offer to the understanding of rural social life and the needs and priorities of common people (Bernard.1994; White, 1967).

Choudhury (2000) in his recent article discusses the shift in development research and proposes an alternative paradigm, which is distinctively anthropological to capture the potentials of local community to find effective links with development efforts. He stresses that in order to have development and to have people understand how development is to be applied in their particular case, development actors need to communicate with the people for whom the efforts are being made. There is a serious need to take into account the accumulated knowledge, traditional skills and technologies of people whom they work.... we see indigenous knowledge as complementary to conventional sciences, which has been proved to be inadequate for solving the problems of rural development. The point of development anthropology today centers round the basic issue that each culture has its own internal dynamics that can be developed from within accordance with its indigenous tradition and values. Unlike other social science, anthropology goes beyond the realm of material development; it incorporates enrichment of culture too. True development process should follow democratic norms and it should consider community needs and enthusiasm more importantly than the mechanism of development. Building of a democratic and participatory society requires freedom as an essential condition to develop the capacity to organize itself. Local autonomy, self-reliance and social effective participation at the local level are inalienable parts of that freedom and development process.

In promoting sustainable local development, anthropology can make important contribution in development planning using the wholistic and participatory approaches with their insight (deep understanding and thorough analysis), intuition (capacity of assumption with accuracy) and empathy (quality of understanding others concerns from their perspectives and expression) and exploring the local and indigenous knowledge systems. Chambers from early 1980s argues: we seek to reverse the pattern of development. The thrust of our argument is that development from below is more productive approach than that from above, and an essential ingredient is indigenous knowledge. Cognitive anthropology stresses upon eliciting indigenous knowledge as a

base for development planning (Chambers, 1983). Further, Mazzucato from African experiences focuses on cognitive approaches. He suggests to bridging gap between economics and anthropology, where cognitive approach can be a great help. To him, there is a fundamental difference in the way anthropologists and economists analyze indigenous economics. Anthropologists see the indigenous economy as part of a wider meaning system. It is this meaning system that gives value to transacted goods, a value that may encompass religious, social and political spheres. Thus while the economy can be defined in terms of the production, distribution and consumption of material goods, anthropologists do not limit their analysis to the material sphere, but rather analyze non-material aspects that give material goods, transactions and networks their meaning. He further says that anthropologists study indigenous economies by analyzing people's economic reasoning, their notions of wealth, labour, and capital, and their view of how these can best be managed, invested and presented, in other words, their processes of decision making. Using the ethnographic approach, they formulate the cultural logic behind decisions, identifying the factors most relevant to decision making for the people under study (Mozzucato, 1997).

But historically, anthropological research has been largely descriptive in nature, some of the more recent studies have quantified certain aspects of these indigenous economies. Many anthropologists draw out local and indigenous criteria through cognitive anthropology, which is the study of people's perceptions of their surroundings as reflecting in their use of language. This type of analysis can be taken one step further by examining local classifications of such economics terms as benefits, costs, insurance, interest, security and risk, in order to determine whether these are locally meaningful concepts. We must employ methods, which are more socially relevant, and it is now time to look at indigenous economies through indigenously defined criteria. The anthropologists have vast experiences to identify local criteria and the methods and tools relevant to local situation.

Sillitoe (2001), in his article published in the *Grassroots Voice*, called upon the anthropologists to facilitate greater uses of local knowledge in development. He says that time has come for anthropology to consolidate its place in development practice, not merely as frustrated post-intervention critic but as implementing partner. There are growing demands for the skills and insights of anthropologists. The development fraternity has been casting around over several yeas for alternative approaches with mounting evidence of resources wasted in ill-conceived, frequently centrally imposed schemes that have not only failed to improve matters in lesser developed countries but have on occasion made them worse. While some anthropologists are abreast of these changes, engaging in development related work (many of them as they seek to build careers outside resource starved academia), the discipline has yet fully to acknowledge and act on them.

Hence, anthropology needs to foster the potential of the end relationship emerging with development, building on its applied anthropological tradition, according to some priority and giving disciplinary creditability to this work. There is a need for mutual professional support, guidelines for practice, contributions to new and appropriate methodologies,

institutional capacity building and assistance networks, and so on. He further adds that the discipline needs to turn from over interest with social philosophy, literary criticism and so on to engage more with development problems, or face further probable diminution in the current political and economic climate, evidenced in the current upsurge and hand-wringing literature on the discipline's future.

Anthropologist needs to pay its attention on how to integrate local knowledge in development, or else others will supplant it in development contexts. There is evidence that many are ready to do so; agricultural economists and human geographers, even foresters and plant pathologists are stealing our disciplinary clothes and wearing them to less effect. This is unfortunate for both anthropology and agricultural development. There is a danger that others might sell the discipline short, using its intellectual capital in attempts to further their work, as evidenced in practices like Rapid Rural Appraisal (RRA) and Participatory Rural Appraisal (PRA). The problems encountered in trying to understand something about others' socio-cultural traditions is considerable and not to be glossed over in glib methodologies (ibid).

Weizenfeld (1998), in an article (published in the Indigenous Knowledge and Development Monitor, a journal of Nuffic-CIRAN), focuses on the importance of anthropological approach to local and indigenous knowledge study. She feels that all knowledge potentially passes into local pool, is blended with what is already known and then informs today's understanding and practice. Rural people's understanding of natural resources management issues is a blend of knowledge from various sources, which is sometime difficult to disentangle. There is a continuum between local and external knowledge...we must reconcile indigenous knowledge, which is wide and holistic and encompasses systematic understanding with scientific knowledge. Referring to the experiences of Regional Program for Promotion of Indigenous Knowledge in Asia (Reppika) at the IIRR in Philippines, Weizenfeld suggests to use IK as one of the widest means in contemporary development discourses and feels that IK research equates largely with anthropological research (IKDM, 6/3, 1998).

Participant Observation – A key basis for Anthropological Study

Fieldwork is a very important part in almost every social science research, while fieldwork trough participatory observation is a key basis of anthropological investigation. Participant observation gives a distinct feature to the discipline. In empirical research, anthropologists collect primary information about society, population, their behavior, activities and cultural practices directly from field. However, the topics of investigation, its background and theoretical framework determine what would be the tools for data collection and the level of participation in the fieldwork. The main sources and techniques of information for anthropological investigation are: observation of people's activities and behavior, taking notes of people's talking and exchange and reviewing documents and historical elements. Freilich M (1986) describes various experiences of fieldwork undertaken by a number of anthropologists in his book on " Marginal Natives – Anthropologists at Fieldwork" and has focused on the challenges of different types of

participatory research with an outlined of the basic features of good and meaningful fieldwork in anthropological investigations.

According to Freilich, although anthropologists use a number of methods for field data collection, the basic methods associated with fieldwork is participant observation, which means observing the behavior of a group of people while participating in the community life. Anthropologists try to attempt to become part of the culture he is studying...at the one extreme, he may go native, in which case his speech, dress, eating, interactions, social relations and personal identification all began to approximate community norms. At the other end of the role-playing continuum, he may become a privileged stranger, a stranger with rights to live for a period in the community to question community members extensively and to record what is observed and heard. More often, the role of an anthropologists is somewhere in between native and privileged stranger. Irrespective of what role he plays, the anthropologist remains a marginal man in the community, an outsider. No matter how skilled he is in native tongue, how nimble in handling strange social relationship.., the anthropologist rarely deludes himself into thinking that many community members really regard him as one of them.

Despite, this problem (marginal position in the society), anthropologists can achieve success in gathering reliable and useful information and gain community insight through good rapport building, hard work and creative thinking. A good field researcher needs sincerity of purpose, sensitivity but emotional maturity, strong mental ability and critical thinking, adaptability, friendliness, honesty and readiness to take all physical and psychological discomforts and hardship. He should be efficient in using time and resources while doing fieldwork. Freilich also mentions that in active phase of fieldwork, the researchers review their basic ideas, thought-frame, the goals and the purpose of the study. Further, at this stage analytical and creative power is employed to mach the field data with the theory for necessary modification in the thought-frame feedbacks from the peers and guides.

2.4 Anthropological Studies in Bangladesh

Anthropology as both academic pursuit and practical research practice has been very new in Bangladesh. Few public universities including Dhaka, Jahangirnagar, Chittagong, and Rajshahi universities have started teaching of anthropology in the last century. Clade Lev - Strauss, Pierre Bessaignet, Hans E Kauffmann and LG Loffler made important initial contributions to anthropological studies in Bangladesh in the second half of the last century. They studied kinship, culture and social systems of the ethnic people in Bangladesh. Few Bangladeshi academics and researchers also conducted limited villages studies focusing on family, culture and traditional organizations by using anthropological approach. Mukherjee, Chowdhury, Arefeen, Hassan, Islam and Alam are pioneers among the Bangladeshi anthropologists. Arens J and Burden Van conducted an excellent study using some anthropological tools in late 1970s and published their findings on rural lives, class and gender relations in a book called "Jhagrapur". They stayed in the study villages and observed various social phenomena very closely for getting insight from the people.

Chowdhury conducted a village study focusing on social stratification of Meherpur village in Dhaka district in 1970s. He examines the social stratification from three dimensions i.e., class, status and power in the rural social setting. Chowdhury during his field study stayed in the village and tried to understand the class composition, social stratification and power relation (which gave important basis for class formation) by taking primary information and perceptions from various categories of people in the traditional village (Chowdhury, 1978). Schmuck Widmann Hanna examines the indigenous and modern engineering knowledge in river training and flood control in Bangladesh. She also shows that how the two groups of people perceive flood and erosion and how do they predict differently and develop strategies for coping as well as management of flood and erosion in Jamuna river. Hanna made intensive fieldwork in the *Charland* village and attempted to find analogy between char-dwellers and engineers from anthropological point of view. She also suggests that indigenous and engineering knowledge could be combined for environment-friendly, cost-effective and sustainable options for river erosion management.

Still, research by using anthropological approaches and methods in the country has been very few in number. Sadeque (1992) in his paper critically analyzed the role of rural sociologists and anthropologists in Bangladesh and pointed out on their limited contribution to agriculture and natural resources development in Bangladesh. According to him, until recently, anthropology and sociology have not been active partners in the process of agricultural research and development. The involvement of social scientists in the development process is largely because of a growing concern among biological scientists and administrators to become socially informed. There is recognition that, too often agricultural research and development has failed or did not fulfill its potential objectives because it was socially uniformed and ill conceived. This realization, by default, has led to increasing attention on identifying socio-cultural variables in project design. In turn this has resulted in the recruitment of social scientists in research and project teams to make use of the applied potentials of social science. This newfound recognition of the uses of anthropology and rural sociology in terms of their place in the multidisciplinary research and development programme has gained much importance very recently.

Sadeque also points out that social scientists such as anthropologists and sociologists can analyze the local social organization, power relations, social class and gender issues that are relevant for the given community and a nation. Agricultural research and development, as viewed by social scientists, is more than a science of developing miracle varieties. To them it is also a critical art that raises awkward questions like what is happening to distributive justice? What are the share and entitlement of people in the increased pie? Thus, it is important that they investigate the political economy of the technologies in use and the ones to be transferred from the laboratory to the field. Anthropologists and rural sociologists can contribute much in extending the social applicability and desirability of experimental knowledge. They can further put bio-technical knowledge to test in terms of social implications and help weigh options for viable and sustainable agricultural technologies. This would constitute the basis and

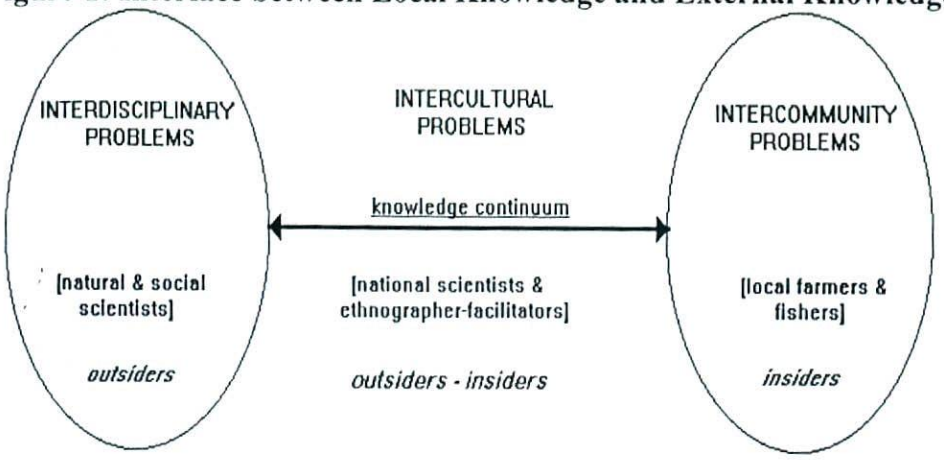
boundaries of the context of social analysis. In terms of research problems, these would include the techniques of approaching and mobilizing people. Under what conditions would they participate and what mechanisms would ensure maximum participation and distribution of benefits? What and how is the social organization in the community? What is the nature of the kinship, political and hierarchical linkage? What are the social class positions of the people in the community and the structural composition of the target group population? What is the gender-composition of the target group? Data and analyses of these and other similar research questions will provide the basis of the social analysis. Only a thorough analysis of the social context can provide the understanding necessary for a promising research and development programme.

On the basis of this understanding of the social context in Bangladesh, social scientists can provide valuable inputs in research design as well as at the experimental and implementation stage...participatory process is another key concept, which defines people's role as an individual and their role-playing within a group. Social scientists study and analyze this process to suggest participatory methods of involving intended beneficiaries with project activities, management and functioning. Class-gender issue is another important concept of social science approach and social scientists dealing with these key concepts can therefore help in design and implementation of development projects and programmes that duly reflect these important considerations. He also feels that farming systems research should be interesting to sociologists and anthropologists, because it provides a challenging opportunity for them to apply their knowledge in solving contemporary agricultural problems that are real in the field and on the farm... Another role they can play in sensitizing other team members to socio-economic considerations. Social scientists can teach enough social science to the agronomists and natural scientists to familiarize them with the culture and life style of people for whom the research, development programme and projects are undertaken (ibid).

Barr and Dixon have recently worked in Bangladesh floodplains on how to incorporate farmer's and fisher's knowledge into natural resources management (NRM) and research systems. They worked with a number of local researchers in Bangladesh on the issues with support from the natural resources systems programme (NRSP) of Department for International Development of the United Kingdom. They also examined the methodological issues for incorporating IK in natural resources management and local development process and found that there are considerable intellectual difficulties and practical problems in integrating scientific knowledge and IK. But there is a growing consensus about the importance of integration of IK with scientific knowledge and they showed a possible synergy between IK and scientific knowledge, where participatory research involving multi-disciplinary team can effectively come up with meaningful negotiation for building synergy (Barr and Dixon, 1998). They have shown the interactions and a process of continuum between local and external knowledge in floodplain system in Bangladesh. The following figure-1 demonstrates such a knowledge continuum. The local community particularly the farmers, fishers, women and other local professional groups have their own localized knowledge, which they use in agriculture, home gardening, agro-forestry, fisheries, livestock rearing, poultry raising, health seeking and many other livelihood related activities. This knowledge is very useful and cost

effective, but sometime this cannot cope with the rapid changes in natural and social system. Hence, the local knowledge systems need improvement through effective interaction between local community and the scientists.

Figure-1: Interface between Local Knowledge and External Knowledge



Source: Adapted from Barr et al, 1998 in the *Grassroots Voice, BARCIK, Dhaka*

It is obvious that the local communities are not isolated and very often they have interactions and useful communication with the outer world through radio, TV, newspapers, NGOs, extension services and neighboring farmers. They often take the new information and knowledge and incorporate the external knowledge into their own context and needs. The process of local knowledge generation is slow but dynamic and many of the farmers are leaning by doing in the field. On the other hand, few scientists and researchers in government, NGOs and private sectors are working for generation and diffusion of knowledge tested in the field. These new set of people sometimes have close interaction with the community people. They undertake participatory action research (PAR) to know local contexts, needs and priorities and thus try to make their innovation more effective and functional. This process again facilitates a knowledge continuum between local and external world.

2.5 Methods and Tools used in the Study

The study on application of IK in agriculture followed a participatory and wholistic approach to understand the strengths and usefulness of indigenous and local knowledge in agriculture. The study tries to understand - why and how people use IKs in agriculture and farming practices, resources management and livelihood activities? Firstly, the study has identified the different kinds of IK (through literature review and fieldwork) that were in use in the past as well as are being used in present day agriculture. Then the IKs are classified according to their uses and usefulness in different agricultural sub-sectors including crops, livestock, fisheries, natural resources and biodiversity. Finally, the study examines the farmer's interests and knowledge about IKs considering the social

categories and personal attributes such as age, gender, experience and involvement of farmers in agriculture and their cultural attainment etc. The level of uses of IK in crop cultivation and the sub-sectors of agriculture has been assessed using participant observation as well as participatory research methods.

The study takes a cultural ecological approach and tries to investigate human adaptation and behavior to environment and nature with a particular focus on knowledge exchange and innovation by local people. The study also undertook a rigorous review of literature to gain greater understanding about sustainable development issues, debates and components of sustainable agriculture, concept of IK and importance of IK in development in general and sustainable agriculture in particular. The literature review also focuses on anthropological approaches, contributions of classic anthropologists in developing a different approach to understand society, culture and role of IK in development. Besides the review and consultations (with academics, researchers and knowledgeable farmers), the study also followed systematic participant observation to assess the strength and usefulness of IK in agriculture. The study further employed a number of relevant tools of Participatory Research along with limited scale of household census and sample survey (using semi-structured questionnaire). Following are the methods, steps and tools that were used for collecting primary information from the field:

- Field Reconnaissance
- Transect Walk
- Social and Resources Mappings
- Systematic Participant Observation
- Household Census
- Sample Survey on Use of IK
- In-depth Interview
- Focus Group Discussion
- Case Study and
- Life History.

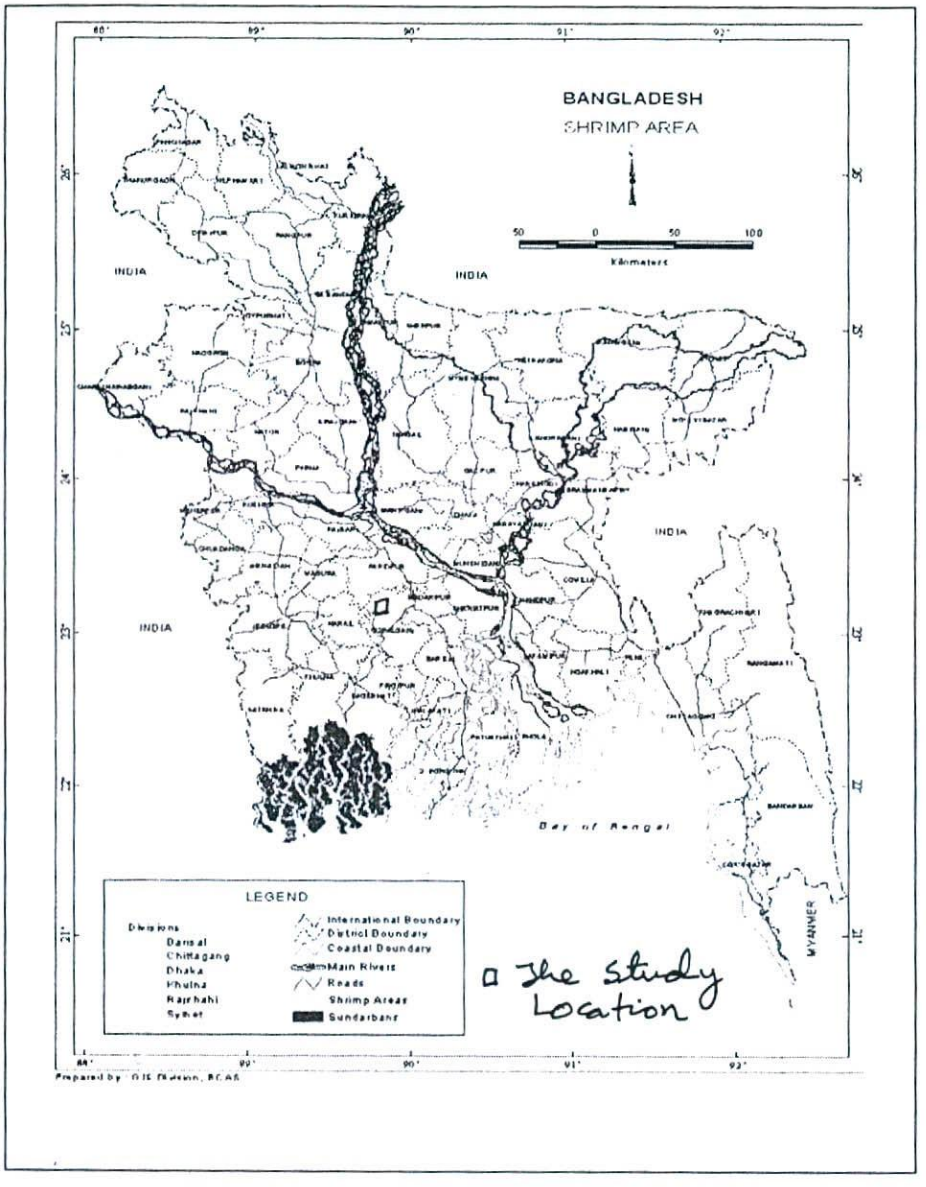
Field Reconnaissance and Selection of the Study Villages

Extensive field visit was undertaken in the initial stage of the study to identify suitable village for the study and finally I could select two villages in a floodplain ecosystem for my study after field reconnaissance. I found two interesting villages i.e., *Talbari and Chamtapara* situated in and around the *Kalatali Beel* in Muksudpur and Sadar Upazials in Gopalganj district. The villages met all the criteria for the study. The villages and the Beel systems are connected with a small branch of Madhumati and Kumar river systems, which are parts of lower Ganges's floodplain.

The villages have different types of land (deep flood, shallow flood, flood free high land). The farmers cultivate both traditional crops (*Aman, Boro, Rabi* crops and vegetables) and modern high yielding varieties of crops, vegetable, fruits etc., on their land. They have both irrigated land as well as non-irrigated rain-fed, flood-inundated land for rice and other crop cultivation. Few farmers also cultivate fish and raise livestock and poultry. Further, there are agro-forestry practices in the villages. It was observed during field observation that few farmers of marginal and poor categories do not use high cost modern

agricultural inputs in their farming practices. Instead of external inputs, they use local and indigenous knowledge in their farming practices for examples in crop cultivation, agroforestry, poultry, livestock and fisheries. After the selection of the study village, I have conducted few participatory research exercises (transect walk, social mapping, in-depth interview etc.) and undertaken household census. I have also talked with few knowledgeable people of the villages about agricultural practices, use of local knowledge and external inputs in agriculture.

Figure-2: Bangladesh map showing the study location



Transect Walk: I have undertaken a number of transect walks through the villages to increase my understanding about the physical and social condition of the study villages and the ecosystem. It helps me to categorize the types of land and types of crop, understand land uses, physical resources and settlement in the villages. I found that farmers produce at least three crops on the high land (Rabi, Kharip and different kinds of vegetables). They cultivate two main crops (local *Aman* paddy and HYV rice) on medium land in a year while they cultivate *Boro* rice on low land. I also found that they produce lot of traditional crops (oil seeds, jute, sugarcane, onion, ground nut, vegetables etc.) in the villages. The villages have both crop diversity and intensity.

Social and Resources Mapping: Social mapping is a very useful tools and I have undertaken social mapping exercise in the villages to understand the category of people living in the villages, their occupations, livelihood patterns, dependency on agriculture and natural resources. It is evident from the social mapping that the large and medium farmers live in the southern part of the village near their farmland. Majority marginal farmers and poor section of people live in the north and central parts of the Talbari village. Agriculture is the main stay of the majority people in the study villages, but a large number of the poor live on wage labor, fishing (par-time), rickshaw pulling and small business.

Systematic Participant Observation (SPO): Systematic participant observation has been the key method for collection of primary information from the field. SPO was employed to collect both qualitative and limited quantitative information from farmers and village community about farmer's interest and insight on farming practices and livelihood approaches, interest on local and external knowledge, their innovation and knowledge generation etc. I have observed agricultural practices including cropping patterns, agro-forestry, fish culture and poultry raising and the use of various local knowledge in those practices. It is very interesting to note that farmers (mainly marginal and poor as well as few well to do farmers) and women use lot of local knowledge and techniques in organizing the farming practices and home gardening. But they are not isolated from the external world. Many of them are trying to integrate the external knowledge and inputs such as seeds and crops selection, planting, soil preparation and land management, irrigation, use of fertilizer and pest control in the farming practices, which were encouraged and disseminated by agricultural extension, NGOs and electronic media.

Household Census: A household census was undertaken using a simple format, which included basic socio-economic information of the farmers including: demographic information, land ownership, type of land (high, medium and low) and types of crops they cultivate on different kinds of land in a year. The census data was very useful to categorize the farmers into different social categories (poor, marginal, rich etc.,) and understand the cropping patterns.

IK Survey: The sample survey covers information on: basic socio-economic data of the farming households, land ownership and cropping patterns, sources and uses of various agricultural inputs (sees, fertilizers, pest control, irrigation, soil preparation and land management etc.), cropping intensity and diversity, farm productivity and profitability,

problems in present day agriculture, uses of potential IKs in agriculture to address the problems and managing risks as well as farmers knowledge in agro-forestry, fisheries and livestock management etc.

Case Studies on specific issues: A number of case studies were conducted using participatory approach on intercropping and crop rotation; crop intensity and diversity and cultivation of traditional crops; agroforestry; use of green manure and compost fertilizer; conventional and integrated pest management; irrigation practices, floating garden and paddy and fish cultivation.

Focus Group Discussion: Several FGDs were conducted, which concentrated on usefulness and efficacy of IK in agriculture and how to improve potential IKs to integrate them in the current agricultural practices in the context of existing and emerging problems in agriculture in the locality. FGDs were very useful for obtaining shared understanding on agricultural practices, uses of inputs and IK. These were also useful to validate information gathered through observation, PR and survey.

Life History: A number life histories of the poor and marginal farmers were documented to capture their local knowledge, innovativeness and interest for IK and MK. The case studies gave important insights into the changes in socio-economic conditions of the floodplain as well as the changes in cropping patterns and local knowledge base.

Data Processing and Analysis: The study collected both primary and secondary information. Emphasis was given on primary and qualitative information (i.e., perceptions, ideas and , opinions about agricultural practices, uses of IKs, farmer's experiences, events and personality histories) rather than on quantitative information. However, the study also gathered limited quantitative and numerical data on land ownership patterns, uses of inputs in agriculture, productions and costs benefits. The qualitative information was categorized into themes using matrix according to respondents groups considering their wealth categories, farm size, age and personality traits for analysis to establish links among the issues and variable.

Limitations of the Study: The study has been anthropological in nature and it concentrated in a particular location (floodplain ecosystem) with a wholistic approach to understand the local knowledge systems, innovation of farmers and their interactions with formal and informal institutions in particular time and in a given social and cultural settings. Hence, the field findings, though give important glimpse of a particular realty regarding the use and usefulness of IK in agriculture as well as blending of IK and modern knowledge, but these could not be generalized for the agricultural sector of the country. However, the findings from literature reviews and consultations are broad and suggest macro and micro links.

2.6 Summary of the Chapter

This chapter gives a glimpse on the nature of anthropological studies, changing focus of discipline and contribution of the key classical anthropologists to the development specific approaches of anthropology to look at people, society, culture and ecology. Anthropology has been comparatively a recent social science and as a formal discipline, it has a history of origin and development of about 150-200 years. Anthropology got a solid and independent basis in the second half of the 19th century only when scholars could collect reliable information about various backward and isolated communities through participant observation. In fact, the historical development and evolution of anthropology as a social science has its roots in the study and research of pre-industrial and primitive societies. The classical anthropologists studied mainly small and isolated indigenous communities and tried to find a trend of historical evolution of human society and culture. But in the recent years, there has been a significant shift in the focus of anthropological studies from historical and cultural aspects to more contemporary issues and concerns of present day society.

This chapter also synthesized the views of the different academicians and development thinkers about the importance of anthropological approaches to study indigenous knowledge and sustainable development issues. Anthropology as a social science is rooted in empiricism. Investigations of anthropology are based on participatory and systematic methods. Anthropologists gain practical experiences with particular people and society through participating in fieldwork. They look at the variations, diversity and covariance between elements. The anthropologists also try to discover connections and unity in a social system. Many academicians and development thinkers have emphasized on the importance of anthropological approaches to improve local development planning, sectoral development (agriculture, fisheries, forestry, health etc.), resources management and livelihoods studies, which focuses on indigenous knowledge and local practices.

It is felt that anthropologists can make important contribution to local and regional development planning by using their comprehensive and participatory approaches with insight (deep understanding and thorough analysis), intuition (capacity of assumption with accuracy) and empathy (quality of understanding others concerns from their perspectives and expression) as well as by exploring the local and indigenous knowledge systems to integrate those in the development process. Because, they have vast experiences to identify local criteria, methods and tools relevant to local situation to capture people's perspectives and knowledge. Sillitoe (2001) called upon the anthropologists to facilitate greater uses of local knowledge in development.

This chapter also analyzed the status of anthropological studies in Bangladesh and identified research needs in IK, agriculture and livelihoods. Anthropology as both academic pursuit and practical research practice has been very new in Bangladesh. Few public universities including Dhaka, Jahangirnagar, Chittagong, and Rajshahi universities have started teaching of anthropology in the latter part of the last century. Clade Lev - Strauss, Pierre Bessaignet, Hans E Kauffmann and LG Loffler made important initial contributions to anthropological studies in Bangladesh in the second half of the last

century. They studied kinship, culture and social systems of the ethnic people in Bangladesh. Few Bangladeshi academics and researchers also conducted limited villages studies focusing on family, culture and traditional organizations by using anthropological approach. Mukherjee, Chowdhury, Arefeen, Hassan, Islam and Alam are pioneers among the Bangladeshi anthropologists.

But research by following anthropological approaches in the country has been very few in number. It is criticized that until recently, anthropologists have not been active partners in the process of agricultural research and development. The involvement of social scientists in the development process is largely because of a growing concerns among natural scientists and administrators to become socially informed. There is recognition that, too often agricultural research and development has failed or did not fulfill its potential objectives, because it was socially uniformed and ill conceived. This realization, by default, has led to increasing attention on identifying socio-cultural variables in project design. In turn, this has resulted in the recruitment of social scientists in research and project teams to make use of the applied potentials of social science. This newfound recognition of the uses of anthropology and rural sociology, in terms of their place in the multidisciplinary research and development programme, has gained much importance in the recent decades. Sillitoe, Barr and Dixon worked in Bangladesh in the late 1990s on how to incorporate farmer's and fisher's knowledge into natural resources management and research systems. They worked with a number of local researchers in Bangladesh and examined the methodological issues for incorporating IK in natural resources management and local development process. However, they found that there were considerable intellectual difficulties and practical problems in integrating scientific knowledge and IK in Bangladesh.

This chapter finally describes the methods and tools used for the study to capture local contexts of farming, agricultural practices, farmer's knowledge, use of IKs and MK, their interests for IK and innovativeness in application of IK in local agricultural practices. The study followed mainly participant observation with few participatory research tools, which are: field reconnaissance, transect walk, social and resources mapping, household census, in-depth interview, life history and case study.

Chapter-3: Local Knowledge in Rural Development and the Practices of IKs in Agriculture of Bangladesh

3.1 Knowledge Systems and Indigenous Knowledge

There are great many definitions of knowledge and indigenous knowledge. These are invariably characterized by the discipline of the various authors. Knowledge refers to the characterizations that individuals make to understand the reality and meanings attached to their experiences. These characterizations are usually shared, or socially available, but it is ultimately at the level of the individual that knowledge occurs (i.e., perception and understanding, information, reasoning and learning). Brouwers defines knowledge as an interaction between the subject and the way reality is perceived or reconstructed. According to this views, knowledge is the result of active reconstruction of reality through sense making activity and these are activities whereby people identify shared objectives, develop thoughts and learning (Chadwick et al, 1998). Local and indigenous knowledge is a vast source of the knowledge systems, which very often gives the basis and strategies for livelihoods of majority people in the rural setting.

Local and indigenous knowledge is the knowledge that people in a given community have developed over time and continue to develop. IK is based on experience and often tested over long time. It is adapted to local culture and environment. It is dynamic and changing (IIRR, 1996). However, the literature of IK does not give a single definition. It is due to differences in background and perspectives of the authors ranging from social anthropology to agricultural engineering. But the various definitions have some common traits. Warren (1991) says that indigenous knowledge is the local knowledge – the knowledge that is unique to a given culture and society. It is often contrasted with "scientific" western, modern or international knowledge that are developed by university, research institutes and private organizations using formal scientific approaches. IK is very important as it forms the information base for a society, which facilitates communication and decision-making. However, Agrawal (1995) felt that in reality there have been lots of overlaps between IK and modern knowledge (MK), because it changes over time and situation and adapts to increase its efficacy.

Indigenous knowledge is different from Western scientific knowledge in three respects i.e., subject of investigation, methods and context of knowledge generation and uses. IK is generated in the local context to address local problems while western scientific knowledge is developed following standard methods and theories to give generic solution to macro-level problems, which may not fit to a local condition due to different contexts. On the other hand, IK is functional and it is developed through trial and error in the social laboratory. It is not based on any theory like Western and modern science, but it has its own popular science (cause-effect relationship). However, local knowledge and modern scientific knowledge can complement to each other, which depend on the purposes of the use of the knowledge systems. As Agrawal says, "the knowledge could be classified on one or the other way depending on the interests it serves, the purposes for which it is harnessed, or the manner in which it is generated (ibid).

this would make it possible to utilize the positive aspects of local knowledge systems developed among the tropical and subtropical agricultural communities (Titilola, 1994). Rahman in his "People's Self-Development", criticizes the conventional development philosophy and urges for breaking the monopoly of knowledge in the hands of the elites. He suggests to generating organic knowledge involving people through participatory research. He shows from his long experiences of participatory research that there are popular initiatives, which demonstrates spirit of self-development by people with their own resources and local knowledge (Rahman, 1994).

Warren and Cashman (1991) examined the possibility of integration of IK in sustainable agriculture and rural development in the early 1990s. They tried to define IK and explore how it functions. They maintain that farmers have their own sophisticated ways to look at their world and the knowledge that they have acquired and developed over many centuries. The local knowledge is very critical and it contains many important aspects of their culture, technology and society. They felt that many of the technological solutions that had been proposed to address problems in rural communities failed in the field, because the process did not take into account the local culture, society's preference, skills and knowledge. Success in rural development and agricultural development are more likely to be achieved when local people are involved in the planning and implementation process and their knowledge are valued. In their briefing paper on sustainability issues in agricultural development, they suggested a number of strategies and options to integrate IK in development processes and making agricultural system sustainable. These include: overcoming biases in extension communication and incorporating local knowledge, improving existing production systems by incorporating new knowledge and technologies into exiting knowledge, brining changes from within societies and creation of an indigenous knowledge foundation.

Farmer First Movement

The crisis of modern knowledge was felt much earlier and that were reflected in various writings and thoughts of social scientists, academics and development practitioners from the early 1980s. The notion of indigenous knowledge has been particularly influential in agricultural development, manifested in the Farmer First Movement (FFM). Chambers, the influential thinker of the farmer first approach, criticized the professional development practitioners as outsiders and sought to reverse its ideological underpinning emphasizing on learning from people. Chambers (1983), in his classical work, "Rural Development-Putting the Last First" seriously criticized the mechanical introduction of western modern knowledge in the development process in Third World countries and he blamed the development professionals for their outsiders biasness. He says, "In rural development, the center-periphery biases of outsiders knowledge are reflected in the concentration of research, publication, training and extension on what exotic rather than indigenous, mechanical rather than human, chemical rather than organic and marketed rather than consumed". For example, in agricultural research priority, prestige and promotion have gone with the work on crops for export, which were grown usually by plantation and large farmers, better off farmers and the men of the household rather than the women. He further maintains that centralized urban and professional power, knowledge and values have

flowed out over and often failed to recognize the knowledge of rural and local people. To him, few social anthropologists were the exceptions, who took lots of pain to experience cultures other than their own from inside, and to learn and understand the values and knowledge of those cultures. The result has been recognition of the complexity, variety and validity of indigenous systems.

Chambers, through his long participatory research experienced in developing countries including Bangladesh, has emphasized on the importance of local knowledge, experience, experiments and priorities of local and rural people. However, he did not totally ignored the essence of modern technological knowledge in many cases and feels that the two types of knowledge complement each other and together they may achieve advances which neither could do alone. For that to happen i.e., blending of local and modern knowledge, he suggests power must shift and all the knowledgeable local and rural people are to be regarded and their perspectives and experiences are to be valued. To this end, one of the most important steps would be for the professionals and development practitioners to step down off their pedestals and sit down, listen to and learn from rural people (Chambers, 1983).

In the context of growing problem in large scale agriculture based on high cost external inputs (seeds, fertilizer and pesticides), Chambers, Pacey and Thrupp (1991) noted that the resources poor farm families in the developing countries maintained a complex, diverse and risk-prone agriculture. The experiences and knowledge of those poor farmers are highly useful in searching sustainable options for rural development and agricultural development. Hence, farmer's experience, ideas, knowledge, innovation, information, adaptive strategies and their own agendas are very important and should get priority. In their book on "Farmer First- Farmer's Innovation and Agriculture Research", they have described the important cropping patterns and innovations of poor and marginal farmers of Bangladesh. Further, Gupta (1991) has shown that farming practices in a north Indian village are not static and these are heavily influenced by indigenous understanding of agronomy and ecology, local politics, development projects and programmes etc. However, he also feels that scientist's views about farmer's practices stills create barriers to effective interactions between farmers and scientists. He suggests that the scientists should have to identify the scientific basis of peasant's practices and link it with their rationality (Gupta, 1991).

Beyond Farmer First Approach

The Farmer First approach has been criticized in a number of ways and one of the criticisms is that it oversimplified the local knowledge. The criticisms came mainly from the Beyond Farmer First Approach (BFFA) and they held that the FF movement failed to grasp the dynamics of local and indigenous knowledge. Knowledge is seen as a ready store for extraction and incorporation by the FFM. Thompson (who represents the group at IIED) feels that the impacts of FF approach has been felt through the works of many NGOs and growing number of universities, national and international agricultural research centres. However, the approach has few limitations. Such an approach represents a naïve populism that fails to consider the socio-cultural, political and economic dimensions of knowledge

creation and innovation, uses and transmissions of knowledge to rural communities and scientific organizations (Thompson, 1993).

The attempts by the FF approach to blend or integrate local knowledge into existing scientific process assume that rural people's knowledge represents an easy definable body of knowledge ready for extraction and incorporation. But the critics have pointed out that that rural people's knowledge is fragmentary, partial and provisional in nature like scientific knowledge. It is never fully unified or integrated in terms of an underlying logic or system of classification. Moreover, knowledge is embedded in and emerges out of a multi-dimensional universe, in which diverse cultural, economic, environmental and socio-political factors interact and influence one another. Knowledge whether indigenous and scientific is inclusive in the sense that it is the results of a great many decisions and selective assumptions of previous beliefs, ideas and images, but at the same time exclusive of other possible forms of conceptualization and understanding. Hence, it is not an accumulation of facts but involves the ways of comprehending the world (ibid).

Mazzucato suggests to bridging gap between scientists and local people following cognitive anthropological approach. In his recent article published in the *Indigenous Knowledge and Development Monitor* (1997), he mentions that there is a fundamental difference in the ways, the anthropologists and economists analyze economics. Anthropologists see the indigenous economy as part of a wider meaning system. It is the meaning system that gives value to transacted goods, a value that may encompass religious, social and political spheres. Thus while the economy can be defined in terms of the production, distribution and consumption of material goods, anthropologists do not limit their analysis to the material sphere, but rather analyze non-material aspects.

Cognitive anthropology studies indigenous economies by analyzing people's economic reasoning, their notions of wealth, labour, and capital, and their view of how these can best be managed, invested and presented, in other words, their processes of decision making. Using the ethnographic approach, they formulate the cultural logic behind decisions, identifying the factors most relevant to decision making for the people under study. While historically, anthropological research has been largely descriptive in nature, some of the more recent studies have quantified certain aspects of these indigenous economies. Many anthropologists draw out local and indigenous criteria through cognitive anthropology, which is the study of people's perceptions of their surroundings as reflecting in their use of language. This type of analysis can be taken as one step further by examining local classifications of such economics terms as benefits, costs, insurance, interest, security and risk, in order to determine whether these are locally meaningful concepts. We must employ methods, which are more socially relevant, and it is now time to look at indigenous economies through indigenously defined criteria. The anthropologists have vast experiences to identify local criteria and the methods and tools relevant to local situation (ibid).

In the context of Bangladesh, Choudhury has noted that farmer's indigenous knowledge, derived from the past experiences, is transmitted from one generation to another, evaluated and fine-tuned, as people engage in continuous process of examination and innovation. But

today, local knowledge is eroding fast and much has been lost with the modernization of agriculture and the rapid spread of foreign technology introduced from outside. However, though farmers are exposed to modern knowledge but they have not abandoned their all local and indigenous knowledge and practices. There is need to understand the strengths and usefulness of the local knowledge to integrate them with modern scientific knowledge and in doing so, we can instigate development initiatives that would be both environmentally and socially appropriate and sustainable (Choudhury, in Sillitoe, 2000).

3.3 Key Features of IK and It's Importance for Agricultural Development

Indigenous knowledge refers to the unique, traditional and local knowledge existing within and developed or modified and added around a specific condition to a particular locality. The development of IK systems covering all aspects of life (i.e., gaining livelihoods, management of natural resources and environment etc.) has been a matter of survival to the people and local community who generated the systems. Such knowledge systems are cumulative representing generations of experiences, careful observations and trail and error experiments (Gernier, 1998). The key feature of IK is that it is holistic and it covers all aspects of lives giving the basis for livelihood of poor and marginal. IK systems minimize risks and it integrated with culture (material and non-material including religion). It is viewed that IK is the basis for self-sufficiency and self-determination for at least three reasons: people are familiar with IK, they can understand use IKs effectively; it draws local resources and it is cost-effective. Further, it does not over exploit natural resources bases and help re-generate for future use and subsistence and it gives long term solution to problems, which are economically productive, ecologically sound and socially acceptable and equitable (IIRR, 1996).

Grenier (1998) also feels that IK systems are dynamic and new knowledge is continually added to it and such systems always internalize and adapt external knowledge to suit with the local situation in the context of changes in physical, social and human conditions. She also mentions that all members of a community may have IK, but the quality and quantity of such knowledge that the individuals possess vary across the age, sex, education, experiences and social position. IKs are stored mainly in people's memories and activities and are expressed in stories, songs, folklore, proverbs, dances, myths, culture, values, practices, beliefs, rituals, local languages, taxonomy, agricultural practices, equipments, materials, food habits, health seeking, plants and animal breeds. IK is shared, transmitted and communicated orally, by specific example and through culture. Indigenous forms of communication and organizations are vital to local level decision-making and preservation and development of IKs. The IIRR has identified a set of common and key characteristics of local knowledge systems. It emphasizes that these traits of IK can influence the outcomes of development at local and regional levels: These are:

Most local people are generalists: They tend to know a little about many things. This contrasts with academia, where people tend to be specialists, knowing a great deal about a few things.

IK systems are holistic: Local people face a set of interrelated problems and they often attempt to solve them by applying their knowledge in a holistic way. For instance, a farmer might view his or her farm as a whole rather than as a set of relatively separate enterprises. The decisions about one enterprise might be affected by the knowledge and perceptions of other parts of the farm or environment. The relationships between the parts and the reasoning behind decisions might not be easily discernible to an outsider.

IK systems integrate culture and religion: Religion is an integral part of IK and cannot necessarily be separated from technical knowledge in traditional settings. Religious beliefs and superstitions might be an important influence on what people do and how ready they are to accept new practices. Trying to change an undesirable practice might be difficult because it is rooted in deeply held belief that underlies many other aspects of the culture.

IK systems minimize risk rather than maximize profit: Avoiding risk is important for local people. For instance, a farmer might keep a few goats as a form of savings, a source of ready cash in case a child falls ill. Since the goats are not a source of regular income, the farmer will try to keep feed costs and labor low, rather than try to optimize meat and milk production. Another farmer might have several small fields in different locations as a hedge against pest damage. This rules out higher yields from mechanization, but pests are less likely to wipe out the entire crop (IIRR, 1996).

The local and indigenous knowledge are locally appropriate and restraint in resources exploitation, flexible and socially responsible and hence, these are conducive to essential preconditions for sustaining agriculture. IK gives the local perspectives and priority for development of agriculture and can help to achieve better management of resources such as land, water, crops, plants, fisheries, species and local resources considering the environmental, economic and social context of the farmers and communities. Application of IK in agriculture can optimize resource uses as well as conserve the biological diversity and agro-ecosystems. Most importantly, IK can help to reduce many of the adverse impacts and risks of the present agricultural practices, which are largely dependent on external inputs and knowledge.

Folk-wisdom is usually integrated with belief systems and cultural norms, which are expressed in traditions and myths, through traditional methods of communication i.e., through songs and proverbs. After its origin, IK is maintained, transmitted, augmented and elaborated during its course of application and practices by the people in farming, healthcare and fisheries. Incorporation of IK in planning, programmes and sectoral development such as agriculture, fisheries, forestry allows better utilization of local resources and sustainable management of natural recourses and eco-systems. Thus, promotion of IK enhances local capacity, help understand local concerns and priority and find better solution of the problems. IK can empower local community and thus helps them to achieve self-sufficiency as well as living in harmony with nature (IDRC, 1998, Sillitoe, 1999). In this regard, Weizenfeld (1998) feels that all knowledge potentially passes into local pool, is blended with what is already known and then informs today's understanding and practice. Rural people's understanding of natural resources management issues is a blend of knowledge from various sources, which is sometime difficult to disentangle.

There is a continuum between local and external knowledge...we must reconcile indigenous knowledge, which is wide and holistic and encompasses systematic understanding with scientific knowledge.

In a paper, Rajasekaran (1993) focuses on the value of IK in relation to the development of agriculture and suggests a framework for incorporating indigenous knowledge systems into agricultural research and agricultural development. To him, indigenous knowledge is dynamic, changing through indigenous mechanisms of creativity and innovativeness as well as through contact with other local and international knowledge systems. These knowledge systems may appear simple to outsiders but they represent mechanisms to ensure minimal livelihoods for local people. Indigenous knowledge systems often are elaborate, and they are adapted to local cultural and environmental conditions. Indigenous knowledge systems are tuned to the needs of local people and the quality and quantity of available resources. They pertain to various cultural norms, social roles, or physical conditions. Their efficiency lies in the capacity to adapt to changing circumstances. He summarizes the key characteristics of indigenous knowledge systems, which are as follows:

- adaptive skills of local people usually derived from many years of experience that have often been communicated through "oral traditions" and learned through family members over generations;
- time-tested agricultural and natural resource management practices, which pave the way for sustainable agriculture;
- strategies and techniques developed by local people to cope with the changes in the socio-cultural and environmental conditions;
- practices that are accumulated by farmers due to constant experimentation and innovation;
- trial-and-error problem-solving approaches by groups of people with an objective to meet the challenges they face in their local environments; and
- decision-making skills of local people that draw upon the resources they have at hand.

The paper suggested policy actions for preserving IK and incorporation of potential IK in agricultural systems. A number of steps were identified for promoting IK in agricultural research and agricultural extension. These are: inter-disciplinary approach, identifying problems, recording relevant IK systems, developing IK research agenda for application, conducting on-station participatory research, conducting on-farm farmer oriented research and advocacy for uptake of the research findings.

Women possess wealth of indigenous knowledge and they use those in their everyday activities. Men and women often possess different skills and different knowledge of local conditions and everyday life. Again, almost in every society, the role and tasks of men and women are differently defined. So the knowledge and skills, the womenfolk possess, sometime differ. In relation to food and agriculture, the main responsibilities of women are collection, preparation, distribution and preservation of foods. They often help to plant and harvest crops, vegetables and fruits. The women also collect drinking water and fuel for cooking. They plant and use herbs for human health and veterinary medicine. They possess and use various local knowledge for home gardening, vegetable growing,

agro-forestry, health care as well as cattle and poultry raising. Women contribute greatly in natural resources management and conservation of bio-resources around home and homestead. Women have valuable knowledge for selection of local crop species appropriate to the soil and weather, inter-crop and crop rotation. They have also important local knowledge for pest management and post harvest crop storage.

There have been growing concerns about the protection of intellectual property right (IPR) of the farmers and women in relation to conservation of local crop species, biodiversity and practices. Poor and marginal farmers very often maintain diversified and complex agricultural systems and thus conserve crops species, forestry resources and biodiversity. They harvest the local species and natural resources in a sustainable way. The emerging market forces and trade related IPRs may affect the poor in developing counties. Under the WTO (World Trade Organization), the TRIPs will favour the developed countries and the multi-national companies. In this context, many developing countries including Bangladesh have rejected TRIPs and the related WTO agreement and termed it unsatisfactory outcomes for he South (Rahman et al, 2004).

The mono-cropping and commercial cultivation of HYV crops have destructed the local resources base as well as the innovative practices and knowledge of the farmers. In the increasing changing world, both the IPR and knowledge of the poor farmers are to be protected and documented. Khan (2000) says that though Bangladesh is a signatory of UN Convention on Biodiversity, the policy and legal framework is weak in the country to protect both the bio-resources and IPR of the common people, particularly of the framers. There is need for improving policy and institutional structure for collective action to protect the IPR of the poor farmers and women.

3.4 The Practices of Local and Indigenous Knowledge in Agriculture of Bangladesh

Bangladesh constitutes important parts of the great Indian civilization, where people started agricultural activities from the long past. They developed and modified their localized knowledge and techniques in the course of time in the context of demands of the population and socio-political and environmental changes. The knowledge and skills were transferred from generation to generations. Alim (1981) noted that in the traditional society, farmers received agricultural education from their fathers and the neighbors with whom they lived and worked in co-operation. The women and girls also received the same from their mothers and grand mothers. There have been old and wise farmers in every locality who were well conversant on various matters of agricultural operation and practices through their experiences.

The people of rural Bangladesh use various local and indigenous knowledge and skills for agricultural practices. These include selecting crops, preserving seeds and soil, pest control, gardening, poultry and cattle raising. They use their various local knowledge and local materials for livestock raring and veterinary medicine. It was found that small-scale fishing is organized mainly with local fishing gears and crafts that helped to conserve fisheries as well as gave long term livelihood support for the fisher folk. Indigenous and local knowledge are being often used for rural health seeking for ages. People also use their

localized knowledge for weather forecasting and disaster management like flood, cyclone, droughts and riverbank erosion in Bangladesh.

Attempts were made to collect relevant printed materials (books, journal, paper, articles, monographs) on local knowledge and practices in agriculture, agricultural development in Bangladesh and related issues for review and synthesize the major findings on IK in agriculture. There has been serious lack in systematic documentation and preservation of IK in the country. But the literature searching found a number of books, journal articles and paper on the issues. The key documents are: Indigenous Knowledge Development in Bangladesh – Present and Future (edited by Sillitoe P, 2000); Indigenous Agricultural Tools and Equipment of Bangladesh Indigenous by BARC, Chowdhury and Elias (1996); Indigenous Technologies of Agriculture in Bangladesh by Bangladesh Academy of Agriculture in 1997. The literature has been greatly benefited from a number of articles, which were published in the *Grassroots Voice*, a journal on indigenous knowledge of the BARCIK.

The following sections (prepared based no both literature and field observations) describe the uses of various IKs in agricultural practices including soil conservation and land management (i.e., increase of soil fertility and nutrient, protection of soil from erosion, conserving soil moisture etc.); maintaining crop diversity and cropping intensity through inter-crops, mixed crops, crop rotation; pest management; irrigation and interface between surface, rain and ground water; drought management; storage of crops and seeds preservation; agro-forestry; integration of crop with fisheries, poultry and livestock etc.

a. Local and Indigenous Knowledge in Farming Practices

The field observation and consultations with the farmers reveal that the marginal and poor farmers in the study villages have developed many local and indigenous practices and techniques of soil conservation, crop rotation and intercropping, pest control, preservation of seeds and storages of grains by using indigenous methods with local materials (such Neem and Mango Leafs and local herbs), irrigation and drought management, agroforestry, integration of crops with vegetables, fish culture and poultry raising. The field observations also indicate that the farmers in the study villages generally use local inputs and organic materials (such as local seeds, fertilizer and pets management) in their farming practices and production process, which are consumed at household and community levels as well as used for meeting their subsistence needs.

The farmers have developed their practices and tools through their long experience. Alim (1981) listed a number of simple implements used in agriculture of Bangladesh and these include: hoe, spade, sickle, plough, ladder, fork, rakes, fodder, cutter, sugarcane crusher, swing basket and *Done* (a device for irrigation). Chowdhury and Elias (1996) in their nation-wide study, reported vast areas of indigenous knowledge regarding cropping, seed-reservation and pest control. One of the earliest works on ITK by BARC described the various agricultural tools and appliances that had been used and still are being used in many parts of the country. The book provided a detail descriptions of the equipment and

gave details including their local names, size, and mode of operation, uses and material of constructions.

Land Management and Soil Conservation

Many parts of Bangladesh have been formed through vast quantity of silt carried from the up-streams and the process of soil formation is still continuing. The enormous quantities of silt are brought through the major rivers and their tributaries and are deposited in the river basin, which forms major parts of the floodplains. If the river flow is obstructed or changed the soil fertility declined. In such case, the village or local communities take care of the land and soil improvement and preservation by digging drainage canals and building protective *bundhs* (temporary embankment). These *bundhs* have good effects on soil as well as protecting crops securing good harvest (Alim, 1981). The field observation indicates that mulching is a common practice in the study villages. It preserves soil moisture, increases soil fertility and nutrient as well as protects the topsoil. Farmers also add green manures (cultivating jute and Dhanicha) and compost fertilizers, particularly in vegetable growing in study villages. The local farmers further felt that intercrop and crop rotation also protect soil and increase soil fertility by fixing nitrogen in the soil.

Many traditional practices of soil conservation are unique to the local conditions. Alim reported that local tillage practices used to add organic matter in the soil. *Dhaincha,* a local plant are being planted in the erosion prone areas and young plants are sometimes mixed in the soil for organic matter as well as soil conservation. People use logs and banana stems to prevent soil erosion from run off and rain water. The logs act as barriers to erosion. Banana is also planted in the soil erosion prone area. The leaves and roots of banana protect soil from erosion (Sharma, 1998). He also reported that ash is being used to improve soil structure and fertility of soil for agriculture. This is practised by both plain land people while broadcast Aman is cultivated as well as by the up-land people for shifting cultivation. Ash mixed in the soil helps create hums specially clay hums complex. This increases nutrient and water holding capacity of the soil and thus improves the soil structure and quality.

Multiple Cropping, Crop Rotation and Inter-cropping

Local farmers have discovered many combinations of crops for mixed cropping from their long experiences. The mixed cropping practices were developed considering the soil contents, land types and climatic variation of the different region of the country. The practices of mixed crops helped preserve soil and increase its fertility. These also protect biodiversity and maintain ecosystems. The study of Chowdhury (1996) revealed that farmers of different region of the country practice various techniques of multiple cropping, which are unique to the local socio-environmental settings. Some of the practices are listed below:

Relaying potato and pointed gourd
Relaying potato and sweet gourd
Relaying potato and pepper
Inter-cropping potato and bitter gourd
Inter-cropping potato and leafy vegetable and

Inter-cropping vegetable like cauliflower, cabbage, tomato and brinjal with sugarcane.

The various literatures also show that a number of crops could be grown in the same plot of land in different seasons. In the past instead of two rice (*Boro* and *Amon*) rice and jute were grown in the *Kharip* (summer and rainy) season while pulses, oil seeds, roots crops, wheat, barley, tobacco and many other vegetable were grown in the *rabi* (winter) season. Cropping systems were developed considering the natural rainfall and such systems are still practiced in some areas of the country where irrigation water is not available. After one or two showers, farmers broadcast the seeds of jute in the month of April-May and the jute is harvested after 3-4 months and then *Amon* rice is planted during the monsoon. The *Amon* is harvested in the month of November and December and then pules, oil seeds millets and vegetables etc are grown in the almost rain free winter season (Alim, 1981 and Mallick D, 2000).

Chowdhury and Elias (1996) viewed that farmers of the central Bangladesh, particularly in Narayanganj traditionally practice effective relay cropping in the following sequences; seedling and seeds of pointed gourd, sweet gourd, bitter gourd, water melon and musk melon are planted in the potato field during November-December before potato harvest. After harvesting of these vegetables and fruits, local Aman rice seeds are sown in doubling method in the same field. This practice reduces the time for land preparation and help maximum use of land. There has been also the practice of inter-cropping, as she mentioned, after potato is sown ridges are raised over each line and the wheat seeds of the variety kanchan are sown in the furrows. Again, after potato harvest, top dressing of urea is made in wheat. Sometimes, seeds of *napa sak* and *lalsak* are grown in every furrows of the potato fields. Cauliflower, cabbage, tomato and red amarnath are grown as short-term inter-crops in the sugarcane fields in the same region.

The filed observation also says that farmers grow different kinds of vegetables, particularly beans, ladis finger, brinjal along the Ails (boundary line) of the farms. There is both crop diversity as well as crop intensity in the study villages. The high land and land near homestead produce three to four crops in a year, while the medium land produces at least two crops (paddy, jute, oil seeds etc.) and the low land produces one crop (Boro or deep water Aman paddy). The farmers in both *Talbari* and *Chamtapara* practice mixed crop during *Rabi* season. Many of them cultivate mustard with pulses; potato with vegetables, spices with vegetables, Sisum with *Kaun* and *China* (local fast growing grain crops). They very often practice inter crop such as sugar cane with onion and vegetables, green chilies with red and green spinach, water melon with bitter gourd and brinjal etc. The farmers also practice relay cropping i.e., jute and Broadcast Aman after wheat and *Rabi* crop.

Control of Pest and Weeds

The farmers in the study villages use various local materials and herbs such leafs of Neem, tobacco leafs, ash, kerosene etc., to control pests in crops and vegetables. These are locally available and are not harmful for ecosystems and human health. However, it was noticed that currently the farmers use the local and organic pest management techniques mainly for vegetable growing while many of them use chemical pesticides to control pests in crops

field mainly for HYV rice, jute and other cash crops. Integrated pest management (IPM) practices including organic repellant are getting popularity in the villages as soon as the farmers are becoming aware of the harmful effects of chemical fertilizers on human health and environment. The literature also shows various good practices of pest control. Alim (1981) found that the farmers in Bangladesh use the following indigenous techniques of pest control in crops:

Haphazard planting of crops to reduce the infestation of certain weeds;
Criss-cross hanging of banana leaf thread above brinjal plot to prevent bird attack;
Digging deep ring around cabbage, cauliflower and tomato seedling to inhibit cutworm attack;
Spreading sawdust over banana beetle;
Using powdered seeds of 'peetraj' (Amoora rohutika) as insecticide; and
Using ash as repellent. (Ibid.).

Many farmers insert bamboo sticks or small branches in the rice field to attract insect-eating birds in rice fields. They further reported that the farmers of Rajshahi regions use different organic repellent in the rice field like tobacco leaf extract and *Neem* extract. Smoking hookah's water is spread to repel rice bug. The farmers of Gazipur area have developed an innovative method for controlling caterpillar attack in the field of cabbage, cauliflower and brinjal. In this method, farmers usually cut deep ring in the soil around the plants. As a result, when the caterpillar comes near the plants, they find holes and get frightened, stop movement and cannot reach up to plant. Thus, the plants are saved. She also reported that in many parts of the country, ash is used to protect rice and wheat from inset attack. To protect potato from tuber moth attack, dry sand and rice husk are used to cover the layers inside Chowdhury and Elias (1996).

Alim (1981) opined that people of the country have developed different ways to destroy, or at least to control the harmful insects and the killers of crops. It was found that the simplest and the oldest method is to destroy them by hands. Farmers used to pickup the harmful insects from the plants and they also pulled out the useless plants from the crop-field which nurture the pests. They first uprooted the affected plants and burnt them, which decreased the attack of pest as well as lessen the risk of using chemical pesticides.

The powdered dust of Motihari tobacco leaf is used by the farmers to repel different insects like leaf roller, brown leaf hopper and rice bug. Early in the morning the dust is spread over the moist leaves of rice. The farmers sometimes repel red bug by igniting a rubber tire under the mango trees. The ignited rubber tire is bound with a rope and pulled over the ground in between the trees. The bad odour of burnt rubber repels red bugs.

Neem leaf-powder is diluted with water and sprayed to repel insect from rice field in Gazipur region. Seedlings and saplings of different fruit trees are protected from grazing animals by applying liquid cow-dung on the stem. Chowdhury also found that ash, dry Neem leaf and Biskatali (Polygonun hydropiper) are widely used by the farmers to protect rice and wheat from insect attack. The farmers of Sunamganj have their own technique of pest control. They make a thick rope with paddy straw, soak it with kerosene and run it

over paddy field for several times. The odour of kerosene repel insects. In Sunamganj, women mix ash with kerosene and spread over leaves to control aphid infestation in vegetables (Chowdhury and Elias, 1996).

Irrigation and Drought Management

The literature says that the farmers use different kind of local tools and equipment for small scale irrigation in the country. The book on *Indigenous Agricultural Tools and Equipment of Bangladesh* reported that *Swingbasket* is a common traditional device for irrigating water, which is most popular in the country site. This is a simple device with triangular shape and it is generally made of bamboo woven sheet fasten with sticks. Sometimes, plane iron sheets are used instead of bamboo woven sheet. Two persons are required to operate it.

Done is another kind of water lifting device. The farmers to lift water from ditch and canals extensively use this irrigation equipment. It is made of mainly by wood. Its shape is more or less like a channel section about of a few feet length with one end slightly curved and closed. The appliance is fitted on the bamboo cross bar with a long bamboo pole which works as a fulcrum. Counter weight is added to facilitate working of the *Done* with minimum exertion. (BARC, 1982).

Farmers use various local techniques for irrigation and drought management. Different types of crops need different amount of moisture for their growth and the farmers know better which crops are more drought-tolerant. Brammer (1997) reported that farmers cultivate broadcast Aus, which needs less moisture instead of transplanted Aus in many floodplains of Bangladesh. During the dry season, in some parts of the country, farmers use to pull a rope across the rice field early in the morning as result, the drops of the dew accumulated on the leaves during night drop down and thus moisturize the soil and the seedling become fresh again. Raw cow-dung is diluted in water and sprinkled in the paddy field in the dry-season, which increase water-retaining capacity of the soil. It has been also reported that in the dry season, farmers pull a rope across the rice field early in the morning as result, the drops of the dew accumulated on the leaves during night drop down and thus moisturize the soil and the seedling become fresh again.

Sharma et al (1998) found that farmers and the tribal people employ many techniques to hold water for farming. One of the age-old techniques is reserving rainwater by building small embankment across the canal and streams. This type of embankment is built with earth dyke to create a reservoir. In the dry season, they use the water for irrigating the lower and nearby agricultural fields. Fish -culture and duckling rearing is practiced along with small irrigation. This indigenous technique enhances efficiency of water use and maintains availability of water round the year. Hassan (1996) in his study found that rainwater harvesting had great importance as a potential supplement to water supply for its technical, economic and social soundness. Rainwater harvesting a technique of taking water out of the hydrological cycle for both domestic and agricultural uses. It is a means through which the rainfall is intercepted and collected on the prepared watershed and catchments areas for both domestic uses and crop cultivation.

The field observations reveal that the farmers in the study villages use surface water (water from pond, canal and river) for irrigating their crops and vegetables. They also use rain and flood water for crop cultivation. However, the farmers use ground water for HYV rice cultivation only in the dry season. The cultivation of Broadcast *Aman* and Transplanted *Aman* in the villages mainly depends on rain and floodwater. Few farmers also dug small pond, ditch and canal in the corner of their farms for preserving water, which they use for vegetable growing during winter and dry season.

Storage of Crops and Seeds Preservation

Chowdhury and Elias (1996) found that to prevent seeds and plants from the attack of insects, powder of *Neem* leaf and tobacco is widely used in the rural Bangladesh. They also reported that earthen pots and pitchers are used to store seeds to store seeds of wheat, chickpea and paddy. Rhizomes of ginger and turmeric, and tubers of garlic are preserved in a well-aerated room by spreading thinly on bamboo trays covered with dry clean sand in Sunamganj and other areas. It was also reported that rhizomes of zinger and turmeric and tuber of garlic are preserved in well-aerated room by spreading thinly on bamboo trays covered with clean sands.

The powder of dry Biskatali leaf is also applied on the seeds of different pulses from insect attack. It was also found that farmers preserve their bottle gourd seeds by keeping them inside the fruit. Selected bottle gourds are kept in the vine, after the season is over, they are exposed to strong sunlight for thorough drying. As the inner pulp dries up completely and dry seeds make sound when the shell is shaken. Then the seeds are stored in the dry corner of the house. During the sowing time, a small cut is made in the upper portion of the fruit and seeds are poured out. Thus germination capacity is fully retained in this way (Islam, 1996). Field observation says that the farmers in the study villages use leafs of various local trees and plants such as Neem, Mango and Biskatali (local herb) for preservation of crops like pulses, paddy, wheat etc. and seeds of crops as well as vegetables. Women play a key role in preserving seeds and crops in the locality. They very often dry the grains and seeds in the sun before storage. Paddy is preserved in sacks, while seeds of vegetables and fruits are stored in earthen pots after enough sunning.

b. IK in Agro-forestry and Home Gardening

Agroforestry has been a very common practice in the study villages. The farmers plant less shady trees like palm and date trees across the boundary of their farms. These give them fuel, fruits, food, and nutrition as well as increase nutrient in the soil (from the leaves of the trees). The field observation indicates that insect killer birds sit in the trees and plants and thus the agroforestry practices help to control pest in the farm. The literature says that homestead forestry and agro-forestry play a vital role in providing fuel wood, fodder, fruits and timber to the rural households in Bangladesh. The rural people have long been planting and growing trees and plants not only for food, fuel, fodder and timber but also for protection of their houses, lives and properties from winds, storms, soil erosion etc. Every homestead in the rural Bangladesh has different kind of tress and bamboo bush, which provide the necessary fuel, fodder and fruits. But the reserve of homestead garden has decreased recently due to population growth and poverty in the rural areas.

Chowdhury (1993) maintained that traditionally farmers are following different agro forestry practices in many parts of the country. A wide variety of trees were found to be grown in the homestead. As many as 52 different species were identified in the homestead of Tangail. The selection of tree species is determined by the needs and choice the family as well as by the local environmental factors. The trees provide wood, fuel, fodder and they also tape ground water and thus help to withstand drought. Trees, therefore, deserve attention for the production of nutritious fodder for livestock and for the production of household fuel in Bangladesh. For instance, Jackfruit trees are abundantly found in the country. Farmers use the leaves of trees as feed for their livestock during scarcity.

Sharma et al (1998) reported that in home-gardens, fruits trees are preferred to get timber. Forest trees and more multi-purpose trees are also raised in the homestead. The land around the dwelling houses and huts is more intensively used by raising vegetable, growing guava, cucumber, betel nuts etc. Raising bamboo and other bushes protects the slopes around the homesteads. The home gardens and agro-forestry increase productivity as well as conserve the soil.

c. IK in Conservation of Fisheries and Fish Culture

Fish contributes large amount of animal protein to the people of Bangladesh and about 10 percent of the rural people live on fishing. The major fishing areas include rivers, *Haors*, *Baors*, *Beels*, and the floodplains. In most cases till the recent times, people use to catch fish with their traditional fishing crafts and techniques they have developed through generations. In this regards, Alam (1997) provided a valuable overview of the indigenous fishing technologies utilized in Bangladesh. People use every conceivable type of fishing gear including hands, spears, traps and nets. The work also provides an insight into some of the management strategies associated with the various water bodies used by the rural population. The study found a total of 51 types of fishing gear in operation over the survey period. The type of fishing gear changes with the seasons, according to flood conditions, target species and size of fish. The *polo* for example is a bell shaped trap with an open bottom and a small opening at the top. This type of trap is used throughout Bangladesh during the dry season from December through to May. The trap is pressed into the mud in shallow water. The gear was used for sustainable harvesting of fish, because this leaves some fish for the next year for breeding.

Chadwick et al (1998) reported that indigenous knowledge extends into many spheres of aquaculture. These may be placed in two broad categories: production and trade. Production knowledge relates to the best locations, times and means of wild hatchling collection or to hatchling production i.e., correct temperature, most suitable feed etc. Trade tends to refer to the movement and sales of eggs, fry and fingerlings via a network (formal and informal) of fish traders and merchants. Islam's work (1996) which involved extensive research into farmer' ITK in Dinajpur district also include comment on a number of fishing practices. Many farmers were found to add *kura*, the red powdery coating of rice under the husk to their ponds. Others food sources include cow dung, poultry waste, *chokar* (the

remains of wheat grains obtained after the extraction of *aata*) and oil cake. The addition of banana leaves to ponds stocked with grass carp was also recorded. The application of lime to ponds and *pagars* to clear unclean water is also common. A large proportion of farmers were also found to add fragments of banana plants (pseudostems) into the pond to clear algal growth on the water surface. In many areas fish are dried, salted or fermented as a means of preservation.

Lewis *et al* (1993) provides an extensive research to date on the state of aquaculture in Bangladesh. They conclude that not all IK is useful any more than all outsider knowledge could be said to be harmful. There are gaps in all knowledge systems and local sets of practices. Access to reliable sources of pond management knowledge is proving to be a problem for many farmers, who may rely on questionable folklore beliefs about aquaculture and upon information from self-interested sources such as fry traders. They described the process of aquaculture in the northwest Bangladesh and they documented the local and indigenous knowledge of the fish traders transporting fish fry from one place to another places. For example, the fingerling traders always carry out the complete water change in the *Patil* (container made of mud) before entering an area of anticipated sale. This makes the appearance of the young fish healthier and stronger and it also reduces the rate of mortality of the fingerlings.

Chowdhury and Elias (1996) have found that in Sunamganj that rice husk is used as fish food. The intestines of cattle, goats, duck and poultry are grinned and fed to the fish where fish is cultivated in the ponds. After cleaning the poultry den, the stools are given to fish. They also observed that farmers very often use the following techniques for fish cultivation: cow dung is applied in the pond instead of chemical fertilizer to increase fish production; stirring is done with the help of fishing net; Lime, banana plants, branches of Neem tree are applied in the water of pond to prevent fish diseases; and Kerosene is spread over aquatic weeds to destroy them.

Aquaculture is still generally an extensive practice undertaken by farmers as an additional means of livelihood security and the incorporation of markets into wider patterns of supply and demand are now generating. At present, a new type of fish producers are interested in the economic possibilities of intensive and commercial pond fish production. The producers are also challenging existing cultural norms of labour task specificity, and many are seeking to harvest their ponds themselves. Such approaches pose a threat in terms of the potential loss of the local system of fish culture, with practices and technologies that have evolved over many generations.

These types of skills, informed by local knowledge, and based upon sets of local beliefs and practices, are somewhat undervalued and often dismissed by outsiders. Cage culture is a relatively modern development in aquaculture, and one that has changed the long established fish farming structures in Bangladesh. The cage culture system is typically characterized by intensive fish farming, running-water culture with high yield and great efficiency. It is generally accepted that cage culture will play an increasingly important role in aquaculture. (Chadwick, 1998). Many fish farmers place and fix a number of bamboo-tops and branches of trees in the middle of the pond where fish is raised. The

fish while swimming around the pond rub their bodies against those sticks and branches. The fish-farmers believe that this rubbing of body stimulates and enhances the growth of fish. He also mentioned that fish-farmers also grow water-lily in their pond and they believe that the broad leave of the lily provide shed and help keep the pond-water relatively cool which is congenial for the growth of fish (Mallick D, 2000 in Sillitoe).

d. IK in Veterinary Medicine and Livestock Management

Livestock as a major sub-sector of agriculture that gives partial livelihood supports for many people and also contributes to the economy. People have been raring cattle and goats from the beginning of the civilization. They not only eat the meet and drink the milk, but also use their cattle as draught power for ploughing their land. Livestock and poultry are the good sources of manure and fuel for the farmers. For curing different diseases of cattle and poultry in rural areas, farmers are practicing different method of indigenous healing. Branches of fresh *Lantana camara* is fed to the cattle for curing gas formation and ill-digestion in Tangail; In Sunamganj, to cure ill digestion of cattle, hot boiled rice mixed with paddy husk is fed to the animals; To cure ill digestion and gas formation of cattle, juice extracts of *Shati (Cercuma amada)* leaves, raw turmeric and ginger is fed; and to cure infection of wounds formed on the shoulder of draft animal, ointment made by motihari tobacco and *pathar chun* is applied and bandaged (Mallick, 2000).

It was also reported that when the cattle are affected by throat swelling disease and fail to swallow food, two types of medicine are used, one for external application and the other as oral dose. The stalk of aroids are cut into pieces and smashed. The mud spilled out by crab is collected and mixed with hot water. All the items are mixed together and heated in an earthen pot. This smear is applied on the swelled throat 3-4 times daily. Neem leaf and bitter gourd leaf crushed together in crushing stone diluted with water and a few drops of mustard oil is added. Then the mixture is heated and the concentrated liquid is fed to the affected cows. Leaf stalk of wild aroids is inserted into the throat for clearing inside. Sick cow or goat suffering from ill digestion and loose motion can get relief by feeding them fresh leaves of wood apple. Raw turmeric mixed with small amount of lime wrapped in banana leaf is fed to the cow to get relief from ill digestion. The leaf extract of cactus and *chalta* wrapped in banana leaf is fed to the sick cow (ibid).

Chowdhury and Elias (1996) observed that the local hens develop a habit of sitting in the same place even after egg laying is finished, which delays next ovulation. For curing this habit, the hen is dipped in water several times and one long feather is picked up from the tail and inserted in the nostrils. This makes the hen irritated and it cannot stay in rest and thus gets cured. After hatching eggs the hen and chickens often become infested with blood sucking lice which hampers quick growth of the chicken. The farmers of Joydebpur area keeps fresh leaves of *Bish katali* in the hen's house to repel lice and other insects. In many areas the straw pile upon which the eggs are hatched is burnt immediately, and fresh straw is provided to the chicken. To cure different foul diseases, rice mixed with turmeric or potash permanganate is fed to the sick poultry. Hot boiled rice mixed with a few drops of kerosene is fed to the poultry as prevention for different diseases.

Rural women very often arrange to hatch eggs of improved exotic variety under local hen to raise better quality chickens. Fertilized eggs of duck are hatched by mixing those with chicken eggs, under healthy hens. The hen protects the ducklings from the attack of flying birds, hawks etc. During egg hatching the hen and the chicken suffer from lice attack under their feathers. Lots of fresh leaves of *Bish katali* is spread on the floor of the poultry house to repel the insects. Snails are collected from the crop fields, shells are broken and the flesh is cut into small pieces, which is fed to the young ducklings. This gives good quality protein and helps the ducklings to grow quickly (Chowdhury and Elias, 1996). The field observation also suggests that the poor farmers, particularly the women in the study villages use various techniques and local herbs to tackle many of the problems of their poultry birds and cattle. They are also in the practice of integration of the sub-sectors i.e., poultry drops and cow dung are used for vegetable growing and fisheries.

3.5 Summary of the Chapter

This chapter focuses on the local and indigenous knowledge in rural development in general and practices of IK in agriculture in particular. The chapter is based on published literature and describes the position of IK in knowledge systems, crisis of modern knowledge and importance of IK in addressing the problems within the sustainable development framework. It is felt that IK is vast source and important part of knowledge system. Indigenous knowledge is the knowledge that people in a given community developed over time and continue to develop. IK is based on experience and often tested over long time. It is adapted to local culture and environment. It has its own dynamic to adapt and improve in the changing situation. IK is different from western scientific and modern knowledge, but there have many overlaps between IK and modern knowledge. IK is different from western scientific knowledge in three respects: subject of investigation, methods and context of knowledge generation and uses. IK is generated in the local context to address local problems while western scientific knowledge is developed following standard methods and theories to give generic solution to macro-level problems. On the other hand, IK is functional and it is developed through trial and error in the social laboratory. IK is wholistic and it covers all aspects of life in local contexts. It minimizes risks and give sustainable basis for resources management and livelihood promotion. IK based production and livelihood systems do not over exploit natural resources and it is cost effective. It gives long term solutions to problems considering local resources and potentials in human and natural systems.

Warren and Cashman examined the possibility of integration of IK in sustainable agriculture and rural development in the early 1990s. They tried to explore how it functions. It is felt that farmers have their own sophisticated ways to look at their world and the knowledge that they have acquired and developed over many centuries. They point out that many of the technological solutions that had been proposed to address problems in rural communities failed in the field, because the process did not take into account the local culture, society's preference, skills and knowledge. Success in rural development and agricultural development are more likely to be achieved when local people are involved in the planning and implementation process and their knowledge are valued.

The crisis of modern knowledge was felt much earlier and that was reflected in various writings and thoughts of social scientists, academics and development practitioners from the early 1980s. The notion of indigenous knowledge was felt influential in agricultural development that was manifested in the Farmer First Movement. Chambers, a great thinker of the farmer first approach, criticized the professional development practitioners as outsiders and sought to reverse its ideological underpinning emphasizing on learning from people. In his classical work, "*Rural Development-Putting the Last First*" Chambers seriously criticized the mechanical introduction of western knowledge in the development process in developing countries. Chambers, through his long participatory research experienced in developing countries including Bangladesh, emphasized on the importance of local knowledge, experience, experiments and priorities of local and rural people for their development. But he did not totally ignored the essence of modern technological knowledge and feels that the two types of knowledge complement each other and together they may achieve advancements, which neither could do alone.

The farmer first approach was criticized in a number of ways. One of the criticisms was that it oversimplified the local knowledge. The criticisms came mainly from the Beyond Farmer First Approach. They held that the FF movement failed to grasp the dynamics of local and indigenous knowledge. Knowledge is seen as a ready store for extraction and incorporation by the FFM. Thompson (who led the Beyond Farmer First movement) says that the impacts of FF approach has been felt through the works of many NGOs and growing number of universities, national and international agricultural research institutes, but the approach fails to some extend to consider the socio-cultural, political and economic dimensions of knowledge creation and innovation, the uses and transmissions of knowledge to rural communities. Further, Mazzucato suggests to bridging gap between scientists and local people by following cognitive anthropological approach. Cognitive anthropology studies indigenous economies valuing people's economic reasoning, their notions of wealth, labor, and capital, and their view of how these can best be managed, invested and presented. This type of analysis can be taken as one step further by examining local classifications of such economics terms as benefits, costs, insurance, interest, security and risk, in order to determine whether these are locally meaningful concepts.

The people of rural Bangladesh use various local and indigenous knowledge and skills for agricultural practices. The farmers use local knowledge for selecting crops, preserving seeds and soil, pest control, gardening, poultry and cattle raising. They also use their various local knowledge and local materials for livestock raring and veterinary medicine. It was found that small-scale fishing is organized mainly with local fishing gears and crafts that helped to conserve fisheries as well as gave long term livelihood support for the fisher folk. Indigenous and local knowledge are being often used for rural health seeking for ages. People in the rural setting, very often use their localized knowledge for weather forecasting and disaster management like flood, cyclone, droughts and riverbank erosion in Bangladesh.

Women possess wealth of indigenous knowledge and they use those in their everyday activities including home gardening, food collection and preparation, nutrition management, health seeking with local herbs, agro-forestry, integration of crops with poultry and livestock, seed preservation and storage of grains. Elderly men also possess and use IK. But men and women often have different skills and different knowledge of local conditions and everyday life. The knowledge and skills, the womenfolk possess, sometime differ. Women also contribute greatly to natural resources management and conservation of bio-resources around home and homestead. Both IK and intellectual property rights (IPR) of the women and farmers are affected by the technology and knowledge diffusion of the agricultural extension, media campaign and emerging market forces in Bangladesh.

Chapter-4: Key Features of Sustainable Agriculture and the Challenges for Bangladesh Agriculture

4.1 Agriculture and Rural Livelihoods

Agriculture used to be conventionally defined as the cultivation of land for producing crops only. Currently, the scope of agriculture has been widened significantly. According to National Agricultural Policy (NAP) of Bangladesh, any applied activity through proper utilization of natural resources, which relates to the production, development, preservation, processing, marketing and extension of not only crops but also other agricultural commodities such as fish, meat, eggs and forest products are accepted within the purview of agriculture. Crop production, animal husbandry, fisheries, forestry etc., are integral components of agriculture. But, crops undoubtedly constitute the largest and most important sector in Bangladesh agriculture (Ministry of Agriculture, GoB, 1998). Agriculture and agro-ecosystems provide the major crops, fish, livestock, poultry, forest products as well as feeds for livestock and poultry. The FAO reports that global agriculture provided 99% of the calories of world population in 1997 and it also provided 95% of all animal and plant protein globally (WRI, 2001).

The World Resources Institute, in its recent report, describes the historical growth and contribution of global agriculture and agro-ecosystems to human society and civilization. The report also identified the emerging problems and challenges of global agriculture. According to the report, historically agricultural output has increased mainly by bringing more land into production systems, but the last five decades have seen intensification of agricultural production with high capital and technological and managerial inputs all over the world. In some areas, particularly in Asia, farmers have intensified production by raising multiple crops each year, irrigating fields and using new crops varieties with short growth cycles. On high quality and non-irrigated lands, farmers have intensified production mainly by abandoning or shortening fallow periods and moving to continuous cultivation applying modern agricultural technologies. Agricultural intensification is widespread even on lower quality lands, particularly in developing countries using modern seeds, irrigation, flood control and chemical inputs (WRI, 2001).

At the same time, the unprecedented scale of agricultural expansion and intensification with modern seed varieties and agricultural technologies has raised many ecological, economic and social concerns. There are growing concerns about productive capacity of the agro-ecological systems e.g., can the agro-ecosystems withstand the stresses (such as erosion, depletion of soil nutrient and fertility, pollution of land and water, destruction of bio-resources and over exploitation of natural resources) imposed by rapid and in many cases unwise intensification of agriculture? There is also concern about the negative impacts on other ecosystems- impacts that are often accentuated by intensification of agriculture. The harmful effects of increased soil erosion on downstream fisheries and wetlands and the damage to both aquatic resources and human health from chemical fertilizer and pesticide residues in products and the agro-ecosystems are cited as examples (ibid). The environmentalists expressed a number of economic concerns (productivity and cost-benefits) as well as social concerns such as the growing inequity,

dislocation of marginal and poor from their tradition occupations and destruction of rural livelihood, rapid social and cultural changes and instability in society.

Hence, the questions of sustainability of the agricultural productivity, sustainability of agro-ecological systems as well as the livelihood of the farmers and rural community are raised. There have been many efforts of both identifying the problems and possible solutions by defining the possible features of sustainable agriculture. There is much discussion on the possible feature of sustainable agriculture and I would like to introduce the discourse on sustainable development before focusing on the issues and concepts of sustainable agriculture.

4.2 Discourses on Sustainable Development

Development is termed as a progressive social and economic transformation for and by the people. Development is defined as an evolutionary process of economic growth and changes of social, institutional and cultural systems for a progressive transformation of the society. The concepts of freedom, participation in decision making towards fulfilling one's potentials, and rights to organize people and activities etc., are all essential conditions for development process (Sen, 1998). Development can also be looked at in terms of basic securities such food security, water security, health security, social security and political decision-making and participation. Sociologists have defined development as unfolding of human potentials for meaningful participation in social, economic, political and cultural processes and institutions, so that people can improve their various conditions (economic, social, cultural and political). Hence development cannot be "delivered" rather it is "achieved" by the people (Rahman MA, 1994).

The history of development literature of the past century reveals that the economists primarily dominated development thinking. Development economics emerged as a discipline after the 2nd World War to reconstruct the newly independent countries in the Asia, Africa and Latin America. It was believed at that time that the countries of the South could be developed following the path of industrialized countries of Europe and North America. Rostow has designed a linear path of development know as five stages development i.e., pre-condition for take off, take off, drive to maturity and high mass consumption. To this paradigm of thought, development meant modernization, industrialization and westernization. Efforts were made from various levels to develop the southern countries through industrialization and modernization and the result was not always pleasing in many cases. There have been some sort of economic and social transformations in the developing countries but the transformation was not always positive and the impacts of such development efforts were in many cases very bad in the forms of destruction of natural resources and degradation of environment, de-stabilization of social system, increase of social inequality and poverty etc.

After 5-6 decades of development efforts and multilateral cooperation, we have a very unequal world with lots of economic, social, political, cultural and environmental problems. Many of the problems are the results of those development efforts centrally designed and greatly influenced by the external forces. Now, the world has accumulated

the highest amount of resources of all kinds (financial, physical, information, human and intellectual) and at the same time, the planet has the highest number of population (more than 6 billions) with greater number of people living in abject poverty, food insecurity, social insecurity, environmental threats and the highest degree of inequality in terms of wealth, consumption and power. The world has the problem of over development and under-development (Rahman and Mallick, 2003).

Many development thinkers (like Chambers, Sen and Rahman) have criticized the conventional development approach and viewed that the basic premise of the conventional development paradigm was the conception of a hierarchical human spectrum, in which some quarters felt that they are superior and are therefore qualified to guide, control and determine the others development. In this view, some nations are more developed than other nations, some classes within society are superior to others in terms of education, achievement and culture. This superior quarters create, or occupy and control of already existing structure to exercise organized domination over the "inferior" – globally, nationally and locally. The world has witnessed the domination of this development paradigm, where western financial capital and the World Bank played a very key role in the form of credit culture and technology transfer. The developing Southern countries were caught in a dependency relation and this process very often resisted the self-development of the South.

However, there have been many shifts in development paradigm and efforts in the last 50-60 years. The modernization and industrialization approach failed. The new approaches like people's centre participatory development; grassroots development; sustainable development etc., were proposed to bring about progressive change in society. In this process, social value, people's participation, their knowledge and wisdom was re-discovered. Further, to address the global and local environmental problems (created by economic growth, production and consumption), the concept of sustainable development was put forward in the late 1980s.

The initial view on sustainable development was given by the Brundtland Commission report known as "Our Common Future". The report was first published in 1987, which defines sustainable development as the "development that meets the needs of present without compromising the needs of future". The Commission's report was placed at the World Conference on Environment and Development (WCED), which suggests the following objectives of sustainable development:

- Reviving growth and changing the quality of growth;
- Meeting the essential needs for job, food, energy, water and sanitation;
- Ensuring sustainable level of population;
- Conserving and enhancing natural resources;
- Reorienting technology and managing risk;
- Merging environmental consideration and economic in decision making;
- Reorienting international economic relation; and
- Making development participatory.

This approach suggests a value system that gives equal weight to generation present today and those yet to come. The concept of sustainable development has three imperatives: a) economic imperative (meaning growth, efficacy and stability); b) environmental imperative (conservation of natural resources and biodiversity, reduction of pollution and maintaining quality of environment); and c) social imperatives such as participation, inclusion, empowerment, social justice and equity (Rahman and Mallick, 2004). After the WCED in the last two decades, sustainable development has emerged as a leading concept for integrating economic, social and environmental aspects of development. The governments, civil society groups, NGOs and the business communities have agreed on the principles of sustainable development and its implementation at the UNCED (UN Conference on Environment and Development) in Rio in 1992 and in the UN-WSSD (United Nations World Summit on Sustainable Development) in Johannesburg in 2002.

The Agenda-21 (which was adopted at the UNCED in 1992) states that economic development; social development; and environmental protection are interdependent and mutually reinforcing components of sustainable development. Sustained economic growth is essential to the economic and social development of all countries, particularly in developing countries. Such growth should be broadly based benefiting all people and countries through eradication of poverty, hunger, disease and illiteracy as well as providing adequate shelter and secure employment and income for all. Growth can foster development only if its benefits are fully shared. It must therefore also be guided by equity, justice and social and environmental considerations. Development, in turn, must involve measures that improve the human conditions and the quality of life itself. It further stresses that sustainable development strategies are important mechanisms for enhancing and linking national capacity so as to bring together priorities in social, economic and environmental policies.

Hlmberg and Sanbrook again gave an interesting analysis on sustainable development and suggested integration of three sets of goals for achieving sustainable development, which include: a) biological system goals i.e., genetic diversity, resilience and biological productivity; b) economic goals for increasing productivity of goods and services, satisfying basic needs and improving quality of lives; and c) social goals for cultural diversity, social justice, equity and participation. The development process has to ensure an equitable and just society. It has to consider creation of inter-generational and intra-generational equity as well as inter-national and intra-national equity. Human beings must remain at the centre of sustainable development. Sustainable development process has to integrate externalities such as environmental and social costs in the development for the present generation without compromising the developmental potential and opportunities for future generations (Hlmberg and Sanbrook, 1992).

The WSSD agreed that the UNCED process has provided the fundamental principles and programme of action for achieving sustainable development and made commitment to achieve Millennium Development Goals (MDGs). The WSSD also promised to promote effective integration of the three key components of sustainable development i.e., economic development, social development and environment protection – as

interdependent and mutually reinforcing pillars. The plan of implementation of the WSSD puts emphasis on poverty eradication, changing unsustainable patterns of production and consumption and protecting and managing the natural resources for achieving goals of sustainable development. One of the priority areas of WSSD Plan of Implementation has been the development of agriculture, which was reflected in their WEHAB (water, energy, health, agriculture and biodiversity) programme.

However, the Third World Network (TWN) has been very critical about the WSSD process and outcomes. The TWN, with other actors in the field of agriculture, raised the ecological, economic and social concerns of the agro-ecological systems at the WSSD in 2002. According to them, agriculture is perhaps the most outstanding issue and challenge for sustainability objective for the planet. They argued that urgent actions were required because agriculture has multiple roles in developing counties to help ensure food security, anchor rural development, provide resources for the livelihood and income of majority people for their survival. The TWN suggests that urgent actions are required on three fronts: ecological, social and economic areas to attain the sustainable development goals for the global communities (TWN, 2002).

4.3 Mainstream Thoughts on Sustainable Agriculture

Defining sustainable agriculture has been a very difficult task. However, the concerns expressed and ideas developed during World Conference on Environment and Development in 1987 and the UN Conference on Environment and Development in 1992 as well as the principle adopted in the Agenda-21 gave the basis and perspectives for thinking about sustainability of agriculture. Concerns about the sustainability have been expressed during UNCED and the Agenda21 puts emphasis on agriculture, which has been the main stay of the majority people in the world, particularly in the developing countries. A number of academics and research institutes have put forward their ideas and concepts about the possible features and elements of sustainable agriculture. The key programmes and institutions that discussed the sustainability of the sector are: sustainable agriculture and rural development (SARD) of UNDP, Low Input Sustainable Agriculture (LISA), Sustainable agriculture Research and Education Programme (SAREP) in USA, Sustainable Agriculture Network (SAN) and International Institute on Environment and Development (IIED), London.

According to the Sustainable Agriculture Research and Education Programme (SAREP) based at the University of California in the USA, the term "sustainable agriculture" means an integrated system of plants and animal production practices having a site-specific application that will, over the long term:

- satisfy human food and fiber needs;
- enhance environmental quality and the natural resource base upon which the agricultural economy depends;
- make the most efficient use of nonrenewable resources and on-farm resources and integrate, where appropriate, natural biological cycles and controls;

- sustain the economic viability of farm operations; and
- enhance the quality of life for farmers and society as a whole (SAREP, 2001).

Sustainable farming systems are capable of maintaining their productivity and usefulness to society indefinitely. Such systems must be resource-conserving, socially supportive, commercially competitive, and environmentally sound. The mainstream thinkers in the domain of agricultural research and development have suggested four key elements of sustainable agriculture including productivity and economic cost-benefit; social and cultural aspects; technological; and ecological concerns. The following sections describe briefly the positions and thought- frames of the key institutes and programmes on the concept of sustainable agriculture.

The Concept of Sustainable Agriculture in the UN Agenda-21

The Agenda 21 reports that by the year 2025, about 83% of the expected global population of 8.5 billion will be living in developing countries while the capacity of available resources and technologies to satisfy the demands of this growing population for food and other agricultural commodities remains uncertain. Agriculture has to meet this challenge, mainly by increasing production on land already in use and by avoiding further encroachment on land that is only marginally suitable for cultivation. The Agenda21 suggests adjustments in agricultural, environmental and macroeconomic policy, at both national and international levels, in developed as well as developing countries, to create the conditions for sustainable agriculture and rural development (SARD). The major objective of SARD is to increase food production in a sustainable way and enhance food security. This may involve education initiatives, utilization of economic incentives and the development of appropriate and new technologies, thus ensuring stable supplies of nutritionally adequate food, access to those supplies by vulnerable groups, and production for markets; employment and income generation to alleviate poverty as well as natural resource management and environmental protection.

The priority must be on maintaining and improving the capacity of the higher potential agricultural lands to support an expanding population of the world. However, conserving and rehabilitating the natural resources on lower potential lands in order to maintain sustainable land and man ratio is also necessary. The main tools of SARD are policy and agrarian reform, participation, income diversification, land conservation and improved management of inputs. The success of SARD will depend largely on the support and participation of rural people, national governments, the private sector and international cooperation including technical and scientific cooperation. The chapter-14 of the Agenda-21, which deals with sustainable agriculture for the planet, suggests the following programme and action areas:

- agricultural policy review, planning and integrated programming in the light of the multifunctional aspect of agriculture, particularly with regard to food security and sustainable development;
- ensuring people's participation and promoting human resource development for sustainable agriculture;

- improving farm production and farming systems through diversification of farm and non-farm employment and infrastructure development;
- land-resource planning information and education for agriculture;
- land conservation and rehabilitation;
- water for sustainable food production and sustainable rural development;
- conservation and sustainable utilization of plant genetic resources for food and sustainable agriculture;
- conservation and sustainable utilization of animal genetic resources for sustainable agriculture; integrated pest management and control in agriculture;
- sustainable plant nutrition to increase food production; rural energy transition to enhance productivity; and
- evaluation of the effects of ultraviolet radiation on plants and animals caused by the depletion of the stratospheric ozone layer (UNDP, 1992).

Low External Input for Sustainable Agriculture

High external and non-renewable inputs in farming created many economic, social and ecological problems. Hence, low external input and high local inputs based agricultural practices have been suggested by researchers and development practitioners. The International Institute for Environment and Development (IIED) in London has long experience of working on sustainable development concept and agricultural issues. Pretty et al (1992) contributed a chapter on regenerating agriculture to a book entitled, "Policies for a small planet." They have suggested to reducing external inputs and increase community participation in farming practices for sustaining agricultural productivity. In their deliberation, they have profoundly discussed the characteristics of high and low input systems of agriculture and maintain that green revolution has encouraged the development of two distinctly different types of agriculture in countries of the South. The first type has been able to respond to the technological packages, producing high-external input (HEI) systems of agriculture. These tend to be endowed with good soils and adequate supply of water, through either stable rainfall or irrigation systems, and access to marketing infrastructure, modern farm inputs, machinery, transport, agro processing facilities and credit.

The HEI systems are found in the large irrigated plains and deltas of South, South-east and East Asia, and parts of Latin America and North Africa, but also in patches in other regions. They tend to be focused upon mono crops and mono-animal enterprises, and geared for sale. They include lowland irrigated rice, wheat and cotton; plantations of bananas, pineapples, oil palm and sugar cane; market gardening near to urban centers; and intensive livestock rearing and ranching.

The second type comprises all the remaining agricultural and livelihood systems, which in terms of area, are in the great majority. These are the low-external input (LEI) systems and are located in dry lands, wetlands, uplands, near-deserts, mountains and hills. Farming systems in these areas are complex and diverse. The rural livelihoods are dependent on natural resources as well as agricultural products. Agricultural yields are

low in LEI system, but it gives livelihood supports and subsistence for millions of poor and marginal farmers, who are directly or indirectly involved in such systems.

The LEI system supports diversity, it means that what is appropriate for one farmer may not be for a neighbour; they are remote from markets and infrastructure; they are located on fragile or problem soils; they have very low productivity; they are less likely to be visited by agricultural scientists and extension workers; and they are much less likely to be studied in research institutions. The number of people directly supported by LEI systems is enormous, but yet most agricultural development assistance has emphasized external resources on HEI. They can neither afford to sustain the use of external resources, nor produce them in their own economics; the alternative lies in LEI systems. For regenerating agriculture through low external inputs, they have noted that there is enormous potential in LEI systems. Productivity is certainly far below potential levels, unlike in the Green Revolution areas. The key question is now: how best can this potential be partly or fully unlocked? An alternative and regenerative agricultural strategy is quite different to that of the HEI approach exemplified by the Green Revolution. However, such LEI agricultural system pursues the following goals:

- produce more thorough incorporation of natural processes such as nutrient cycles, nitrogen fixation and pest-predator relationships;
- reduction in the use of external, off-farm inputs with the greatest potential to harm the environment or the health of farmers and consumers;
- greater productive use of the biological and genetic potential of plant and animal species; and
- improvement of the match between cropping patterns and the productive potential and physical limitations of agricultural lands to ensure long-term sustainability of current production levels (ibid).

There is now growing evidence that the result of such a regenerative strategy will be the creation of more productive and sustainable systems that emphasize the use of available resources and do not damage the environment as well as avoid the dependency on external and locally uncontrollable resources and systems. Despite the diversity of LEI systems, and the range of research and extension efforts developed for them, there are certain common elements critical for their successful development. These are: building on local knowledge of pest management, soil and nutrient conservation, water conservation and harvesting, waste recycling and irrigation; building on local social organization and management systems; and using process-oriented approaches for projects to permit sequential and adaptive planning and development (Pretty et al, 1992).

In their recent work, Rosset and Benjamin reported a very interesting example of low input sustainable agriculture called LISA that has been practiced in Cuba in early 1990s. The Global Exchange from USA sent an international scientific delegation and fact finding mission to examine the change that have been taken place in Cuban agriculture since 1990 collapse of that country's trading relations with the socialist bloc. Cuban agriculture was based on large scale and high capital characterized by mono-culture with high external inputs before 1990. When the trade relation with socialist bloc collapsed

both the import of chemical fertilizers and pesticides dropped greatly. Suddenly, an agricultural system almost as modern and industrialized as that of California was faced with a duel challenges: the need to double food production while more than halving the inputs.

The facts finding mission reports that Cuba was prepared to meet the challenges by introducing an alternative model of agriculture with low inputs - known as organic farming. The approach seeks to promote the ecological sustainability of production by replacing the dependency on heavy machineries and chemical inputs with animal traction, crops and pasture rotation, soil conservation, biological pest control etc. The alternative model also supported re-incorporation of rural population into agriculture through utilizing their labour and local knowledge of traditional farming practices. The approach further encouraged the active participation of farming population in generation of new technologies for alternative agriculture. The mission report concludes that the experience of alternative agriculture in Cuba is unprecedented with potentially enormous implications for other countries suffering from sustainability question due to conventional agricultural production (Rosset and Benjamin, edited, 1994).

Sustainable Agriculture Research and Education Programme (SAREP)

The University of California of the USA runs a programme called SAREP. According to SAREP, sustainable agriculture integrates three main goals: environmental health, economic profitability, and social and economic equity. A variety of philosophies, policies and practices have contributed to these goals. People in many different capacities, from farmers to consumers, have shared their visions and contributed to it. Despite the diversity of people and perspectives, the following themes commonly weave through definitions of sustainable agriculture. Sustainability rests on the principle that we must meet the needs of the present without compromising the ability of future generations to meet their own needs. Therefore, *stewardship of both natural and human resources* is of prime importance. Stewardship of human resources includes consideration of social responsibilities such as working and living conditions of the farmers and farm workers, the needs of rural communities, and consumer health and safety both in the present and the future. Stewardship of land and natural resources involves maintaining or enhancing this vital resource base for the long term.

This thought-frame suggests that a *systems perspective* is essential to understanding sustainability. The system is envisioned in its broadest sense, from the individual farm, to the local ecosystem to communities affected by this farming system both locally and globally. An emphasis on the system allows a larger and more thorough view of the consequences of farming practices on both human communities and the environment. A systems approach gives us the tools to explore the interconnections between farming and other aspects of our environment. A systems approach also implies interdisciplinary efforts in research and education. This requires not only the input of researchers from various disciplines, but also farmers, farm workers, consumers, policymakers and others.

Making the transition to sustainable agriculture should be treated as a process. For farmers, the transition to sustainable agriculture normally requires a series of small, realistic steps. Family economics and personal goals influence how fast or how far

participants can go in the transition. It is important to realize that each small decision can make a difference and contribute to advancing the entire system further on the "sustainable agriculture continuum." The key to moving forward is the will to take the next step. It is also important to point out that reaching toward the goal of sustainable agriculture is the responsibility of all participants in the system, including farmers, laborers, policymakers, researchers, retailers, and consumers. Each group has its own part to play, its own unique contribution to make to strengthen the sustainable agriculture community. Besides the economic and social imperatives achieving sustainable agriculture, it is suggested to maintain diversity in farming systems as well as in species and ecosystems; proper resources management including land and water, appropriate and efficient uses of inputs; and finally upholding a good goal of farming which may commensurate with a worthy purpose of living and livelihood of the farming communities. The SAREP, considering the agricultural development in the West, suggests the following key elements for achieving sustainability in agricultural sector.

a. Maintaining Diversity

Diversified farms are usually more economically and ecologically resilient. While monoculture farming has advantages in terms of efficiency and ease of management, the loss of the crop in any one year could put a farm out of business and seriously disrupt the stability of a community dependent on that crop. By growing a variety of crops, farmers spread economic risk and are less susceptible to the radical price fluctuations associated with changes in supply and demand.

Crop diversity and bio-diversity can also buffer a farm in a biological sense. For example, in annual cropping systems, crop rotation can be used to suppress weeds, pathogens and insect pests. Also, cover crops can have stabilizing effects on the agro-ecosystem by holding soil and nutrients in place, conserving soil moisture with mowed or standing dead mulches, and by increasing the water infiltration rate and soil water holding capacity. Cover crops in orchards and vineyards can buffer the system against pest infestations by increasing beneficial arthropod populations and can therefore reduce the need for chemical inputs. Using a variety of cover crops is also important in order to protect against the failure of a particular species to grow and to attract and sustain a wide range of beneficial arthropods.

Optimum diversity may be obtained by integrating both crops and livestock in the same farming operation. This was the common practice for centuries until the second half of the last century when technology, government policy and economics in developed and developing countries compelled farms to become more specialized. Mixed crop and livestock operations have several advantages. First, growing row crops only on more level land and pasture or forages on steeper slopes will reduce soil erosion. Second, pasture and forage crops in rotation enhance soil quality and reduce erosion; livestock manure, in turn, contributes to soil fertility. Third, livestock can buffer the negative impacts of low rainfall periods by consuming crop residue that in plant only systems would have been considered crop failures. Finally, feeding and marketing are flexible in animal production systems. This can help cushion farmers against trade and price fluctuations and, in conjunction with cropping operations, make more efficient use of farm workers.

b. Land and Soil Management

A common philosophy among sustainable agriculture practitioners is that a "healthy" soil is a key component of sustainability; that is, a healthy soil will produce healthy crop plants that have optimum vigor and are less susceptible to pests. While many crops have key pests that attack even the healthiest of plants. proper soil, water and nutrient management can help prevent some pest problems brought on by crop stress or nutrient imbalance. Furthermore, crop management systems that impair soil quality often result in greater inputs of water, nutrients, pesticides, and/or energy for tillage to maintain yields.

In sustainable systems, the soil is viewed as a fragile and living medium that must be protected and nurtured to ensure its long-term productivity and stability. Methods to protect and enhance the productivity of the soil include using cover crops, compost manures, reducing tillage, avoiding traffic on wet soils, and maintaining soil cover with plants and mulches. Regular additions of organic matter or the use of cover crops can increase soil aggregate stability, soil fertility, and diversity of soil microbial life.

c. Efficient use of inputs and BMP

Many inputs and practices used by conventional farmers are also used in sustainable agriculture. Farmers, however, maximize reliance on natural, renewable, and on-farm inputs. Equally important are the environmental, social, and economic impacts of a particular strategy. Converting to sustainable practices does not mean simple input substitution. Frequently, it substitutes enhanced management and scientific knowledge for conventional inputs, especially chemical inputs that harm the environment on farms and in rural communities. The goal is to develop efficient, biological systems, which do not need high levels of material inputs. Sustainable approaches are those that are the least toxic and least energy intensive, and yet maintain productivity and profitability. Preventive strategies and other alternatives should be employed before using chemical inputs from any source for maintaining agro-ecological systems.

d. Farmer's goals and lifestyle choices

Management decisions should reflect not only environmental and broad social considerations, but also individual goals and lifestyle choices. For example, adoption of some technologies or practices that promise profitability may also require such intensive management that one's lifestyle actually deteriorates. Good practices and better management decisions are required that can promote sustainability, nourish the environment, the community and the individual. A worthy purpose of farming for good food, nutrition and stable income for long time instead quick commercial gains may promote best practices contributing to achieving sustainability of the sector.

e. The Economic and Social Context

In addition to strategies for preserving natural resources and changing production practices, sustainable agriculture requires a commitment to changing public policies, economic institutions, and social values. Strategies for change must take into account the

complex, reciprocal and ever-changing relationship between agricultural production and the broader society. The "food system" extends far beyond the farm and involves the interaction of individuals and institutions with contrasting and often competing goals including farmers, input suppliers, farm workers, unions, traders, processors, retailers, consumers, and policymakers. Relationships among these actors shift over time as new technologies spawn economic, social and political changes. A wide diversity of strategies and approaches are necessary to create a more sustainable food system. These will range from specific and concentrated efforts to alter specific policies or practices, to the longer-term tasks of reforming key institutions, rethinking economic priorities, and challenging widely held social values (SAREP, 2003).

4.4 Key Elements of Sustainable Agriculture

The above discussion reveals that there are many approaches and definitions of sustainable agriculture. Though there are diverse options regarding the issues, problems and possible solutions, but there are also commonality in problem identification, possible solutions and the features of sustainable agricultural systems. The definition of Sustainable Agriculture by the FAO has received very wide international approval and commitment, which states that the sustainable agriculture approach aims to foster sustainable development in the agriculture, fisheries and forestry sectors that conserves land, water, plant and animal genetic resources. The sustainable agricultural systems should be environmentally non-degrading, technically appropriate, economically viable and socially acceptable (Vorley, 2002). Preservation of the productive capacity and resilience of natural systems is obviously a precondition upon which profitability and equitable sharing of benefits depend. This is acknowledged in Gordon Conway's definition: 'Sustainable agriculture is one which is resistant to stress and shock, and which combines productivity, stability and equity. Most uses of the term 'sustainable agriculture' focus on the "environmentally non-degrading" elements of the FAO definition i.e., producing food and income while minimizing negative impacts on the environment (ibid).

Murakami has long experience of agricultural research in Asia and he urges to take lessons from the nature. He prepared a guideline for ecological farming for achieving sustainability in the sector in tropical countries including Bangladesh. To him, the principle of ecological agriculture would be to maintain biodiversity, protect soil fertility, maintaining multi-structures and recycling. He also suggests that we should not disturb the natural environment and reduce dependency on external inputs to make agricultural system sustainable (Murakami, 1991).

Hence, this study considers the key features of the sustainable agriculture could be based on the four common sets of elements, which include: **economic elements** i.e., augmenting productivity, economically beneficial and stable for long time; **social aspects** (livelihood support for farm families, socially responsible and equitable and culturally adaptive); **environmental concerns** (conservation of land, water and all natural and bio-resources, use less harmful and more renewable energy and resources, reducing pollution impacts to ecosystems and human health); and **knowledge and technological**

considerations i.e., information and awareness, promoting local knowledge and low cost inputs and adapted technologies. Further, achieving sustainability in any sector including agriculture would require a worthy set goal for the producers (i.e., production for food, nutrition, livelihood, wealth and well being and quality life choices for the rural community) and preaching and practicing value systems conducive to the above concerns and considerations. Sustainable agriculture must provide a fair and reasonably secured living for farm families; it should benefits rather than harming the natural environment and must maintain basic natural resources such as healthy and productive soil, clean water, clean air, crops and biodiversity. It should support a viable rural communities and fair share of benefits among the involved people including farmers and farm workers to small traders and consumers (SAREP, 2001, Vorley, 2002 and SAN, 2000).

4.5 Agricultural Development in Bangladesh: Present Scenario and the Future Challenges

Bangladesh is experiencing medium scale economic growth with industrialization and expansion of trade, business and service sectors. But still the country is considered an agrarian one and agriculture has been the mainstay of majority people of the country. Agriculture contributes over a quarter of country's GDP, provides about two-thirds of employment and brings about a quarter of export earning. More than 65% of the rural population of Bangladesh directly and indirectly depends on agriculture for their livelihoods and the sector has to feed the country's over 140 million people. Agriculture grew on an average at 2.3 percent annually during the latter half of the 1990s. The main drives came from crops sub-sector, which accounted for 58 percent of total agricultural value added and it grew at 2.2 percent annually over the last decade. But the non-crop sub-sectors of agriculture such as poultry, livestock and fishes also have lot of dynamisms and significantly contributed to people's livelihoods and the economy (Mandal, 2003).

The crops contribute to the major share in agricultural outputs in Bangladesh while the other sub-sectors such as fisheries, livestock, poultry, forestry etc., also contributed to the growth of the sector. Despite this growth, Akash (1998) feels that the main challenge of Bangladesh agriculture has been to increase of output by intensification and diversification of agricultural productivity. Bangladesh agriculture should produce the required marketable surplus to feed the growing population. In this context, Brammer (1997) feels that the increasing capitalization of farm enterprise, which is implicit in the adaptation of modern technologies such as irrigation, HYV seeds, fertilizers, pesticides etc., may increase the threshold of economic farm size in Bangladesh as it has been done elsewhere in the world and thus the process would push many small farmers out of the cereal production. He also predicts many conflicts between economic gain and agro-ecology.

For example, the increase of irrigation for intensive form of agriculture will affect fisheries and wetland. Such changes and conflicts can be painful but they are inevitable in the face of rapid changes taking place as a consequence of the pressure on the society and economy by the increasing population and their need for consumption and commercial

interests of a set of people. It is suggested not to stop development order, but the adoption of development measures should expand benefit for many and society as a whole. Such development measures should not be introduced in a laissez faire manner as were in the past. The introduction of new technologies need to be combined with the realistic assessment of economic, social and environmental implications of both planned and unplanned changes and at the same time mitigation measures are to be taken at different levels ((Akash MM, 1998,Brammer, 1997, Hossain M and Shahabuddin, 1997). The following sections briefly describe the country's geophysical feature and climate, which largely determine the agro-ecological systems and interaction between people, environment and agriculture.

Geo-Physical Conditions and the Climate

The country is located in the northeastern part of South Asia between 20° 34" and 26° 38" north latitude and 88° 01" and 92° 41" east longitude, bordered by India in the west and north, India and Myanmar in the east land and the Bay of Bengal in the south. Geographically, Bangladesh occupies a large part of the massive delta formed by the Ganges, the Brahmaputra, and the Meghna river systems through which rainfall from the catchment area and the melted snows of the Himalayas drain into the Bay of Bengal. Being essentially a delta, the country is a flat, fertile, alluvial plain with a fairly homogeneous type of land resource. Elevation seldom exceeds 10 m above sea level, with major exceptions being the Chittagong Hill Tracts region in the southeast, the low hills of the Sylhet district in the northeast, the Barind Tract in the northern region and the Madhupur Tract in the central region. A most impressive characteristic of the landscape is the profusion of rivers including the Padma, the Jamuna, the Meghna and the Karnafuli and their numerous tributaries that traverse most regions of the country. Tropical monsoon rains drench the land and the rivers overflow their banks and cause flooding of low and outlying areas almost every year. As a result of frequent flooding, the land has been continuously enriched by heavy silt deposition during the rainy season (Rashid, 2005).

The land resource of Bangladesh totals about 14.2 million ha, and the land is cultivated with moderate intensity. About 60% of the total land area is devoted to crop production in a given year. Cereals, mainly rice and wheat, account for two-thirds of agricultural production. Area under cereals accounted for 76% of the total cropped area in 1993/94. The area under pulses, oilseeds and vegetables was reported to be 6.6, 4.4 and 2.2% of the total cropped area, respectively, in the same year. Forests occupy about 15% of the land area. Only 1.7% of land is considered waste and much of that is potentially reclaimable, but at a relatively high economic cost (Chowdhury and Harry, 2001). The major increase in agricultural land use has been associated with rice, wheat and potatoes, while the area under jute cultivation has declined. Marginal increases in area have occurred with rape, mustard and masur or lentil. Land use for other crops has remained more or less stable, except in very limited cases, where irrigation and market access have encouraged small shifts to higher value cash crops. Apparently, some land has moved from "culturable waste" and "current fallow" to crop production over the years.

Bangladesh enjoys a tropical monsoon climate characterized by three main seasons: (i) a hot and humid summer season from March to early May; (ii) a hot and humid monsoon season from June through October; and (iii) a cool and drier winter season from November to February. During the summer period, northwesterly airflow predominates, bringing moderate rainfall. This period is followed by the monsoon season with much heavier rainfall. Winter is quite pleasant with a minimum temperature around 10°C. The monsoon period accounts for 80% of the total annual rainfall. The average annual rainfall varies from 1500 mm (60 inches) in the west to more than 3000 mm (120 inches) in the east, covering the coastal areas of Chittagong and the northern parts of Sylhet district. This is a very critical risk factor in agricultural production, since there is a high degree of rainfall variability in Bangladesh from year to year. A delay of seven to ten days in the arrival of monsoon rains can have a drastic impact on the total grain harvest. Floods and drought are common consequences of the extreme weather patterns found in Bangladesh, causing not only crop damage but also affecting the livelihoods of the rural people.

The following table shows the information on farm families as well as cultivated land in Bangladesh. It is evident from the data that in Bangladesh majority farmers are small holders (80%) followed by medium holders (17%) and only 3% are large farmers. The average farm size is also very small i.e., 1.5 acres in Bangladesh.

Table-2: Basic Information on Farm Households, Cultivable Areas and Irrigated Land in Bangladesh

No. of Rural Household	17.83 million
No. of non-Farm Household	6.03 million
No. of Farm Household	11.80 million
No. of Agril. Labour Household	6.40 million
Small Household	80% (9.42 million)
Medium Household	17.50% (2.08) million)
Large Household	2.50% (0.3 million)
Cultivated Area per Household	1.5 acres
Cropping Intensity (2001-20002)	174%
Irrigation Area (2001-20002)	8.59 million acres

Source: Statistical Year Book of Bangladesh, 2002, BBS

Cropping Patterns

In general, the rainfall and temperature of Bangladesh provide excellent conditions for agricultural production. The climate and land resource endowment are capable of producing a wide variety of products year-round. The year-round growing season offers considerable potential for multiple crops, provided that cropping patterns and resource availability can be properly coordinated. Cropping cycles are closely associated with rainfall and climatic patterns. Among the major crops, Aman rice (particularly the broadcast Aman) and to some extent Aus rice have production cycles to take advantage of the monsoon rains. Boro rice, on the other hand, has been developed to grow in dry season, which requires winter irrigation for optimal production. Wheat, potatoes and most of the pulses, oilseeds, and vegetable crops, which are grown during the winter months, sometime require irrigation. However, irrigation is not widely applied to these crops (ibid).

The main source of crop sub-sector growth has been rice cereals, which demonstrated spectacularly high growth of 4.5 percent during the second half in the first half of the 90s. The overall growth of food grain sub-sector was 3.4 percent, which surpassed the population growth rate of less than 2 percent per annum. Wheat, the second important cereal crop, showed an average annual growth of 11.7 percent during 1995-96 to 1998-99. In addition to rice and wheat, the area and output of vegetables grew at 4.47 and 4.44 percent respectively per annum during the 1990s. In addition to growing demand for vegetables domestically, the main impetus seem to have come from technological improvement in vegetable cultivation and growth in vegetable exports market, although the volume and earning from vegetable exports showed a declining trend since the year of big flood in 1998. The production of fruits also grew moderately at around one percent per annum, although the production of fruits shows a somewhat declining trend in the recent years. While there has been significant growth in overall crop sector, pulses, oilseeds and sugarcane exhibited negative growth rate since the latter half of the 1990s (Mandal, 2003).

Diversification and Commercialization of Agriculture

Bangladesh agriculture has experienced considerable diversification in response to technological shifts, market opportunities and changes in dietary habits. Firstly, relative contribution of crop agriculture to GDP has been declining, while that of non-crop enterprises is gaining greater share. Secondly, monsoon dependent low-yielding Aus rice has been giving space to HYV Boro rice production. Thirdly, significantly diversification from rice to a number of non-rice crops is taking place. Fourthly, there has been a remarkable increase in the share of non-crop agriculture to GDP, especially in the poultry, small-scale dairy and pond fishery production. Fifthly, there has been some improvement to value addition to agricultural products, but it is far less than expected due to inadequate infrastructure, credit and fiscal supports.

Shift in Technological Base and Growing Dependency on External Inputs

Despite declining farm size, increasing land fragmentation and the alleged depletion of organic matter content in soil, the country has enjoyed a major upsurge in food grain production over the last two decades. The main driving forces behind this increase include the following. Firstly, there has been a large-scale adoption of high-yielding varieties of rice and wheat. Secondly, intensive cultivation of HYV rice and wheat varieties has been possible due to rapid adoption of two important technologies-mechanized irrigation and tillage mechanization. There are however large variations between districts in terms of irrigation coverage relative to its potentials and development of irrigation water market. Similarly, in the last two decades, mechanized tillage practice gained prominence over ploughing by draft animals. Thirdly, as a result of the changes in technology and its variation by district cropping intensity varied substantially between districts from just about one crop to just about two crops a year.

The agricultural development in the last two and three decades experienced lots of changes. Many of them are the direct and indirect results of modern technology transfer, knowledge and skill development and input supply initialed by the government departments and finally taken up by the farmers and private sector (seeds, fertilizer,

irrigation device sellers etc.). There are also internal dynamisms in the sector and sub-sector i.e., farmer's involvement and innovation in diversification and intensification of the sector and sub-sectors. These have lots of good results, which are also associated with a number of ecological, economic, social and technological problems. The dominant farming practices (HYV crops, vegetable and commercially valuable crops) and majority farmers have been highly dependent on external inputs and supports including seeds, fertilizer, pesticides, irrigation, harvesting and post harvest technologies. As a result, the productivity and real benefits from agriculture has declined greatly in the recent years. Besides the decline of soil fertility, there have been ecological destabilization and destruction of biological resources in many agro-ecological systems, particularly in the flood plain ecosystems due to excessive use of chemical inputs (Mandal, 2003 and Akash, 1998).

4.6 Major Problems of Agriculture in Bangladesh

The expansion of green revolution technologies (seeds, fertilizer, pesticides and irrigation facilities) has increased both crop intensity and yield rate, but these are associated with a number of social, economic and environmental negative consequences (such as cost of farm production increased in many folds, marginalisation of small farmers, degradation of soil fertility, loss of biodiversity, pollution of water, soil and increasing health risk). Akash (1998) has listed a number of negative consequences of the green revolution in the agriculture in Bangladesh. These include: decrease of crop diversity due to mono-cropping of HYV rice, decrease of local crop varieties affecting nutritional status of farmers and rural communities, increase of farm costs and decrease of real economic benefit from agriculture.

Gregow (1998) has examined the negative impacts of chemical inputs in crop cultivation in Bangladesh. According to Gregow, the technologies introduced in Bangladesh agriculture during the last 30 years were replicated from the west. The HYV seeds, chemical fertilizers, pesticides, large scale irrigation and mechanization of agriculture (land preparation with tractor, spraying pesticides, harvesting and post harvest processing etc.) were the key elements of Green Revolution (GR) and this GR technologies ignored the traditional agricultural practices and crop varieties. In the initial stage, the inputs were heavily subsidized by the government and thus the farmers were trapped in the GR. Now the farmers are highly dependent on external inputs, particularly for crop and vegetable production. She also maintains that the HVY monoculture has led to erosion of biodiversity and domination of few homogenous varieties in Bangladesh. In the context of the promotion of HYV seeds, the multinational companies largely took over distribution and sales of seeds and the framers have lost their ownership and control over their seeds for crops, vegetables and fruits cultivation. In this process, the local varieties of crops and vegetables have been replaced with the HYV crops. Soil fertility has decreased greatly due to excessive use of chemical fertilizer and the contents of organic matters in the soil have disappeared. The topsoil has become very hard and unsuitable for crop cultivation.

The monoculture of YHV crops has promoted increasing uses of deadly pesticides resulting in severe risk for human health and wetland ecosystems. It is felt that agriculture products in Bangladesh contain chemical residues, which ultimately accumulate in human body through food chain. The excessive use of agro-chemicals created new pest problems. In many cases, pests are becoming resistant to strong pesticides. Further, the farmers who spray harmful pesticides are directly exposed to chemical poisons (ibid).

Challenges of Bangladesh Agriculture

The agriculture sector is termed as the largest contributor to income and employment generation, rural livelihoods in the country. The major challenges of Bangladesh agriculture are to achieve self-sufficiency in food production, reduce rural poverty and foster economic development. The government has therefore attached highest priority to this sector to enable the country to meet these challenges and to make this sector commercially profitable, ecologically sound and socially responsive. The Ministry of Agriculture and Livestock, in a recent policy document has identified a number of constraints, which are the following: agriculture is dependent on the whims of nature and is risky; availability of cultivable land is decreasing; widespread poverty among the population engaged in agriculture; lack of required capital for agricultural activities; inadequacy of appropriate technology considering farmers soci-economic conditions; uncertainty of fair price of agricultural commodities due to underdeveloped marketing system; agricultural commodities are rapidly perishable and post harvest losses are too high; and limited knowledge of common people about the nutritional value of agricultural products and commodities including vegetables and fruits (The National Agricultural Policy, 1998).

4.7 Agricultural Policy and Strategies in Bangladesh

The aims of the National Agricultural Policy (NAP) of Bangladesh are to increase agricultural productivity, food production, income and welfare of the farmers through promotion of appropriate farming practices considering economic, social and environmental issues. The specific objectives of the policy are to:

- Ensure a profitable and sustainable agricultural production system and raise the purchasing power by increasing real income of the farmers;
- Preserve and develop land productivity;
- Reduce excessive dependency on any single crop to minimize the risk;
- Increase production and supplies of more nutritious food crops and thereby ensuring food security and improving nutritional status;
- Preserve exiting bio-diversity of different crops;
- Take up programmes for introduction, utilization and extension of bio-technology;
- Take up necessary steps to ensure environmental protection as well as 'environment-friendly sustainable agriculture' through increased use of organic manure and strengthening of the Integrated Pest Management (IPM) programmes;

- Take appropriate steps to develop an efficient irrigation systems and encourage farmers in providing supplementary irrigation during drought with a view to increasing cropping intensity and yield;
- Establish agriculture as diversified and sustainable income generating sector through strengthening of 'Farming System' based agricultural production and agro-forestry programmes;
- Take up steps to ensure input supplies to the farmers at fair prices in a competitive market and remove difficulties at the farm level which have arisen out of the privatization of input distribution system;
- Develop marketing system to ensure fair prices of agricultural commodities;
- Introduce an appropriate institutional system of providing credit to ensure the availability of agricultural credit in time;
- Produce and supply of agricultural commodities as required by the industrial sector;
- Reduce import of agricultural commodities and find out newer opportunities for increasing exports as well;
- Create opportunities for establishing agro-processing and agro-based industries;
- Promote interests of the small, marginal and tenant farmers; and
- Develop contingency management system to combat natural disasters (NAP, 1998).

The main thrusts of the NAP included: increase crop production, improve land use practices, increase access to agricultural credit, risk management, ensure food security and upgrade nutritional status of the common people, particularly of the small and marginal farmers, recognize and increase involvement of women in agriculture and above all encourage environment friendly agriculture. However, the key challenges of Bangladesh agriculture are: how to achieve sustainability in the sector through:

- Enhancing and continuing productivity of the sector and sub-sectors;
- Addressing the ecological problems and making the sector environmentally friendly;
- Diversification and intensification of the sector with adapted technological backup and farmers innovation;
- Integrating local knowledge and priorities in agriculture; and
- Sectoral integration (NAP, 1998).

Hence, it is evident from the agricultural policy and priorities that the government is committed to continue supports for the development of the sector in order to achieve food security for the growing population, give them nutrition and better health, provide employment and income as well as protect soil fertility and environment through efficient and sustainable uses of land, water, cropping, plants and other resources. There is also a positive shift in policy and strategies towards achieving higher growth in a sustainable manner considering all social, economic, livelihood and environmental issues. But there is need for initiating programmes to turn the policy and strategy into reality for action involving farmers and community at the local and regional levels. In many cases, the local institutions and department of agricultural extensions are not well aware of the changes in national policy and programmes. However, there are few good initiatives by

NGOs and community to address the agro-ecological problems involving farmer's local and traditional knowledge and their own resources. The following sections describe few of them.

4.8 The Emerging Innovative Practices

a. Nayakrishi of UBINIG

An innovative initiative to revive the traditional farming practices, known as Nayakrishi, has been undertaken in three rural areas including Tangail, Pabna and Cox's Bazar districts in Bangladesh by UBINIG, a research organization for alternative development. *Nayakrishi* means new agriculture. It is an initiative of the peasants, motivated and organized by UBINIG, to produce healthy food, healthy environment and happy life for the rural people. To the organizer, it is a new way to relate farmers with nature both metabolically and culturally. Human beings, often fails to notice that they themselves are parts of nature, or nature as human beings has the ability to create and manipulate signs and construct itself as a realm of culture. *Nayakrishi* tries to explore the creative margin between the nature and culture where all origins and differences are recollected in the practice of the production of life giving activities know as agriculture. The guiding principles of *Nayakrishi* are: to increase the use of composed fertilizers instead of chemical fertilizers; promote local crops; enhance multi-cropping, inter-cropping, mixed cropping instead of HYV monoculture. The movement also encourages agro-forestry and other local familiar methods of agriculture, which are eco-friendly. The negative impacts of chemical fertilizers and pesticides, which have been randomly used in rice cultivation in the recent years, led the farmers to turn back to their own traditional practices. The women peasants took the lead to stop the use of pesticides mainly for health reason and latter group of farmers came forward to use green and composed manure in the programme villages (UBINIG,1996).

Farmers are practicing agro-forestry for fuel wood, fruits and various kinds of local trees and plants along with rice and vegetables. They are also trying to integrate livestock, poultry and fisheries as part of farming systems. They are trying to combine rice-duck, fish-duck and triple combination of rice-duck and fish cultivation. Priority to local varieties of livestock, poultry, and fish is given as because the local varieties are always economically advantageous and ecologically suitable (ibid).

b. Eco-Farming of PROSHIKA

Continuous use of chemical fertilizer and insecticides in agriculture has reduced soil fertility and productivity of land. Further, these practices have destroyed agro-ecology in many parts of the country. PROSHIKA: A centre for Human Development has been concerned about those disastrous practices and was engaged in popularizing alternative agricultural methods, which is productive, equitable, conductive to bio-diversity, ecology and sustainable (Activity Report, PROSHIKA, 2001). They call it Ecological Agricultural Programme (EAP). The main objective of ecological agriculture in crop-land is to develop farmers' understanding of the causes of agro-ecosystem degradation and a scientific explanation of the adverse effects they experience. The group members are provided with appropriate training along with financial and technical support. The groups can collectively implement the projects or individual members can do it through their groups. As in other PROSHIKA programmes, women group members are in the majority here too.

Training and other technical supports provided to the members practicing ecological agriculture are an integral part of the programme. Over 300 resource persons have been groomed at the local level to conduct these training courses for the group members, and a total of 40,970 group members and staffs have been trained. Quality seeds can increase yield by more than 15-20 per cent. Therefore, PROSHIKA undertook the seed production programme initially at its 16 centres to support its group members as well as other farmers to promote ecological agriculture and increase productivity. The programme has been expanded in nine more centres and has substantially contributed to the seed production sector of the country. PROSHIKA also makes special arrangements for marketing and distributing the seeds produced by the group members. PROSHIKA organized training courses for concerned staffs and group members who have undertaken projects to help them acquire knowledge of seed production technology. Besides, programme-related workshops are held to share experiences and innovate new ideas and strategies. EAP of PROSHIKA has created lot of interest among farmers, community people, researchers, actors and policy makers in Bangladesh (Raj in Gain, 1998).

c. Farmers Driven Programme of Care Bangladesh

The Care Bangladesh has an agricultural and natural resources sector framer-driven experimental programme. Within this approach, Care Bangladesh is focusing on building capacity of the farmers to innovate in their farming system. Instead of extending technologies prescribed by scientists, the ANR sector projects train farmers to become experts in their own farming practices in specific agro-ecological systems. The farmers are helped to identify and analyze their own problems as well as find the doable solutions and options to address the problems in agriculture. The Department of Agricultural Extension (DAE) of the GoB, with support from UNDP and FAO, has undertaken a project called integrated pest management (IPM) during 1996-2001. In order to pursue self-expansion and sustainability of IPM, the project puts great emphasis on participatory and decentralized community based approach to pest management, where farmers become facilitators of extension services. The project has established farmer-field schools (FFS) run by the farmers. The FFSs provide training on IPM to the fellow farmers. A recent study has shown that the awareness and knowledge of the participating farmers on crop pest control, parasites, predator's crop ecosystem, safe and effective pest management practices etc., has increased tremendously after the project interventions (FAO, 2003).

These are few of the good initiatives for promotion of ecological farming at community level. However, a recent study finds that amid mounting concerns regarding excessive use of chemical inputs and their severe negative impacts on ecology and human health, many NGOs have been training the farmers in suitable and sustainable farming methods. But the numbers of farmers adopting ecological farming is not great. Few farmers have adopted this approach on their homestead-based farming, which is less controlled by market forces. They have identified several reasons regarding – why the farmers are not widely practicing eco-farming here. The major facts behind this are: lack of organic manure; low yields and lack of premium for organic products; contradictory approaches and message from the NGOs, government extension services, media and actors; and

wider promotion of HYV seeds and external input for farming. They also suggested to enhancement of learning by doing; widening the target groups; improvement of coordination among the actors; and advocacy to promote ecological farming (Datta and Kar, 2006).

4.9 Summary of the Chapter

This chapter discusses wide ranging issues, which cover elements of sustainable development; sustainable agriculture and livelihoods; agricultural development in Bangladesh; national agricultural policy and strategies; and emerging good practices. Agriculture is defined primarily as cultivation of land for production of crops, but currently the scope of agriculture has been widened. Any applied activity through proper utilization of natural resources, which relates to the production, development, preservation, processing, marketing and extension of not only crops but also other agricultural commodities such as fish, meat, eggs and forest products are accepted within the purview of agriculture. Crop production, animal husbandry, fisheries, forestry etc., are integral components of agriculture, but again crops undoubtedly constitute the largest and most important sector in Bangladesh agriculture.

The unprecedented scale of agricultural expansion and intensification with modern seeds varieties, chemical inputs, and agricultural technologies has raised many ecological, economic and social concerns locally, nationally and globally. There are growing concerns about productive capacity of the agro-ecological systems e.g., can the agro-ecosystems withstand the stresses (such as erosion, depletion of soil nutrient and fertility, pollution of land and water, destruction of bio-resources and over exploitation of natural resources) imposed by rapid and in many cases unwise intensification of agriculture? There is also concern about the negative impacts on other ecosystems- impacts that are often accentuated by intensification of agriculture. The harmful effects of increased soil erosion on downstream fisheries and wetlands and the damage to both aquatic resources and human health from chemical fertilizer and pesticide residues in products and the agro-ecosystems are felt badly.

Many environmentalists and social scientists have expressed a number of ecological and economic concerns (soil degradation, loss of productivity, high economic cost with low real benefits) as well as social concerns such as the growing inequity, dislocation of marginal and poor from their tradition occupations and destruction of rural livelihood, rapid social and cultural changes in society. Hence, the questions of sustainability of the agriculture are raised. It is difficult to define sustainable agriculture. However, the discourse on sustainable development, which started during the WCED in 1987 and elaborated in UNCED in 1992, gave important basis for understanding key elements of sustainable agriculture. The Agenda 21 and the WSSD plan of implementation put emphasis on natural resources conservation, environment management and development of agriculture in a sustainable way. The World Resources Institute, IIED and SAREP have developed own analysis about the process and key elements of sustainable agriculture.

The IIED suggests to reducing use of external inputs in agriculture and increasing community participation and local inputs for sustaining agriculture. The SAREP of the University of California, USA points out that a sustainable agricultural system should integrate three goals: environmental health; economic profitability and social equity. A system perspective is important for sustaining agriculture, where individual farmers, community people and local ecosystems may have different interactions for long. Sustainable Agriculture Research Education Programme approach has identified the following elements of agriculture: mainlining diversity; land and soil management; efficient use of inputs (local inputs instead of external and non-renewable inputs); best management practices (BMP); economic and social cost-benefits; and farmers goal and life style choices.

This study considers four key components of sustainable agriculture, which include: economic elements i.e., augmenting productivity, economically beneficial and stable for long time; social aspects (livelihood support for farm families, socially responsible and equitable and culturally adaptive); environmental concerns (conservation of land, water and all natural and bio-resources, use less harmful and more renewable energy and resources, reducing pollution impacts to ecosystems and human health); and knowledge and technological considerations i.e., information and awareness, promotion of local knowledge and low cost inputs and appropriate technologies. A sustainable agricultural system should be based on local resources and knowledge and must be environmentally non-degrading, technically appropriate, economically viable, and socially equitable and acceptable

Bangladesh is experiencing medium moderately good economic growth with industrialization and expansion of trade, business and service sectors. But still the country is considered an agrarian one. Agriculture is the mainstay of majority people of the country. Agriculture contributes over a quarter of country's GDP, provides about two-thirds of employment and brings about a quarter of export earning. More than 65% of the rural population of Bangladesh directly and indirectly depends on agriculture for their livelihoods and the sector has to feed the country's over 150 million people. Agriculture grew on an average at 2.3 percent annually during the latter half of the 1990s. The main drives came from crops sub-sector, which accounted for 58 percent of total agricultural value added and it grew at 2.2 percent annually over the last decade. But the non-crop sub-sectors of agriculture such as poultry, livestock and fishes also have lot of dynamisms and significantly contributed to people's livelihoods and the economy. The crops contribute to the major share in agricultural outputs in Bangladesh while the other sub-sectors such as fisheries, livestock, poultry, forestry etc., also contributed to the growth of the sector. Despite this growth, Bangladesh agriculture has to increase the productivity by intensification and diversification of agricultural productivity and the sector has to produce the required food to feed the growing population.

The major challenges of Bangladesh agriculture are to achieve self-sufficiency in food production, reduce rural poverty and foster economic development. The government has therefore attached highest priority to this sector to enable the country to meet these

challenges and to make this sector commercially profitable, ecologically sound and socially responsive. The Ministry of Agriculture, in a recent policy document has identified a number of constraints, which are the following: agriculture is dependent on the whims of nature and is risky; availability of cultivable land is decreasing; widespread poverty among the population engaged in agriculture; lack of required capital for agricultural activities; inadequacy of appropriate technology considering farmers socio-economic conditions; uncertainty of fair price of agricultural commodities due to underdeveloped marketing system; agricultural commodities are rapidly perishable and post harvest losses are too high; and limited knowledge of common people about the nutritional value of agricultural products and commodities including vegetables and fruits.

The country has seen some progressive shift in policy and strategies of agriculture. The aims of the National Agricultural Policy of Bangladesh (1998) are to increase agricultural productivity, food production, income and welfare of the farmers through promotion of appropriate farming practices considering economic, social and environmental issues. The policy and strategies also put emphasis on use of local inputs and consider local people's need, priorities and knowledge while implementing sectoral programmes and action. But there is problem in implementation of those policy and strategies. The local and regional government agencies and institutes are not adequate aware of the changes in policy and not motivated to take required action at the local level.

Besides the government initiatives, few NGOs and research organizations are taking limited efforts in agriculture sector to address the current problems and enhance sustainability of the sector. UBINIG (a research and right based NGO) undertook an innovative initiative to revive the traditional farming practices, known as Nayakrishi Andolon. They are working in three districts including Tangail, Pabna and Cox's Bazar. *Nayakrishi* means new agriculture. It is an initiative of the peasants, motivated and organized by UBINIG, to produce healthy food, healthy environment and happy life for the rural people. PROSHIKA (a leading NGO) has also been engaged in popularizing alternative agricultural methods, which is productive, equitable, conductive to bio-diversity and ecology. They call it Ecological Agricultural Programme. The main objective of ecological agriculture is to develop farmer's understanding of the causes of agro-ecosystem degradation and a scientific explanation of the adverse effects they experience. The group members are provided with appropriate training along with financial and technical support. The groups can collectively implement the projects or individual members can do it through their groups. The farmers use local organic manure instead of chemical fertilizer. They also integrate crops with other sub-sectors such as cattle raising, poultry and vegetable growing.

However, a recent study finds that there have been mounting concerns regarding excessive use of chemical inputs and their severe negative impacts on ecology and human health. This consequently increased NGOs initiatives for ecological farming, but the success is vary minimal. The numbers of farmers adopting ecological farming is not great. Few farmers have adopted this approach on their homestead-based farming, which is less controlled by market forces. The study identified several reasons regarding – why the

farmers are not widely practicing eco-farming here. The major facts behind this are: lack of organic manure; low yields and lack of premium for organic products; contradictory approaches and message from the NGOs, government extension services, media and actors; and wider promotion of HYV seeds and external input for farming. They also suggested to enhancement of learning by doing; widening the target groups; improvement of coordination among the actors; and advocacy to promote ecological farming.

Chapter-5: Farming Practices and Application of IKs in Agriculture in the selected Floodplain Villages

5.1 Floodplain Ecosystems and Physical Settings of the Study Villages

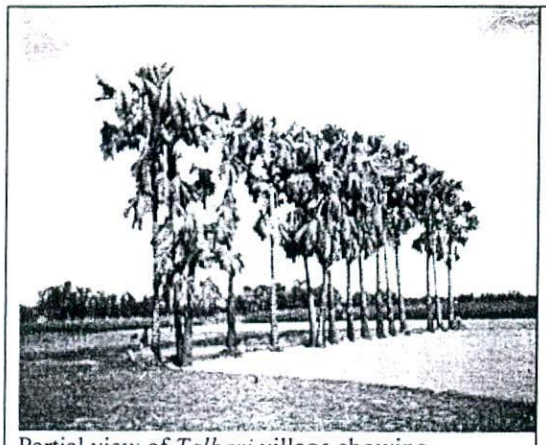
Floodplain occupies over 65% of the country's land surface. It would be 80% if the tidal plains and the young estuarine plains are considered as floodplains. The floodplain in Bangladesh has diversity and complexity in physical conditions in terms of soil and land formation, hydrology and climate. There are also variations and commonness in social setting, demographic composition, and people's dependency on natural resources as well as in uses of the floodplain resources such as land, water, agriculture, fisheries and aquatic resources across the major floodplains in Bangladesh. The Floodplains as wetland ecosystems provide important livelihood and resource supports (such as food, water, fish, nutrition etc.,), ecosystemic services and navigation facilities to the local people. The floodplains are treated as the large and last remaining habitats for numerous rare and endangered species such as plants, birds and animals in the country. Hassan (2003) identified a number of benefits of floodplain ecosystems, which include: habitats for flora and fauna; sources of water for agriculture, navigation and domestic uses; supplying of food, fish, fodder and medicine; pollution abatement; maintaining soil fertility; regeneration of ecosystems; and protection of biological diversity. But the wetlands and major floodplains in Bangladesh have been subject to rapid degradation due to population pressure, massive withdrawal of water for irrigation, obstruction of water flow by construction of roads, culverts and other anthropogenic causes (IUCN-B, 2004).

Normal flood which seasonally submerges the land of floodplains is an essential character feature of the floodplain and this gives the basis to the floodplain agriculture and determines the cropping patterns, uses of water, fishing, livelihood activities of the majority people living in the floodplains. Normal flood does not damage crops, rather it increases soil fertility, gives water to crops, increases fisheries and facilities navigations and regenerates ecosystems while disastrous flood affects the agriculture and livelihoods of the people.

The study villages are located in a major floodplain called *Kalatali Beel* in the south central Bangladesh. This was very aquatic flora and fauna in the past, but the resources base has been greatly depleted in the floodplain in the recent years due to many human interventions and natural factors. The land formation of floodplains has many interfaces with hydrological system. The landscape of the study villages is not flat. It has high land (normally flood free), medium land (flooded upto 3-5 feet) and low land (flooded upto 5-10 feet) during monsoon. About 50% land is medium land and 30% are low land in the village while about 20% land is high land. People also raised land for homestead. The soil of the villages is mainly loamy and clayey. There are limited sandy and peat soils in the villages.

The annual flood levels of agricultural land influences the cropping and agricultural practices in the villages. Normal flooding by river water and rain starts in the locality in

June. It touches the peak in July and August while the flood water starts to recede in September. But the monsoon flood water continues to stay in the low lying land till December. The very low land holds water till March. The *Kharip* crops (*Aus, Aman*, Jute, Sugarcane etc.) mainly depend on monsoon rain and floodwater while *Rabi* crops (*Boro*, vegetable, wheat etc.) require supplementary irrigation during winter and summer. The cultivation of HYV rice (locally called IRRI *Dhan*), grown on medium land, requires dry season irrigation.



Partial view of *Talbari* village showing agrofore-stry practice. Palm trees can grow in shallow and moderately flooded land

Farmers grow B *Aman* (local variety of paddy) in *Talbari*, which mainly depends on rainfed irrigation and flood water and takes almost no chemical fertilizer and pesticides

The *Talbari and Chamtapara* - two villages, in a south central floodplain, have been selected for the study. The villages are situated around *Kalatali Beel* (seasonal water body) in Mukshudpur and Sadar Upzilas in Gopalganj district. The floodplain and the *Beel* systems are connected with a branch of Kumar river systems. The villages have different types of land (low land, medium high land and high land). The farmers cultivate both traditional crops (*Aus, Aman, Boro, Rabi* crops etc.) and modern high yielding varieties of crops, vegetable, fruits etc., in the villages. They have both irrigated land as well as non-irrigated rain-fed, flood-inundated land for rice and other crop cultivation. Farmers also cultivate fish and raise livestock and poultry. Further, there are agro-forestry practices in the villages. The farmers are mainly marginal and poor in the villages and many of them use local and indigenous knowledge and low costs local inputs in their farming practices. However, modern knowledge as well as purchased external inputs are also used in HYV rice and vegetable cultivation in the villages.

5.2 The Population and Social Dynamism

The two villages have about 450 households with over 2,500 population. The average family size has been 5.7 in the study villages, which is higher than the national average of 5. About 60% of them are Hindus followed by Muslims (25%) and Christian (15%). The people started living in this lower Ganges floodplain about 300 year ago and they are

earning their livelihoods mainly from agriculture and fisheries for generations. People from the greater Jessore, Faridpur and Madaripur districts migrated to the locality and started agriculture in the past during pre-British period. They coped with the changes in land types, hydrology, technology and socio-political systems in different periods (i.e., pre-British, British, Pakistan and Bangladesh regimes).

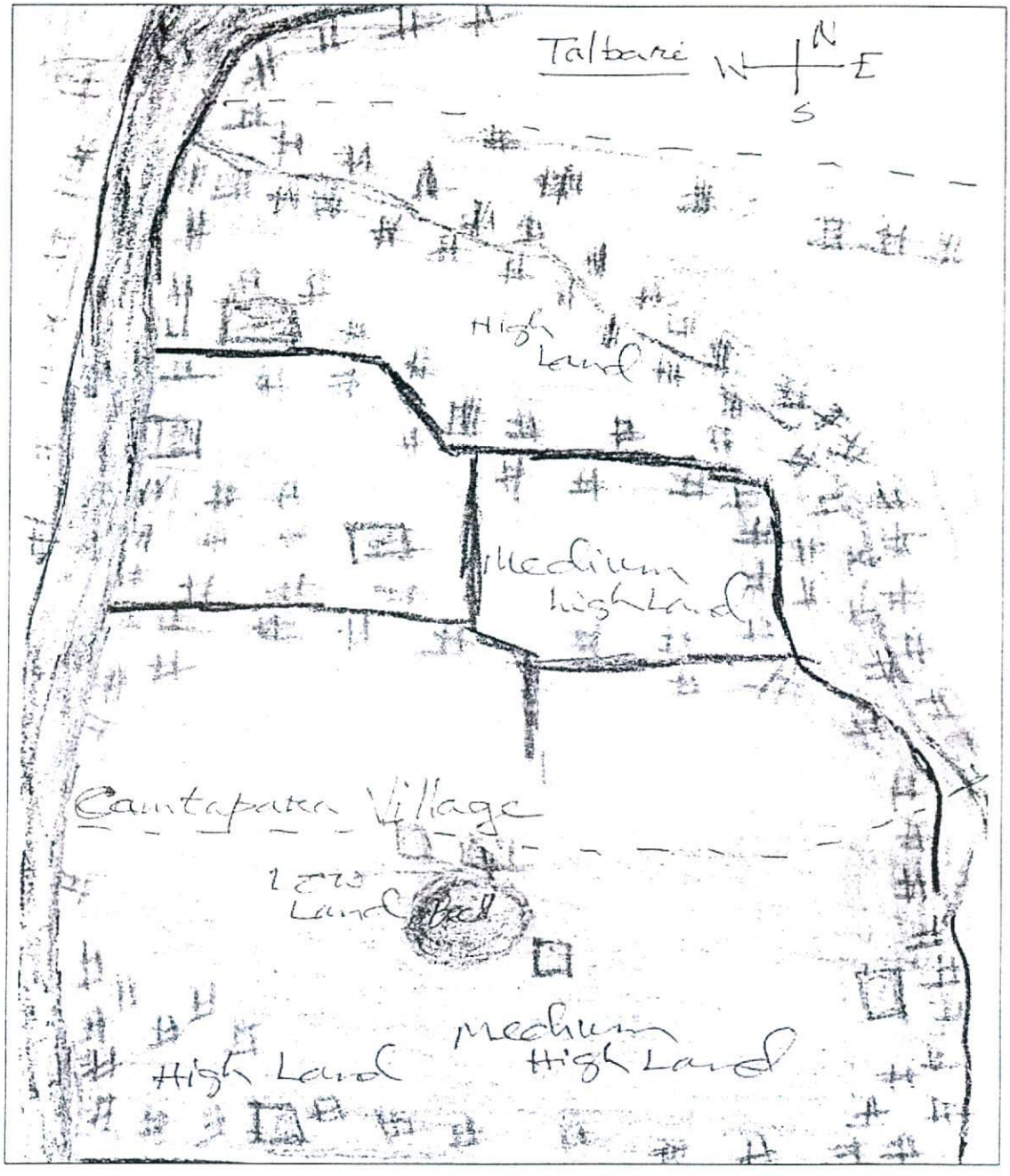
A big canal connecting the *Kumer* river with *Madhumati* was dug in the early years of 20th century through the large wetland known as *Chandabeel*. The *Kalatala Beel* is a part the *Chandabeel* floodplain and the associated river systems. The annual flooding by the river systems has silted up parts of the *Kalatali Beel* in the recent time. The continuous siltation from the river also changed the hydrology a bit of floodplain ecosystem in the recent years. The changes in hydrology and flooding patterns have affected water level and duration of inundation of flood, wetland resources, particularly fish migration and livelihoods of many marginal groups of people. The villagers experienced lots of changed in the cropping patterns, agricultural practices and livelihood systems in the last two decades. The life histories in the boxes tell a bit about the changes in the agriculture, community organizations and social systems. The following sections describe key characters of the farming community including their religious composition, social and wealth categories, literacy rate, land ownership etc., which were collected through household census and survey.

The majority people live on agriculture, share-cropping, wage and agri-labour, fishing, small business and rickshaw van pulling. The household census shows that majority of the villagers (58%) depend directly on agriculture for their livelihoods. Over 40 of them are engaged in agriculture in their own farmland while another 17% live on share-cropping. About 20% of the villagers earn their livelihood through wage labor, mainly in agriculture and 10% of them are engaged in rickshaw/van pulling. Another 12% of them are involved in small business, fishing and fish culture and petty service.

The villagers could be classified into different social categories. About 60% people of the study villages are poor while 35% are marginal and medium farmers and only 5% of them are rich. However, there has been no very rich family in the study villages in terms of their land and accumulation of wealth. The household census reveals that 40% of the villagers are functionally landless, who have land less than 50 decimal. Another 18% of them are also land-poor farmers who have land between 50-100 decimal. About 22% of the villagers are marginal farmers having land between 100-250 decimal. The household census shows that about 15% of them are medium farmers having land between 250-500 decimal and only 5% families are comparatively wealthy, who own land 5-7 acres.

Literacy rate in general is low here, because the majority poor people cannot send their children to schools. Many families cannot bear the educational expenses after the primary schooling of their children. The census data shows that 35% of farmers are illiterate and the rest 65% got some sot of education. About 30% of the farmers attained primary education while 26% of them got secondary education and only 9% of the farmers received higher education.

Figure-3: The Sketch map of the Villages showing Land Type



5.3 Farming Practices: Uses of Inputs in Agriculture and Cost-Benefits

Agriculture is the main stay of the majority people in the study villages. Most of them are land poor and marginal farmers while few of them are rich in terms of their land ownership, capital and organizing capacity. They cultivate various crops (both traditional and modern varieties) in different types of lands. They grow 3-4 crops on the medium and high land. However, they grow *Boro* paddy (dry season rice) in the low land. Lots of

vegetable and fruits are grown in the homesteads. In-depth interview and field observation say that the villages experienced lots of changes in the last 3-4 decades in their cropping patterns, agricultural practices, livelihood option and social organizations. Both diversity and intensity has been increased in some areas in the villages. There are practices of mono-crops, multi crops and integration among agricultural sub-sectors, but the level of integration differs across the farmer's categories.

The information gathered through household survey (households were selected from various farming categories under IK and agricultural survey), case study (on green manure, compost fertilizer, pest management, floating gardening, agroforestry, rice and fish cultivation etc.,) in-depth interviews, and participatory systematic observation have been processed, analyzed and presented using qualitative tools. The key findings on land use and cropping patterns, uses of inputs in agriculture by different categories of farmers (poor, marginal, medium and large farmers), farmer's perceptions about farm productivity, cost-benefits, current problems in agriculture, livelihood supports from agriculture, uses of potential IKs in agriculture and how to improve IK to address the current problems in agriculture, knowledge continuum (inter exchange between local and external modern knowledge) etc., have been presented in the following sections. The chapter also briefly describes farmer's interests for and application of IK in agriculture and their understanding about usefulness of IK to address the problems of agriculture (productivity, cost-benefits, environmental and social issues) and their innovativeness to integrate IKs and modern knowledge (MK) in agriculture for achieving both productivity and sustainability of the sector.

a. Crop Diversity and Intensity

The field data shows that the farmers have different types of land i.e., high land, medium land, low land and very low land. They have larger amount of medium land than high land. The average amount of land of the surveyed households was 191.4 decimal (majority of the surveyed households are land poor and marginal). The study used participatory techniques to classify categories of farmers according to the perceptions of the villagers. The survey found four types of farmers according to holding of land (please see the tables-5.1 and 5.2). The poor farmers in the study villages have very small amount of own land. The average land holding of the poor has been 130 decimal. The poor farmer have little amount of own land and many of them are engaged in sharecropping. The marginal and medium groups of farmers have different kinds (high, medium and low) of land. The average holding size of the marginal and medium farmers have been 236 and 434 decimal. They have comparatively large amount of medium and low land. The rich farmers have all categories of land. The average holding size of the rich farmers has been 660 decimal in the study villages.

According to type of land, the surveyed households have on an average of 40 decimal of homestead, 85.1 decimal of high land, 146.2 decimal of medium land and 90.2 decimal of low land. There is greater crop intensity and diversity on high and medium land. The poor farmers have little amount of medium and low land while the marginal, medium and large farmers have all types of land in the study villages. The marginal and medium

farmers have high level of crop diversity and intensity on their high and medium land compared to both rich and poor farmers. The following table shows the level of crop diversity and intensity in the study villages on different types of land.

Table-5.1: Cropping Patterns by Land Types and Farmer's Categories (poor, marginal and rich farmers)

Land Type/ Categories of Farmers	Poor farmers (Having land 1.0-1.5 acre)	Marginal farmers (Having land 1.5-2.5 acre)	Medium farmers (Having land 2.5-5.0 acre)	Rich farmers (Land above 5.0 acre)
Homestead (flood free)	Medium crop diversity (CD) *****	High CD ********** ********	High CD ********* *******	Medium CD ******
High land (Almost flood free, but during high flood 1-3 feet inundation during high flood)	High crop diversity ********* ******* ****	High CD ********** ********** ******* ****	High CD ********* ********** ******	Medium CD ******
Medium land (Inundation level 3-5 feet)	Medium CD ******	Medium CD ********** ******	Medium CD ******	Low CD ****
Low land (Inundation level above 5 feet)	Low crop diversity **	Low CD ***	Low CD ***	Low CD **

*** shows level of crop diversity**

Most of the farmers are very experienced and involved in agriculture for long. The field data shows that homestead and high land has greater crop diversity and intensity. Both the marginal and medium farmers grow at least 2-3 crops on the high and medium land. They also practice intercrops, multi-crops and maintain crop rotation (For example: Rabi crop + Jute + Aus and Aman).

Box-1: Life History of an Innovative Farmer

Personal profile: *Mr. Chittaranjan Mandal of Talbari village is about 45 years of old. He has been a very innovative farmer in the locality. He was educated up to class five in the village school. His farmer had a large family with limited resources and could not maintain educational expenses for his higher secondary education. He then started to helping is father primarily in agriculture and cattle raring. His father owned about two acres of land before the liberation of the country, which produced various crops mainly for the consumption of the family. He got married at the age of 25 years and had a separate family with little agricultural land. Gradually, he was involved in cultivation of sugar cane, growing HYV rice and fish culture, which changed his socioeconomic condition. Now he is a very innovative medium farmer in the Talbari village.*

Major events in life: *During his youth (before he got married) in 1980s, few farmers started cultivation of sugar cane on high sandy land along the riverbank in the village. This land was not good for growing rice of other crop because of high concentration of sands on the topsoil. His family also started growing of sugarcane in a small plot of land in 1983, which gave very good*

yields. In the next year, they extended their plot and leased in land for cultivation of sugarcane for greater economic gains. They also set up an indigenous system for crushing sugarçane and preparing Gur (sweet bar made of sugarcane) at that time and thus they made huge economic profits. His family also started cultivation of HYV rice (locally known IRRI Dhan) in their medium high land. Agricultural extension played a key role in transferring necessary skills to the formers for cultivation of IRRI by using irrigated water, chemical fertilizers and pesticides in their locality. These two things (i.e., growing of sugarcane and HYV rice) have influenced him and helped to bring about lots of changes in his life and livelihood.

Change in Agricultural Practices in the last two decades

Cropping patterns in the past

According to Mr. Mandal, agricultural practices were very simple in the past and at that time, they did not need any external inputs. Everything was local such as own seeds, surface water from rivers, monsoon floodwater and rainwater. The soil was very fertile and they did not need to provide any chemical fertilizers in the field. The environment was very clean and there had been no pollution of water and air. The canal, river and Beels were full of fish and other aquatic resources in the 1970s and in the early 1980s. They used to provide compost and green manure. They managed pest (using ash, Neem leafs, predator and birds sitting) and weeds using local methods. There has been diversity of local crops, vegetables and agroforestry practices in the villages. They used to rotate crop such as paddy after jute and oilseed or lentils. During winter, the farmers produced various local varieties of crops such as Kaun, Chinna, Job, jute, sugarcane, Til, Tishi, Mustard, Kalai, Mug etc..) on high and medium land while the low land produced Aus and Aman paddy. However, the crop cultivation as well as yield was dependent on nature and sometime it was very insecured. They faced crop failure due the lack of rain and drought in a year while heavy rain and floods also damaged their crops in the other year. The farmers could get good yields in the normal year while they faced many risks and vulnerability due to natural events in the past.

Change in input uses

With the introduction of HYV rice and cash crops such as groundnuts, sugarcane, and vegetables in the filed people started using various external inputs in their farms such as improved seeds, chemical fertilizers, ground water and various pesticides. Now, many farmers use external inputs for cultivation of rice and vegetables. They purchased seeds, fertilizers, pesticides from market and BADC. They have to buy water from the water sellers who manage irrigation schemes in the locality. Mr. Mandal has a small irrigation scheme. The uses of various inputs in agriculture has increased production of rice, cash crops and vegetables and reduced seasonal risks but at the sometime increased production costs in manifolds, so the net benefits from agriculture is going down day by day. He has mentioned many other problems in agriculture besides cost-benefits.

Current problems in agriculture

Mr. Mandal has mentioned many problems in present day agriculture, which include decrease of soil fertility, increase of pest attack, lack of good seeds, cost of irrigated water for HYV IRRI cultivation, loss of local variety of crops and vegetables. Land and water bodies are polluted by the excessive use of chemical fertilizers, which affected the fisheries resources in the Kalatala Beel, he mentioned

Uses of IK in the past in agriculture

In the past, the agriculture was simple and diversified and they would use local and own seeds, composed fertilizers (cow dung and green manure) other inputs in agricultural practices. Farmers mainly cultivated for household consumption and subsistence needs. They used to till the land with

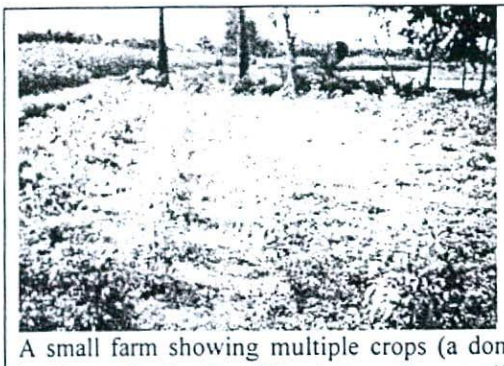
cows and used surface water for irrigation. They integrated crop cultivation with livestock, poultry and fisheries.

Uses of IKs at present in agriculture

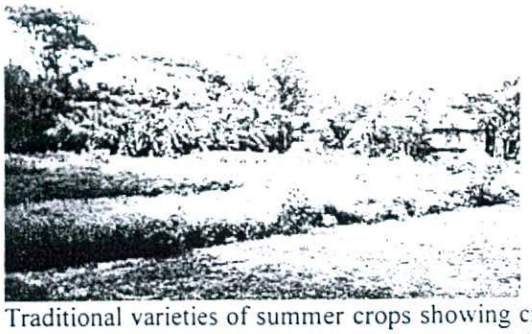
Currently, agricultural practices are more complex and controlled with both local and external ideas, knowledge and inputs. Despite this change in the present agricultural practices, they use lots of local ideas, techniques, knowledge and inputs in crop cultivation, vegetable and fruits growing, fish culture and livestock and poultry rising. They practise crop rotation, multi-cropping, mixed cropping, agro-forestry, which conserve local species as well as conserve soil fertility and moisture. They provide compost fertilizer (household waste, cow dung, poultry drops etc.) and crop residues, water hyacinth as organic input to increase soil fertility, particularly for vegetables and local varieties of crops. Though they use chemical pesticides for controlling pest in HYV rice and cash crop like jute and sugarcane, they also use local techniques and local material such as ash, herb, bird sitting for controlling harmful pest, because they are aware of the adverse impacts of the chemical inputs on environment and human health. They also use surface water for most of the crop cultivation except HYV rice, which needs huge water during dry season, when the flow of water in the river and canals goes down. They prefer to consume local varieties of rice and vegetable, while they produce MV rice, crops and vegetable for selling in the market.

Potential IKs for promotion

He feel that farmers are aware of the high cost and bad impacts of external inputs on land, water and human health due to the excessive use of chemical inputs in agriculture. Many of them, who have adequate resources (land, cows, manpower) are again trying to re-introduce good practices in agriculture such as multi-crop instead of HYV mono-crop, cultivation of local varieties of rice and vegetable at least for house consumption, compost and green manuring, use of surface water and pest control using indigenous methods and local inputs. There is need for greater awareness among the farmers to promote good practice to conserve land, soil fertility, water and improvement of human health as well as to increase human welfare at the community level. He expected that the government departments and NGOs would take lead role to motivate farmers towards best practice using moistly local resources and own knowledge. But, he also mentioned that farmers should not be isolated from the outside world and they must know about new innovation and good examples elsewhere in the country and try to adapt good practices in their local situation.



A small farm showing multiple crops (a dominant local practice in the village) as well as traditional practice of soil moisture and fertility conservation by covering the soil with paddy stalk



Traditional varieties of summer crops showing crop diversity and intensity. Home gardening practices are also seen in floodplain ecosystems

The following table-5.2 shows different types of crops grown on various kinds of land in different seasons of a year. During winter season, various Rabi crops such as oil seeds (Mustard), lentil (Masur, Kalai, Mug etc.) and lots of winter vegetable are grown on both high and medium land. Medium and high land has greater level of crop diversity and intensity in the study villages. HYV rice is grown on medium high and low land during Kharip-1 crop in summer while Aus, Aman and limited modern variety of Aman are cultivated on medium and low land during Kharip-2 in Monsoon and Autumn season. Farmers produce lots of vegetables on their homesteads as well as on floating gardens in the floodplain during rainy season.

Table-5.2: Crops by Types of Land by Seasons

Types of Land	Cropping Seasons		
	Rabi Crops (November-March)	**Kharip-1 (April-June)**	**Kharip-2 (July-October)**
Homestead and High Land (almost flood free land, but sometime 1-3 feet water depth during monsoon)	Various vegetables like, red and green spinach, Pui Sak, Cabbage, Cauliflower, Reddish, Carrot, Onion, Green Chile, beans, bringal, sweet gourd, bitter gourd, potato, mustard, Masur, Kalai, Mug, wheat, Deros, Kalojira, Dhania etc.	Groundnut, wheat, Mug, Masur, Kaun, til, tisi, beans, green spinach, Pui Sak, Cabbage, Cauliflower, Reddish, Carrot, patal, Onion, Green Chile, beans, brinjal, sweet gourd, bitter gourd, potato, arum, jute, sugarcane, Aus and B. Aman	Broadcast and Transplanted Aman, Aus, Sugarcane, vegetables like: sweet gourd, bitter gourd, brinjal, patal, Arum, lau, puisak, red and green spinach etc.
Medium High Land (water depth 3-5 feet during monsoon)	Groundnut, wheat, Mug, Masur, Kalai, Kaun, til, tisi, potato, arum, vegetables	Jute, groundnuts, wheat, sugarcane, mug, Masur, kalai, til, tisi, vegetables such as green chile, beans, brinjal, sweet gourd, bitter gourd, potato, arum, Irri, Aus, Aman	Aus, Aman, Irri, Sugarcane, shoal, Dhaincha and vegetables on shallow flooded areas
Low Land (water depth 5-7 feet during monsoon)	Mustard, Kalai, Masur, Irri, Boro (in the very low land)	Irri, Boro, Aus and Aman	Aman, Shola, Dhaincha, floating gardens with vegetables

b. Uses of Inputs (local and external knowledge) in Farming Practices

The following table shows the types of inputs (local, family and low cost as well as external inputs, modern knowledge and technology which are costly) and level of uses of various inputs according to farmer's social categories and their orientation to life and society and their links with various institutions (agricultural extensions, NGOs, media etc.). The survey results reveal that the poor and marginal farmers use various low cost local inputs and knowledge (including local seeds, green and composed manure, surface water and local herbs and indigenous techniques) in their farming practices (such as crop cultivation, vegetable and fruits growing and agroforestry, poultry and livestock, fisheries etc). On the other hand, the rich farmers take high level of external inputs (HYV seeds,

chemical fertilizer and pesticides, ground water by STW for irrigation) available in the markets and in formal government agencies.

Table-5.3: The Sources of Seeds by farmers Categories

Types of Crops/ Farmer's Categories	Categories of Farmers		
	Poor Farmers (50% own and 50% from other sources)	Marginal and Medium Farmers (80% own and 20% from other sources)	Rich Farmers (20% own and 80% from market)
Cereals: Paddy, Wheat, Kaun etc.	Own, neighbor, relatives, market and NGOs	Own, neighbor and market	Market and own
Cash crops: jute, sugarcane/ potato	Own and market	Own, neighbor and market	Market and own
Oil seeds and lentils	Own, neighbor, market	Own and neighbor	Market and own
Vegetables: spinach, cabbage, cauliflower, gourd, beans, brinjal etc.	Own, neighbor, NGOs and market	Own, neighbor and market	Market and neighbor

The table-5.3 shows that poor farmers use seeds from both own sources and other like market, NGOs and neighbors. According to survey results, they use 50% of the seeds from their own sources and the rest from other sources. The marginal and medium farmers preserve seeds of all kind of crops such ad paddy, wheat, jute, oil seeds, vegetables etc., in their own house and they meet 80% of their seeds needs from own source and neighbor, while they buy about 20% seeds from market or BADC. The rich farmer some time store seeds, but they use highest amount of purchased modern variety of seeds of all kinds of crops and vegetables.

The following table-5.4 also shows that the marginal and self-sufficient medium farmers take greater amount of local inputs and family inputs and value the indigenous knowledge in farming practices compared to both of the rich and poor farmers in the study villages. This finding has been supported by the survey results, participant observation and in-depth interviews. It was learnt that the medium and the marginal groups of farmers are very involved in farming, experienced and innovative in the process. They practise learning by doing in the field and initiate good farming practices through lots of trial and errors. The poor also take various local inputs and apply indigenous knowledge and techniques in farming, vegetable growing, home gardening, agroforestry and fish culture. But they are very often guided by the interest of gaining quick economic returns from HYV crop cultivation and mono cropping, which are largely dependent on external purchased inputs. Sometimes, they also do it unconsciously. But the rich sections of the farmer take very low level of local inputs, because they want to make huge economic profits from agriculture (crop, fisheries and livestock). They use higher amount of external input to grow MV and HYV crops and vegetable for quick economic gains.

Table-5.4: The Uses of inputs (local and modern/external) and farming practices by farm families/categories

Types of Inputs, farming practices and sources of knowledge	Categories of Farmers					
	Poor farmers		Marginal and Medium farmers		Rich farmers	
	Local/Organic/ Family sources	HYV/MV/ MK/External/ Market	Local/Organic/ Family sources	HYV/MV/ MK/ External/ Market	Local/Organic/ Family sources	HYV/MV/ MK/External / Market
Seeds, crop diversity, intercropping and rotation	M	L	H	M	L	H
Soil fertility/land management	M	L	H	M	L	H
Fertilizer	L	M	M	M	L	H
Pest Control	M	M	H	M	L	H
Irrigation	H	L	M	M	L	H
Agro-forestry	Y	N	Y	Y	Y	Y
Poultry & livestock	Y	Y	Y	Y	Y	Y
Fish culture and capture fishing	M	M	M	L	L	H
Integration of agriculture with other sub-sectors	M	L	H	M	L	M
Labour	H	N	M	M	N	H
Money	L	L	M	L	H	L
Sources of knowledge and technologies	Y/M	Y/L	Y/H	Y/M	Y/L	Y/H

- **H means high, M means medium, L means low and Y means yeas**

Uses of green and compost manures, which reduce costs of farming as well as increases soil fertility. Many farmers have shown their interest for these types of manure instead of chemical fertilizers

Jute cultivation is wide spread here. Farmers feel that leaves of jute increase soil fertility. B *Aman* will be grown on the land after jute and summer vegetables (practices of crop rotation) .

c. *Farm Productivity and Cost-Benefits*

There have been mixed reactions about farm productivity and cost-benefits of present day agriculture. The poor farmers feel that the productivity in agriculture is almost static and they receive marginal economic benefits from agriculture. However, the poor and marginal farmers practise agriculture to gain livelihood supports (food, fuel and fodder). The rich farmers also informed that the productivity in farm (paddy, jute, vegetable, fish, livestock etc.) has decreased greatly in the recent years and the input cost has increased in

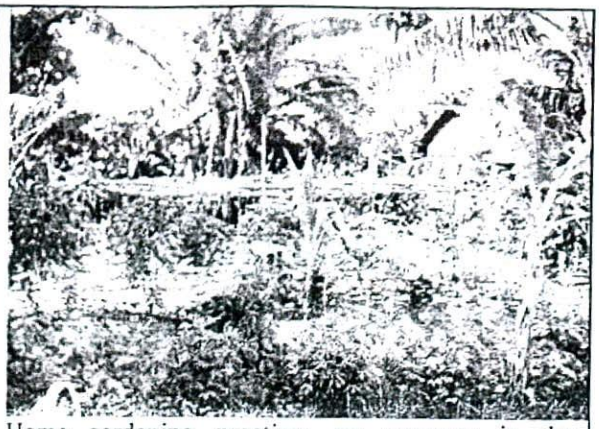
many folds. Hence, the net benefit is going down in every year and many of them have lost their interest in agriculture since the rich farmers are interested more for economic gains from agriculture. Though they take livelihood supports such as food, fuel, fodder, nutrition etc., but they are also keen to produce cash crops for selling the products in the markets besides livelihood supports (see the table-5.5).

The marginal and medium farms have some different views about productivity and cost benefits from agriculture. They think that there is some sort stagnation in farm production, particularly in HYV rich cultivation because of degradation of soil fertility and uses of high external input including seeds, irrigated water and chemical fertilizer and pesticides. But it is increasingly beneficial for vegetable growing, winter crops (oil seeds, lentil, ground nuts etc.), agroforestry, poultry and livestock raising and fish culture. They are very involved in agriculture and take about 80-90% of their livelihood support from agriculture. The marginal and medium farmers are very involved in farming activities and adapt various knowledge and inputs in their current agricultural practice effectively. This group of farmers have long-term stake in agriculture. They try to explore and develop good practices in the context of their needs, problems and resources bases such as organic inputs, IPM (integrated pest management), integration of poultry and livestock with crop cultivation and fisheries.

Table-5.5: Farmer's perception about farm productivity, cost-benefits and livelihood supports from agriculture

Issues	Poor farmers	Marginal and medium farmers	Rich farmers
Farm Productivity	Increased in 1980s. Now almost static in farm production, but productivity in vegetable growing, fish and poultry is increasing	Productivity is static in HYV and paddy cultivation, but it is slowly increasing in vegetable growing, winter crop, fish, poultry, agro-forestry, paddy and fish	Productivity decreased, due to loss of soil fertility and increasing input costs (chemical fertilizer, pesticides, irrigation of ground water, hired labour and managerial costs)
Livelihood supports	They take 40-60% livelihood support from agriculture and natural resources	They take 80-90% livelihood supports from agriculture and agri-business	They take 20-30% livelihood supports from agriculture. They have many other non-farm economic activity such as services, trade and business
Cost and net benefits	Marginally beneficial, but it gives food and nutrition	Moderately beneficial, but in few cases such paddy growing is not economically beneficial	Economically not much beneficial and they use to lease out their land for share cropping
Views on Environmental and social issues	Loss of soil fertility and decrease of productivity, pest attack, major benefits goes to land owners (most of them are share croppers)	Loss of soil fertility, loss of biodiversity (crop, plant, fisheries and animal), water and land pollution, health problems, low price of products	Soil degradation and low productivity, low price of paddy, jute and vegetables in the market, particularly after harvesting of paddy and jute

Partial view of a *Beel* (seasonal wetland) near the village, which is sources of capture fisheries and other aquatic resources. These resources provide much of the animal protein and give substantial livelihood supports to poor and marginal groups of people of the village



Home gardening practices are common in the village, where women play a very key role in the form of seeds preservation, crop selection, raising the crops, traditional pest control etc. This gives nutrition to the poor families

The following table-5.6 shows that livelihood supports taken by the different farm families varies across the farmer's categories. The medium and self-sufficient farmers take the highest amount livelihood supports from agriculture in the form of food and nutrition, employment and income. They also take fuel, fodder for cattle and construction materials from their own agricultural sub-sectors.

Table-5.6: Perception and Views of different Categories of Farmers on Livelihood Supports from Agriculture (%)

Areas/Issues	Categories of Farmer		
	Poor	Marginal and Medium	Rich
Food and Nutrition (rice, vegetable, fruits, fish, egg, meat etc.)	The poor gets 50-60% of their livelihood support from agriculture, but they are food deficit group and have to buy from market or take from other to meet their annual food needs besides their own production	This groups get 90-95% of their livelihood supports from agriculture and they are almost self sufficient groups and produce their required food and sometimes sell surplus foods stuffs.	The rich takes 70-80% of their livelihood supports from agriculture. (This section of farmers produce lot, but also consume lots of food from market besides their own production
Employment and Income	Employment-70% Income – 60%	Employment- 80% Income – 60%	Employment –20-30% Income - 50%
Fuel, Fodder and Housing Material	50%	70%	60%
Welfare and Happiness	Low to medium level of family welfare and happiness	Medium to high level family welfare and happiness	Medium welfare, but low happiness

Both the poor and rich farmers also take various livelihood supports from agriculture, but they depend on other sources for their employment and income. The results of the in-depth interviews and participant observation also reveal that the marginal and medium farmers gain more family welfare from agriculture than that of both the poor and rich and they are have greater happiness in involving them in agriculture.

5.4 The Current Problems in Agriculture

It was learnt from the participatory research (PR) and consultations with the relevant people that during the last 20-30 years, the farmers of the *Talbai* and *Chamtapara* villages have faced many problems and challenges. They experienced lots of new things in relation to agricultural practices and livelihood activities. Some of the experiences are good (for examples intensification of crops and increased of food production; diversity in agriculture and livelihood activities; increase of income from agriculture and agro-business for a certain quarters etc.). But these successes are also associated with a numbers of problems, which limit the long term sustainability of agriculture and rural livelihoods and have already threatened the social stability, cultural diversity and integration as well as happiness at both farmer's household and community levels.

The diffusion of Green Revolution technologies (such HYV seeds, chemical fertilizers, pesticides, irrigation water technology, agro-processing and storing of grains and crops) supported with extension services by both department of agriculture and NGOs in the villages; expansion of market and rural communication; micro-credit facilities for the poor and marginal groups have boosted the growth in agriculture such as production of rice, veritable, fruits, poultry and fisheries and created lots of livelihood opportunities for the people in the villages late 1980s and 1990s. But again from the mid 1990s, the farmers in the villages were facing many problems in agriculture including loss of soil fertility and decrease of crop production, loss of local crops and degradation of bio-resources. They are facing draw down of ground water for irrigation in dry season, particularly for HYV rice. They are also facing problems in securing adequate inputs in time (due to their dependency on external input such as seeds, fertilizers and water technologies for irrigation) for agriculture due to market fluctuation and induced by dis-functionality of supply chain at local level, which again affected agricultural productivity and livelihoods. The farmers also experienced fall in price of their products (particularly, rice, vegetable, jute etc.) after the harvesting, which affected the poor and marginal growers. The introduction of HYV and modern varieties of crops in the study villages has displaced many of the local crops as well as traditional cropping methods, which were eco-friendly that combined the natural and biological cycles.

The farmers have informed that they are facing three key problems in agriculture including: the decrease of soil fertility and farm productivity; the decrease of economic return and net benefits from agriculture; and environmental degradation in the locality. The household survey collected views of the farmers from different social categories on their perceptions of major problems in current agriculture. The following table-5.7 shows the key problems identified by the farmers. All the farmers (poor, marginal and rich) have

mentioned a number of common problems that they are facing in agriculture. These include: loss of soil fertility and decrease of productivity; increase of inputs costs (for seeds, fertilizers, water, pesticides and labour costs) and decrease of net economic benefits from crop farming; and want of good quality seeds in the locality. They also reported the excessive use of chemical fertilizers and pesticides and associated health risks and its impacts on ecosystem and local bio-resources, particularly on open water fisheries as major problem in the local agro-ecological system. The farmers also feel that over extraction of ground water during dry season has drew the ground water level down making many of the hand tube well inoperative in the dry season. Many of them have also reported the loss of local crops and biodiversity as a major problem in agriculture.

Table-5.7: The views of different Categories of Farmers regarding Problems in Agriculture

Poor Farmers	Marginal and Medium Farmers	Rich Farmers
1. Loss of soil fertility and decease of productivity of land 2. Increase input costs and decrease of real benefits from agriculture 3. Landlessness and poverty 4. Lack of good quality seeds 5. Problems of irrigation (Want of surface water, draw down of ground water and cost of water) 6. Excessive uses of chemical fertilizers and pesticides 7. Loss of local species (crops, plants, fish and animals)	1. Loss of soil fertility 2. Want of quality seeds 3. Increase of input cost 4. Decrease of productivity 5. Excessive uses of chemical inputs 6. Pollution of land and water 7. Problem of irrigation 8. Health problems 9. Price of crops goes down during harvesting of crops 10. Real benefits from agriculture is going down 11. Poor service from agricultural extension 12. Loss of local crops and species	1. Increase of input costs 2. Loss of soil fertility and decrease of productivity 3. Drawn of ground water and irrigation problems 4. Lack of quality seeds 5. Lack of labor 6. Net benefits from agriculture is going down

Sources: IK Survey and PR

The farmers have illustrated five major agro-ecological problems, they are currently facing in relation to agriculture, food and nutrition, human health and gaining livelihood. Theses are: *Loss of soil fertility and decreases of productivity:* Currently, the soil gets inadequate amount of alluvial due to low flow of flood water from river and canal during monsoon. Construction of roads, embankment and sluice gates have decreased natural flow of water from rivers and canal. On the other hand, cultivation of almost same crops (HYV rice, cash crops and vegetable) on the medium and high land has decreased soil fertility. As a result, farmers have to provide higher amount of chemical fertilizers to their land, which degraded soil quality and its fertility. However, few innovative farmers (marginal and surplus groups) use green manure and compost fertilizers for production of local varieties rice, crops and vegetables mainly for household consumption.

Lack of quality seeds and loss of biodiversity: There is want of good quality seeds of rice, crops and vegetables in the locality. Many farmers do not preserve seeds in their homes; they rather buy seeds of modern varieties from the market. Seeds from market, BADC and NGOs give higher yields. Farmers are interested for such seeds (but these crops also take higher external inputs). As many farmers do not preserve seeds and depend manly on market, the local varieties of crops and vegetables are disappearing quickly affecting

the local bio-resources. The uses of chemical inputs in agriculture also affect open water fisheries, floodplain ecosystem and wetland resources (flora and fauna).

Increase of Pest attack: The uses of chemical pesticides control pests and gives good yields, but the excessive use of pesticides kill many useful insects. Further, the evidence says that there are more harmful pests, which are now tolerant to chemical pesticides. Again the farmers are very often cheated with adulterated items in the market, which are not much effective in pest control.

Pollution of land and water: All the external chemical inputs remain on land and water and pollute the ecosystem. The chemicals, used as fertilizers and pesticides, changed the soil contents and these are accumulated on land and in water bodies affecting fisheries. The current agricultural practices based on agro-chemical decreased fish population, wetland birds and many aquatic lives.

Health problem: It has been reported that the excessive use of chemical inputs in the farming practice has affected the food chain and human health. The people do not get much taste in rice, vegetable and crops now a day. It has been also felt that the food using external chemical inputs has low nutritious values and people suffer from malnutrition and ill health consuming the foods produced using chemical inputs. Many people suffer from acidity in their stomach and intestine systems, because they consume food produced with chemical inputs.

5.5 Uses of Indigenous Knowledge in the Past in the Study Villages

In the past, agricultural practices were mainly based on local inputs and indigenous knowledge. They have developed localized methods of ploughing land with cows and soil conservation with crop rotation, inter cropping, mixed cropping (which helped to conserve soil nutrient as well as moisture in the soil); increase of soil fertility by burning crop residues in the field, green manuring, pest control by using local techniques and organic materials such as herb and ash; use of surface water and rain water, drought management by local techniques (pulling rope on young plants); agroforestry and integration of agriculture with livestock and poultry. They had also indigenous methods of seeds and crop preservation without using any harmful materials. They were self-sufficient in undertaking agricultural activities with their own resources and efforts. However, they would sometime take inputs, new ideas and material assistances from relatives and fellow farmers. The local people were also keen to know from innovative farmers of the neighboring villages. They would introduce new varieties of crops and techniques of cultivation suitable to their own situations and context considering land types, flood, water availability and seasonal variation across the year. The following sections describe the IK that were practised in the study villages.

Land Management and soil fertility: Land in the floodplain villages would get lots of alluvial in the past through floodwater, which gave fertility to the soil every year. It would need almost no additional fertilizer in 30 years ago. But farmers used to do lots of indigenous practices in the past for conservation of land and soil. These are

intercropping, crop rotation, mulching, green manuring etc. Mulching is a common practice in the study villages. It preserves soil moisture, increases soil fertility and nutrient as well as protects the topsoil. Farmers also add green manures by cultivating jute and *Dhanicha*) and compost fertilizers.

IK in Soil Classification: The soil was and currently is being classified on the basis of soil contents: proportion of sand, clay and moisture in it. Farmers consider the soil suitable and good for planning seeds and crops when there is some water in the soil and it is like power. Plough can go easily in the soil. They also selected different kinds of soil for various kinds of crops and vegetables. The villages have three categories of soil in terms of its contents: mixed soil (sand and clay); fine clay (Etel mati) and *Dhap mati* (composed content is high in the low lying land).

Crops diversity and local species: In the past, farmers grew all the local varieties of rice, vegetable, fruits, tree and plants considering soil fertility, land types and flood ability in the villages. There had been less crop intensity but high diversity of local crops in the 30-40 year ago in the locality. They grew lost of traditional crops besides different kind of local paddy like Kaun, China, Kalai, Masuri, Till, Tisi, Mustard and vegetables. The farmers have discovered many combinations of crops for mixed cropping from their long experiences. The mixed cropping practices were developed considering the soil contents, land types and climatic variation. The practices of mixed crops helped preserve soil and increase its fertility. They grew various crops round the year.

Irrigation and drought management: The farmers in the study villages used surface water from pond, canal and river for irrigation in the past. They also use rain and flood water for crop cultivation. The cultivation of B. Aman and T Aman in the villages depended mainly on rain and floodwater. In the dry season, farmers used to pull a rope across the rice field early in the morning as result, the drops of the dew accumulated on the leaves during night would drop down and thus moisturize the soil and the seedling become fresh again. They used to dig canal and small ponds in the corner of the large field, which were used for conserving water for irrigation during dry season as well as capturing fish from the floodplains for household consumption.

Pest Control: The farmers in the study villages used various local materials and herbs such leafs of Neem and tobacco, ash, kerosene etc., to control pests in crops and vegetables. These were locally available and not harmful for ecosystems and human health. The farmers used the local and organic pest management techniques mainly for vegetable growing while many of them use chemical pesticides to control pests in crops field mainly for HYV rice, jute and other cash crops. The powdered dust of tobacco leaf was used by the farmers to repel different insects like leaf roller, brown leaf hopper and rice bug. Early in the morning the dust is spread over the moist leaves of rice. Bird sitting and Alor Phad were being widely used in the past in the study villages.

Home Gardening: The villagers traditionally used to produce lots of vegetables, fruits and sometimes crops in their home and homestead for long. The home garden of the poor and marginal farmers have high level of crops intensity and diversity producing different kinds of vegetables, crops and fruits round the year primarily for household consumption.

They used local and household inputs and labour for this, where women played a very key important role in terms of seed selection, planting, nursing the crops with organic inputs and indigenous knowledge, sustainable harvesting of the yields and conservation of crops and natural resources base at the homestead. The home gardening and fruit growing gave them food, nutrition, medicines, timber, fuel, construction materials, protection from natural hazards and some income. In the past, home gardening was a key livelihood activity for almost every farming family in the study villages.

Agroforestry: Agroforestry had been a very common practice in the study villages. The farmers would plant trees like palm and date trees across the boundary of their farms. The trees and plants gave them fuel, fruits, food, and nutrition as well as increase nutrient in the soil (from the leaves of the trees). The field observation indicates that insect killer birds also sit in the trees and plants and thus the agroforestry practices help to control pest in the farm. Homestead forestry and agro-forestry play a vital role in providing fuel wood, fodder, fruits and timber to the poor and marginal households. The people have long been planting and growing trees and plants not only for food, fuel, fodder and timber but also for protection of their houses, lives and properties from winds, storms and soil erosion during flood. Every homestead in the study villages has different kind of tress and bamboo bush, which provide the necessary fuel. But the reserve of homestead garden has decreased recently due to population growth and poverty in the rural areas.

Storage of crops and seeds preservation: In the past every farmer's households, mainly the women would preserve seeds in home using various local methods in the past, which kept the seeds in good quality. The farmers in the past would use leafs of various local trees and plants such as Neem, Mango and Biskatali (local herb) for preservation of crops (pulses, paddy, wheat etc.) and seeds of crops as well as vegetables. Women played a key role in preserving seeds and crops in the locality. They very often dry the grains and seeds in the sun before storage. Paddy is preserved in sacks and bamboo structure locally called *Gola.* To prevent seeds and plants from the attack of insects, powder of *Neem* leaf and tobacco is widely used. The powder of dry Biskatali leaf and sands were also applied on the seeds and different kinds of pulses to prevent attack of insects.

Integration of crops with livestock, poultry and fish: The cattle and poultry birds like duck and hens were dependent on crops, grains and crop residues, while crops cultivation again took lots of input from cattle and birds in the forms of draught power, cow dun and poultry drops and thus all the agricultural sub sector were integrated to each other in the past. For curing different diseases of cattle and poultry in rural areas, farmers practised different method of indigenous healing. Branches of fresh Lantana camara was fed to the cattle for curing gas formation and ill-digestion. To cure ill digestion of cattle warm boiled rice mixed with paddy husk was fed to the animals. The raw turmeric and ginger was fed to cure ill digestion. To cure infection of wounds formed on the shoulder of draft animal, ointment by tobacco and *pathar chun* was applied and bandaged. Neem leaf and bitter gourd leaf crushed together in crushing stone diluted with water and mustard oil was added.

The field observation and consultations with farmers and knowledgeable people suggest a trend of change in uses of knowledge (both local and modern knowledge) in agriculture

in the study villages. The farmers have informed that all the agricultural and livelihood activities in the locality were mostly dependent on indigenous knowledge and local inputs (seeds, manure, pest control, labour etc.) in the 30-40 years ago. In the late 1960s and early 1970s, external and modern knowledge as well as many external inputs were introduced by different agencies (BADC and NGOs). Many of the IKs and local indigenous practices were replaced by the emergence of MKs and external inputs. After 10-15 years, there has been a slow change in the mind sets of the local farmers and many of them (who are involved and experienced farmers) have become interested to apply few of the good local practices and indigenous knowledge for soil conservation, pest control, irrigation and drought management, crops and species conservation through intercropping, multi-cropping, agroforestry and integration of sub-sectors of agriculture. They integrate both IK and MK.

Table-5.8: Trends in Change of Uses of IKs and Modern Knowledge in Agriculture in the last three Decades

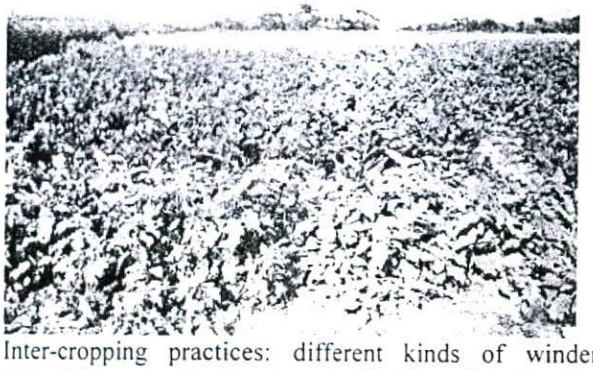
Decades	Type and Levels of IK in Agriculture
1960s – 1970	The agricultural and rural livelihood practices were mostly dependent on local inputs and indigenous knowledge/practices
1970-1980s	MK and external inputs were introduced by different agencies (BADC and NGOs) and many of the IK and local indigenous practices were replaced by the MKs and external inputs. Media played a key role in information dissemination
1990 –2000 +	MK and various external inputs (HYV seeds, chemical fertilizers and pesticides) still dominate the agricultural practices, but again innovative farmers are re-introducing IKs or adopting MK in their local situation and increasing IKs

5.6 Uses of Indigenous Knowledge in Current Agricultural Practices

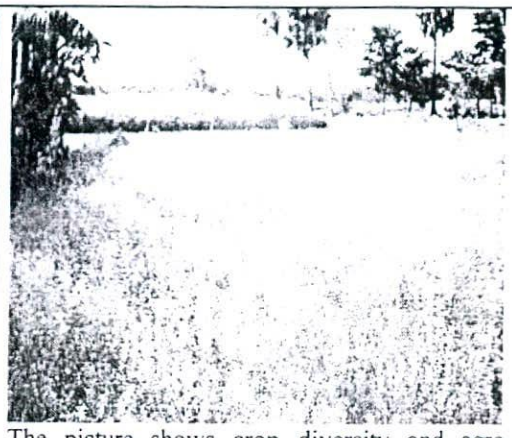
The use and application of local inputs and IK has decreased in the last decades, but the farmers, mainly the self-sufficient and marginal groups as well as few poor farmers apply various potential IKs and many local inputs in their current farming and agricultural practices. These are: multi-crop, inter crops and crop rotation and cultivation of local varieties of crops (Aus, Aman, jute, kaun, china, sugarcane, mustard, til tisi, groundnuts, Dhanchia, Shola, vegetables etc.); uses of Green Manures (Dhaincha, sola, jute etc.), compost and organic manures (cow dung, crop residues, water hyacinth, aquatic flora etc.); local techniques for pest (birds sitting, *Alor Phad.* and predators) and weed controls as well as using limited chemical pesticides for HYV IRRI rice and cash crops; ploughing land with cows and bulls instead of tractors good for soil conservation; use of water from surface sources such as river, canal, pond, *Beels,* rain water and flood water for traditional crops and vegetables cultivation. But the farmers sometimes irrigate ground water for HYV rice cultivation; agro-forestry for food and nutrition for the poor farmers; soil fertility and pest control; integration of livestock and poultry with home gardening, vegetable growing, agriculture and fisheries; uses of local inputs (such as local seeds, surface and rain water,

green and compost manures, cow dung, poultry drops; and uses of family labor by poor and marginal farmers.

The participatory research and field observation says that the experienced and involved farmers mainly use various IKs in agriculture in different forms (such as inter cropping, multi cropping, uses of local inputs such as local seeds, use of organic and green fertilizers, uses of surface water and pest management practices with local herb and leaves etc.). However, the farmers are not isolated from the outside world and they use both local knowledge and local inputs as well as external modern knowledge and purchased inputs in the present day agriculture. During Rabi season, they cultivate lots of local crops (oil seed, lentil. till. tisi etc.) and use less external inputs in the farms, while in cultivation of vegetables, they uses lots of purchased inputs including seeds, fertilizers and pesticides. Many of them grow HYV rice, which is totally dependent on external inputs (seeds, fertilizers, pesticides and irrigated ground water in the dry season).



Inter-cropping practices: different kinds of winder vegetables are grown on a small plot of land. The farmers will cultivate jute and B *Aman* after the harvest of vegetable on the same land



The picture shows crop diversity and agro-forestry practices in the study village

They also grow limited scale local paddy (Aus and Aman) on their medium land without much chemical inputs. According to the local farmers, crop intensity has increased in the locality with new varieties of vegetable and cash crops. Except, HYV rice, the farmers practise crop rotation, mixed and inter cropping. They also practice agroforestry, where rice and other crops cannot be grown. Pump and date trees are commonly grown along the boundary of farm land. These types of trees are less shady, but give fruits, income and fuel to the farm family. The following table-5.9 gives an indication about the current practices of IKs in the study villages and their potentials in faming as well as other sub-sectors of agriculture.

Table -5.9: The Existing Practices of IKs in Agriculture in the Study Villages

Areas and Sub-sectors	Types of Practices and Efficacy of the Uses of IKs
Cropping Patterns: Mixed Crops, Inter crops and Relay Cropping/ Conservation of bio-resources and local species	Mixed crops: mustard with pulse; potato with vegetables; brinjal with chilly, onion, green add red spinach; *Dhania with Kalijira, Masus dal; Kaun* with *Til, Tisi* etc. Inter Crops: Sugarcane with onion and vegetables; Ground nuts with water melon, Chilly with Ladies fingers and green add red spinach Relay croping: B Aman after wheat, B Aman and Aus after jute, potato after B Aman etc. Growing country bean and ladies fingers on the *Aila* (boundary of the farms) Raising seedling on and growing vegetables on floating gardens made of water hyacinth and crop residues (stalks of Aman and Aus paddy)
Soil Classification; Conservation of Soil Fertility and Land Management	Farmers classify the soil for different crops based soil contents (sand, clay and moisture in the soil; Cultivation of jute for soil fertility and conservation; multi-cropping Conservation of top soil and humidity covering the soil with crop residues Mulching to preserve moisture and fertility of soil Spreading ash on soil to improve soil quality and fertility Green manuring with jute and *Dhancha* Inter-crop and crop rotation for fixation of nitrozation and soil conservation Planting drought tolerant crops like ground nuts and sugarcane
Pest Control	Pest control with tobacco leaves extracts, powders, ash, water of smoking *Hooka* Spaying of Kesosene in controlling insect pest of paddy, crops, fruits and vegetables Putting branches of trees in the crop field to attract birds to eat insect and harmful pests Controling of rice bug with Neem leave powder and tobacco leave powders Ash to control pest of vegetables, *Alor Phad* (putting lamp in the crop field in the evening to attract flying insects IPM practices involving organic repellant and local knowledge
Irrigation and sources of water	Majority poor and marginal farmers use canal. river and pond water for vegetable and crop cultivations They also take water from river for irrigation HYV rice using LLP Rainfed agriculture is a common practice in the villages Aman, Aus and other *Kharip* crops are grown with monsoon flood water coming from river and canal Growing interface between surface and ground water Dig small pond in the corner of farmland to preserve water for dry season to irrigate vegetables and summer crops\ Cultivating drought tolerant crops like ground nuts and sugarcane
Agroforestry, home gardening and conservation of local species	Planting trees and plants in the boundary of crop field, which give food, fruits and fodders, every homestead has plenty of local trees and plants and these give them fruits, food, fuel and fodder Leave increases foil fertility to the crop fields Sand layer are dug and piled of on a corner of the sandy land for planting trees and plants and the soil under sandy layers are used for growing crops Birds take shelter on the trees and plants in the crop lands and kills the harmful insects and pest
Preservation and storage of crops and seeds	*Biskatali* leaves are uses as insect repellent for stored seeds and crops Preservation of pulses and iol seeds with sands and ash Sunning the seeds in regular intervals Preserving seeds in earthen pot (pitchers and *Motka*)

	Mango leaves are spread in grains (paddy and wheat) in store houses Grain stored in sacks are dried in sun frequently Paddy and wheat stored in bamboo made cases with aeration facilities with *Neem* and Mango leaves
IK in Veterinary and Health Seeking	Various local herbs (Neem and tobacco leafs, turmeric, ginger etc.) parts of animals and materials and popular knowledge are used in controlling the diseases of cattle and poultry birds People also use various medicinal plants, herbs and parts of animal to prevent and cure human diseases. These material are available around their homes. These are less costly and do not have much harmful effects on their health

Source: Field observation and interview with farmers

The good IKs in the locality: The farmers have identified a number of good and effective IKs that are being used by the farmers in their villages. These are: use of green manure and compost fertilizers; inter-crops and multi-crops; crop rotation; cultivation of local crops and species; agro-forestry; IKs in pest and weeds management; uses of surface water; growing vegetables on floating graders; using water hyacinth as compost manure; and integration of poultry and fish with crop and vegetable cultivation.

5.7 Farmer's Interest, Innovation and Application of IKs in Agriculture by Wealth Categories and Personal Attributes

It is evident from field observation, interviews and IK survey that the poor farmers use IKs, but the marginal and medium farmers have greater interest for IK. They use IK in farming practices to a great extent. The poor farmers have interest for IK, but many of them have inadequate understanding about the uses and effectiveness of IK. They are in the hegemony of market forces, media campaign and technology diffusion. The dominant practices of the rich farmers very often influence them. The rich farmers have lack of understanding and interest for IK, because of their formal education (which makes them biased towards MK), their external connection, interest for quick economic gain and their affordability of high cost external inputs.

The field observation and participatory research say that both the poor and marginal farmers apply IK in their farming practices (seed and crop selection, crop rotation, intercropping, agroforestry and integration of agricultural sub-sectors) and in terms of taking local low cost inputs in agriculture. The marginal and medium farmers are very innovative and they often try to modify and improve IKs. They also adapt the MKs and external knowledge in the context of local situation and their needs and thus contribute to generation of knowledge. The following table-5.10 shows level of interest and application of IK and MK by the various farmer groups according to their perceptions about the effectiveness of IK in agriculture.

Table -5.10: Interest of farmers, level of application of IK and Perceptions about Usefulness of the IKs to address the Problems in Agriculture and Sustainability Issues

Issues	Poor farmers	Marginal and medium farmers	Rich farmers
Interest of farmers	Lack proper understanding of the strength of IK and losing interest about IK, since they are influenced by market forces and other farmers who use external inputs for quick economic gains	They are in the practice of both MK and IKs as well as low cost local inputs. Many of them have lots of interest in IK. Few of them got orientation from local NGOs about importance and uses of IK and ecological farming. They are very innovative and involved farmers	Lack of understanding about uses of IK (sometime the large holders do not directly participate in farm level activities) and they have little interest about IK
Level of application and uses of IKs	Most of them uses IK and take local and low cost inputs due to poor economic situation. But there is a great need of orientation and awareness about the use and importance of IK	They use both MK (external high cost inputs) and local low cost inputs i.e., IK in agriculture. It differs across sub-sector and types of crops and seasons. There is increasing trend of using IK considering its usefulness (soil fertility and land management, no harm to nature, maintaining diversity and ecosystems etc.)	They mainly use external inputs in agriculture for quick economic gains and commercial interest. The rich farmers employ paid managers and labour to organize agriculture
Perception about usefulness and efficacy of IK	They understand usefulness of many IK, but very often they are influenced by the practices of rich farmers for immediate economic gains. The share croppers have to use external inputs like HYV seeds, chemical fertilizer, pesticides as suggested by the land owners	Many of them have good understanding about usefulness and efficacy of IK. In fact, they are applying, modifying, improving and conserving IK. They are very innovative. Sometimes, they use external knowledge, modify and adapt those to local situation and again those become local knowledge	They prefer MK and external inputs which are simple to use and available in the market and formal institutions
Innovation and integration of IK in agriculture	They are hard working and creative and try to integrate local knowledge in current farming practices and in this process they sometime modify, improve and innovate new ideas and practices	They are very active in field and innovative. They are in the practice of integration of agriculture, inter-cropping, crop rotation, preference to own seeds and local species, green and compost manure, Agro-forestry, Paddy fish, IPM, floating vegetable gardening	They hardly practice in the field and their participation in knowledge generation and innovation is very minimal in agriculture

On the other hand, the rich farmers are in the practice of mono-culture and prefer commercial cultivation (HYV rice, new varieties of crops, fish cultured in the ponds etc.), which very often require MKs and external knowledge tested elsewhere by extension department, private sector and multinational companies. They do not apply much of IK in their farming practices as well as they have very little confidence on the uses and usefulness of IK. So, there is a great need for proper orientation and awareness raising for both rich and poor farmers. There is also need for appropriate policy, programme, institutional arrangement, legal framework and collective actions at community level.

The field observation says that there are innovate farmers, particularly among the marginal and medium wealth categories, who try to blend the IKs and MKs to address their problems in agriculture. Some of them try to experiment new ideas and things out of curiosity to see what happens. There are also few farmers, who try to experiment new things to solve specific problem (soil fertility, pest control, inter-cropping etc.). Many of them try to adopt new crops and new ideas to their own field. Thus the farmers have the necessary knowledge and information about their crops, farming systems, input uses, pest control etc., but this knowledge is not always sufficient to address all the existing and emerging problems and challenges. Hence they need further information, new ideas and sharing of good practices from others farmers, agricultural extension and researchers.

Many of the poor and medium farmers use their own local inputs (seeds, fertilizers, water, pest control etc.,) in agriculture besides external inputs. Farmers uses purchased inputs mainly for HYV rice cultivation as well as growing for cash crops (sugarcane, jute, groundnuts etc.,) and modern varieties of vegetables. However, they use local inputs and knowledge for growing Rabi crop, Aus and Aman paddy. Many of them are interested for organic inputs having been aware of the harms of using chemical inputs in the fields, but the local resources bases such as crop residues, cow dung and other organic materials are decreasing day by day and they have become dependent on in-organic purchased inputs for agriculture. Despite this, few innovative farmers use the organic inputs with external inputs. They use compost and green fertilizer (Dhaincha. Sola and green fast growing plants) in crop filed and supplement the fertilizer need with minimum chemical inputs. Farmers are very aware of the adverse impact of chemical pesticides on ecosystem and human health and many of them are using local techniques and organic material for pest control such as Neem and tobacco leaves, ash and other local herbs to control pest particularly in vegetables. They very often arrange bird sitting, which help to control pest. The farmers in Talbari and Chamtapara villages also put small lamp in the crop fields (locally called as *Alor Phad*), which kills flying insects attracted by the flame of the lamp.

The innovative farmers have developed methods of conjunctive use of surface water (from river, canal, pods, rain and flood) with limited ground water during dry season. Farmers plough their land with both tractors and cows. They prefer ploughing land with cows, because it creates large furrows in the soil, which is good for soil fertility. This also gives additional fertility to land from cow dung dropping during ploughing the land. Farmers use their local knowledge and techniques for preserving seeds and crops in the houses. They use to dry the crops, paddy and seeds well in the sun and preserve the stuffs in good condition on storage house. They also use leaves of various local plats and trees to protect the crops from the attack of harmful insects. But in few cases, they use limited scale of DDT powder and other chemicals to preserve the crops and grains, which are sold in the market. However, farmers are aware of the harmful effects of chemical on health and thus try to avoid those materials. The poor and marginal groups always prefer local knowledge and inputs in preserving crops and seeds. The farmers also try to blend the IK with MK to reduce risk of greater loss due to attack of harmful insects.

Box-2: Farmers turning back to Organic Inputs for growing Crops

Profile of life: *Mr. Ananada Sarker of Talbari has been a very experienced farmer in the village. He is about 60 years of old. He is a marginal farmer having agricultural land of around 2 acre. He also leases in land for share cropping of HYV rice. He has been involved in agriculture from his boyhood with is farther and elder brother during Pakistan period. He got married in 1960 and used to live in an extended family. However, he built a new house in the farmland one km away from their old home after the liberation of the country in early 1970s. He also shifted his own family in the new house to manage better the farming activities living near the farm land. According to Mr. Sarker, agriculture was very simple and profitable at that time, because the land was so fertile and they got enough rain and flood water to irrigate their local traditional*

crops (B. Aman, Aus, jute and various Rabi crops). He had cows for ploughing land as well as to add manure to the soil from cow dung. They did not need to purchase any input from the market at that time and the yield of crops was also very good. He could manage his family well with the crops he produced in his highly productive land.

Key events in life: *In 1974, he experienced a crop failure and faced serious economic hardship and in the next year, one of his friends encouraged him to take carpenter ship as temporary job. He undertook this as a seasonal work. He used to go to Dhaka to do wood work during the lean period of agriculture. In mid 1970s to early 1980s, Mr. Sarker took carpenter ship as main occupation and agriculture as secondary occupation, because he could earn good cash income from wood work and also got livelihood support from agriculture (crops, oil seeds, lentils and vegetables). He was doing well with the income from carpenter ship and livelihood supports from agriculture. But in the mid of 1980s, he found it difficult to continue both carpenter ship and agriculture together. He got a realization that though doing woodwork was economically profitable, but it did not give him much welfare. They had to buy food and vegetable from market and the cash income was inadequate to support his family and they suffered from livelihood insecurity. At that stage, he changed his mind and gave up carpenter ship and devoted fully to agriculture again, which gave him less economic gains but various livelihoods supports such food, nutrition, fuel and fodder for cattle. He had small amount of land at that time and he stared share cropping on others land from 1986. He made huge profits from HYV rice cultivation at that time, because, it took less purchased inputs in the initial stage of IRRI cultivation since the land was very fertile and they could irrigate water from surface sources (canal, Beel and pond). He also preferred HYV rice cultivation to feed his large family all through the late 1980s and early 1990s. Meanwhile, his sons grew up and he trained them to cultivate vegetables and grow paddy and other cash crops in the field and homestead.*

Current Agricultural Practices

Mr. Sarker is known as a good vegetable grower in the village. He cultivates various kinds of vegetables (red and green spinach, cabbage, radish, pumpkin, bitter gourd, green chile, Patal, Derash etc.) in his homestead and surrounding high land round the year. He grows most of the vegetable for selling in the local market and he takes great livelihood support from growing vegetables besides HYV rice. However, he also grows local verities of paddy (B. Aman and Aus) and various traditional crops. The HYV rice is grown for selling, while the local varieties of rice are grown for household consumption. HYV rice is cultivated for greater yield, but it requires costly inputs. To him cultivation of IRRI helps the poor to reduce food insecurity. He uses own and local inputs for vegetable growing as well as growing local varieties of crops such as Aman, Aus and other traditional crops while the HYV rice is cultivated using purchased inputs (such as seeds, chemical fertilizers, irrigated water and pesticides). He mentioned that currently agriculture is faced with numbers of problems including: loss of soil fertility, draw down of ground water table, pollution of water and wetland as well as decrease of fisheries resources affecting human health and level of nutrition.

Uses of IKs: *He uses composed and organic fertilizers (household waste, cow dung, poultry drops, crops residues, residues from local fish drying centres, water hyacinth, Jute leafs, Daincha etc.) for growing vegetables in homestead as well as in farmland. Mulching is a common practice in his farmland to conserve soil moisture and fertility. He also informed that excessive use of chemical fertilizers badly affects the soil conditions making it hard, but they can not manage to have organic fertilizers for cultivation of HYV rice at large scale. He practices intercrops and mixed crops on high and medium land, which helps to fix nitrogen in the soil and sometime control pests. For Rabi crops and vegetable growing, he always irrigates surface water from pond, canal and rain, but for HYV rice and cash crops like sugarcane, he has to purchase*

the irrigated ground water from the irrigation scheme. The B. Aman and Aus cultivation mainly depends on monsoon rain and flood water. He has started tilling his land with cattle again. He has four cows, which gives him milk, draft power, organic fertilizers and fuel for cooking.

For pest control, he puts stick and branches of trees in the filed so that birds can sit and eat harmful insects from the crop field. He also uses ash, tobacco and Neem leaves for controlling pest. But, HYV rice sometimes requires chemical pesticides along with local pest control techniques. Agro forestry has been practiced by him for long, which help to improve fertility, pest control as well as gives his family food, fuel and fodders. He hopes that people will use more and more local and organic inputs in future since they are facing the harmful impacts of external inputs on land, ecosystems and human health. The external inputs are costly, hence the increasing uses of purchased inputs reduce the real benefits of agriculture, he added. He expected that the government department and local NGOs would help them to aware of the future treat in agriculture and show them how to use better the local inputs in agriculture, so that they can avoid costly external inputs and make the agricultural systems more productive giving them greater welfare.

Rituals and Cultural Practices: *Mr. Sarker also informed that during his youth, they used to perform some rituals in relation to crop cultivation. They would respect their agricultural equipment by worshiping of the equipment such as Langal (plough), Joal (yoke), sickle, scythe etc., on the first day of planting seeds in the field with the hope that they would receive good yields of crops. They used to put different marks (white and black) on the first fruits and vegetables such as pumkin and sweet gourd with the belief that those marks would protect the crops and vegetables from the attack of any evil. Many of them also put scarecrows in the crop field, so that birds and harmful insects did not damage their grain and crops. In the past, his father used to worship growing crops in the field, particularly when Aman plants got sheaves of paddy with the hope that the crops would be healthy. They also performed Nabannya Utshab (festival of new crops) in the past every year. They would invite their relatives, friends and dear ones to a dinner on the first day of crop (Aman) harvest. But he regrets that these kinds of socio-cultural rituals are not performed now a day in the village.*

The rich farmers very often prefer MK and purchased inputs (such HYV seeds, fertilizers, pesticides, ground water etc.,) for quick growth of crops and vegetable for greater economic gains. But they are trying to integrate poultry, livestock with crops and fisheries. The cow dung and poultry drops are used as compost fertilizers as well as feed for fish cultured in the pond. It indicates that all farmers have increasing interest for IK and local inputs and they are increasingly using the IKs in current agricultural practices to a great extent compared to the past decade. This gives a hope that potential IKs would be used in future and thus these would be conserved, improved and made up to date through application in the field.

Women play a very key role in agriculture in the study villages. The women from poor farming families preserve seeds and participate in planting of crops and post harvesting activities. They suggest for appropriate crop rotation and mixed cropping. They organize home gardening and vegetable growing in home and in the field. They prepare food and collect the vegetable and other elements of food from home and natural resources bases in the floodplain (small fish and aquatic vegetable for household consumption). They conserve bio-resources, which gives important basis for IK practices. They collect herbal plants and use those widely for human health seeking and veterinary medicines.

Age differences and personal experiences sometimes influence the use of IK and MK. Elderly people very often prefer the use of local inputs (own seeds, local crops, compost manures and local pest management) and local knowledge while the young people generally prefer external inputs (HYV seeds and chemical fertilizers and pesticides) and modern knowledge in their farming practices. However, there are young farmers who use both MK and IK in crop cultivation and take inputs from other sub-sectors (poultry and cattle). There are also innovative young farmers (those who are very involved in agriculture) are aware of the current and emerging problems in agriculture (such as loss of soil fertility and productivity and ecological destruction) are again interested for both IK and MK. Formal education sometimes creates barriers towards the use of IK. But most of the farmers are illiterate in the study villages while few of them got primary education. Again, it is the out look and worldviews of the farmers that determines the use of IK and MK in agriculture.

However, there has been limited awareness about the use and usefulness of IK among the farmers, but the level of awareness differs across the categories of farmers. Only the innovative and experienced farmers, women mainly conserve the IKs through application in the farms and homestead. The farmers have the main responsibility to apply the potential IKs and improve those in the local context and changing situation. It is expected that the use of IK and blending of MK in the local context can enhance productivity without harming soil. water and environment. Thus, effective uses of local inputs and indigenous knowledge can increase local resources bases, reduces production costs and give basis for long-term livelihood supports (foods and nutrition, employment, income, fuel, fodder, medicines etc.,) and happiness at the farm and community levels. Hence, there is also need for awareness and demonstration activities at the farm level to show the uses and efficacy of IKs to the farmers. The agricultural extension department at the Upazila, grassroots NGOs and media can play effective role in this areas.

A dynamic and growing agricultural system requires meaningful interactions among the farmers and scientist. This is needed for establishing effective links between micro and macro process. Farmers have to have the critical understanding and awareness about the problems and prospects of the agro-ecological systems and only then they will engage their knowledge, inputs and resources to find appropriate solutions. The local knowledge and resources may not give solution to their every problem and the farmer have to acquire new ideas, information and support from the external sources such extension services, research organizations, NGOs and market places, but they must have adequate understanding of the suitability of the external knowledge and inputs. Hence, there is a strong need for knowledge continuum between the farmer and external world.

5.8 Farmer's Worldview and Knowledge Continuum

There has been already a process of knowledge continuum i.e., integration of external knowledge in local situation by the innovate farmers. The goals of farming influence the farmer's decisions and engage them in innovative actions by optimizing the uses of both local and external inputs in efficient ways for achieving sustainability in the agricultural

sector. It was observed that the farmers have different goals and objectives (such as household consumption, subsistence for living, commercial interest, family welfare etc.) of production of crops, vegetable, fruits, agro forestry, poultry and cattle raising and fisheries. These goals vary across social categories. The multiplicity of purposes and goals often determine the production process and the level of inputs uses (local, external and modern inputs) in the farming systems. The poor do agriculture mainly for food and household consumption, meeting their subsistence needs and livelihood support (food, fuel, fodder and family nutrition). They also gain income from agriculture, agri-labour, agro-business and related activities. The poor use both IKs as well as modern and external inputs in agriculture, because they need higher income and quick growth from agriculture. Thus, we see much difference with what Chambers say about the interest of poor for IK from their experiences of early 1980s. At that time poor were isolated from mainstream development and market forces in Bangladesh.

The marginal and medium farmers in the study villages undertake agriculture for food, household consumption, income and family welfare. They prefer farming practices without harming the land, water, local resources bases and ecosystems. They are concerned about cost-benefits and effect of the agricultural inputs on soil, environment and human health. But many of them are also interested for growing cash crops for quick economic gains. They use both external and local inputs as well as IKs in their farming practices. It is evident from field observation that few of the innovative farmers (marginal and medium groups) have understood well the harmful effects of chemical fertilizers and pesticides on land, water, ecosystems and human health from their experience. Now, they prefer to use local and organic inputs in crops and vegetable cultivation. Mr. Ananda Sarker and Mr. Mandal are the examples of such conscious and innovative farmers in the villages.

The rich farmers undertake agriculture for food and family welfare, but they have commercial interests in farming. They organize farming with hired labor and external inputs (seeds, fertilizers, irrigated water and chemical pesticides) for quick and secured growth. Though, few of them are aware of the harmful effects of the external inputs on land, water and environment, but they don't attach much importance to those factors since the main driving forces behind their farming (HYV paddy cultivation, vegetable, jute, sugarcane growing, fish culture etc.) has been to seek quick economic gains. They purchase all inputs from markets, or BADC and sell their maximum products in the market.

Thus, the very goals of farming and living (such as agriculture for food, livelihood or commercial gains) can influence the decision making of the farmers and engage them in innovative actions by optimizing the uses of both local and external inputs in efficient ways for achieving sustainability in the agricultural sector. It is also evident from the field observation, key informant interviews and IK survey that since local and indigenous knowledge gives a good basis and strategy for sustainable development of agriculture and livelihood of the rural communities, the marginal and poor farmers are using more and more local and indigenous knowledge in farming, agroforestry, fisheries, poultry and

livestock management. But these knowledge and practices are not always sufficient to address the needs, priorities and challenges.

It is felt that the effective use of the potential IKs and local inputs in the current agricultural practices could help to protect soil fertility and increase productivity in agriculture steadily for long time. Indigenous knowledge and local and popular wisdom encourages to optimize the uses of local and on farm resources which are renewable. At the same time, IK based practice discourses the uses of external and purchased inputs in agriculture and thus it can enhance greater self-sufficiency in farming practices and minimizes adverse impacts of the chemical inputs on ecosystems and human health. Further, the use of IKs and local inputs increases employment at farm family and community levels and increases their real income. The uses of local inputs and indigenous knowledge has promoted best practices (as stated in the case studies) in the farm management i.e., wise and efficient uses of resources, uses of renewable and organic inputs, integration of biological and natural cycles etc., and thus increase productivity as well as conserve natural resources and ecosystems. These good practices can enhance livelihood of the farmers and local community for long time. A balanced out look about live, society and nature may promote good practices in agriculture.

5.9 Summary of the Chapter

This chapter focuses on floodplain ecosystem, population and social dynamics in the study villages, interface between human and natural systems, agricultural practices in the study villages, use of inputs and cost-benefits, problems of agriculture, use of IK and MK in agriculture and farmer's interest for application of IK for addressing the current and emerging problems in agriculture. Floodplain occupies over 65% of the country's land surface. Floodplain has diversity and complexity in physical conditions in terms of soil and land formation, hydrology and climate. Floodplains as wetland ecosystems provide important livelihood and resource supports (such as food, water, fish, nutrition etc.,), eco-systemic services and navigation facilities to the local people. Floodplains are treated as the large and last remaining habitats for numerous rare and endangered species such as plants, birds and animals in the country. But the major floodplains in Bangladesh have been subject to rapid degradation due to population pressure, massive withdrawal of water for irrigation, obstruction of water flow by construction of roads, culverts and other anthropogenic causes.

The study villages are located in a major floodplain called *Kalatali Beel* in the south central Bangladesh in Gopalganj district. There was richness of aquatic flora and fauna in the past, but the resources base has been greatly depleted in the floodplain in the recent decades due to many human interventions and natural factors. The land formation of floodplains has many interfaces with hydrological system. The landscape of the study villages is not flat. It has high land (normally flood free), medium land (flooded up to 3-5 feet) and low land (flooded up to 5-10 feet) during monsoon. About 50% land is medium land and 30% are low land in the village while about 20% land is high land in the study villages called *Talbari* and *Chamtapara*. The study villages are moderately populated. People settled in the lower Ganges floodplain villages about 300 years ago and they

experienced many changes in physical environment, political system and social environment. Despite those changes, agriculture remains the major occupation for majority people in the villages. But most of them are poor and marginal farmers. Next to agriculture, they are also engaged in wage earning, fishing and small business.

The villagers are classified into different social categories. According to the local people, about 60% people of the study villages are poor while 35% are marginal and medium farmers and only 5% of them are rich. The household census reveals that 40% of the villagers are functionally landless and another 18% of them are also land-poor farmers who have land between 50-100 decimal. About 22% of the villagers are marginal farmers having land between 100-250 decimal. About 15% of them are medium farmers having land between 250-500 decimal and only 5% families are comparatively wealthy, who own land 5-7 acres. Literacy rate is low in the villages. The census data shows that 35% of farmers are illiterate and the rest 65% got some sot of education. About 30% of the farmers attained primary education only while 26% of them got secondary education. About 9% of the farmers received higher education.

The farmers cultivate various crops of both traditional and modern varieties on different types of lands. They grow various crops on the medium and high land. *Boro* paddy (dry season rice) is grown on the low land. Lots of vegetable and fruits are grown in the homesteads. Most of the farmers are very experienced and involved in agriculture. Homestead and high land has greater crop diversity and intensity. Both the marginal and medium farmers grow at least 2-3 crops on the high and medium land. They also practice intercrops, multi-crops and maintain crop rotation in different seasons of the year. The marginal and medium farmers have practice of higher crop diversity and intensity on their various lands. During winter season, various *Rabi* crops such as oil seeds (Mustard), lentil (*Masur, Kalai, Mug* etc.) and lots of winter vegetable are grown on both high and medium land. Medium and high land has greater level of crop diversity and intensity in the study villages. HYV rice is grown on medium and low land during *Kharip-1* season in summer while local *Aus, Aman* and limited modern variety of *Aman* are cultivated on medium and low land during *Kharip-2* in Monsoon and Autumn season. Farmers produce lots of vegetables on their homesteads round the year as well as on floating gardens in the floodplain during rainy season.

The farmer of all categories use different types of inputs such as local, family and low cost as well as external and high inputs, modern knowledge and technology. The survey results reveal that the poor and marginal farmers use various low cost local inputs and knowledge (including local seeds, green and composed manure, surface water and local herbs and indigenous techniques) in their farming practices (such as crop cultivation, vegetable and fruits growing and agroforestry, poultry and livestock, fisheries etc). On the other hand, the rich farmers take high level of external inputs such as HYV seeds, chemical fertilizer and pesticides, ground water by STW for irrigation, which are available in the markets and in formal government agencies.

The marginal and poor farmers use seeds from both of their own sources and market, NGOs and neighbors. The marginal and self-sufficient farmers take greater amount of

local inputs and family inputs and they value most the indigenous knowledge in farming practices compared to both of the rich and poor farmers in the study villages. They practice learning by doing in the field and initiate good farming practices through lots of trial and errors. The poor also take various local inputs and apply indigenous knowledge and techniques in farming, vegetable growing, home gardening, agroforestry and fish culture. But they are very often guided by the interest of gaining quick economic returns from HYV crop cultivation and mono cropping, which are largely dependent on external purchased inputs. Sometimes, they also do it unconsciously. So, the poorest farmers do not use most of the IK and they are not isolated from market and external forces in the study villages. It is the marginal and self-sufficient groups of farmer use IK to larger extend, because of their own understanding of the problems in agriculture and the potentials of IK to address the problems.

The farmers are facing three key problems in agriculture. These are: decrease of soil fertility and farm productivity; decrease of economic return and net benefits from agriculture; and environmental degradation in the locality. The survey results show that loss of soil fertility and decrease of productivity; increase of inputs costs (for seeds, fertilizers, water, pesticides and labour costs) and decrease of net economic benefits from crop farming are common in the villages. They also reported the excessive use of chemical fertilizers and pesticides and associated health risks and its impacts on ecosystem and local bio-resources, particularly on open water fisheries as major problem in the local agro-ecological system. Over extraction of ground water during dry season drew down the ground water level making many of the hand tube wells inoperative in the dry season. Many of them have also reported the loss of local crops and biodiversity as a major problem in agriculture.

In the past, agricultural practices were mainly based on local inputs and indigenous knowledge. Farmers developed localized methods of ploughing land with cows; soil conservation with crop rotation, inter cropping, mixed cropping; increase of soil fertility by burning crop residues in the field, use of green manure, pest control by using local techniques and organic materials such as herb and ash; use of surface water and rain water, drought management by local techniques (pulling rope on young plants); agro-forestry and integration of agriculture with livestock and poultry. They were self-sufficient in undertaking agricultural activities with their own resources and efforts. However, they would sometimes take inputs, new ideas and material assistances from relatives and fellow farmers. The innovative farmers were also keen to know from farmers of the neighboring villages. They would introduce new varieties of crops and techniques of cultivation suitable to their own situations and context considering land types, flood, water availability and seasonal variation across the year.

It was also learnt that all the agricultural and livelihood activities in the locality were mostly dependent on indigenous knowledge and local inputs in the 30-40 years ago. In the late 1960s and early 1970s, external and modern knowledge as well as many external inputs were introduced by different agencies (BADC and NGOs). Many of the IKs and local indigenous practices were replaced by the emergence of MKs and external inputs, which gave quick results in the initial stage. In the 1990s, (after 20 years Green

Revolution), there has been a slow change in the mind sets of the local farmers and many of them have become interested to the good local practices and indigenous knowledge for soil conservation, pest control, irrigation and drought management, crops and species conservation through intercropping, multi-cropping, agro-forestry and integration of sub-sectors of agriculture.

Though the use and application of local inputs and IK has decreased in the last decades, but presently many farmers, mainly the self-sufficient and marginal groups as well as few poor farmers are increasingly applying various IKs and local inputs (such as local crops and seeds varieties, green and compost manures, herbal pest control, rain and surface water for irrigation and drought management) in farming practices. There are practices of multi-crop, inter crops and crop rotation and cultivation of local varieties of crops (Aus, Aman, jute, *kaun, china,* sugarcane, mustard, *til tisi*, groundnuts); mulching for soil conservation, uses of green manures (*Dhaincha, sola,* jute etc.), compost and organic manures (cow dung, crop residues, water hyacinth, aquatic flora etc.); local techniques for pest (birds sitting, *Alor Phad.* and predators) and weed controls. But the level of uses and interest for IK and blending of IK and MK differ across the wealth categories. The level of awareness about IK, good practices and their world views (purpose of agriculture and living; relation between human and natural systems), orientation about ecological good practices and connection with external world often influence the use of IK and MK in agriculture.

The field observation says that the medium and marginal farmers apply IK to great extent in their farming practices and in terms of taking local low cost inputs in agriculture, because they have long term stake in agriculture and try to promote good practices. They are very innovative and often try to modify and improve IKs in their own needs and local contexts. They also adapt the MKs and external knowledge in the context of local situation and their needs and thus contribute to generation of new knowledge. Women play a very key role in agriculture in the study villages. Women from poor farming families preserve seeds and participate in planting of crops and post harvesting activities. They suggest for appropriate crop rotation and mixed cropping. They organize home gardening and vegetable growing in home and in the field. They prepare food and collect the vegetable and other elements of food from home and natural resources bases in the floodplain (small fish and aquatic vegetable for household consumption). They conserve bio-resources (fruits, herbs and vegetables) and collect herbal plants and use those widely for human health seeking and veterinary medicines.

Age differences and personal experiences sometimes influence the use of IK and MK. Elderly people very often prefer the use of local inputs (own seeds, local crops, compost manures and local pest management) and local knowledge while the young people generally prefer external inputs (HYV seeds and chemical fertilizers and pesticides) and modern knowledge in their farming practices. However, there are young farmers who use both MK and IK in crop cultivation and take inputs from other sub-sectors (poultry and cattle). There are also innovative young farmers (those who are very involved in agriculture) are aware of the current and emerging problems in agriculture (such as loss of soil fertility and productivity and ecological destruction) are again interested for both IK and MK. Formal education sometimes creates barriers towards the use of IK. But most

of the farmers are illiterate in the study villages while few of them got primary education. Again, it is the out look and worldviews of the farmers that determines the use of IK and MK. Proper orientation about agriculture, ecology and society as well as good food and nutrition for farm families, consumers and the communities can promote use of IK and good practices in agriculture.

But there is limited awareness about the use and usefulness of IK among the farmers, particularly among the involved and innovative farmers. The poor and marginal groups have some interest for the IK and local input, but they have resources constraints. They don't have adequate access to natural and common resources, which gives important basis for ecological farming with local knowledge and inputs. Hence, there is need for awareness, policy measures and institutional support for the poor and marginal farmers for promoting good practices. Demonstration of good practices at the farm level by showing the usefulness and efficacy of IKs can encourage farmers towards good practices. The agricultural extension department at the Upazila, development NGOs and media can play effective role in this areas.

A dynamic and growing agricultural system requires meaningful interactions among the farmers and scientists. This is needed for establishing effective links between micro and macro process. Farmers must have the critical understanding and awareness about the problems and prospects of the agro-ecological systems and only then they will engage their knowledge, inputs and resources to find appropriate solutions. The local knowledge and resources may not give solution to their every problem and the farmer have to acquire new ideas, information and support from the external sources such extension services, research organizations, NGOs and market places, but they must have adequate understanding of the suitability of the external knowledge and inputs. Hence, there is a strong need for knowledge continuum between the farmer and external world. Participatory action research may facilitate an effective knowledge continuum between farmers, scientists, policy people and development actors.

Chapter-6: Conclusion and Recommendations

Introduction

Bangladesh experienced growth in agriculture in the last 2-3 decades, but this has been associated with a number of agro-ecological and socio-economic problems due to mainly top-down imposition of Green Revolution technologies and promotion of mono-crops. This has been equally true for the floodplain agro-ecological system. The local resources base, knowledge and practices are greatly affected by the agricultural development process and the sustainability of the sector has been at a stake. The agricultural extension service promoted modern knowledge and technology and supported the market forces, which ignored the local knowledge, local contexts, poor farmer's needs and the potentials of the eco-systems. The study in the selected floodplain villages has found that the involved and innovative farmers are aware of the problems in their agriculture and are trying to address the problems by blending local knowledge and inputs with the modern knowledge and external inputs. Effective integration of the local knowledge systems in the agricultural sub-sectors requires meaningful collaboration among the actors including farmers, researchers, extension department, development actors and the policy people.

Sustainable Development and Sustainability of Agriculture

Sustainable development seeks to respond to a set of key requirements including: a) integration of resources conservation and development with continuous growth; b) satisfying basic human needs (food and nutrition, fiber, fodders, shelter, health etc.,) and c); promotion of social justice, self-determination and culture diversity. For sustaining growth and development in any sector, maximization of internal inputs and renewable resources is essential to avoid the costly external and non-renewable inputs. This is equally true for agricultural sector to make the agro-ecological system sustainable. A sustainable production system should meet at least three sets of goals and imperatives. These are: **economic goal** (increase productivity and meeting basic needs of the farming communities using local and necessary external resources in an efficient and cost-effective way); **environmental imperatives** (conservation and optimal uses of natural resources) and **social goals** i.e., maintaining farm family welfare, food security, poverty reduction, social progress, participation and knowledge generation, social justice, cultural diversity and happiness.

Sustainable agriculture and rural livelihood largely depends on the level of integration of natural, human and social sub-systems, where knowledge of farmers, worthy purpose of farming and living; and wise and efficient uses of resources can play important role. An agricultural system becomes sustainable, when it protects and renews the natural resources up on which all the agricultural and most of the livelihood activities are organized. The agricultural and livelihood systems could be made sustainable, when the farmers are aware of the problems, potentials and can undertake measures to improve the situation consciously and effectively with their knowledge and resources optimizing the uses of local resources and inputs and minimizing the adverse impacts of external inputs on natural resources, human systems and social systems. Such efforts many not de-link

the farmers from the external world and scientific innovation. The farmers would adopt the external knowledge in their local context. They might use all resources and inputs efficiently considering the carrying capacity of the nature and long-term productivity of land, water, and forest for supporting the livelihoods of the farming community.

The Role of Local Knowledge in Sustaining Agriculture

All the popular wisdom, traditional knowledge, local practices, beliefs, the local resources bases, equipment and various local techniques for resources management, enhancement of livelihoods, health seeking etc., could be treated as indigenous knowledge. These are developed through long practice. The IKs have their own dynamics to adapt with the changing situation, needs and priorities of the local people. The IKs evolve through trial and errors and it very often integrate external knowledge in the local context. Hence, IK gives sustainable options for resources management, agriculture and livelihood options considering the various risks, stakes and challenges of the local people. The field observation reveals that IKs can help to address many of the problems in recourse management, agriculture and livelihoods of local communities through promoting good practices and integration of the human and social systems with natural systems.

It was also found that the farmer's world is not isolated from the external world. The farmers very often obtain knowledge and information from various sources such agricultural extension, NGOs, neighboring farmers, market forces, private sector and media. But they do not always get adequate information and knowledge at the right time from appropriate sources. There is need to enhance the exiting knowledge continuum, where the poor and marginal groups of farmers can access the required information and knowledge about problems of agriculture, possible solutions of the problems involving both indigenous knowledge and modern knowledge. Therefore, it strongly felt that the agricultural systems based on IK, local renewable inputs and adopting necessary MKs supported with an effective knowledge continuum and worthy purposes of farming may help to achieving sustainability of the sector through:

e. greater integration of human, social and natural systems;
f. protection and renewal of the local natural resources base for healthy and productive land, water and ecosystems;
g. optimization of using on-farm organic inputs maintaining cycles between biological and natural resources and reduction of uses of non-organic inputs avoiding the adverse impacts on ecosystems and human health; and
h. ensuring equity by providing employment, adequate income, food and nutrition for farm families and local communities for supporting their livelihoods.

Knowledge is distributed unevenly

The participatory research and field observation says that the uses of IK and modern knowledge (MK) at individual, family and community levels depend on various personal (age, education, level of awareness about problems and prospects of agriculture and link

with external world), social (wealth categories, family needs, resources bases, family and social values), physical aspects i.e., productivity of land, soil fertility, availability of water and hydrological systems) market and external factor such as knowledge diffusion by agricultural extension, NGOs and media campaign. The poor and marginal farmers have interest about IK and good practices (use of local and organic inputs instead of external and non-renewable high cost purchased inputs). But most of them lack adequate awareness about the effectiveness of the IK. They also lack required resources such as adequate land, cattle and access to common property resources, which limit their potentials of good practice for sustainable agriculture.

The rich farmers don't have much interest and awareness about wealth of IKs and their effectiveness. It is the self-sufficient and medium farmers who have great interest and growing awareness about IK and good practices in agriculture. They are applying the effective IKs and local inputs in their farming practices. Education, awareness and worldview at individual level often favor use of IK, but these can also create barriers towards application if the awareness is not built from the right perspectives with sound worldview. Elderly people and women are the treasure of IK and good practices.

The field observation reveals that knowledge is unevenly distributed across the social and farming categories. The experienced, involved and innovative farmers possess both IKs and MKs that are being used in the their current farming and livelihood practices. They learn through action and interaction with nature as well as human and social systems. There is need for effective communication across the farmer's categories, particularly for the poor so that they can learn the good practices based on local inputs and IKs and thus apply those in their own farming.

Blending of IK and MK

The IK is holistic and it gives basis for cost-effective solutions to the local problems of resources management, agriculture and livelihoods. It can also help to regenerate natural resources bases and reduces livelihood risks and vulnerability of the farming community. Hence, it is expected that the promotion of IKs and wise introduction of MKs in agriculture may solve many of the current problems and future threats of both agriculture and livelihood of the farming community in the villages. It is also viewed that the local production systems sometimes, based on local inputs only gives low yield, can be unlocked by blending the IKs and MKs in the local context with active participation of the farmers, where all the human, natural and social systems can be integrated meaningfully in a dynamically changing world. But the questions are: i) how to achieve that level of integration; and ii) what would be the role of farmers, extension services, scientists and social change agents at different levels to optimize the uses of IKs and adopting the MKs in local context; and iii) how to strike the balance i.e., blending the MK in local context, which gradually become local knowledge and IK.

The physical environment and social systems are changing continuously and hence many of the IKs need modification to improve their efficacy and acceptability among the farmers considering the dynamics in physical and social systems. There is growing

interest and awareness about the various uses and usefulness of IKs in agriculture, NRM, enhancement of livelihood and rural development in Bangladesh, but there is lack of true initiatives by the local governments (agricultural extension) and development actors to integrate potential IKs effectively in agriculture and other rural livelihood options by improving their efficacy.

Farmer's Innovation requires greater Access to Resources

The field observation further says that there are few innovative farmers, particularly among the marginal and medium wealth categories, who try to blend the IKs and MKs to address their problems in agriculture. Some of them try to experiment new ideas and things out of curiosity to see what happens; there are also few farmers, who try to experiment new things to solve specific problem (soil fertility, pest control, inter-cropping etc.). Many of them try to adopt new crops and new ideas to their own environment. Thus, the farmers have the necessary knowledge and information (both IKs and MKs) about their crops, farming systems, input uses, pest control etc., but this knowledge is not always sufficient to address all the existing and emerging problems and challenges and hence they need further information, new ideas and sharing of good practices from others farmers, agricultural extension and researchers. So there is great need for effective interaction between farmers and the extension services, NGOs and scientists.

The level of IK in agriculture and livelihood activities mainly depends on interest for and understanding of IKs, their usefulness and availability. But the field observation says that many farmers have interest and good understanding about the uses and usefulness of IK, while the prospects of such regenerative sustainable agriculture using local knowledge and resources in the floodplain villages has been constrained by the degrading trends of natural resources bases as well as limited access of the poor to the resources base, which gives the basis for maintaining cycles between biological and natural systems in agriculture and rural livelihoods. The poor and marginal farmers are continuously being denied of their traditional rights and access to the local resources base including productive land, water and aquatic flora and fauna due to the existing social structure, rural power relation and institutional arrangement, where the rich and local power elites are getting more and more control as well as ownership of the resources.

Further, the poor in every ecosystem in Bangladesh are denied of their traditional rights and access to the local natural resources bases (such as land, water, fisheries, forest and bio-resources) due to many economic, socio-cultural and political reasons, which has created barriers to achieve bear minimum livelihoods for their families. Thus they are sometime compelled to overexploit their resources bases and degrade their own support systems. The market forces and dominant practices of the commercial interest groups, who are guided by the chief economic gains, also influence the poor and marginal groups of people. They need greater access to natural resources and livelihood options, so that they can avoid the harmful practice and live with nature in paces and harmony using their popular wisdom, IKs and innovative practices. The poor and marginal farmers need greater access and control over the natural resources and common property resources so

that they can use their IKs and promote good practices in agriculture by integrating the human, social and natural systems as well as by taking local inputs and thus reduce external dependency and avoid the adverse impacts of chemical inputs on ecosystems and human systems.

PAR promotes Knowledge Continuum

Knowledge and understanding of specific the issue in relation to agriculture and farm management and the mode of thinking of the farmers, extension workers and the scientists may differ in many ways, but participatory action research (PAR) and continuous interaction among the farmers, researchers and relevant actors can help to have better understanding of the farming systems, the problems and enhance co-learning leading to more productive, dynamic and sustainable agricultural systems. It was noticed that the poor and marginal farmers sometimes lack proper understanding of the farming systems and the problems and they need appropriate information and sometime orientation about the dynamics of the systems as well as greater access to local resources base, which can help them to take right decision at farm level and initiate good practices. Critical awareness and understanding of the problems and prospects of agriculture may give part of solution by engaging the farmers and the key actors in collective action and reflection for promotion of good practices, where poor and marginal farmers must play a key central role in exchange, innovation and knowledge generation.

Women, particularly the old women possess wealth of knowledge in home gardening, vegetable and fruit growing, agroforestry, natural resources management, post harvesting activities, storing grains and seeds, uses and conservation of local herbs and medicinal plant both for human health seeking and veterinary medicines. Thus, any development, research and local action for enhancement of livelihoods, development of agriculture and promotion of rural health should consider the knowledge the women. The scientists of both social and natural sciences discipline should consider the local and indigenous knowledge base of the experienced farmers, women and community people and they should have meaningful interaction with them to better understand the local contexts and true needs and priorities of the farmers and the local communities and thus they can facilitate the process of generation of new knowledge and sustainable development process in such a participatory and interactive way.

Recommendations

The public policies and programmes in developing countries including Bangladesh very often favour the large farmers, who are small in number but can influence the decision making at local and national levels. The national policy and programmes should redirect their focus on the marginal and small farmers, who are large in number in Bangladesh. The programmes based on local needs and priorities utilizing local and indigenous knowledge can best help the small farmers and poor rural communities. Fortunately, the present National Agricultural Policy of Bangladesh suggests to promote IK in agriculture, but the country needs a national strategy and practical programmes to enhance the application of IKs and good practices for promotion of ecological farming. The required

information on indigenous knowledge is to be made more accessible to the poor and small farmers, development actors and the relevant stakeholders. The strategy should ensure that important IKs are placed more firmly and widely in the local and national development agenda. Effective instruments and institutional arrangement is also required to identify and recording of the existing wealth of IKs and promotion of the potential IKs through local innovation and effective integration of local knowledge to the farming, NRM and other rural livelihood activities.

It is also felt that the worthy goal of farmers for farming and livelihood can promote good practices at farming and livelihood activities, where farmers may use their conventional wisdom, skills and IKs to integrate human and social systems with natural and biological systems without harming the nature and ecosystems at the community level. A good sense of live on earth and re-orientation of farmers about how to best integrate the human and social systems with natural systems considering it carrying capacity can help develop good practices as well as generation of new knowledge in the area of agriculture, natural resources management and livelihoods. In the above context, the study puts forward the following recommendations in relation to policy, programme, local actions and further research in the areas of IK and sustainable agriculture.

Recommendations for Policy and Institutions:

- Increasing the understanding, awareness and interest of people both in policy and programmes at various local levels as well as the farmers and rural communities (who are the ultimate users of the local knowledge) about IKs;
- Enhancing better information sharing on IKs and its usefulness through improving extension service and informed collective actions at local levels;
- Promoting application of IK in development process and sectoral development such as agriculture, water management, fisheries, forestry etc., through action research and effective policy advocacy;
- Sensitization and engagement of the people in policy and programme about the uses and usefulness of IKs in the context of sustainable agriculture and achieving livelihoods from agriculture;
- Building new institutions and bring about necessary shift in existing institutions at different levels is required towards working for sustainable agricultural development and promotion of livelihoods of the poor and the marginal groups (because the existing formal government institutes work for the large farmers and promotion of commercial production systems);
- Improve legal framework and incentives (economic, social, property right etc.) to stop harmful practices and encourage good practices, organic farming and integration of natural and biological cycles;
- Building local organizations for farmers, particularly for the poor and marginal farmers to share information on problems, prospects and good practices in farming (for the promotion and uses of IKs, blending of MK and IKs and integration of natural, human and social systems etc.); and
- Actions at community and farm levels to reorient farmers and other actors about the use and usefulness of IK as well about worthy goals of living with nature

considering long-term human welfare and interface of human and social systems with natural systems and local environment.

Recommendations for further research:

- Preparing inventories of IKs used in different agro-ecological systems and improve the potential IKs though facilitating the continuous applications of IKs in farming, so that the IKs can contribute to addressing the problems in agriculture and rural livelihoods;
- Initiating more participatory and action research (PAR) for promotion and effective application of IKs in agriculture for achieving its sustainability;
- Initiate more on-farm research involving farmers and community people where the scientists, trained in the formal institutes, can play more facilitating role in identifying issues and develop methodology for the farmers to act meaningfully in the process of agricultural development, enhancement of livelihoods and generation of knowledge;
- More academic as well as action research on – how to blend IK and MKs i.e., improve potential IKs in the current contexts, needs, priorities and adopting MKs to the local situation;
- Research is needed on how the human, natural and social systems can be integrated meaningfully in the dynamically changing agro-ecological systems, which have many interfaces with the social, economic and political systems; and
- Improve methods and approach to initiate more effective participatory action research, where farmers and local people can be the key players in the research and contribute to the generation of knowledge generation and thereby the local community can get benefits from new knowledge by improving their productions and livelihood systems.

Recommendations for immediate practical Action:

- Increase of awareness about use and usefulness of local knowledge and blending of IK and MK for better environment, good food and health as well as social progress with equity
- Effective information sharing among farmers, actors and stakeholders;
- Engagement of the actors including policy and programme people;
- Institutional and legal support for promotion of IK and good practices in agriculture;
- Collective action with poor and marginal farmers at farm levels; and
- Promotion of good sense of live, living and farming.

**** **** ****

References:

1. Agrawal A (1995): *Indigenous Knowledge and Scientific Knowledge – Some Critical Comments,* in Indigenous Knowledge and Development Monitor (IKDM), Vol. 3, No. 3, Nuffic-CIRAN, The Netherlands
2. Ahmad QK and Zaman SMH (1997): *Bangladesh – Agricultural Growth and Environment,* in the Asia Pacific Journal of Environment and Development. Vol. 4, No.1. Bangladesh Unnayan Parishad, Dhanmondi, Dhaka
3. Ahmed *et al* (1996): *Achievement of Gender Research and Training Project: Proceeding of a Workshop*, Bangladesh Agricultural Research Council (BARC), Dhaka
4. Ahmed N (1955): *Fishing Craft of East Pakistan*, Asiatic Society of Pakistan, Dhaka
5. Alam SMN (2006): *Changing Focus of Anthropology: Where is the End?* In Anthropology in Move – Contextualizing Culture Studies in Bangladesh, Department of Anthropology, University of Dhaka
6. Alam SS (1997): *Fishing Gears in Floodplains of Bangladesh*, in Open Water Fisheries of Bangladesh, UPL, Dhaka
7. Alim A (1981): *Growth of Soil and the Furrow*, Published by Sufia Mahmud from Juthi Printing Press, Kalabagan, Dhaka
8. Akash MM (1998): *Agriculture of Bangladesh* in Bangladesh Environment Facing the 21st Century, SEHD, Dhaka
9. Arens J and Burden J. V., (1985): JHAGRAPUR (A village study on family, social conflict and gender relation), Ganaprkashani, Dhaka
10. Bangladesh Agricultural Research Council (1982): *Indigenous Agricultural Tools and Equipment of Bangladesh,* BARC, Farm Gate, Dhaka
11. Barr JJF and Dixon PJ (1998): *Incorporating Farmers' and Fishers' Knowledge into Natural Resources Systems Research on the Bangladesh Floodplains,* in Grassroots Voice, Vol. III, Issue-I, BARCIK, Dhaka
12. Barr JJF and Others (1996): *Preliminary Investigation of Agricultural Diversification and Farmers' Practices in Bangladesh Floodplain Production Systems Involving Rice-Fish Production,* Centre for Land Use and Water Resources Research, University of Newcastle, UK
13. Bernard RH (1994): *Research Methods in Anthropology – Qualitative and Quantitative Approaches*, Sage Publication, California, USA
14. Berreman et al (1987): *Cultural Anthropology Today*, Communication Research Machines, USA
15. Brammer H (1997): *Agricultural Development Possibilities in Bangladesh*, University Press Limited (UPL), Dhaka
16. Centre for Indigenous Knowledge for Agriculture and Rural Development (1998): *Sustainable Agriculture and Rural Development*, CIKRAD, Iowa State University, USA
17. Chadwick M, Mallick D and Alam SS (1998): *Understanding Indigenous Knowledge: Its Role and Potential in water Resources in Bangladesh,* Environment Centre of University of Leeds, UK and BCAS, Dhaka
18. Chambers R (1983): *Rural Development; Putting the Last in the First*, Longman, London

19. Chambers R (1991): *The Role of Farmers in Creation of Agricultural Technology*, in Farmer First–Farmer's Innovation and Agrieultural Research (Edited by Chambers, Pacy and Thrupp), Intermediate Technology Publication, UK
20. Choudhury A (2000): *Preface* to The Indigenous Knowledge Development in Bangladesh: Present and Future, (Edited by Sillitoe) UPL, Dhaka
21. Chowdhury DN and Elias SM (1996), *Indigenous Technology used mostly by Women in Agriculture,* (An article included in the Proceedings of a Workshop), Bangladesh Agricultural Research Council (BARC), Dhaka
22. Chowdhury HFH (2000): *Indigenous Knowledge Systems: A Development Paradigm in Anthropology,* in Of Popular Wisdom, indigenous Knowledge and Practices in Bangladesh, (Edited by Khan and Sen), UPL, Dhaka
23. Chowdhury MK et al (1993): *Agroforestry-Farming Systems Linkages in Bangladesh,* BARC – Winrock International, Dhaka
24. Dixon P., Barr J., and Sillitoe P. (2000): Actor and Rural Livelihood – Integrating Interdisciplinary Research and Local Knowledge, in *Indigenous Knowledge Development in Bangladesh: Present and Future,* UPL, Dhaka
25. Food and Agricultural Organization (2003): *Bangladesh Country Report-2003*, FAO Dhaka Office, Dhaka
26. Farrington and Martin (1986): in their article in Marginal Natives-Anthropologists at Work, edited Freilich and published by Hopper and Row Publishers, New York
27. Freilich M ed. (1986): *Marginal Natives- Anthropologists at Work*, Hopper and Row Publishers, New York
28. Grenier L (1998): *Working with Indigenous Knowledge – A Guide for Researchers,* International Development Research Centre (IDRC), Canada
29. Gregow K (1998): *Ecological Farming – Cultivating for Life,* in Bangladesh Environment Facing the 21st Century, SEHD, Dhaka
30. Gupta AK (1991): *Scientist's Views of Farmers. Practices in India; Barriers to Effective Integration.* in Changes in Farmer First – Farmer's Innovation and Agricultural Research (edited by Chamber, Pacy and Thrupp), Intermediate Technology Publication, UK
31. Hassan Shahed (1996), *Rainwater Harvesting: An Eco-specific Intervention for Bangladesh,* Social Science Review, Volume-XIII, Number-1, Dhaka University Studies, Dhaka
32. Hassan S (2003): *Ethno-Medicine in Bangladesh*, in Right – A Journal of Samata, Vol.4, September 2003, Mohammadpur, Dhaka
33. Holmberg J. edited (1992): *Policies for a Small Planet*, International Institute for Environment and Development (IIED) and Earthscan Publication Ltd., London
34. Hossain M and Shahabuddin Q (1997): *Sustainable Agricultural Development in Bangladesh: Challenges and Issues*, BRRI Dialogue Paper, Dhaka
35. International Institute of Rural Reconstruction (1996): *Recording and Using Indigenous Knowledge,* IIRR, Silang, Cavite, Philippines
36. Islam K., et al (1990): *Folk Literature of Tangail Districts*, Public Library, Dhaka
37. Islam Z and Shafie H (2006): *The Anthropological Tradition: Experiences and Expectation in Bangladesh,* in Anthropology in Move – Contextualizing Culture Studies in Bangladesh, Department of Anthropology, University of Dhaka

38. IUCN – The World Conservation Office of Bangladesh (2004): Introduction to Community Based Haor and Floodplain Resources Management, IUCNB, Dhaka
39. Jalal MS (2006): *Exploration into Epistemology and Ontology of Anthropology: The Question of Disciplinary Continuity and Beyond,* in Anthropology in Move – Contextualizing Culture Studies in Bangladesh, Department of Anthropology, University of Dhaka
40. Jansen EG and other (1989): *The Country Boats of Bangladesh: Social and Economic Development and Decision-making in Inland water Transport*, UPL, Dhaka
41. Khan S (1987): *Folklore of Bangladesh*, Bangla Academy, Dhaka
42. Lewis DJ and Others (1996): *Trading the Silver Seed: Local Knowledge and Market Mortalities in Aquacultural Development*, UPL, Dhaka
43. Mallick D (2000): *Investigating Indigenous Knowledge – A Review of Bangladeshi Literature on Natural Resources*, in Indigenous Knowledge Development in Bangladesh: Present and Future, UPL, Dhaka
44. Mandal MAS (2002); Linking Agriculture and Livelihoods in Bangladesh, DFID, Dhaka
45. Mandal MAS (2003): *Trends in Rural Economy in Bangladesh – Issues and Strategies for Development*, in Natural Resources Management Towards Better Integration, BCAS and DFID, Dhaka
46. Mazzucato (1997): *Bridging Gaps between Economics and Anthropology*, Indigenous Knowledge and Development Monitor, Vol. 5/1 Nuffic, The Netherlands
47. Ministry of Agriculture (1998): *National Agricultural Policy of Bangladesh*, MoA, The Government of Bangladesh, Dhaka
48. Morries F (1970): Marginal Natives; Anthropologist at Work, Harper and Row, New York
49. Murakami S (1991): Lessons from Nature – A Guide to Ecological Agriculture in Tropics, Proshika MUK, Dhaka
50. Rahman H (1989): *An Assessment of Anthropological Thoughts*, Jamuna Press, Dhaka
51. Rahman A and Mallick (2003): *Sustainability of the Planet and International Politics; Looking for an Effective Global Governance*, in Sharing The Planet – Population, Consumption and Science, Eburon Academic Publishers, Delft, The Netherlands
52. Rahman A and Mallick D (2004): *Sustainable Development and Climate Change: How can Sustainable Development Policies contribute to Climate Change Mitigation and Adaptation in Developing Countries?* in Climate Policy for the 21st Century, Centre for Transatlantic Relations (CRT), Johns Hopkins University, USA
53. Rahman Md A (1994): *People's Self Development - Perspectives of Participatory Action Research; A Journey Through Experiences*, The University Press Limited (UPL), Dhaka
54. Raj P (1998): *Proshika's Ecological Farming,* in Bangladesh Environment Facing the 21st Century, SEHD, Dhaka

55. Rajsekaran B (1993): *A Framework for Incorporating Indigenous Knowledge Systems into Agricultural Research*, Studies in Technology and Social Change No. 21, Iowa State University, USA
56. Reijtjes C., Harverkort B. and Waters-Bayer A (1992): Farming for the Future – An Introduction to Low-external Inputs and Sustainable Agriculture, Macmillan, London
57. Roger and Flex (1987): New Perspectives in Cultural Anthropology, New York
58. Rosset and Benjamin (edited). 1994: The Greening of the Revolution – Cuba's Experiment with organic farming, Ocean Press, Australia
59. Sadeque SZ (1992): *Rural Sociological and Anthropological Contribution in Agricultural and Natural Resources Research and Development in Bangladesh*, in Environment and Natural Resources Management in Bangladesh, Bangladesh Sociological Association, Dhaka University, Dhaka
60. Sen A (1999): Development As Freedom, Alfred A Knopf, New York
61. Sharma PN (ed., 1998): *A Compilation of Indigenous Technology and Knowledge for Upland Watershed Management in Bangladesh*, PWMTA Program, Katmandu
62. Sillitoe P. and other (1998): Indigenous Knowledge Research on Floodplain of Bangladesh: The Search for a Methodology, Grassroots Voice, Vol. 1, Issue-1, BARCIK, Lalmatia, Dhaka
63. Sillitoe P (2001): *What know Natives? Local Knowledge in Development*, in Grassroots Voice, Vol. IV, Issues-I, December 2001, BARCIK, Dhaka
64. Sillitoe P edited (2000): *The State of Indigenous Knowledge in Bangladesh*, in *Indigenous Knowledge Development in Bangladesh: Present and Future*, UPL, Dhaka
65. Sillitoe P., Dixon P. and Barr J (1998): *Indigenous Knowledge Research on the Floodplains of Bangladesh – The Search for a Methodology*, Grassroots Voice, Vil.1, No.1, BARCIK, Lalmatia, Dhaka
66. Sustainable Agriculture Research and Education Programme (2001): *What is Sustainable Agriculture*, University California, USA
67. Sustainable Agriculture Network (2000): What is Sustainable Agriculture? Working Paper, SAN, New York
68. Third World Network (2002): *Criticism to WSSD Plan of Action*, TWN, Indonesia
69. Thompson J (1993): Beyond Farmer First: Research Programme and Workshop, IKDM, Vol. 1/1, Nuffic, The Netherlands
70. Titilola T (1994): *Indigenous Knowledge Systems and Sustainable Agriculture in Africa: External Linkages*, IKDM, Vol. 2/2, Nuffic, The Netherlands
71. Tsai C and Ali MY edited (1997): *Open Water Fisheries of Bangladesh*, University Press Limited (UPL), Dhaka
72. UBNIG (1996): *Naya Krishi Andolon – Cultivating Anando, Planting Seeds for Joy*, UBINIG, Adabar Mhanpur, Dhaka
73. United Nations Development Programme (1992): *The Agenda 21*, UNDP, New York
74. United Nations Development Programme (2002): *The WSSD Plan of Action*, UNDP, New York
75. Vorley B (2002): *Sustaining Agriculture; Policy, Governance and the Future of Family-based Farming*, DFID, Sida and IIED, UK

76. Warren and Cashman (1991): *Indigenous Knowledge for Sustainable Agriculture and Rural Development*, Gate Keeper Series - Working Paper-10, IIED, London
77. Warren (1995): Indigenous Knowledge for Sustainable Agriculture and Rural Development, IKDM, Nuffic, The Netherlands
78. Weizenfeld (1998): *Anthropological Approach to Indigenous Knowledge Research,* IK Monitor, Vol. 6 Issue no. 3, Nuffic-CIRAN, The Netherlands
79. White M (1967): *Teaching Yourself Anthropology*, University Press, UK
80. Wignaraja P (2001): *The Knowledge System*, in The Lovraj Kumar Memorial Lecture 2001, Foundation of Poverty Eradication in South Asia, New Delhi
81. World Resources Institute (2001): *A Guide to World Resources; People and Ecosystems – The Fraying Web of Life*, WRI, Washington DC, USA

Appendices:

Appendix-I: Format of Household Census

Department of Anthropology, The Dhaka University

Para: **Village:** **Union:** **Upzila:** **District:**

Name of the Household Head Fathers' / Husbands' Names	Age	Education *	Gender Ml-1 F-2	Religion M= 1 H= 2 C=3	Family Size	Primary Occupation ** codes	Secondary Occupation ** Codes	Ownership of Land and Types of Crops (Amount of Land in Decimal)									No. of Poultry	No. of Cattle	No. of Pond	Social Category ****
								Homestead		High land		Medium Land		Low Land		Total Land				
								Amt	Crops ***	Amt	Crops	Amt	Crops	Amt	Crops					

*** Education Codes:**

Illiterate-1
Primary-2
Secondary-3
Higher-4
Other-5

**** Occupation Codes:**

Agriculture-1
Share-cropping-2
Agri-labour-3
Rick/van pulling-4
Small business-5
Service-6
Fishing-7
Other-8 (Please specify)

*****Crops Codes:**

IRRI (28)-1
IRRI (11)-2
Boro-3
B Aman-4
Wheat-5
Bhutta-6
Kaun-7
Ground nut-8
Jute-9
Sugar cane-10
Khesari-11
Mug dal-12
Masur dal-13
Kalai-14
Mustard-15
Tishi-16
Til-17
Sayabeen-18
Kalajira-19
Dhania-20
Shola-21
Dhaincha-22
Other crops-23
Lalshak-24
Puishak-25
Datashak-26
Dheros-27
Kachu-28
Sheem-29
Brinjal-30
Kumra-31
Patal-32
Karala-33
Chilly-34
Ful kapi-35
Badha kapi-36
Mula-37
Gagar-39
Papaya-40
Banana-41
Others-42 (Specify)

******Social Category:**

Extreme Poor-1
Moderate Poor-2
Marginal-3
Middle Farmer-4
Rich Farmer-5
Very Rich-6
Other-7

Appendix-II : **কৃষিতে স্থানীয় জ্ঞান সমীক্ষা**

নৃ-বিজ্ঞান বিভাগ, ঢাকা বিশ্ববিদ্যালয়

১. পরিবারের ক্রমিক নং : গ্রামের নাম :

পরিবার প্রধানের নাম : বয়স : শিক্ষা :

পরিবার প্রধানের পেশা : দ্বিতীয় পেশা : তৃতীয় পেশা :

পেশা কোড : ১. কৃষি, ২. কৃষি শ্রম, ৩. বর্গা চাষ, ৪. রিক্সা/ভ্যান চালানো,
৫. ব্যবসা, ৬. চাকুরী, ৭. মাছ ধরা/চাষ, ৮. অন্যান্য (নির্দিষ্ট করে লিখুন)

পরিবারের সদস্য সংখ্যা : পরিবারের উপার্জনকারীর সংখ্যা :

পরিবারের আয়ের উৎস : পরিবারের মাসিক আয় :

২। ক. **জমির পরিমান এবং ফসলের ধরণ**

জমির ধরণ	জমির পরিমান (শতক)	রবিশস্য * (অগ্রহায়ন-মাঘ)	খরিপ-১ * (ফাল্গুন-জ্যৈষ্ঠ)	খরিপ-২ * (আষাঢ়-কার্তিক)
বাড়ীর আঙ্গীনা				
উঁচু জমি (বর্ষাকালে যেখানে ১-২ ফুট/ হাঁটু পানি হয়)				
মাঝারি জমি (বর্ষাকালে যেখানে কোমর পর্যন্ত পানি হয়)				
নিচু জমি (বর্ষা মৌসুমে যেখানে কোমর থেকে মাথা পর্যন্ত পানি হয়)				
খুব নিচু জমি (বর্ষায় যেখানে মাথার উপর পর্যন্ত পানি হয়)				

* **ফসল কোড:** ১. ইরি (২৮), ২. ইরি (১১), ৩. বোরো, ৪. আমন ৫. গম, ৬. ভুট্টা, ৭. কাউন, ৮. বাদাম, ৯. পাট, ১০. আখ, ১১. খেশারী, ১২. মুগ, ১৩. মসুর, ১৪. কলাই, ১৫. সরিসা, ১৬. তিল, ১৭. তিসি, ১৮. সয়াবিন, ১৯. কালজিরা, ২০. ধনিয়া, ২১. সোলা, ২২. ধৈঞ্চা, ২৩. অন্যান্য শস্য। ২৪. লাল শাক, ২৫. পুঁই শাক, ২৬. ডাটা শাক, ২৭. ঢেরস, ২৮. কচু, ২৯. সীম, ৩০. বেগুন, ৩১. কুমড়া, ৩২. পটল, ৩৩. করলা, ৩৪. মরিচ, ৩৫. ফুলকপি, ৩৬. বাঁধা কপি, ৩৭. মূলা, ৩৮. গাজর, ৩৯. উচ্ছে, ৪০. লাউ, ৪১. পিঁয়াজ, ৪২. রসুন, ৪৩. কলা, ৪৪. পেঁপে, ৪৫. অন্যান্য ।

খ. বাড়ীর আঙ্গিনায় ও মাঠে যে সকল ফসলের আবাদ করেন, তার বীজ ও চারা কোথা থেকে সংগ্রহ করেন? (এ গুলি কি নিজের সংগ্রহ, প্রতিবেশির কাছ থেকে নাকি বাজার থেকে ক্রয় করেন)।

গ. ফসল, সাক-সব্জি এবং গাছপালা কি স্থানীয় প্রজাতির নাকি শংকর (HYV) জাতের? স্থানীয় ও শংকর জাতের ফসল/সব্জির/ফল গাছের বিবরণ দিন। (স্থানীয় ও শংকর জাতের ফসল, শাক-সব্জির নাম লিখুন)

ঘ. ফসল ও সাক-সব্জির জন্য কি কি ধরণের উপকরণ ব্যবহার করেন (নিচের ছক পূরণ করুণ)

ফসল / শাক-সবজী ও ফলের নাম	উপকরণ			
	বীজ (√ দিন)		সার (√ দিন)	
	স্থানীয়	উন্নত/ HYV/ আধুনিক	জৈব/গোবর	রাসায়নিক
ইরি ধান				
বোরো ধান				
আমন ধান				
আউশধান				
গম				
কাউন				
বাদাম				
পাট				
কলাই				
খেশারি ডাল				
মুগ ডাল				
মসুর ডাল				
সরিসা				
তিল				
তিসি				
আখ				
রসুন				
পিঁয়াজ				
সীম				
বেগুন				
কুমরা				
লাউ				

ফসল / শাক-সবজী ও ফলের নাম	উপকরণ			
	বীজ (√ দিন)		সার (√ দিন)	
	স্থানীয়	উন্নত/ HYV/ আধুনিক	জৈব/গোবর	রাসায়নিক
উচ্ছে				
মরিচ				
পটল				
ফুলকপি				
বাঁধাকপি				
এলা/গাজর				
পেঁপে				
কলা				
ধনিয়া				
কাল জিরা				
কাকরোল				
চিচিঙ্গা				
ডাটা				
লাল				
পুঁই				
অন্যান্য:				

৬. ফসলে পানি সেচ

ফসলের নাম	উপকরণ পানি	
	দেশীয় পদ্ধতি (বৃষ্টির পানি পুকুর/খাল/ডোবা-নালা থেকে)	আধুনিক সেচ-মাটির নীচের পানি (√ দিন)
ইরি ধান		
বোরো ধান		
আমন/আউশ		
গম/কাউন		
বাদাম		
পাট		
ডাল (মসুর, খেসারি)		

১২০

ফসলের নাম	উপকরণ পানি	
	দেশীয় পদ্ধতি (বৃষ্টির পানি পুকুর/খাল/ডোবা-নালা থেকে)	আধুনিক সেচ-মাটির নীচের পানি (√ দিন)
সরিসা / তিসি / তিল		
আখ		
রসুন/পিয়াজ		
সব্জি-পটল, বেগুন, কুমরা, লাউ		
শাক-লাল, পালং, ডাটা		
ফলের গাছ : পেঁপে, কলা, আম, কাঠাল		
অন্যান্য:		

চ. কীট-পতঙ্গ দমন

ফসলের নাম	উপকরণ / পদ্ধতি (কীট দমন/ আগাছা দমন)	
	দেশীয় পদ্ধতি	রাসায়নিক কিটনাশক
ইরি ধান		
বোরো ধান		
আমন/আউশ		
গম/কাউন		
বাদাম		
ঈাট		
ডাল		
সরিসা/তিল		
আখ		
রসুন/পিয়াজ		
গবজি		
কাক		
এরিচ		
ফলের গাছ		
কলা / পেঁপে / আম		
অন্যান্য:		

৩। কৃষিতে উৎপাদনশীলতা ও অর্থনৈতিক লাভ

ক. বাড়ীর অঙ্গিনা, উঁচু জমি ও নীচু জমির ফসল ও সব্জির উৎপাদন কেমন? আগের তুলনায় কি উৎপাদন (ধান, গম, বাদাম, সব্জি) বেড়েছে না কমেছে?

খ. কি কি কারনে উৎপাদন বেড়েছে বা কমেছে?

গ. আগের তুলনায় (২০-৩০ বছর) বর্তমানে কি কৃষি কাজের খরচ বৃদ্ধি পেয়েছে এবং কেন?

ঘ. কোন কোন ক্ষেত্রে খরচ বেড়েছে?

ঙ. কৃষি কি বর্তমানে অর্থনৈতিকভাবে লাভজনক? বিস্তারিত বলুন।

চ. বর্তমানে খরচের বিবেচনায় কৃষির উৎপাদন কি লাভ জনক? বিস্তারিত বলুন।

ছ. কৃষি লাভজনক না হলে আপনি কেন কৃষি আবাদ করছেন?

জ. উৎপাদিত ফসল, শাক-সব্জি এবং ফল ফলাদি কি আপনি ভোগ করেন, নাকি বাজারে বিক্রয় করেন? (কোনটা কি পরিমান ভোগ ও বিক্রয় করেন?)

৪। **কৃষিতে বিদ্যমান সমস্যা**

ক. আপনার মতে কৃষিতে কি কি ধরণের সমস্যা আছে? (মাটির উর্বরতা, মাটির ও পানি দূষণ, ভাল বীজের সল্পতা, স্থানীয় প্রজাতির ফসল, তথা সব্জি ও ফলগাছ হারিয়ে যাওয়া, উৎপাদন হ্রাস, উপকরণ ব্যয় বৃদ্ধি ইত্যাদি)

খ. আপনার মতে বর্তমানে কৃষির সমস্যা এবং কৃষকের জীবন জীবিকার উন্নয়নে কি কি করা দরকার। এ ব্যপারে কৃষক, সরকার, বেসরকারী সংস্থা/ NGO কি কি করতে পারে?

৫। কৃষিতে স্থানীয় জ্ঞান

ক. কৃষির বর্তমান সমস্যা মোকাবেলায় এবং কৃষিকে টেকসই করার জন্য স্থানীয় জ্ঞান ও প্রজুক্তির (যেমন জৈব সার, একই জমিতে একাধিক ফসল, সমন্বিত কীট দমন ইত্যাদি) ভূমিকা কি?

খ. বর্তমানে এসমস্ত স্থানীয় জ্ঞান কৃষিতে কি কার্যকর ভাবে ব্যবহার করা সম্ভব?

গ. **অতীতে (২০-৩০ বছর আগে)** কৃষিতে কি কি স্থানীয় জ্ঞান/ উপকরণ প্রয়োগ করা হতো :

- বীজ নির্বাচন / ফসল বিন্যাস / ফসলের আবর্তন জন্য কি কি করা হত?
- মাটির উর্বরতা বৃদ্ধি ও সংরক্ষণের জন্য কি কি করা হত?
- পানি সেচ / পানির সল্পতা / খড়ামোকাবেলা
- কীট দমন / আগাছা দমন
- ফসল কর্তন / প্রক্রিয়া করণ ও বীজ সংরক্ষণ
- অতীতে কি ভাবে কৃষির সাথে গো-পালন এবং মৎস চাষ সমন্বয় করা হতো?

ঘ. কিভাবে স্থানীয় জ্ঞান ও প্রযুক্তির উন্নয়নের মাধ্যমে কৃষিতে প্রয়োগ করে বর্তমান কৃষি ব্যবস্থাকে টেকসই করা সম্ভব? অর্থাৎ স্থানীয় জ্ঞান ও প্রযুক্তির প্রয়োগের মাধ্যমে কৃষি উৎপাদন বাড়ানো, পরিবেশ ও স্বাস্থ্যের ক্ষতি কমানো এবং শষ্য ও জীব বৈচিত্র্য রক্ষা করা যায়?

৬। **ফল গাছ ও বাড়ীর আঁঙ্গিনায় সব্জি চাষ**

ক. বাড়ীর আঙ্গিনায় কি কি ধরণের সব্জি আবাদ করেন? বৎসরের কোন সময় কি কি সব্জি ও ফল হয়? স্থানীয় / দেশী প্রজাতির গাছ-পালা কি কি?

খ. আঙ্গিনায় সব্জি ও ফল কি ভাবে পরিচর্যা করেন? আপনি কোন ধরনের বীজ, সার, পানি, কীটনাশক/ পোকাদমন পদ্ধতি ইত্যাদি প্রয়োগ করেন? এক্ষেত্রে কিকোন সমস্যা আছে?

গ. বাড়ীর আঁঙ্গিনায় সবজি ও ফল চাষ কি লাভ জনক? সব্জি / ফল কি নিজেদের খাবারের জন্য না বিক্রির জন্য আবাদ করেন?

ঘ. এক্ষেত্রে স্থানীয় জ্ঞান ও প্রযুক্তি কি কি? আপনি কি মনে করেন ফল ও বাড়ীর আঙ্গীনায় সব্জী চাষের স্থানীয় জ্ঞান ও প্রযুক্তি আরো উন্নত ও কার্যকর করা সম্ভব? কি ভাবে উন্নত করা সম্ভব?

ঙ. সব্জি, ফল ও হাঁস-মুরগী পালনে **মহিলাদের ভূমিকা কি?** (যেমন বীজ সংরক্ষণ, বীজবোনা, গাছ পরিচর্যা, সার, পানি, কীটনাশক প্রদান, বালাই দমন, ফসল তোলা, প্রক্রিয়াকরণ, সংরক্ষণ, বাজারজাত করণ ইত্যাদি)

৭। **হাঁস-মুরগী ও গবাদী পশু পালন**

ক. আপনার কি কি প্রজাতির গরু-ছাগল আছে? এগুলি স্থানীয় / দেশী প্রজাতির না কি শংকর প্রজাতির? কবে থেকে আপনি শংকর প্রজাতির গরু / ছাগল / হাঁস-মুরগী পালন শুরু করছেন এবং কেন?

খ. গরু-ছাগল/হাঁস-মুরগী খাবার কি কি? আপনি কি নিজের উৎস থেকে গোখাদ্য ও হাঁস-মুরগীর খাবার সংগ্রহ করেন নাকি বাজার থেকে ক্রয় করেন?

গ. গরু-ছাগলের ও হাঁস-মুরগীর কি কি রোগ হয় এবং রোগ সারানোর উপায় কি কি? কি ভাবে আপনি রোগ নির্ণয় করেন? এ বিষয়ে স্থানীয় জ্ঞান/প্রযুক্তি কি কি?

ঘ. গরু-ছাগল ও হাঁস-মুরগীর রাখার ব্যবস্থা কেমন? পরিষ্কার পরিচ্ছন্নতা বজায় রাখা হয় কিনা?

ঙ. গরু-ছাগল ও হাঁস-মুরগী পালন কি ভাবে কৃষির সাথে সম্পৃক্ত করা সম্ভব? (গোবর, জমির সার, মাছের খাবার ইত্যাদি)

৮। **মাছ চাষ / মৎস আহরণ**

ক. আপনার পুকুরে কি কি প্রজাতির মাছ আছে? মাছের পোনা কি প্রাকৃতিক না কি হ্যাচারি থেকে সংগ্রহ করা হয়?

খ. পুকুর কি ভাবে প্রস্তুত করেন? পুকুরের মাটি শুকানো, চুন দেওয়া, গোবর সার / পানি পরিশোধন ইত্যাদি বিস্তারিত বলুন।

গ. পুকুরের মাছে কি কি খাবার দেওয়া হয়? খৈল, ভূসি, মুরগীর বিষ্ঠা, পারিবারিক আবর্জনা ইত্যাদি দেওয়া হয় কিনা? আপনি কি মাছ চাষের ক্ষেত্রে রাসায়নিক সার প্রয়োগ করেন? এগুলির আপেক্ষিক সুবিধা ও অসুবিধা কি কি?

ঘ. মাছ চাষের পুকুরের পানি কি ভাবে পরিশোধন করেন? মাছের রোগ কি ভাবে নির্ণয় এবং নিরাময় করেন?

ঙ. মাছের উৎপাদন কি আগের তুলনায় বেড়েছে না কমেছে? কেন?

চ. বর্তমানে খরচের তুলনায় মাছ উৎপাদন কি লাভজনক?

ছ. চাষের মাছ কি বাজারে বিক্রয় করেন/ না কি পারিবারিক ভোগের জন্য ব্যবহার করেন?

জ. মাছ চাষের বিদ্যমান সমস্যা কি কি? কি ভাবে সমস্যার সমাধান সম্ভব? এ ক্ষেত্রে স্থানীয় জ্ঞান ও প্রযুক্তি প্রয়োগের সম্ভাবনা কেমন?

ঝ. বর্তমানে উন্মুক্ত জলাশয়ের মাছের সরবরাহ কেমন? আগের তুলনায় খাল, বিল, নদী, নালায় মাছ বেড়েছে না কি কমেছে? বাড়লে বা কমলে কারণ কি কি? কি ভাবে মাছের সংখ্যা ও প্রজাতি বাড়ানো যায়?

ঞ. উন্মুক্ত জলাশয়ে মাছের প্রজাতি ও সংখ্যা বাড়ানোর জন্য কি কি স্থানীয় জ্ঞান ও প্রযুক্তি প্রয়োগ করা সম্ভব? এ ক্ষেত্রে স্থানীয় জনগণ (কৃষক ও মৎসজীবি), বেসরকারী সংস্থা এবং স্থানীয় সরকারের ভূমিকা কি কি?

- স্থানীয় জনগণ (কৃষক ও মৎসজীবি):

- সরকার:

- বেসরকারী সংস্থা (NGO):

Appendix-III: Checklist for In-depth Interview

Section-A: Agricultural Practices, Productivity and Livelihood Supports

1. Personal Profile (age, education, occupation, experiences in agriculture, social position and wealth status and link with the external world through radio, TV, newspapers, NGOs, Extension Services ect.)
2. Land ownership and types of crops in different land types (Inter-crops, mixed crops, crop rotation, traditional varieties and local crops etc.) in different seasons
3. Sources of seeds (own sources, neighbour, markets, NGOs, BADC and Government Extension) and types of seeds (local, HYV, exotic etc.) of paddy, vegetables, fruits, cash crops
4. Types and levels of inputs in agriculture (seeds, fertilizers, water, weed management, wage etc.) from own, local and external sources
5. Problems in present day agriculture (soil fertility, soil and water pollution due to excessive uses of chemicals, seeds problems, biodiversity –crops, plants and trees, decrease of yield, high production cost and low economic return, degradation of quality of foods –rice, vegetable, fruits, fish etc.
6. How do you and farmers solve the problems – local innovation, IKs or with external solution? Who comes to help you?
7. Has the productivity of crops, vegetables, fruits and agro-forestry increased or decreased in the last 10-20 years? Why – increased or decreased?
8. Has the cost of farming increased or decreased in the last 10-15 years and for what items (land preparation, fertilizer, irrigation, pest control, weed management etc..)
9. Is agriculture economically beneficial considering the costs and livelihoods of the farmers?
10. Do you consume your products or sell those in the market? And how much livelihood support do you get from agriculture and share cropping?

Section-B: Application and Promotion of Local Knowledge in Agriculture

1. What types of local and indigenous knowledge and practices are there in crop cultivation, soil management fertility conservation, pest control, irrigation, drought management, flood control, weed management, harvest and post harvest storing of crops and seeds?
2. What types of local and indigenous knowledge and practices were there in the past in crop cultivation, soil management fertility conservation, pest control, irrigation, drought management, flood control, weed management, harvest and post harvest storing of crops and seeds? What are the related religious practices and social rituals for crop planting, pest control, and harvesting etc.,
3. What are / were the good IK practices in agriculture in the locality and their usefulness/efficacy?
4. Why do you and farmers uses IK and MK ?
5. Do you think the potentials of IK and local practices (green manure, composting, IPM, Inter-crop, crop-rotation, use of traditional and local varieties, agro-forestry,

rice fish, floating grader, integration of livestock and agriculture, open water fisheries etc.,) can help to resolve many of the problems of present day agriculture?

6. Do you think the IKs are sufficient to address the problems of productivity, soil and water management, pest control and achieve sustainability of the sector?
7. How the IK and local practices can be improved to meet the present and future challenges of agriculture?
8. How the IKs can be integrated with MKs and external knowledge?
9. What are the IK in home gardening and fruits gardening and who (women) take main responsibility?
10. What are the IKs in poultry raising and livestock raising? How the IK s can be improved and blended with MK?
11. What are the local practices and IKs in fish culture and fishing (conservation, management and sustainable harvesting of open water fisheries) and how to integrate those practices in NRM?
12. Role of women in conservation of species and IKs for home gardening, poultry, veterinary medicine and rural health seeking ?
13. How the participation and contribution of women and old people in knowledge generation and conservation could be enhanced in relation to agriculture?
14. What are the role the UP, NGOs and agricultural extension in addressing local agricultural problems integrating IKs in the process?
15. How the role of local poor farmers could be enhanced in conservation and promotion of IKs in agriculture, NRM and livelihood activities?

Appendix-IV: Guideline for FGDs

Note: *Discussion would be held in a suitable place, where participants will feel comfort to express their views freely and independently. The discussion may concentrate on the following issues, but it may go beyond the listed issues.*

1. Discussion about the population and their settlement in the locality; ethnic composition; occupational patterns and livelihoods; social changes in the last tow/three decades
2. Discussion on agricultural practices (cropping patterns, integration of crop cultivation with livestock and fisheries) and changes in inputs uses (seeds, irrigation, pesticides etc) productivity and cost-benefits from agriculture in the villages
3. Impacts of external inputs and modern knowledge on agriculture, ecology and human systems including human health
4. Uses of IKs in agriculture: crop cultivation, agro-forestry, home gardening, livestock and fisheries in the past and present
5. Usefulness of potential IKs for addressing the major and emerging problems in agriculture (loss of soil fertility, loss of bio-diversity; pest control; health risk and conservation of land, water and fisheries)
6. Factors (personal, social, economic, market, media, NGOs and external) behind the uses of IK and MKs in agriculture and the causes of loss of IKs
7. Share some of the key findings on IK practices in agriculture in the villages collected through systematic participatory observation and interviews, IK Survey and get their opinions about the efficacy of the IKs and local low cost inputs for sustaining agriculture
8. Role and responsibilities of the farmers, community people, women, agricultural extension and NGOs to promote use of good IKs in agriculture, natural resources management and health seeking