2006

Environmental Consequences of Development Interventions in Rural Areas: A Study on Selected Villages

Ahsan, Kamrul

University of Rajshahi

ENVIRONMENTAL CONSEQUENCES OF DEVELOPMENT INTERVENTIONS IN RURAL AREAS: A STUDY ON SELECTED VILLAGES

Researcher

Kamrul Ahsan

Ph.D. Research Fellow
Institute of Environmental Science
Rajshahi University
Rajshahi, Bangladesh

Supervisor

M. Sarwar Jahan, Ph.D.

Professor & Director
Institute of Environmental Science (IES)
Rajshahi University
Rajshahi, Bangladesh

Institute of Environmental Science
Rajshahi University
Rajshahi, Bangladesh

January, 2006

DECLARATION

I do hereby declare that the dissertation entitled "Environmental Consequences of Development Intervention in Rural Areas: A Study on Selected Villages" is prepared by myself. This dissertation is an outcome of one-year course work experience field survey and laboratory experimentation under the auspicious supervision of Professor Dr. M. Sarwar Jahan, Director, Institute of Environmental Science, Rajshahi University. The study was designed to explore degradation of rural environment for implementing various development activities and to provide an additional contribution to this very crucial issue of rural area for the development. I humbly submit this thesis to the Institute of Environmental Science, University of Rajshahi, Rajshahi. The contents of this thesis or part of it were not submitted to any other institutes for achieving any academic degree.

Kamrul Ahsan 31/01/200

January, 2006

(Kamrul Ahsan)
Research Fellow
Institute of Environmental Science
University of Rajshahi
Rajshahi, Bangladesh

CERTIFICATE

This is my proud privilege to certify that the dissertation entitled "Environmental Consequences of Development Interventions in Rural Areas: A Study on Selected Villages" was prepared by Mr. Kamrul Ahsan, Joint Director, Bangladesh Academy for Rural Development (BARD), Kotbari, Comilla under my direct supervision. Mr. Ahsan has successfully completed his one year course works of 36 units of credits (UoC) during the session 2002 – 2003 and carried out his field works and laboratory experimentations meticulously. This dissertation is a comprehensive presentation of the investigation he made about the rural environment of Bangladesh. He has tried to explore the experiences and indigenous knowledge of peoples of various statuses along with the scientific investigations of the consequences of developmental interventions on rural environment.

To the best of my knowledge, this dissertation or part thereof has not been submitted for the award of any academic degree, diploma or associate ship of any other similar title to any other University.

Mr. Kamrul Ahsan has fulfilled all the requirements according to the rules of Rajshahi University for Ph. D degree and has made distinct contribution to the field of Environmental Science.

I am forwarding this dissertation to be examined for the degree of Doctor of Philosophy to the Institute of Environmental Science (IES), University of Rajshahi.

31.01.2006

January, 2006

(Prof. Dr. Md. Sarwar Jahan)
Director
Institute of Environmental Science
University of Rajshahi
Rajshahi, Bangladesh

&
Supervisor

ACKNOWLEDGEMENT

It is my great pleasure to convey indebtedness, gratitude and respect to my reverend Supervisor Professor Dr. M. Sarwar Jahan, Director, Institute of Environmental Science, University of Rajshahi, Rajshahi for his continuous encouragement, cordial guidance and thoughtful suggestion during the whole period of my course and thesis works. His intellectual suggestions and care during the course and research works were invaluable. In spite of his heavy involvement with academic and administrative works of the institute he was always cordial and amiable to provide me guidance and directions for the research work. I express my sincere gratitude from the core of my heart for his great contribution for the research work.

Md. Sikandar Ali Mondal, the then Director General of Bangladesh Academy for Rural Development (BARD) provided all types of inspirations like getting admission into higher degree, getting scholarship and deputation to carryout Ph. D work. Teachers of the course work of this higher degree from Institute of Environmental Science and other Departments of Rajshahi University provided their optimum output to make us suitable for carrying out such a research work in the filed of environment. I express my gratitude to all of them.

Executive Chairman of Bangladesh Agricultural Research Council (BARC) Dr. M. Nurul Alam helped me in getting tests of insecticides residual effects on soil samples from Bangladesh Atomic Energy Commission, Savar, Dhaka. Social Science Research Council (SSRC), Ministry of Planning, GoB provided research grants to carryout the research work, which was very much helpful to me. I take the opportunity of expressing my sincere thanks to the authorities of both BARC and SSRC in this regard.

Laboratories of Department of Public Health Engineering (DPHE), Comilla, Soil Resources Development Institute (SRDI), Comilla and Bangladesh Atomic Energy Commission (BAEC), Savar, Dhaka carried out various tests of water and soil samples for the study. I express my sincere thanks to the authorities of these departments.

Villagers; Elected Representatives of Union Parishads, Local Leaders and Field Level Workers and Upazila Officials of the study, who were the respondents and acted as key persons of the study provided all information regarding rural environment. The research work could not be furnished up to this level without their contributions. I express my sincere thanks to all of them. Fellow researchers of IES for the year of 2002 – 2003 helped me in various ways particularly in reviewing of literatures, carrying out statistical tests etc. I acknowledge their contributions with respect.

Md. Abdul Hakim, Research Supervisor and Md. Shafiqul Islam Investigator of Research Division of BARD who helped me in various ways for selecting study villages; pre testing of different types of questionnaires; carrying out PRA exercises; collecting and tabulating of data; collecting various samples of water and soils; and carrying out focus group discussion. I acknowledge their contributions with respect.

Staffs of BARD library, IES library, Central Library of Rajshahi University and Library of Department of Environment, Dhaka helped me in reviewing literatures for the study. I endorse their contributions with respect.

Md. Aminul Islam, Computer Operator and Syed Shahadat Hossain PA to the Director of Local Government and Rural Administration Division of BARD took the painstaking load of typing such a big report. I acknowledge with respect for his contribution.

My wife, Mrs. Nilufar Akhtari, Principal Officer, Janata Bank, Comilla who inspired me all along with mental and financial supports to carryout such a big work. She created scope for me to keep myself away from family works and concentrate on academic and research works. Her contribution was great. I express my sincere thanks to her. My two daughters Fariba Ahsan and Tasannuma Ahsan who were deprived of me in their very valuable time of education during my course work period. I owe to my family members for their contribution.

Good wishes and blessing from my father and mother in laws, my sisters & brothers and relatives helped me to furnish my works smoothly. I owe to them.

I acknowledge the contributions of those who contributed in my research works but I could not mention their names in this acknowledgement.

January, 2006 **Kamrul Ahsan**

DEDICATED TO THE MEMORY OF MY RESPECTED PARENTS
WHO LAID THE FOUNDATION OF MY EDUCATION

ABSTRACT

The study was conducted to explore the indigenous knowledge and concept of people of various statuses from two floods free and two flood-affected villages on rural environmental consequences of development interventions under Comilla Sadar and Sonargaon Upazilas of Bangladesh. As well as the impact of development interventions in soil and water qualities were assessed.

Participatory Rural Appraisal (PRA) and survey methods were used to assess the current environmental conditions in the study areas. Agriculture soil tests covered soil texture, p^H, organic matter content, percent of total nitrogen, P and K. Nine soil samples from different land types of the study villages were tested for finding out residual effects of insecticides in soils under the groups of organophosphorus, organocarbamate and organochlorine after the boro season of 2003. Soil samples were collected from different types of agricultural land under the study. Water quality both for surface and ground water were considered for the study. Total Dissolved Salt, SS, NH_4^+, P^H, P and K tests were carried out for surface water. Arsenic, TH and TDS tests were carried out for ground water assessment in the study villages.

Organic matter contents in agriculture soils were found very low compared to the actual need of 5.0 percent. Major crop nutrients i.e., N, P and K were found very low and low except phosphorus in two villages under Comilla Sadar Upazila. No residual effects of insecticides under the group of organophosphorus, and organocarbamate were found in different soils under tests. DDT and DDE under the organochlorine group were found in two soil samples of Shahpur village under the study. It is learned that DDT was used in a few of the crop fields of the village two decades ago. So, DDT remains more than 21 years in crop fields. A part of the existed DDT in the field had broken into DDE. On average three crops were cultivated in villages of Comila Sadar Upazila and two crops were cultivated in villages under Sonargaon Upazila under the study. Amount of fertilizers and insecticides used were more in villages of Comilla Sadar Upazila than other two villages under the study. The balance existence of major crop nutrients and

agricultural soil quality were better in two villages in Sonargaon Upazila than other two villages of Sonargaon Upazila under the study.

High amount of arsenic i.e., much more than the standard of 0.05 mg per liter was found in Ground Water (GW) of Khangshardi village of Sonargaon Upazila. Total Hardness (TH) values of canal water of two villages under Soanargaon Upazila were found higher than the standard for 120 mg per liter for fish. Physical appearances of surface water both for pond and canal water in terms of cleanliness and smell were found better in villages under Sonargaon Upazila. Tests results of suspended solids values in surface water were within the limit of standard fixed for potable water quality. p^H values of the same were around the lower limit of standard for potable water quality in all study villages. Major crop nutrients N, P and K were found in all samples of surface water under the study. All water samples had more P than the standard (0) fixed for potable water/ fish resources.

Micro credit leads IGAs in case of crop cultivation were found injurious for environment for the same reasons of using insecticides and fertilizers in crops. Majority of IGAs were small trade related which had no environmental effect on the study villages.

Diversity of trees was mainly affected in two villages under Comilla Sadar Upazila with the domination in planting timber rich plants. Besides, majority of big trees were lost from all study villages for various reasons. A number of traditional fish species, birds and wild animals extinct form all study villages during the last four decades. Besides, population of these species including frogs of various types reduced remarkably in the study villages. In case of cultured fish, production of the same increased in folds mainly in two villages under Comilla Sadar Upazila. Number of ponds was also increased remarkably in the study villages. Number and area of catchments were reduced in two villages of Comilla Sadar Upazila in the last four decades.

Respondents provided information of environmental issues of the village like soil and water pollution; and reduction of biodiversity; effects of these changes to the rural environment; and steps needed for the development. It is evident that major environmental problems for reduction of soil fertility, soil and water pollution; and destruction of biodiversity in rural areas take place due to application of insecticides in crops. Besides, killing and hunting of amphibian, reptile, bird and mammal and over fishing deteriorated further the rural environment.

Most of the upazila level officials did not know about the vital legislation of environment ECR-1997. A number of committees work at the upazila level for better output of various development works. No committee works exclusively for taking care of environmental issues of development activities in the upazila. But Upazila Development and Coordination Committee (UPIC); and Upazila Project Implementation Committee (UPIC) take cares mainly water stagnancy related problems during construction works. Respondents opined that using of mass media like radio, television, miking etc. in large scale for awareness building of common people about the importance of conserving and developing environment would provide a better output for environmental development. Besides, conduction of training and orientation courses for the upazila officials about the measures to be adopted time to time should need to be introduced as regular phenomena. Establishment of safe habitats of fish, amphibian, reptile, bird and wild mammal with people's participation at the local level would improve rural environment. Besides, creating scope for giving posting a official from DoF at the upazila level would help to apply more coordinated efforts to address environmental issues properly in different development activities.

Notable findings of the study included existence of DDT in agricultural soils over two decades of time; existence of crop nutrients particularly P more than prescribed standard in pond and canal water create unfavorable conditions of aquatic lives. Excavation of a irrigation canal in a study village affected the biodiversity of the village seriously as run off rain water from hilly areas of India could not cross that canal and reached up to the catchment's area of the village. The rich biodiversity of the village destroyed and the whole area turned into HYV paddy fields where huge amount of fertilizers and insecticides are used every year to produce HYV paddy and other crops. Replacing of aus paddy cultivation with HYV crops destroyed the vast habitats of migratory birds and moving ground of various traditional fishes at the shallow water of aus fields in the early monsoon season of two flood affected villages under the study. Decreasing trend of owl, eagle and vulture increased harmful mammals like rat and squirrel in study villages. Awareness of villagers and development workers about effects of development interventions on biodiversity of the study villages and their consequent opinion to develop the situation were notable. Besides, information on change of status of tree, fish, amphibian, reptile, bird and mammal both wild and domestic over last four decades gives a clear picture of their conditions in two different periods of the study villages.

CONTENTS

Chapter 1
General Introduction

"Verily all things have We created in proportion and measure" (Al-Quran: Sura Qamar- Verse: 49). This suggests that man needs not change this natural proportion and measure of all things in the environment. But man has established civilization by changing the natural set up. He is just supposed to utilize the creation of nature as it is and, in some cases, to make them suitable for developmental purposes. In course of such changes, man is upsetting the appropriate proportion and measures of the environmental components, whereas man indeed has an obligation to future generations to keep life on the planet as original as possible and as diverse as possible, so that the future generation can meet their needs (Challinor, 1988).

Development interventions should be the broad programmes of sectoral change in proportion and measure at structural level and constituents of the environmental states by the activities of government and community (Goodhand, 2001). This is not the case for Bangladesh. In rural Bangladesh, development interventions mainly include efforts of government through various Nation Building Departments (NBDs) at the upazila level and village based community participation. These development interventions mainly comprise agricultural and infrastructural development programmes aimed at maximum utilization of available natural resources for uplifting the pecuniary state and livelihood of people. The development interventions in rural areas of Bangladesh started in 60's with the introduction of High Yielding Variety (HYV) paddy cultivation, lavee & embankment construction for flood protection and rural road construction. Moreover, the general goal of development activities of Bangladesh is to improve the socio-ecnomic condition of rural and mostly agriculture based urban people. Development of agriculture; construction of road & embankment; development of education, health, fishery, livestock, sanitation etc. are the major development interventions in rural areas. But it is assumed that major environmental degradation in rural areas is mainly taking place due to excessive use of agrochemicals in crops and unplanned construction of road and embankments in rural areas; soil and water are being polluted; and fish, amphibian, reptile, bird and mammal becoming affected as the consequences of these development interventions. Whereas, Basher (2004) explicitly states that the standard of living for

rural people depends on agriculture commodities, fishing and navigation which is benifitted invaluably by water flowing over the country through more than 200 rivers demands the proper management of agriculture soil and water pullution.

1.1 Emergence of Development Initiatives in Bangladesh

Under the Local Self Government Act of 1885 and the Village Self Government Act of 1919 of the then British India local government was established to enhance development through creating a number of NBDs and provide with logistic supports for expansion of education, improvement of health, modernization of agriculture and the promotion of co-operative movement for rural development. Various development projects began to start in 1920's and 1930's, at the initiatives of some interested individuals among the members of the Indian Civil Service and Christian Missionaries. During the 1930's there was determined effort by the governments to improve the village conditions (Khan and Solaiman, 1978).

The most significant achievement in Rural Development (RD) during the Pakistan period was the 'Comilla Model of Rural Development' initiated by Dr. Akhter Hameed Khan, the founder Director of Bangladesh Academy for Rural Development (BARD). Experiments were carried out in Comilla Kotowali Thana considered as social laboratory area of BARD.The Comilla experiment produced models of several viable programmes and institutions in rural development. Four of the models were adopted for nationwide replication. These four national programmes are: Rural Works Programme (RWP), Thana Irrigation Programme (TIP), Thana Training and Development Centre (TTDC) and Two-tier Rural Co-operative System in every thana. The unique combination of this package programmes provided administrative, institutional and physical infrastructure which ultimately helped for ensuring support service delivery, forming cooperatives, developing better physical infrastructures like road, growth centre, marketing, flood control embankments etc. for uplifting the socio-economic conditions of the rural people.

Awareness about the environmental health of the world began from late 1970's, which originated at the Stockholm conference on the environment in 1972 and later dramatized at the Earth Summit, 1992 at Rio de Genero, Brazil. Since then the phenomenon of a constantly degrading world environment has been receiving international attention.

In Bangladesh a number of important factors have been identified which affect environment: These are (i) vast poverty and inadequate literacy of the majority population; (ii) high population growth resulting in high demographic density; (iii) increase of salinity in the south western coastal belt; (iv) falling of underground water level due to uplifting of excessive water for irrigation; (v) increasing trend of flood due to heavy siltation of river bed; (vi) global warming; (vii) use of chemicals for crop production causing harm to aquatic lives, soil microbes and fish resources ; (viii) growing slums in urban areas, specially in the capital city Dhaka ; (ix) discharge of industrial waste and urban sewerage systems in the rivers ; and (x) industrial smoke and increasing vehicular emissions in the big cities (PC, 1990).

To address the above phenomena, the environmental management activities in Bangladesh were organized by the Department of Public Health and Engineering (DPHE) through the water pollution control ordinance of 1973. A National Environmental Policy was finalized in 1992 as a guide to a long-term sustainable environment friendly development. The environment policy 1992 spelled out the following objectives:

(i) Preservation and improvement of ecological balance;

(ii) Identifying and controlling all environment polluting and degrading activities;

(iii) Minimizing the impact of natural disaster on environment;

(iv) Ensuring environment friendly development in all sectors;

(v) Ensuring long term sustainable/environmentally sound utilization of natural resources; and

(vi) Active promotion and participation in all international initiatives for the improvement of global /regional environment.

The government attached a high priority to environmental promotion, protection and preservation. A separate Ministry of Environment and Forests (MoEF) and a Department of Environment (DoE) were established (PC, 1990).

1.1.1 Physical Infrastructure Development

Physical construction works in habitats bring immediate benefits and cause losses of long sustained ecosystem in most cases, such as when a reservoir is created by flooding rich soils or an area with a large amount of organic matter, the

first stage in development is a highly productive "bloom" stage of fish production but when the stored nutrients are dispersed and the accumulated food used up, the reservoir stabilizes at a lower rate of productivity resulting in greater benthic oxygen, and lower fish yield (Odum, 1971). There are many examples of agriculture projects, which were initially profitable but had to be abandoned after a few years because of various severe environmental problems. In a study of an irrigation district in Uttar Pradesh in India, 87 percent of farmers reported problems of alkalinity, salinity or water logging. These caused 29 percent of cropland to be out of production after a few years (APO, 2000).

In case of Bangladesh, the rural roadways of the country have been constructed under Upazila or District programmes through Upazila or Union Parishads. A significant amount of the roadways constructed under the rural road network program fall within the flood plain. These roads are to facilitate easy road communication during the monsoon season from village to village, village to market and village to some industrial units. Therefore, the road heights had to be kept above flood level, for which a significant portion of agricultural land was acquired for the roadway and the borrow pits along the sides of the roads (GoB and UNEP, 2001). The impacts of Flood Control, Drainage and Irrigation (FCD/I) projects are the breaking up of the link between the beels and the rivers through the canals. This breaking up of the link prohibits brood stock of fish from moving out to the rivers and moving further upstream in search of congenial breeding grounds. Migration between rivers and floodplains is necessary for maintaining population stability of diverse fish species. Implementation of these water management projects also reduces the size of the flood lands as well as the length and intensity of flooding. Thus fish output is lost because fishing grounds are converted to paddy fields, or the growth in biomass and in the number of fish is hampered due to deterioration in the quality of fish habitat (Ali, 2001). Besides, FCD embankment restricts the flood plain and also modifies the timing and amplitude of flooding. These two i.e., FCD and FCD/I embankments together reduce fish productivity and species diversity. Reduction or completed elimination of the flood plain aquatic habitat will result in a corresponding reduction in fish biomass produced. No-availability or reduced availability of floodplain aquatic habitat during the monsoon months would wipe out fishing activity of the subsistence fishermen (farmers) and fish supply to the rural areas (Ali, 1990).

1.1.2 Land and Soil

Soil is degraded by the excessive use of agricultural chemicals and also lost through erosion. The loss and degradation of soil is a global problem and is often regarded as one of the most serious causes of non-sustainability of agriculture (Brown and Young, 1991). Soil Fertility and its sustainability for crop production mostly depend on the status of Organic Matter (OM) of the soil. In Bangladesh, due to intensive and continuous cultivation of crop, soil OM is gradually depleting. The sources of OM, cow dung, compost, crop residue, farmyard manure, green manure etc. are not sufficiently available to satisfy the requirement. Addition of OM through growing green manure crop alone is not possible as because the farmers do not have sufficient land for growing the same by sacrificing their food crops (Bhuiya and Hossain, 1993). Again, OM is the main fuel source of rural Bangladesh. Traditional biomass fuel is being continuously over-exploited as more than 90 percent of total population of the country depends on biomass fuel for their daily need. The continuous diminishing of biomass fuel adversely affects the fertility of land as agricultural wastes are withdrawn for fuel and other uses (PC, 1985). It was found that OM contents of the topsoils are generally very low in Bangladesh (below 1 percent in the ridges and 1-2 percent in most other soils). In part of the North-Western Region with droughty sandy ridge soil poor in OM, symtoms of ongoing desertification can be observed (Jansoneus *et al.*, 1994).

A study of Bangladesh Rural Advancement Committee (BRAC) shows that 44.5 percent (4.0 Mha) of net cultivable area has less than one percent of OM matter which is very low with respect to need. Net cultivable land of 17.1 percent (1.56 Mha), 21.3 percent (1.94 Mha) and 17.1 percent (1.56 Mha) have OM contents of 1.0-1.7 percent, 1.7-3.5 percent and > 3.5 percent respectively which are considered as low, medium and high amount of OM contents (GoB and UNEP, 2001). Use of Fertilizer-Irrigation-Seed (FIS) technology has resulted in the break through in cereal production in our country. But continuous crop cultivation especially cereal production puts stress on agricultural soil as agricultural soil does not give enough scope to retain their OM content. As a result of higher Cropping Intensity (CI), improper cropping sequences and faulty management practices, depletion of soil fertility takes place (Khan *et al.*, 1996). Farmers having little knowledge about soil components i.e., about actual requirement, often use huge quantity of fertilizer to get higher yield, as a result soil fertility decreases (Anonymous, 2001).

It is proved that increasing substitution of organic fertilizer with chemical fertilizers is bound to destroy the inherent quality of health of the soil in the long run. But at the same time, in order to maintain a high yield rate, the farmers are being forced to apply more and more fertilizers in the successive rounds of cultivation until the cost becomes unbearable (SHED, 1998).

In Bangladesh excessive cultivation and the absence of proper crop rotation practice are the primary reasons behind agricultural land degradation. Physical, chemical and structural changes in soil result in decreased fertility (Anonymous, 2001). The modern rice crops are heavily fertilized to get high returns but crops do not need all fertilizers. As a result, large quantities of nitrogen and mineral fertilizers are drained out of the land to surface water. These also leach into ground water or get absorved into soil in chemically unusable forms, particularly in soil having inadequate humus. The changed soil condition reduces fertilizer absorption by plant tissue (Khan *et al.,* 1996).

World fertilizer use in 1999 totalled 134 million tons, down from 137 million tons in 1998. Indeed, in each of the last three years, 1997 to 1999, fertilizer use has been essentially flat, fluctuating narrowly between 134 million and 137 million tons (Soh and Isherwood, 1999). But in the case of Bangladesh, fertilizer consumption has been growing at over 9 percent per year since independence in 1971 from 282,000 MT in 1969/70 to 1,704,000 MT in 1988/89; average fertilizer use was 131kg per hectare for food grain crops (PC, 1990).

Bangladesh is a pest prone area and most of the food crops suffer from pre and post harvest losses due to pest attack which emphasize the need for pest management (Alam and Hossain, 1998). Pesticide use in HYVs has become a regular feature of farming although most of the farmers do not understand adequately the necessity and mode of pesticides application. In most of the cases, farmers do not have accurate knowledge of using the pesticides. Even, the spraying decisions often taken by the general farmers are sometimes non-optimal (Sarker *et al.,* 2002). Consequently pollution caused by pesticides has been among the greatest causes of concern in the field of agricultural pollution. Pesticide residues occur in soil, air and water as well as in living organisms. Besides, killing the living organism present on the surface of the soil, they reach even the deeper layers

through filling and irrigation on the land, killing still more living forms. With the continuous use, the soil microorganisms lose their capacity of nitrogen fixation (Katyal and Stake, 1998).

World exports of pesticides stood at $ US 11.4 billion in 1980, nearly nine times the level in 1961 (FAO, 1999). This is a 5.4 percent increase over 1997, when trade was adversely affected by the economic slump in Asia. Pesticide use per hectare has been raised dramatically worldwide since 1961 from 0.49 kilogram per hectare to 1.79 kilograms in 1995 (Porter, 2000). Poor weather conditions and pest out- breaks, changes in crop acreages, government regulations, and economic factors such as commodity prices- all have an impact on pesticide usage (Arnold and Grube, 1997).

Insecticides accounts for about 90 percent of total consumed pesticides and are mostly used for cultivating vegetables and Rabi crops in Bangladesh. Research findings show that pesticides applied at the rate of about one kilogram per hectare contaminates the topsoil to a depth of about 30 cm. The pesticides not only destroy harmful insects, but also destroy useful topsoil microbes, which eventually reduce the biological nutrient replenishment of the soil (GoB and UNEP, 2001). The danger of higher concentrations of pesticides in soil arises from fertile soils that contain much living organisms. One pound of rich farm soil contains up to one trillion bacteria, 200 million fungi, 25 million algae, and 25 million protozoa as well as worms, insects and mites. They fix nitrogen for continued fertility of the soil, make minerals available to plants, retain moisture, aerate soil and bring about the essential process of decay. Studies have shown that some chlorinated pesticides seriously inhibit nitrification by soil bacteria (Bhuiya and Hossain, 1993).

The WHO estimated that nearly 4.0 million people suffer from acute pesticide poisoning and at least 20,000 die in each year. At least two thirds of these illnesses and deaths result from occasional exposures in developing countries where people use pesticide without proper warnings or protective clothing. In Bangladesh, on an average 12,000 MT of pesticide is used per year. Farmers usually have lack of understanding about pest and their control, type of chemical use and the rate of application and timing of control. They also do not know about proper pesticide management including safe pesticide handling and storage (Sarker *et al.*, 2002).

Dichloro Diphenyl Trichloroethane (DDT) is the best-known organochlorine pesticide. It was synthesized in 1874 and discovery of its insecticidal activity by Paul Miller in 1939 subsequently led to his receiving the Nobel Prize (Carson, 1962). Early work with heavy applications of DDT resulted in mortality of non-target organisms (Cottam and Higgins, 1946, Barnett, 1950, Mohr, 1951). More than 90 species of birds, particularly American robins (*Turdus migratorious*), were found dead in neighbourhoods where DDT was applied to trees (Bernard, 1963, Hickey and Hunt, 1960 and Wurster *et al.,* 1965). Subsequently, a large-scale mortality of insects and other invertebrates was discovered as well as earthworms accumulated high concentrations of DDT and metabolites that subsequently proved lethal to robins and other birds that ingested cotaminated prey (Barker, 1958). Mortality from organochlorines can occur within hours after exposure in the environment (Blus *et al.,* 1989), but usually death occurs after a builtup in residues after weeks or months. Determination of lethal brain residues of DDT in laboratory rats (Dale *et al.,* 1963) and birds (Bernard, 1963) and subsequently with the parent compound and the major metabolites Dichloro Ddiphenyl Ethane (DDE) and Dichloro Diphenyl Dichloroethane (DDD) in experimental birds (Stickel *et al.,* 1966 and 1969, Stickel & Stickel, 1969, Stickel *et al.,* 1970 and Stickel, 1984) provided the mechanism whereby die-off in the field was linked with the DDT group.

1.1.3 Ground and Surface Water

As farmers have increasingly turned to underground sources of water to irrigate their crops, the over pumping of Ground Water (GW) is causing water tables to decline beneath vast areas of agricultural land. Based on the best data available, farmers are collectively over pumping regional GW sources by at least 160 billion cubic meters a year - the amount of water used to produce nearly one tenth of the world's current grain supply (Postal, 1999). Even as our dependence on GW has grown over the past 50 years, the quality of this virtual resource has been deteriorating in several parts of the world. Aquifers store most of the world's unfrozen fresh water - some 97 percent- and provide driking water to almost a third of the planet's people and over a billion residents of Asia alone depend on GW for drinking (UNEP, 1996). The capacity of GW to sustain people and ecosystem is under enormous threat (USGS, 1999). At Rio Summit 1992, pollution of fresh water resources had taken unfortunately a back seat as developed nations mostly focused

on stringent regimes to dispose of toxic chemical and nuclear waste. Developing countries like Ghana has serious problems with water borne diseases; wastes of 188 industries and sewage of Cairo city drain into the Nile of Egypt; streams and rivers around Lahore, Peshwar, Karachi and Faislabad are reportedly highly contaminated and barely 30 percent of Pakistan's 122 million people have safe drinking water; and China suffers from the same syndrome (Katiyar, 1997). In India, some 1,75,000 villages are still without potable water. The urban poor too suffer from a particular lack of access to drinking water with only a third or so having safe access. In consequence, the poor must take resort to pollute surface sources (Rao, 2000).

Water quality is a key environmental concern because of its importance in provision of water for drinking and domestic purpose, irrigation and aquatic life including fish and fisheries. Water quality in Bangladesh is severely affected by industrial pollution in hot-spots e.g. Buriganga, Sitalakhya, Karnophuli and Surma near the major city centre, especially in the capital city and divisional cities by fecal contamination, saline intrusion, as well as by agro-chemicals and large amount of suspended sediments carried out by upstream flow to the Bay of Bengal by mighty rivers Jamuna, Padma and Meghna (Hossain *et al.,* 2002). The overall inland surface water quality in the monsoon season is within tolerable limits, with a few exceptions, including the rivers Buriganga, Balu, Shitalakhaya, Karnaphuli and Rupsha. However, concerns over surface water quality are gradually emerging due to the dispersed location of poultry industries and the adverse effect on surrounding land and aquatic ecosystems, as well as subsequent impacts on the livelihood system of the local community. Among the polluted areas, the worst problems are in the River Buriganga situated to the South of Dhaka, where the most significant source of pollution appears to be from tanneries in the Hazaribagh area (GoB and UNEP, 2001). Non-point sources of pollution include (but are not limited to) agricultural run-off, urban run-off, fertilizers, pesticides, acid rain, animal waste, raw sewage, septic tank leakage, household waste etc. Since the source of pollution is not known or identified, it becomes problematic to control their discharge into rivers and streams in a watershed. Proper sampling techniques and long term monitoring of water quality at carefully selected locations can help to delineate "the sources" of such diffuse pollution.

In many instances, pollutants have direct and measurable effects, so that potential impacts can be fairly confidently predicted. The decomposition of OM (e.g.,

sewage), for example, results in lowered levels of dissolved oxygen, which are closely correlated with the healths of fish stocks as fish dies at low oxygen level. The excess nitrogen and phosphorus from fertilizers and other sources in water body deteriorate water quality and affect aquatic life. The residual fertilizers infiltrate into soil with irrigation or rainwater and percolate a long way to join ground water. Leaching of water from fertilized land is one of the major sources of nitrate pollution (Khan *et al.,* 1996). Urea, Triple Super Phosphate (TSP), Muriate of Potash (MP) and Gypsum are the major chemical fertilizers used in Bangladesh.

The total amount of fertilizers used annually is about 2 million tons. With the increase of irrigated areas and cultivation of HYV rice, there was an increase of about 20 percent fertilizer use in 1990. But the present growth in use has decreased and fluctuates from plus minus 5 to 10 percent (GoB and UNEP, 2001). At present about 33% of the country's cultivated land is under irrigation. Fresh water supply for irrigation is becoming increasingly scarce. Continuous irrigation faces/poses the problems of (i) declining water availability, (ii) low capacity utilization of irrigation system, (iii) degrading natural resources by water logging, salinization and sedimentation due to excessive water use and (iv) pollution of ground and surface water resources (Huq and Hossain, 2000). It is known that irrigation creates new microclimates, which favour certain pests and diseases. Their buildup is often encouraged by the introduction of well-fertilized monocultures of crop varieties, often having limited genetic resistance to pest attack. The response to the pest outbreak is often massive use of pesticides. This causes pollution of watercourses, death of wildlife and frequent illness and death among human. Heavy use of pesticides, however, may also destroy natural controlling agents and results in pest populations becoming resistant. The end effect may be a dramatic crop loss (Conway, 1990).

A new dimension of GW pollution with arsenic was identified first in 1993 at Barogharia Union of Chapai Nawabganj district. Realizing the gravity of the problem, water sample testing activities were started in 1995 by various organizations and agencies. It is reported that 61 out of 64 districts and municipalities of Bangladesh are facing the menace of Arsenic poisoning (Alam *et al.,* 2002). Arsenic toxicity in the water of the affected districts is 25 to 35 times higher than the safety level set by the WHO (0.01 mg per liter). Permissible level of arsenic in water is 0.05 ppm for Bangladesh, according to experts. Bangladesh Atomic Energy Commission (BAEC)

found the level of arsenic at between 1.5 and 2ppm in tube well in the districts bordering upon West Bengal of India (Chowdhury, 1999). High levels of arsenic in ground water can cause serious human health problems if imbibed for a long time (from 5 to 15 years); including skin ailments, damage to internal organs, skin and lung cancers, and eventual death. The recent major studies carried out on arsenic reveal that among 30,000 TWs studied, 2000 exceeded the national standard of 0.05 mg per liter for drinking purposes. More than 20 million people drink water exceeding the national standard for arsenic levels (GoB and UNEP, 2001).

1.1.4 Income Generating Activities

Income Generating Activities (IGAs) at the individual level may have negligible impact on environment, but a large number of people's involvement may have significant impact when considered in a cumulative sense. Consequently, minor negative impact of IGAs on environment must be recognized and mitigation measure should be taken to stop long-term ecological damage. It is observed from a study that 94 percent of micro credit led IGAs beneficiaries believed that their economic condition improved, while ninety percent of them perceived that their social status improved (Kamal *et al.,* 1992). It is evident from another study that agro based IGAs like nursery, bee keeping and road side plantation have positive impacts on social, health related, ecological and economic aspects. Shrimp culture and catfish cultivation have negative impacts on social and ecological aspects. But these two IGAs have positive impacts on health and economic aspects (Kamal, 1995).

1.1.5 Bio Diversity

It is estimated that between 5 and 30 million species exist on the earth (Shafi, 1993). The tropical forests are regarded as the richest in biodiversity. More than half of the species on the earth live in moist tropical forests, which are only 7 percent of the total land surface (Agrawal, 1998). As the human population and its domination over this planet increases, the threat to the naturally evolved life forms also increases. As the human population continues to raise more and more land under direct human control for agriculture, the amount of natural vegetation diminishes and with it the space available for the species which live in such habitats. The vast expanses of tropical forest have become increasingly threatened in the last few decades (Chapman and Reiss, 1995).

The process of identification of the threatened species at the global level started in 1960s. As information was compiled and awareness on the threatened animals was growing, it was realized that there must be a well-defined and agreed catagorization for the assessment of species. The need to revise the catagories had been strongly recognized since 1984 when the Species Survival Commission (SSC) held a symposium titled 'The Road to Extinction' (IUCN, 2000). Unplanned constructions of these physical structures in rural areas, on the other hand, have resulted in various environmental problems like drainage congestion, topsoil removal from agricultural lands, destruction of wild and aquatic habitats etc. in many cases.

Environmental degradation such as deforestation, soil erosion and pollution are most visible around the poor settlements both in rural and urban areas (WCED, 1987). In the agricultural production system, several activities like over cultivation, overgrazing, irrigation and salinization, large areas with only one variety (resulting into loss of biodiversity) and so forth, cause various problems that lead to the degradation and destruction of the biological potential of the land. Biodiversity at all levels are negatively impacted. Some consequences of these trends are seen in examples such as the southern corn leaf blight of the 1960s on the Russian wheat epidemic of the 1970s, which has been clearly identified to have been caused by a reduction of the genetic diversity (Fowler and Mooney, 1991).

Bangladesh, a country with rich bio-diversity, flora and fauna is now under threat due to development activities that have been undertaken since the country's independence in 1971. Exploration for oil and gas is apprehended to adversely affect the unique ecosystem of the Sundarbans (Haque, 2000). Biodiversity is helpful for pest control (by growing diversionary host plant and through predator prey interaction), for renewal of soil fertility (by growing nitrogen fixing leguminous weeds and crops intermixed with cereals), and for weed control (by growing species that inhibits weed growth through toxic secretions) (Bhatia and Sinha, 2000).

Bangladesh supports approximately 5000 floral species, of which about 300 species are being actively cultivated. A tentative list of about 26 angiosperm species endangered in Bangladesh was prepared as the first step in intensive field studies. Field studies also focus on threatened plants, which have been expanded to more than 100 in number (Haque, 2000). Bangladesh was prepared as the first step in

intensive field studies to locate the species in the wild. The list of threatened plants has been expanded to more than 100 in number (Haque, 2000). The total forest area in Bangladesh including unclassed state forestland is about 2.25 million ha. A large part of the area, however, has no tree cover. Over the last three decades, forest cover declined by 2.1 percent annually. Village groves or village forests play a very important role in the economy of the country. Since independence, efforts have been directed to develop the forest resource base of the country through expansion and qualitative improvements of the existing forestland. However, for the meager forest resources of the country, usually the removal rates far exceed the sustainable yield limit (PC, 1990). High rate of deforestation affect the biodiversity of the country. Felling of trees for timber, fuel and encroachment on areas covered by forest has reduced the total reserve forest area in Bangladesh to 50 percent in the last twenty years. Besides, salinity has affected coastal mangroves forests. In hills of Chittagong, felling of trees took place due to rubber plantation, a monoculture with low economic return (Haque, 2000).

The global decline in fish catch resulted in part from the strongest EL Nino weather event on record, which warmed the eastern Pacific in 1997-98 and reduced fish stocks (NMF, 1998). In three of the world's five top producers-Peru, Chile and the United States-all fish in waters were affected by EL Nino, and all types saw fishe's decline in the catch. China, on the other hand, the World's leading producer, saw fish catch increase in 1998 by a growth of 9.5 percent (FAO, 2000). In spite of tremendous population growth, fish production has failed to keep pace with its ever-increasing demand due to increased population. As a consequence, per capita availability of fish has declined over the years causing serious nutritional and other problems (PC, 1990).

There are various impediments to fisheries development, some of which are particular to sources of fisheries. In case of capture fishery, inadequate knowledge, over fishing and indiscriminate killing of juveniles and destruction of spawning grounds, observation on migration routes due to unplanned construction of dams and embankments under the FCD/I projects, degradation of water quality, fish diseases, defective fish conservation laws and inadequacy of proper processing, marketing and other facilities are some of the factors affecting the desired development (PC, 1997)

Despite the depletion of rivers, canals and flood plains for hundreds of years, Bangladesh still holds the world's most diverse and abundant inland fisheries. But the catch of many population of local species have drastically reduced and many are no more seen. On the migration journey to the flood plains and return journey to the safe sanctuaries the fish face many obstructions and hazards, which seriously disturb its reproduction in the open water and ponds. Mistakenly, the subsistence fisherman is often blamed for over fishing and thus reducing the fish population.

Effluent discharges, excessive use of agrochemicals, faulty fishing practices, and construction of FCD/1 structures are all contributing to depletion of fisheries in the water bodies of Bangladesh. Unsustainable shrimp cultivation has added a new dimension to environmental degradation in the coastal areas (Haque, 1999). Besides, in dry season surface water withdrawal for irrigation use enhances shrinkage of dry-season water surface area and volume of standing water, thereby reducing living space for the residual parent stocks of fish. This reduction of habitat will produce further reduction of the parent stocks through over fishing/or enhanced natural mortality (Ali, 1990).

Amphibians-frogs, toads, salamanders, and the lesser-known "legless salamanders" called caecilians- are the world's oldest terrestrial vertebrate class, but because most of them are inconspicuous, relatively little are known about them (Wake, 1991). Today, a wealth of new evidence has convinced nearly all specialists that a catastrophic decline is indeed occurring (Wake, 1998). Virtually every major type of environmental stress has been identified as a cause for the decline of one amphibian species or another. Perhaps the most obvious reason has been the loss or degradation of habitat (Halliday and Hever, 1997).

Frogs are in high demand for the international market, although they are environmentally important because they eat a lot of insects (about 42 species) that are agricultural pests. Therefore, indiscriminate collection of frogs from agriculture fields has resulted in enormous use of insecticides to control the subsequent collosal attack of insect pests. The excessive harvesting of frogs from the wild has also affected the food chain of their predators, such as monitor lizards, snakes and many species of birds (GoB and UNEP, 2001) whereas frogs reduce the reproduction of insects by eating up 80 to 90 percent eggs and larva (Kabir, 1998).

The population of birds in Bangladesh is still very rich (IUCN, 2000) and there is a wide variety in the country. However, bird population around the globe is declining at an alarming rate and it does not exclude Bangladesh. The primary threats to them are habitat destruction, illegal trade, and over-hunting.

Total number of inland and resident vertebrates (fresh and brackish water fishes, amphibians, reptiles, birds and mammals) of Bangladesh have been identified as 895, of which 13 are extinct, 64 are critically endangered, 86 are endangered and 51 are vulnerable. Rest of the species constitutes not threatened (371) and no information (323) (IUCN, 2000). There are 266 fresh and brakish water fish species in Bangladesh, out of which 12 are in critically endangered, 28 are in endangered and 14 are in vulnerable conditions. Out of 22 species of amphibians, 3 are in endangered and 5 are in vulnerable conditions. Similarly, out of 109 reptiles, 1 species has already been extinct, 12 are in critically endangered, 24 are in endangered and 58 are in vulnerable conditions. Among 388 species of birds, 2 have been extinct, 19 are in critically endangered, 18 are in endangered and 4 are in vulnerable conditions (Ullah *et al.,* 2001). In a study, it was found that tigers, deers, wild pigs, monkeys and foxes already disappeared or seriously were reduced due to deforesation. The wild birds that already disappeared from the study area were jungle fowl, red-breasted parakets (Tuta), spotted owls (Pecha), vultures etc. (Ali *et al.,* 2000).

The above discussions show that construction of road, embankment etc. in the vast flood plain of the country brings huge amount of agriculture land out of agriculture production. Besides, natural fish production faces tremendous barriers due to these construction works all over the country. Agricultural soil degradation takes place due to adoption of modern agricultural practices. High CI and increasing use of chemicals to crops decrease soil fertility. Studies and reports about the effects of insecticides on beneficial birds, insects and microorganism provide us with considerable information on large-scale environmental pollution in our country. But these studies do not provide any picture about the soil contamination of pesticides used in crops. Findings of residual effects of pesticides on agriculture soil will fill up knowledge gap of soil pollution. Besides, opinion survey on respondents of different

status and occupation about the degradation of soil fertility and other environmental issues in the villages over the last four decades will provide the effects on environment in rural areas, due to adopting various development interventions.

Ground and surface water are under threat in Bangladesh. Drainage of huge agrochemicals and industrial pollutants to surface water (SW) polluted vast surface water sources of Bangladesh. Recently aesenic contamination in ground water (GW) has become a critical problem in Bangladesh.

Different GOs and NGOs are working with micro credit in rural areas. Though micro credit programmes are mostly related with IGAs of rural poor, which mainly covers agriculture and small business, nevertheless no investigation has been conducted in order to assess the impact on environment especially at villge level.

References on biodiversity particularly relating to tree, fish, amphibians, birds, reptiles and mammals imply that very limited study have been carried out in these fields. Probably no study has been carried out on the above subjects in village situations of Bangladesh.

Based on the above revelations, it appears that there is a relationship between development activities and the environment. However, perhaps, it is fair to say that the probable issues relating to environmental pollution and degradation in rural areas have been addressed inconsistently so far available in literature, and they are not sufficient in content either. A comprehensive account of 'causes and effects' analysis is almost absent in most cases. So, this research proposes to investigate the 'domino effect' of the relationship of 'development and environment' thoroughly. This will help to assess the current situations and hence to point out the issues that need to be addressed before it gets too late.

1.2 Objectives

In the light of above background, the study aims at the following objectives:

The general objective of the study was to assess the overall environmental consequences of different development interventions in rural areas, and

The specific objectives of the study were to:

i. make investigations to identify environmental consequences of development interventions such as construction, adopting modern agriculture practice and IGAs;

ii. assess the extent of ground and surface water qualities;

iii. find out the change of biodiversity particularly change of tree, fish, amphibian, reptiles, bird and mammals over the last four decades for adopting different development programs;

iv. find out the different nature of the environmental consequences in flood prone and non-flooding areas;

v. find out villagers' awareness about environmental issues and find out development workers' i.e. government & non-government officials, Elected Representatives (ERs) of Union Parishads (UPs), Local Leaders (LLs) and Field Level Workers (FLWs) views and programmes in relation to environment and rural development; and

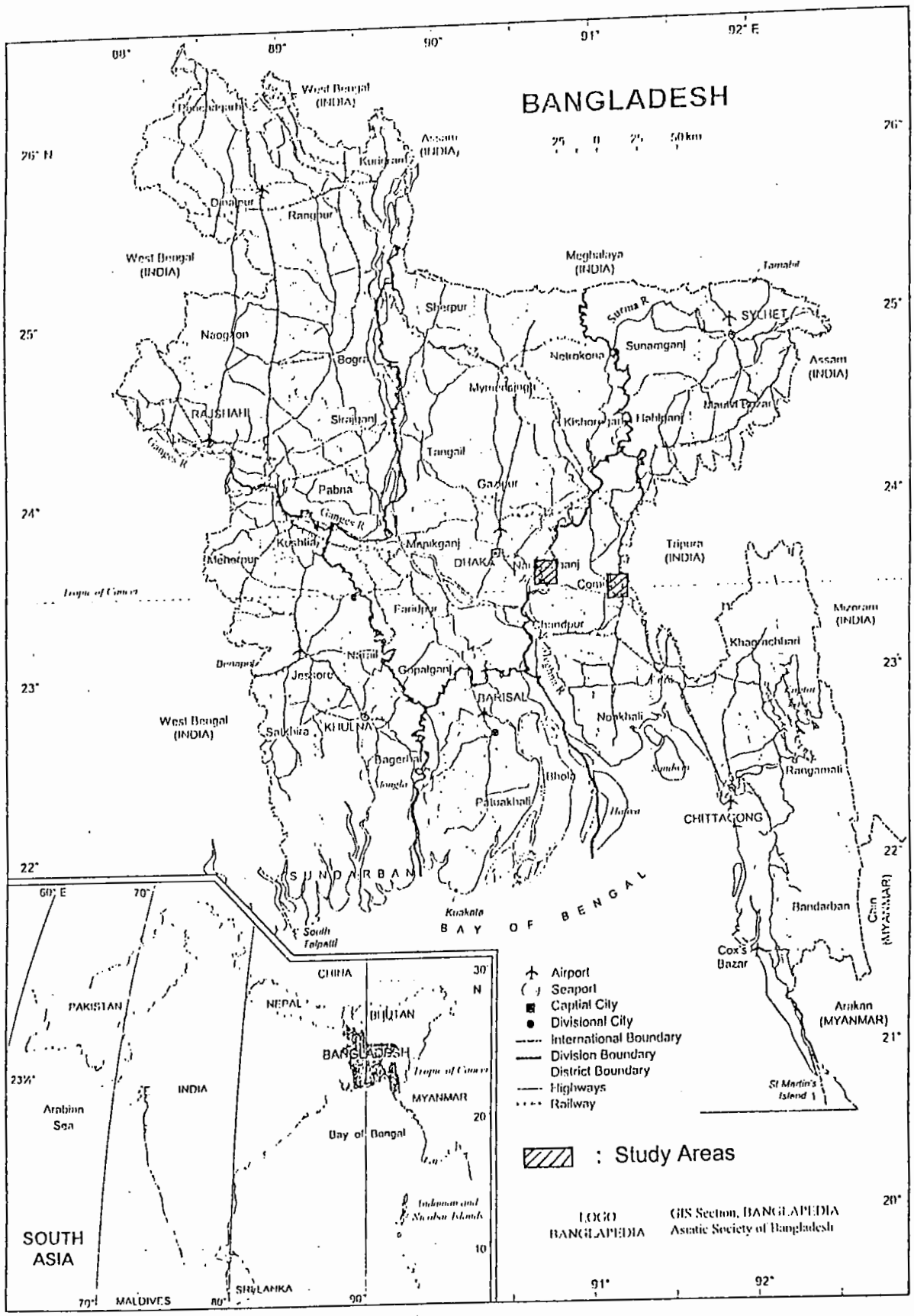
vi. recommend the possible future coservation activities.

Chapter 2
Materials and Methods

2.1 Study Area

Bangladesh is a small country having a land area of only 55,598 square miles. It is one of the largest delta lands in the world with a flat alluvial plain criss-crossed by a number of mighty rivers and their innumerable tributaries. These rivers are the primary importance of the economic and social life of the people. Lying between 20°30' and 26°45' North Latitudes and 88°00' and 92°56' East longitudes, the country has subtropical climate with three prominent seasons: monsoon, winter and summer (ASB, 2003). Mean annual temperature is around 80°F and annual rainfall from 50 inches in the west to 100 inches in the southeast and 200 inches in the hilly regions of the north. Rains are sometimes accompanied by tropical cyclones and storms (Quddus, 1995).

Population density is the highest in the world and it was 1000 persons per square kilometer (CIRDAP, 2002). Flood is a common phenomenon of the country and on an average 10 to 50 percent of the total land area is affected with flood every year. The natural resources of Bangladesh are threatened with both our exploration and mismanagement due to high population density and lack of comprehensive planning & inefficient implementing procedures of development interventions in most cases.



Map No.-1: Map of Bangladesh Indicating Study Areas

Four villages were selected from two upazilas keeping in mind the objectives of the study. Out of these four villages, two villages were selected on the basis that flood did not occur at least during the last 25 years. These non-flooding villages were selected from Comilla Sadar Upazila and these were Shahpur and Gazipur villages under Jagannathpur Union of the Upazila. The other two villages were selected on the basis that at least 50 percent of the land remains under water in the rainy season. These flooding villages were Alabdi under Moghrapara Union and Khangshardi under Boidder Bazar Union of Sonargaon Upazila within the jurisdiction of Narayanganj District.

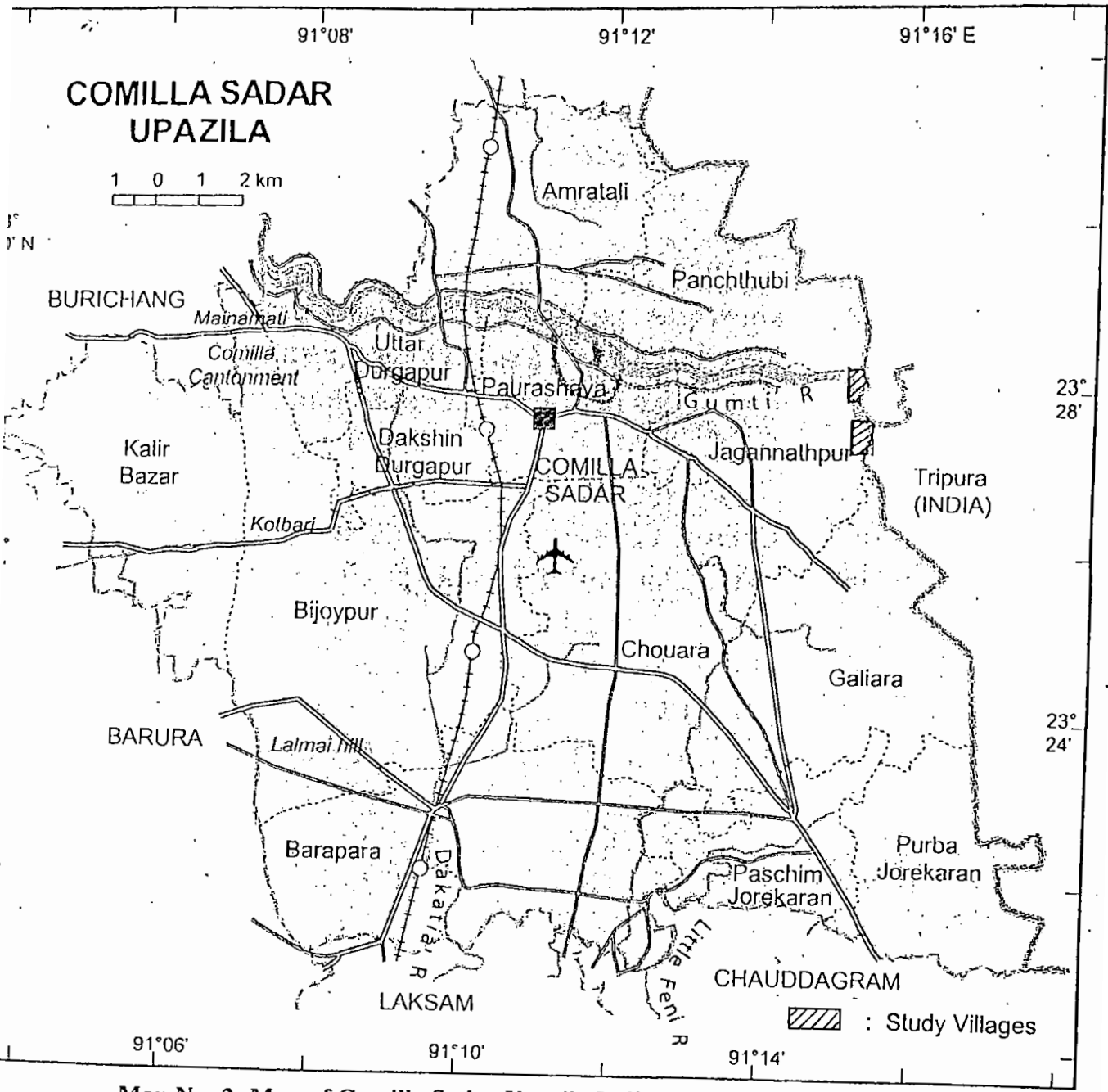
2.2 Comilla Sadar Upazila

Comilla Sadar Upazila is bounded with an area of 280 sq. km. on the north Burichang Upazila and Tripura State of India, Laksham and Chauddagram Upazilas on the south, Tripura State of India on the east and Barura Upazila on the west. Main rivers are Gumti and Little Feni. Rajendrapur forestry, Shalban Bihar and Lalmai hills are most notable features of the upazila. Total population of the upazila is 516319. Main occupations cover 30.67% agriculture, 18.73% service, 18.03% commerce, 8.96% transport, 8.08%labourer, 2.69% construction, 1.94% wage labourer and 9.97% others. Total cultivable land is 21473.49 hectares; fallow land 72.85 hectares; single crop 2.34%, double crop 66.23% and tripple crop land 31.43%. Main crops cover paddy, wheat, potato, onion, garlic, sesame and vegetables (ASB, 2003).

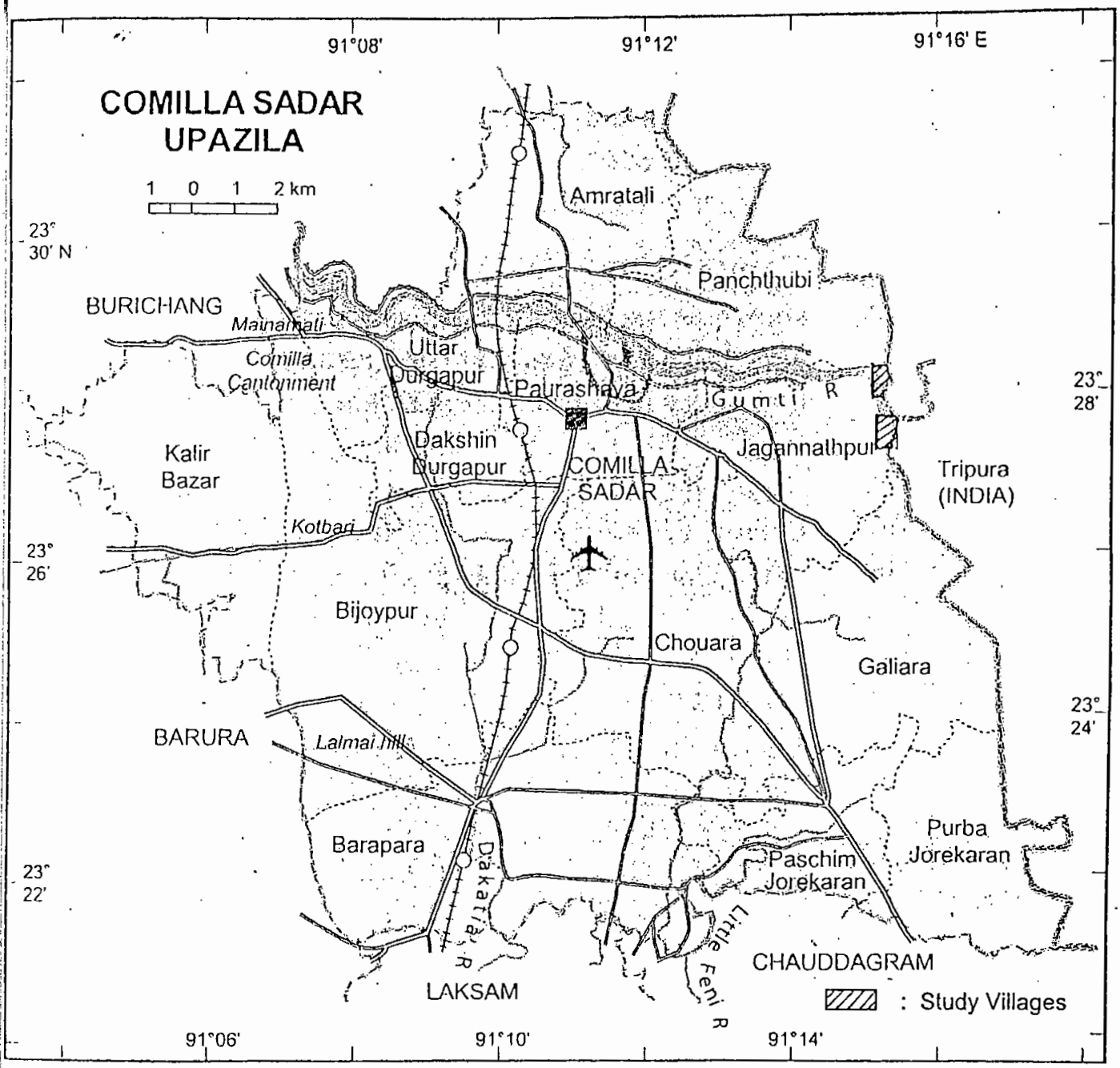
Comilla Sadar Upazila has been used by the Academy as its experimental laboratory area since 1960. Pilot project method of practical development model building activities in a number of rural aspects has caused substantial changes in the socio-economic conditions of this upazila. From change, growth and development point of view the average conditions in most areas of rural Bangladesh are not at present as good as they appear in Comilla. But when the Academy started its experiments in 1960, the condition of rural area of this upazila was much worse than the average condition obtaining in other parts of Bangladesh. Population densities in

Comilla district and Comilla upazila were well above the density for the country. The farms were smaller and the proportions of rural dwellers without land were greater (Khan and Solaiman, 1978).

Various development interventions of BARD and NBDs in different fields of RD improved agricultural production practices, fishery and livestock development, institution building, family planning, health and nutrition development, gender development etc. The common villagers of Comilla Sadar Upazila become more aware and technologically sound in adopting those improved methods compared to the common villagers of other areas.



Map No.-2: Map of Comilla Sadar Upazila Indicating Study Villages



Map No.-2: Map of Comilla Sadar Upazila Indicating Study Villages

Picture 2.1 River Seperates Bangladesh and India Adjacent to the Gazipur Village

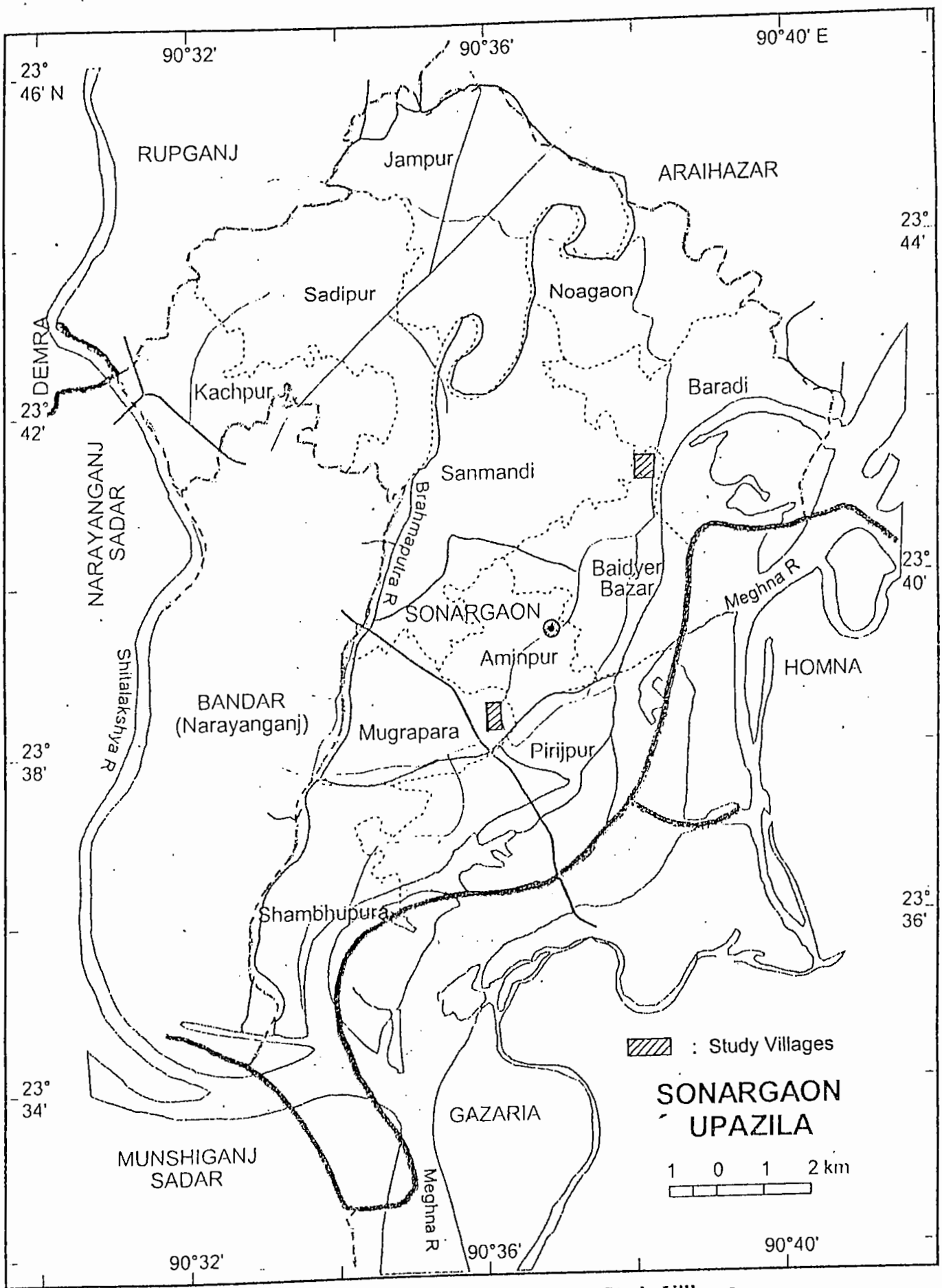
2.3 Sonargaon Upazila

Sonargaon is one of the upazilas of Narayangonj district. Total area of the upazila is 171.66 sq. km. It is bounded by Araihazar and Rupgange Upazilas on the north, Munshiganj Sadar and Gazaria upazilas on the south, Homna and Gazaria Upazilas on the east, Bandar, Narayanganj Sadar, Rupganj Upazilas and Demra Thana on the west. The Meghna and Shitalakshya wash the upazila. The original Brahmaputra river which once flew through the upazila is now moribund.

Total population of the upazila is 2,61,881. Main occupations cover 20.6% commerce, 17.87% agriculture, 17.61% agricultural labour, 17.6% service, 3.61% weaving, 3.02% fishing, 2.72% wage labour, 2.23% transport, 2.04% industry and 12.7% others. Total agriculture land is 14154.2 hectares, fallow land 999.6 hectares; single crop land is 14%, double crop land is 60% and tripple crop land 26%. Land under irrigation is 38%. Main crops cover paddy, potato, brinjal, patal, cauliflower, sugarcane and radish (ASB, 2003).

NBDs especially Department of Health and Family Planning (DHFP), Department of Agriculture Extension (DAE), Bangladesh Rural Development Board (BRDB) and Power Development Board (PDB) carried out major development activities in the upazila for the upliftment of socio-economic conditions of the common people in the last four decades.

Two villages selected for the study from Sonargaon Upazila were Alabdi from Moghrapara Union and Khangshardi from Boidderbazar Union. Both the villages are situated on the vast flood plain of Meghna river and flooded almost every year.



Map No.-3: Map of Sonargaon Upazila Indicating Study Villages

2.4 Survey and Sampling Methods

i) **Key Informant Interviews:** One to one interviews with key resource persons[1] were conducted for this study depending on the requirement of the findings from field observations using appropriate questionnaires.

In total, 91 randomly selected farmers of different categories, landless labourers and other villagers were selected as respondents for the study. Besides, 24 Elected Representatives (ERs) of Union Parishads (UPs), Local Leaders (LLs) and Field Level Workers (FLWs) of different NBDs were selected as respondents. From each of Comilla Sadar and Sonargaon Upazilas, 10 relevant officials were also interviewed for the study.

a) Village Level Respondents

Types of Respondents: Randomly selected village level respondents belong to four different categories depending on the size of land owned as shown in table-1.

Table 2.1 : Types of Respondents in the Study Villages

Upazila	Union	Village	No. of Respondents	Types of Respondents			
				Landless 0-0.49 Acre	Small Farmers 0.50-2.49 Acres	Medium Farmers 2.50-7.49 Acres	Big Farmer 7.50+ Acres
Comilla Sadar	Jagannathpur	Shapur	22	10	10	2	-
		Gazipur	38	17	15	6	-
Sonar Gaon	Moghrapara	Alabdi	19	13	5	1	-
	Boidder Bazar	Khangshardi	12	9	2	1	-

Education of Respondents: According to educational qualification, village level rspondents were found to belong to six different groups. These were illiterate, can write their names only, class I - V, class VI-X, SSC-HSC and above HSC as shown in figure-2.1.

[1] Includes randomly selected villagers of different occupations; ERs of UPs, LLs and VLWs; and Upazila Officials who are the respondents of survey works of the study.

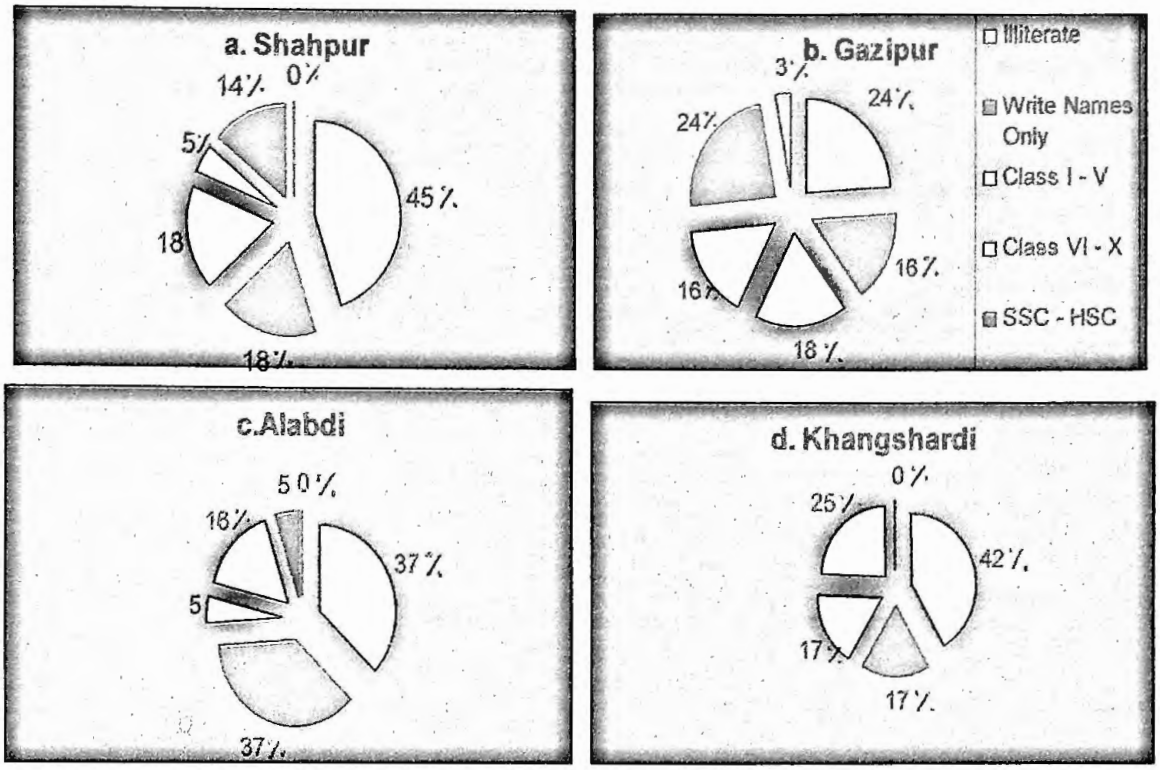


Figure 2.1: Educational Qualifications of Respondents of the Study Villages

Age of Respondents: On the basis of age, randomly selected villagers were divided in five categories which were 55-60, 61-65, 66-70, 71-75 and over 75 years. Majority of the respondents in all study villages belong to age group of 55-60 years as shown in figure-2.2.

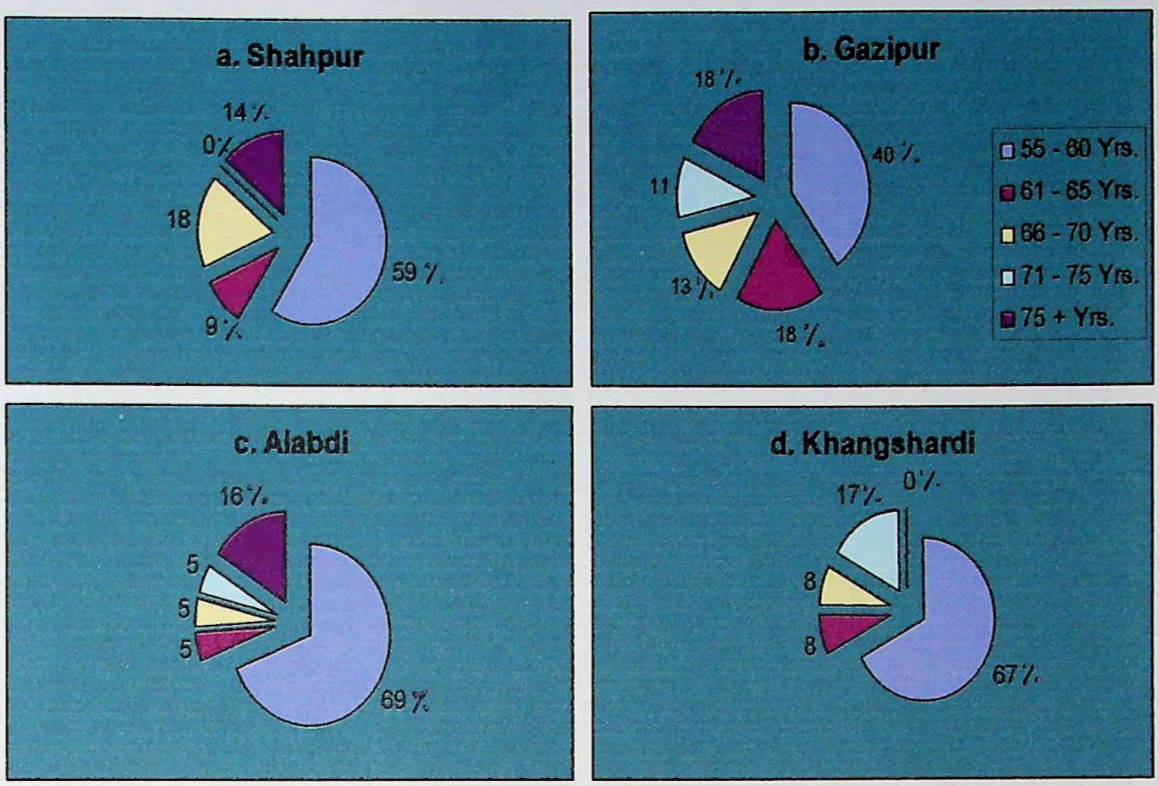


Figure 2.2: Age of the Respondents of Study Villages

Principal Occupations of Respondents: Agriculture was found as the principal occupation of majority of the selected respondents in Shahpur, Gazipur and Alabdi. In Khangshardi, business was the principal occupation of the majority of respondents. Detail is shown in figure-2.3.

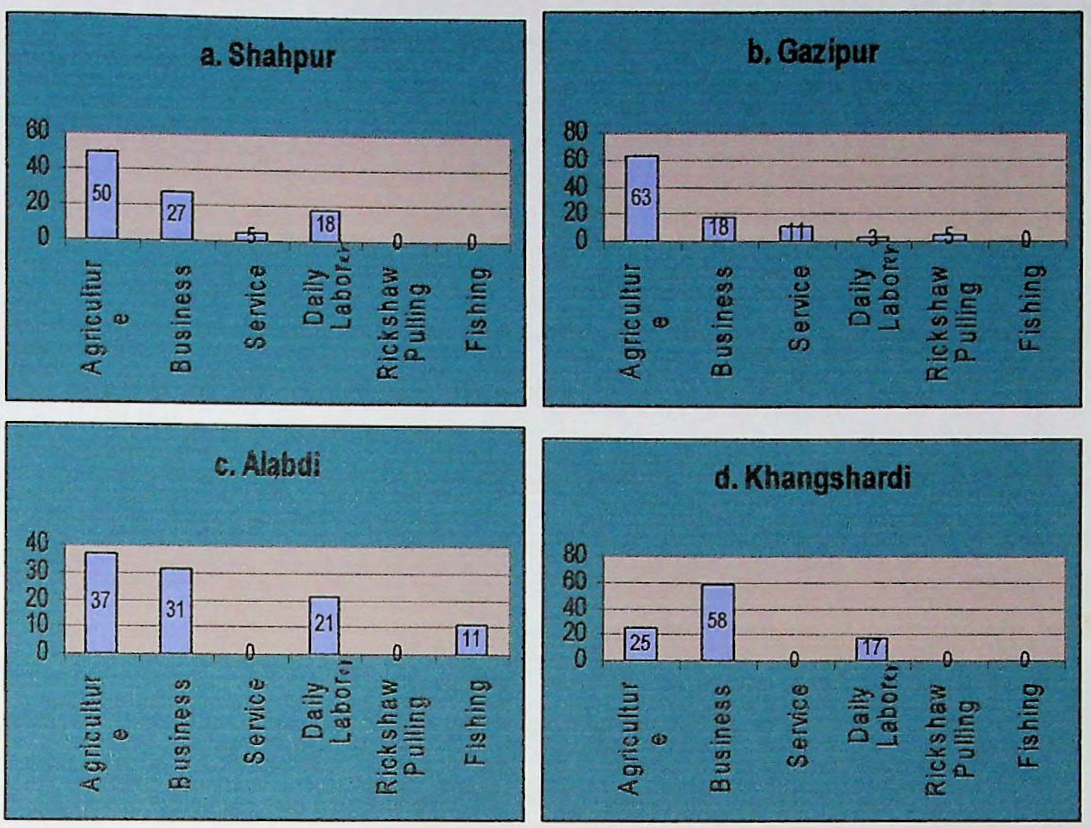


Figure 2.3: Principal Occupations of the Respondents of Study Villages

b) *Elected Representatives of Union Parishads, Local Leaders and Field Level Workers Respondents*

Types of Respondents: In total, two UP Chairmen, five UP Members, two Block Supervisors (BSs), one Inspector of Social Welfare Department, one NGO worker and twelve local leaders were the respondents in this category as shown in table-2.2.

Table 2.2: Elected Representatives of UPs, Local Leaders and Field Level Workers of Study Villages

Upazila	Union	Village	Number of Respondents					
			Chairman of UP	Member of UP	Block Super-visor	Inspector of Social Welfare Dept.	NGO Wor-ker	Local Leader
Comilla Sadar	Jagannathpur	Shahpur	1	1	-	-	-	4
	Jagannathpur	Gazipur	-	1	1	1	1	2
Soanr Gaon	Moghrapara	Alabdi	-	2	1	-	-	3
	Boidder Bazar	Khangshardi	1	1	1	-	-	3

Education of Respondents: On the basis of educational qualification, selected respondents were divided into six groups. These were Illiterate, can sign their names only, I-V, VI-X, SSC-HSC and Bachelor and above as detailed in table-2.3.

Table 2.3: Educational Qualifications of Respondents

Village	Educational Qualification (% of Respondents)					
	Illiterate	Can Sing Only	I - V	VI - X	SSC - HSC	Bachelor & Above
Shahapur	-	16.67	16.67	16.67	50.00	-
Gazipru	-	-	-	16.67	50.00	33.33
Alabdi	-	16.67	-	33.33	50.00	-
Khangshardi	-	-	16.67	50.00	33.33	-
Total		**8.33**	**8.33**	**29.17**	**45.83**	**8.33**

Experience of Respondents: Working experience of the respondents in their locations was categorized into four different time frames. These were 1-5 years, 6-10 years, 11-15 years and 16 years and above. Fifty percent of the respondents had experiences of 16 years and above (detail in figure-4).

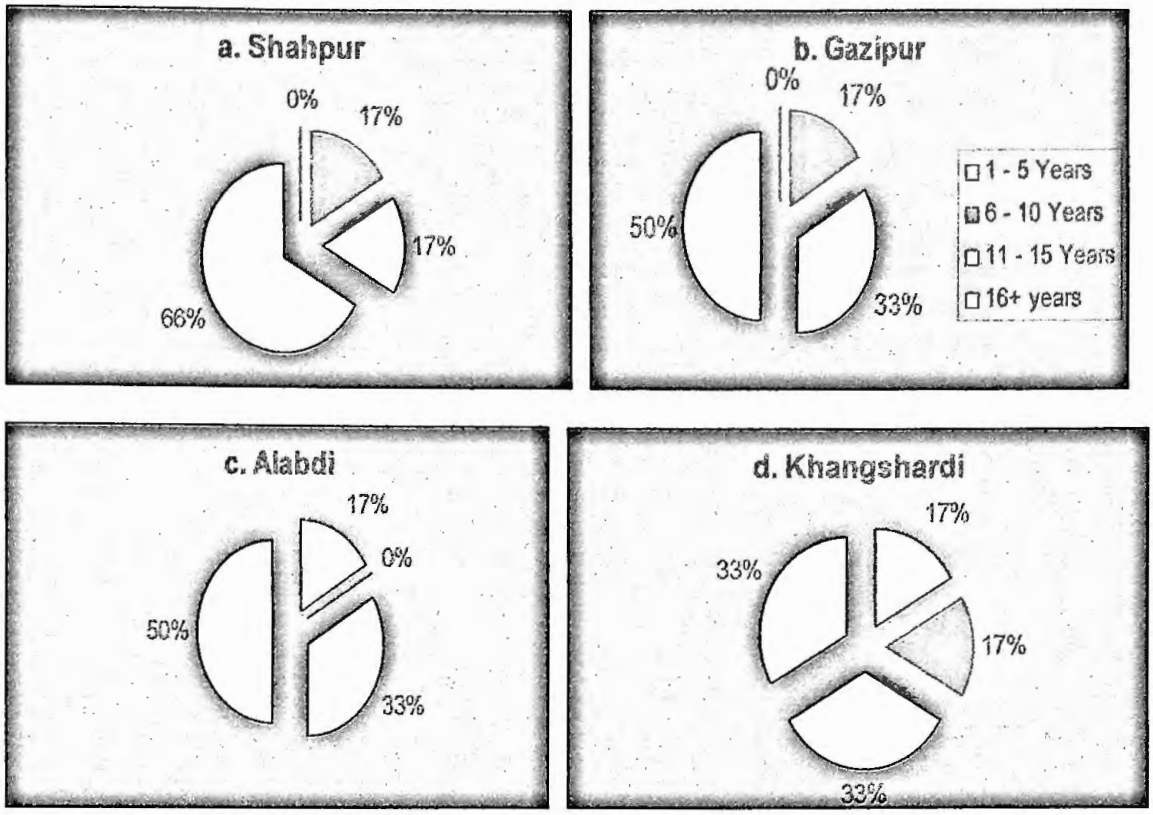


Figure 2.4: Experiences of the Respondents in Their Present Places

c) Upazila Level Respondents

Types of Respondents: In order to learn about experiences of respondents in their present places, ten relevant upazila officials were interviewed in each of the two upazilas with another structured questionnaire. Eight upazila officials were common by position or their substitutes both at Comilla Sadar and Sonargaon Upazilas. These officials were Upazila Nirbahi Officer (UNO), Upazila Agriculture Officer (UAO), Upazila Engineer (UE), Upazila Rural Development Officer (URDO), Upazila Social Welfare Officer (USWO) and Upazila Statistical Officer (USO). In Comilla Sadar Upazila, two other respondents were Sub Divisional Engineer of BWDB and an officer of the NGO - Association of Social Advancement (ASA). No office set up of BWDB exists at the upazila level. In Sonargaon Upazila rest two respondents were an officer of Village Education Resource Center (VERC) and an officer of Bangladesh Rural Advancement Committee (BRAC).

Experience of Respondents: According to the experiences, selected uapzila officers were categorized into four time frames. These were up to 5 years, 5-10 years, 11-15 years and above 15 years. Majority of the respondents both at Comilla Sadar and Sonargaon Upazila had experience over 15 years (detail in table-4.4).

Table 2.4: Experience of the Respondents

Experience	Comilla Sadar Upazila		Sonargaon Upazila	
	No.	%	No.	%
Up to 5 Years	1	10.00	-	-
5-10 years	1	10.00	2	20.00
11-15 years	3	30.00	2	20.00
Over 15 years	5	50.00	6	60.00

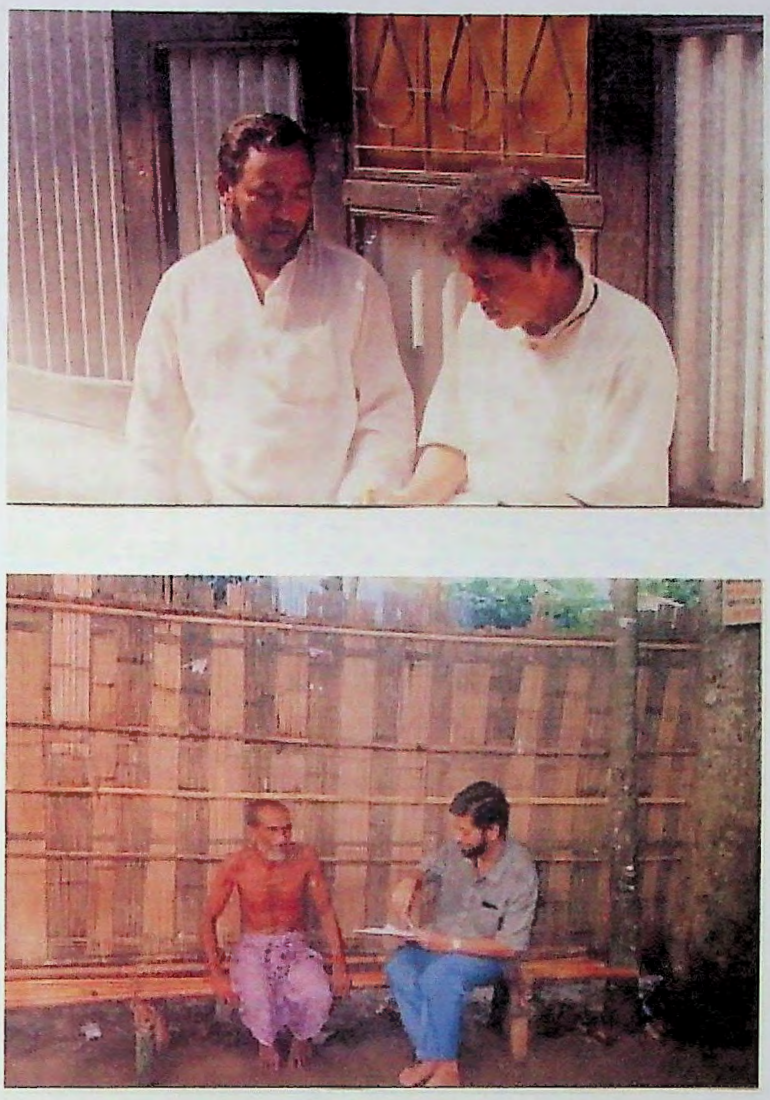
ii) **Participatory Rural Appraisal (PRA):** PRA[2] methods were used to assess the past and current conditions of the environment in the study areas. Social mapping; and problems identification and preference ranking on environmental problems of the study villages were carried out.

iii) **Focus Group Discussion:** A number of focus group discussions[3] were carried out with villagers and LLs for getting information on the chronology of development of the selected upazilas and villages.

[2] A combination of a number of modern techniques of research, which are used to study the total strengths and weaknesses of a village with direct participation of different sections of people of the particular village (Ahmed, 1996).

[3] Issue based discussion where different sections of people participate. The role of researcher is passable and like that of a facilitator.

2.5 Data and Sample Collecting, Processing and Alalysing Methods for Laboratory Tests



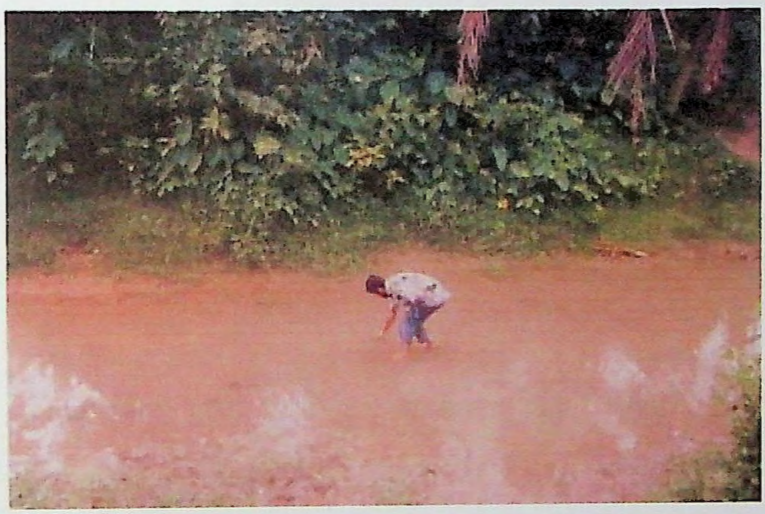
Picture 2.2 : Interview with Common Villagers

i) Nine to ten soil samples were collected from various parts of the field to prepare a representative composite soil sample. In this process, soil was cut into V-shaped with a spade upto six to seven inches from top of the soil and then a slice of soil of half to one inch width was collected from one of the sides of V-shaped ditch. For making each composite soil sample, eleven representative soils were collected from different parts of the same type of land. All collected samples were dried in shade condition for 10-days separately. Each of the samples was mixed nicely before kept in shade for making natural dry. Only High Land (HL) was found under agriculture production in Shahpur and Gazipur

village. Two soil samples were collected from each of Shahpur and Gazipur villages of Comilla Sadar Upazila. One sample from vegetables production area of HL and other sample from rice production area of HL were collected from each of these two villages under the study. In Alabdi village, two types of land and in Khangsherdi village, three types of land were found under agriculture production. Samples were collected from Medium Low Land (MLL) and Low Land (LL) from Alabdi village. From Khangshardi village, three samples i.e. one from Medium High Land (MHL), one from MLL and one from LL were collected. Following the suggested method of Soil Resources Development Institute (SRDI) from each of the samples, 500 gm of soil were separated. Collected samples were then sent to SRDI, Comilla. Similarly, 200 gm of soil samples were separated and sent to Bangladesh Atomic Energy Commission (BAEC) at Savar, Dhaka for different tests.

Picture 2.3: Soil Sample Collection According to the Method Followed by Soil Resource Development Institute

ii) Representative water samples of surface and ground water were collected from study areas. Surface water samples were collected from ponds and canal/khal. Sub-surface water samples were collected from Hand Tubewells (HTs). Three samples of pond water were collected from three different ponds of each of the study villages. One pond was selected from central and two other ponds were selected from the periphery of two different sides of each of the villages. For each sample, 700 ml water was collected from a depth of about one foot below the surface of water. Water samples of canal/ khal were collected from Sonaichari Irrigation Canal, both for Shahpur and Gazipur villages of Comilla Sadar Upazila. In Alabdi and Khangshardi village, samples of stream water were collected from two different canals. Three samples of canal/ khal water were collected from almost equal distance of the canal from each of the study villages. Clean plastic bottles were used to collect water samples.



Picture 2.4: Water Sample Collection from Canal

Picture 2.5: Water Sample Collection from Pond

Water samples of GW were collected from three hand TWs from each of the study villages. HTs were selected from central and peripheral sides of each of the villages. Different parameters of each of the selected HTs such as total depth, length of filter etc. were also recorded. Tests of GW samples were carried out at DPHE Laboratory, Comilla and SRDI, Comilla.

SRDI, Comilla provided tests on texture, P^H, OM content, percent of total nitrogen, P and K of soil samples. SRDI also provided tests on p^H, K_2O and P_2O_5 for water.

DPHE, Comilla provided tests on Arsenic, Total Hardness (TH) and Total Dissolved Salt (TDS) for Ground Water (GW); and TH, Suspended Solid (SS) and NH_4^+ for Surface Water (SW).

BAEC, Savar, Dhaka provided tests of soil samples on commonly used hydrocarbons as insecticides in agriculture production under the organophosphorus, organocarbamate and organochlorine group.

Laboratory Tests Methods

p^H values both for soil and water samples were found out through ***Glass Electrode p^H Meter method (Soil : Water = 1 : 2.5)*** method. Soil texture was found out through ***Hydrometer*** method. OM contents of soil samples were determined through *Wet Oxidation* method. Nitrogen contents of soils and water samples were

found out through ***Kjeldahl*** method. ***Amonium Acetate Extraction*** method was used to determine the amount of K in soil and ***Flame Photometric*** method was used to determine the same in water. In case of phosphorus, ***Bray & Curtz and Olesen*** methods were used for determining its contents for soils having p^H values less than 6.5 and above 6.5 respectively.

Arsenic content of GW was determined through ***Atomic Absorption Spectro Photometric*** method. TH was determined through ***Titration*** method. TDS and NH_4^+ contents were measured through ***Instrumental*** methods.

Analysis of soil samples for finding out the residual effects of insecticides was carried out through ***Gas Chromatography (Hewlett Packard 5890 II)*** and ***High Performance Liquid Chromatography (Waters716)*** (HPLC) method. GC – ECD mode was used for the detection of organochlorine insecticides residues; and ***HPLC*** was used for the detection of organophosphorus and orgaocarbamates insecticides residues.

2.6 Data Analysis Formulae

Comparisons of different variables achieved from survey methods were made through percentage, stratified into different groups and mean. Available data were presented through mean supported by standard deviations. Data were also computed with different standards fixed by national and international organizations. Data achieved through survey method, PRA and laboratory tests were crosschecked. Statistical tools like standard deviations and t-tests (to compare differences of data between flooding and non flooding areas) area were carried out to analyse available data. Pie charts, graphs and bar diagrams were also used to present data in the study report.

Chapter 3
Results and Observations

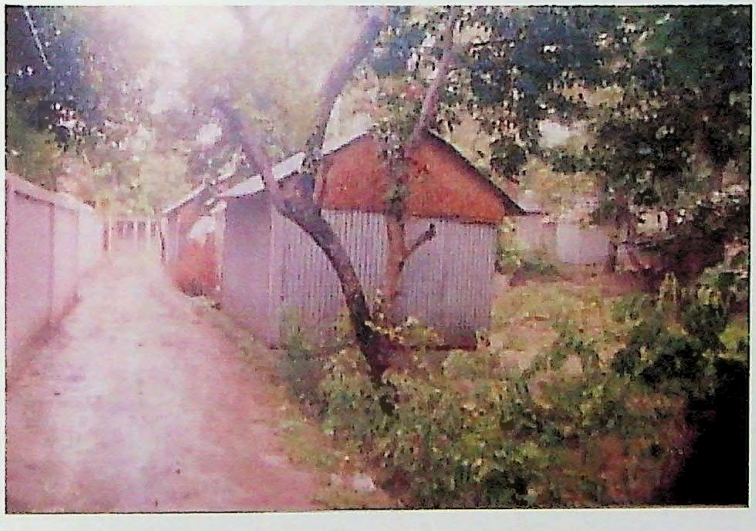
The study was carried out through PRA exercises on social and resource mapping and ranking exercises on major environmental problems of study villages; group discussion; interviews of villagers, ERs of UPs, local leaders and relevant upazila officials; and laboratory tests of soils and water. The findings of the study are presented below:

3.1 Features of Study Villages under Common Criteria

Average family size also varied from 4 to 7 and the lowest average family size was 4 in Shahpur. Settlement pattern was scattered in both the non-flood affected area whereas it was clustered in nature in both the flood-affected villages under the study. Literacy rate was highest at Khangshardi (50%) and lowest at Gazipur (35%). Agriculture was the main occupation of the villagers of both the non-flood affected villages whereas business covered the main occupation of majority of the villagers in both the flood affected villages. Marketing facilities of different commodities produced in the study villages are good. Good road communication in all the four villages helped villagers to sell their commodities in near, upazila and district markets. Topography of two villages under Comilla Sadar Upazila was high whereas no HL was found in other two study villages under Sonargaon Upazila. Flooding did not take place in Shahpur and Gazipur during the last 45 years. Most of the area of the two villages under Sonargaon Upazila experience flood every year. All farmers used HYVs for crop production in the two villages of Comilla Sadar Upazila. Farmers of two other villages under Soanargaon Upazila used traditional varieties of paddy in amon season. The village Gazipur is comparatively big in area coverage among the all villages under the study. Total agriculture land is the highest (172 acres) in this village and lowest (36.70 acres) at Khangshardi. Homestead coverage was more in Shahpur (20.0 acres) and Gazipur (22.5 acres) compared to homestead coverage at Alabdi (3.0 acres) and Khangshardi (4.7acres). In true sense, no forest exists in the four villages considered for the study. Households and roadsides are covered with trees and small bushes in Shahpur, Gazipur and Khangshardi. A few very small fragments of land were found in Shahpur and Gazipur covered with shallow bushes

and thrones only. Very few trees were found in Alabdi. Total area of Shahpur, Gazipur, Alabdi and Khangshardi were 142.8, 197.5, 47.2 and 45.1 acres respectively (Table-3.1).

Picture 3.1: Clustered Houses at Alabdi Village



Picture 3.2: Clustered Houses at Khangshardi Village

Table 3.1: Comparative Parameters of Common Issues of the Study Villages in 2003

Feature/ Item	Villages (Not Flood Affected)		Villages (Flood Affected)	
	Shahpur	Gazipur	Alabdi	Khangshardi
Location of Village	East of Comilla/ Share common boarder with India	East of Comilla/ Share common boarder with India	West to Sonargaon Upazila/ In vast flood plain of Meghna river	North east to Sonargaon Upazila/ In vast flood plain of Meghna river
Population (No.)	610	2001	907	798
Household (No.)	142	305	142	117
Average Family Size (No.)	4	7	6	7
Settlement Pattern	Scattered	Scattered	Clustered	Clustered
Literacy Rate (%)	40	35	45	50
School/ Madrasha	2 Primary Schools / 1 Maktab	4 Primary Schools / 2 Maktabs	1 Hafeezia Madrasha	1 Primary School
Main Occupation (%)	Agric.(80)	Agric.(40)	Business (30)	Business (50)
Marketing Facility	Good (No market in the village)	Good (No market in the village)	Good (No market in the village)	Good (No market in the village)
Road Communication	Good	Good	Good	Good
Topography	HL	HL	MLL/ LL	MHL/ MLL/ LL
Extent of Flooding	No flooding	No flooding	All village area	All village area
Source of Water for Domestic Use	TW/ Pond	TW/ Pond / Canal	TW/ Pond / Canal	TW/ Pond / Canal
Nature of Crops	All HYVs	All HYVs	Mostly local varieties of amon and HYV boro paddy	Mostly local varieties of amon and HYV boro paddy
Homestead Area (Acres)	20.0	22.5	3.0	4.7
Agriculture Land Area (Acres)	119.80	172.0	40.0	36.7
Forest Area (Acres)	Absent	Absent	Absent	Absent
Total Area (Acres)	142.8	197.5	47.2	45.1

3.2 Developmental Interventions in the Study Villages

It is evident from group discussion that villagers of Comilla Sadar Upazila are well advanced in adopting improved agricultural technologies; and using and managing non-farm activities. The Comilla experiment of BARD produced models of several viable programmes and institutions of RD in 60's. Village institution based RD programmes supported by GOs, NGOs and other agencies changed the socio-economic condition of the villagers in Comilla Sadar Upazila over the last four decades. Increased irrigated paddy production, adoption of improved cultivation practices, adoption of family planning and Expanded Programme on Immunization (EPI), supply of electricity, adoption of micro-credit led IGAs, construction of physical infrastructures etc. were the major development interventions that took place in concerned villages of Comilla Sadar Upazila in the last four decades. The use of Sonaichari Irrigation Canal by Kotowali Thana Central Cooperative Association Limited (KTCCA Ltd.) for irrigation facility added advantages to villagers of Shahpur to produce crops round the year.

Adoption of improved agricultural practices started slowly in late seventies in two other study villages belonging to Sonargaon Upazila. Family planning activities were notable development interventions in these two villages in 1960s. EPI of DHFP, institution based village development programme by BRDB, micro credit of GOs & NGOs and rural electrification were the major development activities during the last four decades. Comprehensive Village Development Programme (CVDP) of BARD provided scope to the villagers of Alabdi village to develop their socio-economic conditions in the mid of 1990's. But the programme could not continue in the village for some practical constraints (Table-3.2).

Table 3.2: Major Development Activities Took Place in the Study Villages during the Last Four Decades

Nature of Development Works	Implementing Agencies Village (Decades)	
	Government Organizations	Non Government Organizations and Other Agencies
HYV Paddy Cultivation & Irrigation Development (including excavation of Sonaichari irrigation canal)	BARD Shahpur (60) Gazipur (60) DAE Alabdi (70/80/90) Khangshardi (70/80/90)	–
Cooperative Society	BRDB Khangshardi (70)	KTCCA LTD. * Shahpur (60) Gazipur (70)
Family Planning	DHFP Shahpur (70/80/90) Gazipur (70/80) Alabdi (60/70) Khangshardi (70/80)	–
Production of Paddy Increasing	BARD Shahpur (70) Gazipur (70) DAE Shahpur (70) Gazipur (70) Water and Power Development Authority (WAPDA) Gazipur (70)	–
EPI	DHFP Shahpur (70) Gazipur (70) Alabdi (70) Khangshardi (70)	–
Adoption of HYV Paddy	DAE Alabdi (70) Khangshardi (70)	–
Agriculture Development	Bangladesh Agriculture Development Corporation (BADC) Shahpur (70) DAE Shahpur (90) Gazipur (80/90) Alabdi (80) Khangshardi (80) BRDB Khangshardi (80)	ASA Alabdi (90) Khangshardi (90) KTCCA LTD. Shahpur (80)
Electrification	PDB Shahpur (90) Gazipur (80/90) Alabdi (80) Khangshardi (80)	–
Micro credit	–	BRAC Gazipur (90) Alabdi (90) Grameen Bank (GB) Gazipur (90) Alabdi (90) ASA Khangshardi (90) Alabdi (90) CVDP[a] Alabdi (90)
Construction school, culvert etc.	Local Government and Engineering Department (LGED) Shahpur (90)	BRAC Gazipur (90)
Introduction of Integrated Pest Management (IPM)	DAE Gazipur (90)	–
Comprehensive RD	–	CVDP Alabdi (90)

Note: *It is the central body of primary cooperative societies and federates member societies at the upazila level. It provided support and services to its village based member societies. Bangladesh Rural Development Board was developed from this model of BARD.

[a]A village based RD programme of BARD, which has recently accepted by the government to be replicated all over the country in phases.

3.3 Consequences of Developmental Interventions in the Study Villages

3.3.1 Participatory Rural Appraisal Exercises of the Study Villages

Major environmental problems of the study villages differed between flood affected and non-flooding villages. A few of the problems found common in three villages. Six respondents took part in the ranking exercises in each of Shahpur and Gazipur; and five respondents took part in each of Alabdi and Khangshardi.

Respondents of Shahpur and Alabdi ranked use of chemicals in crops as the first major environmental problem of their villages whereas respondents of Gazipur ranked the same as the second major environmental problem of their village. Respondents of Khangshardi did not mention the problem as a major environmental problem of their village. Similarly, degradation of agriculture land was the second, third and first environmental problems of Shahpur, Gazipur and Khangshardi respectively. Scarcity and pollution of water in the dry season was the third, second and fourth major environmental problem of Shahpur, Gazipur and Khangshardi respectively. Respondents of Shahpur, Alabdi and Khangshardi mentioned killing/loss of wild lives as their sixth, fifth and fifth major environmental problem respectively. Respondents of Gazipur, Alabdi and Khangshardi mentioned that high population growth was the first, third and third major environmental problem of their villages respectively.

Damage and loss of fish resources was the second major environmental problem of Alabdi and Khangshardi whereas respondents of Shahpur and Gazipur did not mention the problem as major environmental problem of their villages.

Respondents of Shahpur mentioned that existence of too much squirrel in their village and non-availability of big trees was the fourth and fifth major environmental problem of their village. Besides, respondents of Gazipur and Alabdi mentioned that non-existence of forest and reduction of plant population was the fifth and fourth major environmental problem respectively of their villages (Table-3.3).

Table 3.3: Ranking of Major Environmental Problems of Study Villages

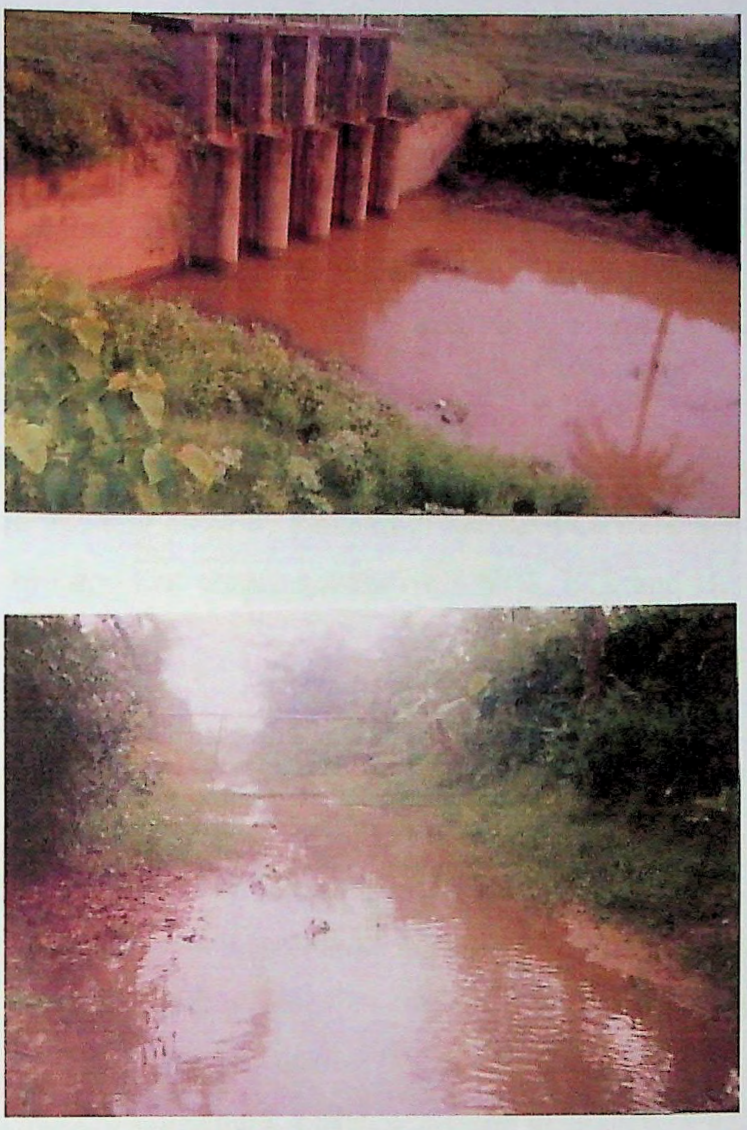
Major Environmental Problems	Shahpur		Gazipur		Alabdi		Khangshardi	
	Point	Rank	Point	Rank	Points	Rank	Points	Rank
(i) Use of chemicals in crops	32	1st	23	2nd	24	1st	-	-
(ii) Degradation of agriculture land	26	2nd	22	3rd	-	-	20	1st
(iii) Scarcity & pollution of water in dry season	24	3rd	23	2nd	-	-	12	4th
(iv) Killing/ Loss of wild lives	7	6th	-	-	7	5th	9	5th
(v) High population growth	-	-	26	1st	13	3rd	15	3rd
(vi) Damage & loss of fish resources	-	-	-	-	20	2nd	19	2nd
(vii) Existing of too much squirrels in the village	23	4th	-	-	-	-	-	-
(viii) Non availability of big trees	16	5th	-	-	-	-	-	-
(ix) Non existence of forest	-	-	15	5th	-	-	-	-
(x) Reduction of plant population	-	-	-	-	11	4th	-	-

Note: Points were determined on the basis of problems ranked by the villagers. Suppose 5 respondents ranked a problem ' Use of chemicals in crops' as 1^{st}, 2^{nd}, 3^{rd}, 4^{th} and 5^{th} each, then total points of this particular problem would be (5+4+3+2+1 = 15).

Social mapping and detail of ranking exercises on major environmental problems in the study villages are attached in annexure – 1.

3.3.2 Road and Embankment Construction in Study Villages

Respondents of the study villages were asked about road or embankment construction in their villages with types and drainage facilities in the last four decades. In response, they mentioned that no such road or embankment construction took place there during the last four decades. Rather the Sonaichari irrigation canal was excavated for facilitating irrigation support to the villagers at Shapur village four decades ago. The canal starts at Gazipur village and passes through Shahpur village.



Picture 3.3: Sonaichari Irrigation Canal

3.3.3 Agricultural Crop Production and Soil Management

a) Major Cropping Pattern

Crop production in HL was found in Shahpur and Gazipur under the study. In Alabdi, MLL and LL were found under crop production. Similarly, in Khangsharedi, MHL, MLL and LL were found. A number of major cropping patterns were found in the study villages. Major cropping pattern and various crops included in these villages are given below:

Four and three major cropping patterns were found at Shahpur and Gazipur respectively. One and four cropping patterns in MLL and LL were found respectively at Alabdi. One, two and four cropping patterns in MHL, MLL and LL were practiced respectively at Khangshardi.

Major Cropping patterns and types of crops & percentage of their adoption by the respondents are detailed in annexure – 2.

b) Effects of Adoption of Modern Agricultural Practices

Opinions of village level respondents were sought about the effect of adopting modern agriculture particularly effect of chemicals use in agriculture production. All respondents of the study villages opined that production has increased manifolds due to adopting modern agriculture. Besides, income increased or extent of poverty reduced were the benefits of using modern agriculture. Respondents expressed a number of disadvantages of adopting modern agriculture. Respondents of Shahpur, Gazipur, Alabdi and Khangshardi mentioned five, one, five and three disadvantages respectively (Table-3.4).

Table 3.4: Percentage of Respondents in Favour of Advantages and Disadvantages of Adopting Modern Agricultural Practices in Study Villages

Advantages/ Disadvantages	Opinion	Shahpur (%)	Gazipur (%)	Alabdi (%)	Khangshardi (%)	t-test
Advantages	Increased production	100.00	100.00	100.00	100.00	tstat = -0.19 tcrit.= 2.57
	Enhanced income	63.64	-	-	-	
	Reduced poverty	-	21.05	52.63	50.00	
Disadvantages	Soil fertility deteriorated	64.18	73.68	31.58	33.33	tstat = 0.09 tcrit.= 2.20
	Reduced grazing land	40.91	-	42.11	41.67	
	Increased soil hardness	18.18	-	10.53	-	
	Increased labour cost	9.09	-	10.53	-	
	Decreased water holding capacity of soil	13.64	-	-	16.67	
	Traditional varieties of crops affected	-	-	26.32	-	

Note: Percentage was calculated on the basis of frequency of responses with respect to number of respondents

c) Use of Fertilizers and Pesticides and their Effects

Amount of fertilizers used in crops: Amount of fertilizers used in crop fields in different seasons were collected from the respondents on the basis of seasons of the year (season wise fertilizer use is attached in annexure – 3).

In Shahpur, average amount of urea, TSP and MP fertilizers used in amon, boro, rabi and kharif crops were 378.00, 265.78 and 122.78 kg per acre respectively. Similarly, in Gazipur, average amount of urea, TSP and MP fertilizers used in similar crops were 478.78, 325.91 and 141.64 kg per acre respectively.

In MHL of Khangshardi, average amount of urea, TSP and MP fertilizers used in rabi and kharif crops were 247.50, 192.50 and 85.00 kg per acre respectively.

In MLL of Alabdi, average amount of urea, TSP and MP fertilizers used in amon and rabi crops were 64.96, 68.85 and 36.63 kg per acre respectively. In Khangshardi and in similar type of land, average amount of urea, TSP and MP fertilizers used in similar crops were 56.25, 55.00 and 29.17 kg per acre.

Table 3.4: Percentage of Respondents in Favour of Advantages and Disadvantages of Adopting Modern Agricultural Practices in Study Villages

Advantages/ Disadvantages	Opinion	Shahpur (%)	Gazipur (%)	Alabdi (%)	Khangshardi (%)	t-test
Advantages	Increased production	100.00	100.00	100.00	100.00	tstat = -0.19 tcrit.= 2.57
	Enhanced income	63.64	-	-	-	
	Reduced poverty	-	21.05	52.63	50.00	
Disadvantages	Soil fertility deteriorated	64.18	73.68	31.58	33.33	tstat = 0.09 tcrit.= 2.20
	Reduced grazing land	40.91	-	42.11	41.67	
	Increased soil hardness	18.18	-	10.53	-	
	Increased labour cost	9.09	-	10.53	-	
	Decreased water holding capacity of soil	13.64	-	-	16.67	
	Traditional varieties of crops affected	-	-	26.32	-	

Note: Percentage was calculated on the basis of frequency of responses with respect to number of respondents

c) Use of Fertilizers and Pesticides and their Effects

Amount of fertilizers used in crops: Amount of fertilizers used in crop fields in different seasons were collected from the respondents on the basis of seasons of the year (season wise fertilizer use is attached in annexure – 3).

In Shahpur, average amount of urea, TSP and MP fertilizers used in amon, boro, rabi and kharif crops were 378.00, 265.78 and 122.78 kg per acre respectively. Similarly, in Gazipur, average amount of urea, TSP and MP fertilizers used in similar crops were 478.78, 325.91 and 141.64 kg per acre respectively.

In MHL of Khangshardi, average amount of urea, TSP and MP fertilizers used in rabi and kharif crops were 247.50, 192.50 and 85.00 kg per acre respectively.

In MLL of Alabdi, average amount of urea, TSP and MP fertilizers used in amon and rabi crops were 64.96, 68.85 and 36.63 kg per acre respectively. In Khangshardi and in similar type of land, average amount of urea, TSP and MP fertilizers used in similar crops were 56.25, 55.00 and 29.17 kg per acre.

In LL of Alabdi, average amount of urea, TSP and MP used in amon and boro crops were 79.11, 73.42 and 44.04 kg per acre. In similar land type of Khangshardi average amount of urea, TSP and MP in similar crops were 101.25, 79.00 and 36.50 kg per acre respectively (Figure 3.1).

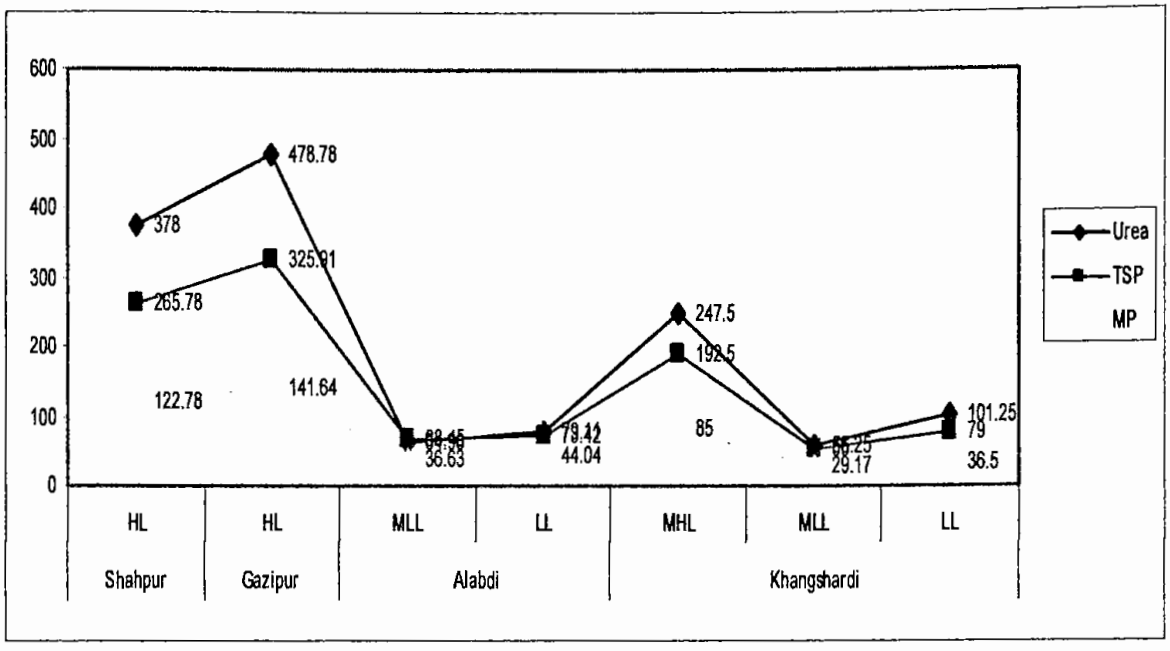


Figure 3.1: Amount of Major Fertilizers Used in Crop Production in 2003

Amount of Insecticides Used in Crops: Farmers of the study villages informed the name and amount of insecticides used in different crops. Farmers of the study villages did not use any insecticide and fertilizers for crop production four decades ago.

Respondents of Shahpur and Gazipur used insecticides in amon, boro, rabi and kharif crops. Average amount of liquid insecticides used in rabi and kharif crops were remarkably higher than the use of same in amon and boro crops. Average amount of liquid insecticide used in Shahpur and Gazipur in different crops were 1177 and 1152 mg per acre respectively. Average amount of powder insecticides used in Shahpur and Gazipur were 10280 and 9810 gm per acre respectively. All insecticides used in crops were under the groups of organophosphorus and organocarbamate.

In different crops of MHL at Khangshadi, average annual liquid and powder insecticides used in rabi and kharif crops were 530 mg and 5350 gm per acre respectively.

In MLL of Alabdi and Khangshardi, respondents cultivated amon and rabi crops. In Alabdi, respondents did not use any insecticides in amon crops. The average amount of liquid and powder insecticides used in rabi crops were 113 mg and 2250 gm per acre respectively. In Khangshardi, respondents used liquid insecticides at the average rate of 300 mg per acre. They did not use powder insecticides in amon crops but they used the same in rabi crops at the average rate of 2000 gm per acre.

In LL of Alabdi and Khangshardi villages, respondents cultivated boro and rabii crops. Average amount of liquid insecticides used in boro and rabi crops in Alabdi and Khangshardi villages were 196.71 and 231.67 mg per acre respectively. Average amount of powder insecticides used in the same crops of Alabdi and Khangshardi villages were 4380 and 4250 gm per acre respectively (detail of insecticides used is attached in annexure – 4) (Figure 3.2).

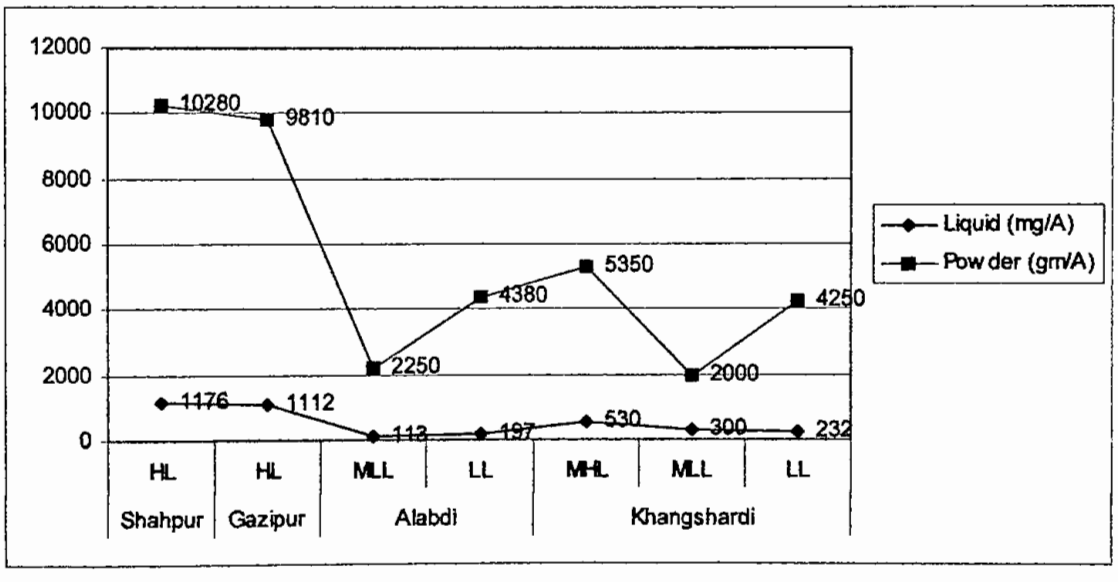


Figure 3.2: Use of Insecticides in Crops in 2003

Advantages and Disadvantages of High Rate of Fertilizer Use: In the study villages, village level respondents expressed a number of advantages and disadvantages of using fertilizers in crop production.

Village level respondents of all concerned areas commonly mentioned that production and income increased and poverty reduced due to using fertilizers in crops. Common disadvantages mentioned by the respondents of all study villages included: soils become hard and fertility of soils reduces due to using high rate of fertilizers in crops.

Again, common disadvantages for using fertilizers in crops mentioned by the village level respondents in two non-flooding villages under the study were: water become polluted and attack of pest & insect increases. Similarly, taste of crops reduces due to using fertilizers in crops' was mentioned by the respondents of Alabdi and Khangshardi (detail is attached in annexure – 5).

Advantages and Disadvantages of Insecticide Use: Village level respondents of each of the study villages mentioned three advantages, which included: increased crop production, decreased insect's attack and reduced crop diseases due to using insecticides in crops.

They also mentioned six to seven disadvantages of using insecticides in agriculture crops. Advantages and disadvantages of using insecticides mentioned by the respondents of the study villages are attached in annexure-6.

Respondents of ERs of UPs, LLs and VLWs mentioned seven disadvantages regarding deterioration of soil quality for adopting high rate of fertilizers and insecticides in agricultural crops. Majority of them mentioned that soils became hard; fertility of soils reduced; and beneficial insects to soils and earthworm population was exhausted.

d) Use of Organic Materials in Agriculture Soils and their Effects

Use of Organic Materials in Agriculture Soils: Village level respondents of the study were asked about the type of organic materials they used in their agricultural land; and whether the use of those materials was increased or decreased in comparison to the use of the same in the past. They mentioned three sources of

organic materials they used in agricultural land; and these were cow dung, oilcake and green waste. Regarding the increased use of organic materials, only 13.6 percent of respondents in Shahpur village mentioned that they increased the use of cow dung on an average rate of 36.67±5.27 maunds per acre comparatively to the use of the same in the past whereas, the villagers mentioned that the use of organic manures i. e., cowdung, oilcake and green wastes in agriculture soil was reduced in comparison to use of the same in the past (Table – 3.5).

Table 3.5: Use of Organic Materials (average amount) in Agriculture Soils in Study Villages

Village	No. of Respondents	Increase			Decrease		
		Cow dung (Md/Ac)	Oil Cake (Kg/Ac)	Green Waste (Md/Ac)	Cow dung (Md/Ac)	Oil Cake (Kg/Ac)	Green Waste (Md/Ac)
Shahpur	22	36.67*±5.27	-	-	48.42±15.28	27.50±9.87	-
Gazipur	38	-	-	-	50.79±17.01	35.00±14.43	20.00±0.0
Alabdi	19	-	-	-	57.37±12.84	59.38±18.60	-
Khangshardi	12	-	-	-	56.25±9.80	35.00±17.32	-

*On the basis of only 13 percent respondents of Shahpur village

Advantages of Using Organic Materials in Agriculture Soils: Village level respondents expressed eleven sorts of advantages of using organic materials in agriculture soils. Respondents of Shahpur and Gazipur mentioned greater number of advantages of using organic materials in agriculture soils than respondents of other two villages under the study (Table– 3.6).

Table 3.6: Percentage of Respondents in Favour of Advantages of Using Organic Materials in Agriculture Soils

Advantages	Shahpur (%)	Gazipur (%)	Alabdi (%)	Khangshardi (%)	t-test
1. Soil becomes soft	100	55.26	94.74	100	
2. Produced crop is good	81.82	42.11	68.18	91.67	
3. No. of beneficial insects to the soil increases	59.09	39.47	21.05	33.33	
4. Fertility of soil increases	50.00	60.53	63.64	66.67	
5. It needs less price	22.73	7.89	47.37	33.33	
6. No deterioration of soil qualities takes place	13.64	44.74	10.53	-	t_{Stat} = 1.05
7.No deterioration of environment takes place	13.64	39.47	-	-	t_{Crit} = 2.08
8. No deterioration of water and air takes place	13.64	28.95	5.26	-	
9. Water holding capacity increases	13.64	26.32	5.28	-	
10. Inland and aquatic lives become safe	9.09	31.58	-	8.33	
11. Crops produced is of better quality	9.09	18.42	-	8.33	

Respondents of ERs of UPs, LLs and VLWs of the study villages mentioned similar advantages that OM can conserve soil qualities. Almost all respondents of the study villages said that utilization of OM in large scale would reduce the use of insecticides and fertilizers in agricultural crops and thus would help to conserve soil fertility. They added that it would keep better environment in soil management.

e) Surface Water Pollution from Agrochemicals

In response to the question regarding the affect of agrochemicals on surface water, varying percent of respondents of the four study villages identified six major disadvantages as presented in table–3.7.

Table 3.7: Percent Respondents Regarding Disadvantages for Mixing of Fertilizers with Surface Water

Disadvantage	Shahpur (%)	Gazipur (%)	Alabdi (%)	Khangshandi (%)	t-test
(i) Aquatic fauna affected	100.00	100.00	73.68	75.00	t_{Stat} = 2.99 $t_{Crit.}$ = 2.20
(ii) Ground water affected	63.64	47.37	52.63	58.33	
(iii)Aquatic flora affected	63.64	26.32	57.89	50.00	
(iv) Loss suitability for drinking and other uses	50.00	68.42	42.11	41.67	
(v) Overall aquatic environment distorted	63.64	36.84	31.58	8.33	
(vi) Causes skin diseases	27.27	31.58	-	-	

Significant at 5 percent level

f) Credit Supports and Adopted Income Generating Activities (IGAs)

Credit Supports: A few village level respondents were found who took credit from Nationalized Banks, GB and BRAC. In Shahpur village, one respondent took credit from Nationalized Bank and one form GB. In Gazipur village, three respondents took credit from Nationalized Bank and one form GB. In Alabdi village, three respondents took credit from Nationalized Bank, four from GB and four from BRAC. In Khangshardi village, one and two respondents took credit from Nationalized Bank and BRAC respectively.

Table 3.8: Percent Respondents Availed Credit Supports from Banks and NGOs

Village	Organization Provided Credit		
	Nationalized Bank	Grameen Bank	BRAC
Shahpur	4.55	4.55	-
Gazipur	7.90	2.66	-
Alabdi	15.79	21.05	21.05
Khangshardi	8.33	16.67	-

Amount of Credit: Amounts of credit received by the village level respondents from different organizations were categorized upto Tk. 5,000, Tk. 5,001-10,000, Tk. 10,001-15,000, Tk. 15,001-20000 and more than Tk. 20,000. Only one respondent took less than Tk. 5000 as credit in Gazipur. A total of seven respondents i.e., one from Shahpur, one from Gazipur and five from Alabdi received credit each amounting to the range of Tk. 5,001-10,000. Five respondents, which included one form Gazipur, two from Alabdi and two from Khangshardi took credit each amounting to the range of Tk. 10001-15000. Similarly, five respondents, three from Alabdi and one each from Gazipur and Khangshardi got credit support amounting to the range of Tk. 15001-20000. Besides, one respondent each from Gazipur and Alabdi took credit amounting to more than Tk. 20000.

Utilization of Credit: Village level respondents mentioned three purposes for which they took credits from different sources. They took twenty credits in total. These included thirteen for using in small trades, six for agricultural related activities and one for rearing of milking cow. One respondent from each of Shahpur and Gazipru; eight respondents from Alabdi; and three respondents from Khangshardi took credit for investing money in small trade related business. Three respondents each from Gazipur and Alabdi took credit for crop production related works. One respondent in Shahpur village under the study took credit for purchasing of milking cow.

Respondents of ERs of UPs, LLs and VLWs mentioned that the villagers with the credit money adopted nine different IGAs. Majority of the respondents adopted small business; milking cow rearing; and keeping of poultry and duck as micro credit

supported IGAs. Other common IGAs were found to assist vegetables and paddy production; goat rearing; and beef fattening. Besides, handicraft/cottage industry related IGAs were found in Gazipur, Alabdi and Khnagshardi. Moreover, one respondent of Gazipur and one respondent of Khangshardi informed that purchasing of rickshaw was a common IGA in their villages. One respondent of Gazipur informed that credit for pisciculture was available in his village.

Environmental Impact on Credit Supported Activities: Village level respondents were asked to express their opinion about the environmental impacts on various activities they adopted with the money they received as credit. Three respondents of each Gazipur and Alabdi informed that they purchased fertilizers and insecticides with the credit money. They mentioned various environmental impacts for using fertilizers and insecticides in agricultural crops. Environmental impacts for using fertilizers and insecticides in agricultural crops included (a) water pollution, (b) reduction of soil fertility and destruction of beneficial insects, (c) air pollution, (d) plants and crops affected and (e) inland and aquatic lives destroyed.

Respondents who took credit for small trades and rearing of milking cow did not mention anything about environmental effects of their IGAs.

Respondents of ERs of UPs, LLs and VLWs mentioned commonly that keeping of goat has negative impact on environment as plants and different crops were affected with goats. They considered it as a major social problem. It created quarrels among the villagers now and then. Besides, 33.33 percent respondents of Gazipur and Alabdi villages; and 66.67 percent of respondents of Khangshardi village expressed that water became polluted for keeping cow.

Steps Needed to Prevent Environmental Effects of IGAs: Respondents of ERs of UPs, LLs and VLWs mentioned four steps in this regard: two common steps by the respondents of all study villages and two other steps mentioned by the respondents of Shahpur and Gazipur villages (Table 3.9).

Table 3.9: Percentage of Respondents Regarding Steps Needed to be Adopted to Prevent Effects on Environment from Micro Credit Led IGAs

Steps Needed to be Adopted	Shahpur (%)	Gazipur (%)	Alabdi (%)	Khangshardi (%)	t-test
(i) Taking care of goat. It should not get chance to eat others crops	33.33	33.33	50.00	66.67	t_{Stat} = -0.26 $t_{Crit.}$ = 2.36
(ii) Managing of cow dung and urine properly so that it does not affect the environment	33.33	33.33	33.33	66.67	
(iii) Use of insecticides in crops should be stopped	16.67	16.67	-	-	
(iv) Manures should be used in place of fertilizers	16.67	16.67	-	-	

3.4 Biodiversity Status

3.4.1 Conditions of Major Type of Trees

Major change took place in planting or replacing various traditional trees with timber rich plants in the study villages. So, many traditional trees were no more found in the villages. It can generally be said that rich plant diversity in those villages was derogated seriously over the last four decades.

a) Major Type of Trees

Trees available in the study villages were categorized into timber and fruit tree, fruit tree, timber tree, medicinal plants, ornamental trees and others. Timber fruit trees included *Artocarpus heterophyllus Lamk. (Kathal), Syzygium grandis (Wt.) Wall. (Jam), Diospyros peregrinal. (Gub), Borassus flabellifer L. (Tal), Tamarindus indicus L. (Tetul), Garcinia cowa Roxb. (Cowa), Elaeocarpus robustus Roxb. (Jalpai)* etc. Fruit trees included *Cocos nucifera L. (Narikel), Psidium guajava (L.) Bat. (Peyara), Zyzyphus mauritiana Lank. (Baroi), Averrhoa carambola (Kamranga), Citrus grandis Osb. (Jambura), Amanas sativus Schult. f. (Anarash), Mimusops elengi L. (Bal), Phoenix sylvestric (L.) Roxb. (Khejur), Phyllanthus acidus (L.) Skiels (Arboroi), Litchi chinensis Sonn. (Lichu), Anona squamosa (Ata), Musa paradisiaca L. (Kola), Carica papaya L. (Pepe), Manilkara zapta (Safeda), Citrus aurantifolia (Lebu), Ficus hispida L. (Dumur)* etc. Wood trees included *Techtona grandis L. (Segun), Aphanamixis polystachya (Roina), Derris robusta Benth. (Koroi), Swietenia mahagoni (L.) (Mahogani), Gmelina arborea L. (Gamari), Anthocephalus chichinensis (Kadom), Derris robusta (Rain Tree), Artocarpus chaplasha Roxb.*

(Chambol), Acacia moniliformis Griseb (Akashmoni) etc. Medicinal plants of the study villages covered *Azadirachta indica A. Juss. (Neem), Terminalia arjuna Bedd. (Arjun), Moringa oleifera Lamk. (Sajina), Justicia oreophyla Clarke (Bashuk-Pata), Calotropis procera Br. (Akanda), Phyllanthus embelica L. (Amloki), Mimosa pudica L. (Lajjabati)* etc. Ornamental trees of the study villages included *Bombax ceiba L. (Shimul), Delonix regia (Boj.) Raf. (Krishna Chura), Abroma augasta L. (Ulat Kambal), Vitex negundo L. (Nishinda)* etc. Trees covered under other groups included *Lawsonia inermis L. (Menda), Streblus asper lour. (Shaora), Barringtonia acutargula (L) Gacrtn. (Hijal)* etc. Timber trees dominated in Shahpur and Gazipur villages whereas timber and fruit trees dominated in Alabdi and Khangshardi villages (Table–3.10).

Table 3.10: Percentage of Major Types of Trees Available in Study Villages

Type of t Trees	Shahpur	Gazipur	Alabdi	Khangshardi
(a)Timber & fruit trees	19	18	43	42
(b) Fruit trees	22	21	28	31
(c) Timber rich trees	52	53	18	18
(d) Medicinal trees	03	03	02	02
(e) Ornamental trees	02	03	02	02
(f) Others	02	02	07	05

b) Sizes of Trees

Sizes of trees in terms of diameter measurement about 3 ft above the ground was considered to compare the tree population of different sizes in the study villages with respect to their population that existed four decades ago. Sizes of trees were categorized into up to 1-foot diameter, 1-2 ft diameter, 2-3 ft diameter and above 3 ft diameter.

Results show that population of big trees were more four decades ago whereas population of small trees covered majority of tree population at present in all study villages (Table–3.11).

Table 3.11: Percentage of Trees of Different Sizes in Respect of Diameter on the Basis of Respondents Opinion and In-situ Observation

Village	Four Decades Ago				In 2003			
	Up to 1 Ft.	1-2 Ft.	2-3 Ft.	Above 3 Ft.	Up to 1 Ft.	1-2 Ft.	2-3 Ft.	Above 3 Ft.
Shahpur	12	27	28	33	37	36	18	9
Gazipur	12	28	26	34	43	32	17	8
Alabdi	13	26	29	32	43	31	17	9
Khangshardi	19	26	27	28	41	34	16	9

c) Increase of Tree Population of One Foot and Above Diameter

Village level respondents informed about the increase of different trees having diameter of one foot and above. Respondents were given a scale consisting of 1-25 percent, 26-50 percent, 51-75 percent, 76-100 percent and above 100 percent increase of tree population in their villages over the last four decades to express their opinion.

All respondents of Shahpur and Gazipur expressed that tree population of the said parameters increased in their villages. In Alabdi, 63.16 percent of respondents and in Khangshardi, 75.00 percent of respondents opined that tree population of the village increased from 1 to 25 percent in their villages over the last four decades. Contrarily, 31.58 and 5.26 percent of respondents of Alabdi opined that population of the said parameter of trees decreased by 1 – 25% and 26 – 50% respectively in their village. Similarly, 16.67 and 8.33 percent of respondents of Khangshardi also informed that population of trees of the said parameter decreased by 1 – 25% and 26 – 50% respectively in their village in the last four decades.

Table 3.12: Percentage of Respondents Regarding Increase of Trees HavingDiameter of One Foot and Above in the Last Four Decades

Village	1-25%	26-50%	51-75%	76-100%	Above 100%	t-test
Shahpur	-	45.45	54.55	-	-	
Gazipur	-	52.63	47.37	-	-	t_{Stat} = 5:22
Alabdi	63.16	-	-	-	-	$t_{Crit.}$ = 12.71
Khangshardi	75.00	-	-	-	-	

d) Effects on Environment for Changing Major Type of Trees

Respondents of villagers; and ERs of UPs, LLs and VLWs mentioned nine different effects on environment for changing major trees in the last four decades. Respondents of Shahpur and Gazipur mainly expressed these effects on environment (Table–3.13).

Table 3.13: Percentage of Respondents Regarding Effects on Environment for Changing of Major Types of Trees in Study Villages

Effects on Environment	Shahpur (%)		Gazipur (%)		Alabdi (%)		Khandgshardi (%)	
	Vil.	ERs.	Vil.	ERs.	Vil.	ERs.	Vil.	ERs.
(a) Food diversity of man and bird reduced	100.00	100.00	94.74	100.00	-	-	8.33	-
(b) Diversity of trees reduced	100.00	66.67	81.58	66.67	-	-	8.33	-
(c) Number of birds reduced in the village	100.00	-	100.00	-	36.84	-	50.00	-
(d) Traditional beneficial and health friendly fruit trees become extinct from the village	100.00	33.33	78.95	50.00	-	-	8.33	-
(e) Diversity of birds reduced	100.00	-	73.68	-	-	50.00	8.33	16.67
(f) Diversity of fruits reduced	100.00	33.33	73.68	50.00	-	-	8.33	-
(g) Production of fruits reduced	-	50.00	-	83.33	-	-	-	-
(h) No. of wild lives reduced	-	50.00	-	50.00	-	-	-	-
(i) Beauty of the village deteriorated	-	33.33	-	-	-	-	-	-

t_{Stat} = 5.45 and $t_{Crit.}$ = 2.11 for villagers. t_{Stat} = 4.12 and $t_{Crit.}$ = 2.11 for ERs of UPs, LLs and VLWs/ Significant at 5 percent level

e) Causes of Changing Major Type of Trees

Village level respondents mentioned eight different causes responsible for changing major tree types in the study villages. Among them, the respondents of Shahpur and Gazipur mainly mentioned seven causes. Rest one cause was mentioned by the respondents of Alabdi and Khangshardi (Table – 3.14).

Table 3.14: Percentage of Respondents Regarding Causes of Changing Major Types of Trees in Study Villages

Causes of Changing Major Types of Trees	Shahpur (%)	Gazipur (%)	Alabdi (%)	Khandgshardi (%)	t-test
(a) High price of timber	72.73	84.21	-	16.67	
(b) Timber rich trees grow fast	68.18	60.53	-	-	
(c) Use of timer increases	18.18	50.00	-	16.67	
(d) Timber rich tree is profitable	45.45	42.11	-	-	t_{Stat} = 3.27
(e) Fruits can not safely be harvested if trees are away from home	18.18	34.21	-	-	t_{Crit} = 2.13
(f) Huge campaign for timber rich tree plantation	13.64	31.58	-	-	
(g) Cow and goat preferably eat fruit trees	13.64	18.42	-	-	
(h) Cutting of big banyan and shimul trees by considering those as less valuable	-	-	36.84	50.00	

Significant at 5 percent level

f) Steps Needed to Conserve and Increase Plant Diversity

Village level respondents of the study villages mentioned seven different steps to be adopted to increase plant diversity in the study villages. The respondents of all study villages mentioned three common steps in this regard. Respondents of Shahpur and Gazipur provided three different suggestions to increase plant diversity in their villages (Table – 3.15).

Table 3.15: Percentage of Respondents Regarding Steps Needed to Conserve and Increase Plant Diversity in Study Villages

Steps Needed to be Adopted to Increase Plant Diversity	Shahpur (%)	Gazipur (%)	Alabdi (%)	Khandgshardi (%)	t-test
(a) Use mass media for building awareness among commmon people to plant fruit and medicinal plants along with timber trees	89.47	78.95	10.53	16.67	
(b) Seedling of fruit and medicinal plants should be distributed with subsidized price/free of cost	54.55	8.84	15.79	25.00	
(c) All types of plants should be planted	50.00	13.16	36.84	50.00	t_{Stat} = 2.99
(d) Large scale awareness building for ensuring plant diversity	54.55	86.84	-	-	t_{Crit} = 2.16
(e) More fruit and medicinal plants should be planted than timber plants	40.91	34.21	-	-	
(f) Timber rich fruit trees should be planted	36.36	47.37	-	-	
(g) Timber rich plant should get priority in planting beside road	-	-	21.05	-	

Significant at 5 percent level

3.4.2 Fish Diversity

a) Fish Diversity in Cultured Ponds

Cultured Pond's Fish Production: Village level respondents were asked to mention the extent of increase and name of cultured fishes in their respective villages. Increase of culture fishs in the ponds were categorized into five different groups; and these were increase from 1 to 25 percent, from 26 to 50 percent, from 51 to 75 percent, from 76 to 100 percent, over 100 percent. Answer of the respondents was accepted on the basis of highest frequency observed. For example, if 10 percent of respondents opined that population of *Labeo rohita (Rui)* fish increased from 1 to 25 percent in the village over the last four decades; and at the same time 25 percent of respondents opined that population of the same fish increased from 26 to 50 percent, then the second answer was accepted for this particular query and obtained results are presented table – 3.16.

Table 3.16: Specieswise Enhanced Production Percentage of Cultured Fishes (Traditional) and Newly Introduced Fishes (Exotic) in Ponds of Concerned Villages

Village	Name of Culture Fish Increased Over the Last Four Decades					
	1-25%	26-50%	51-75%	76-100%	> 100%	Newly Introduced Fish
Shahpur	*Puntius sarana (Sharputi)*	*Catla catla (Katla)* and *Labeo rohita (Rui)*	*Cirrhinus mrigala (Mrigal)*	-	-	*Hypophthalmichthys nobilish (Bighead Carp), Ctenopharyngodon idellus (Grass Carp), Pangasius pangasius (Pangus), Hypophthalmichthys molitrix (Silver Carp), Cyprinus carpio linneaeus (Common Carp)* and *Oreochromis mossambica (Tilapia)*
Gazipur	*Puntius sarana (Sharputi)*	*Labeo rohita (Rui), Cirrhinus mrigala (Mrigal)* and *Catla catla (Katla)*	-	-	-	*Hypophthalmichthys molitrix (Silver Carp), Hypophthalmichthys nobilish (Bighead Carp), Ctenopharyngodon idellus (Grass Carp), Pangasius pangasius (Pangus), Oreochromis mossambica (Tilapia), Cyprinus carpio linneaeus (Common Carp)* and *Clarius gariepinus (Africal Catfish)*
Alabdi	-	-	-	-	-	-
Khangshardi	-	-	*Catla catla (Katla) Labeo rohita (Rui)* and *Puntius sarana (Sharputi)*	*Cirrhinus mrigala (Mrigal)*	-	*Ctenopharyngodon idellus (Grass Carp), Hypophthalmichthys nobilish (Bighead Carp), Hypophthalmichthys molitrix (Silver Carp), Oreochromis mossambica (Tilapia), Pangasius pangasius (Pangus)* and *Cyprinus carpio linneaeus (Common Carp).*

Causes for Increasing Cultured Fish Production: All village level respondents of the study villages except Alabdi opined that production of fish was a profitable practice. Return from fish production was high. In Alabdi, respondents did not practice cultured fish in their ponds as all ponds of the village lie in the LL area and got flooded every year. In this regard, respondents of three other villages mentioned five causes of which four were common (Table – 3.17).

Table 3.17: Percentage of Respondents Regarding Causes of Increasing Cultured Pond Fish in Study Village

Causes of Increasing Fish Production	Shahpur (%)	Gazipur (%)	Alabdi (%)	Khandgshardi (%)	t-test
(a) High income from fish production	100.00	100.00	-	100.00	
(b)For the need of family	45.45	9.50	-	41.67	
(c) Using modern techniques of fish culture	27.27	36.84	-	25.00	t_{Stat} = 1.70
(d) Demand and price of fish increase	9.09	26.32	-	8.33	$t_{Crit.}$ = 2.26
(e) For introducing and cultivating new varieties of fish	-	7.89	-	-	

b) Open Water Fish Diversity

Decrease of Traditional Fish Production: Respondents of the study villages informed that natural fish decreased in their villages. Traditional fishes and their extent of reduction over the last four decades were assessed through a scale ranging from 1 to 25 percent, from 26 to 50 percent, from 51 to 75 percent, from 76 to 99 percent. Number of extinct traditional fish from Shahpur, Gazipur, Alabdi and Khangshardi villages was 10, 12, 17 and 11 respectively during the last four decades. Fishes extinct like *Ompok pabo (Pabda), Notopterus chitala (Chital), Bengala elanga (Bangla), Gudusia chapra (Chapila)* and *Macrabrachium rosenbergii (Baro Chingri)* were the extinct common traditional fishes in all the four villages. Fish species, *Nandus nandus (Meni), Channa marulius (Gojar), Wallago attu (Boyal)* and *Colisha fasciatus (Khalisha)* became extinct from two flood-free villages. Whereas, *Leiognathus equulus (Tekchanda), Aorichthys aor (Ayr), Cirrhinus reba (Bhagna), Anguilla bengalensis (Bain Baush)* and *Mystus cavasius (Golsha)* became extinct from flood-affected villages. Names and reduction of population of different species of traditional fishes from study villages are attached in annexure-7.

Causes of Decreasing Traditional Fish Production: Respondents opined four common and six location based causes resposible for decreasing traditional fishes (Table – 3.18).

Table 3.18: Percentage of Respondents Regarding Causes of Decreasing Traditional Fish Production in Study Villages

Causes of Decreasing Fish Production	Shahpur (%)		Gazipur (%)		Alabdi (%)		Khandgshardi (%)	
	Vil.	ERs.	Vil.	ERs.	Vil.	ERs.	Vil.	ERs.
(a) Use of insecticides and fertilizers in crops	100.00	100.00	100.00	100.00	47.37	83.33	33.33	83.33
(b)Fill up of canals and water bodies	68.18	100.00	68.42	66.67	-	-	-	-
(c) Catching of egg carrying mother fish and fingerlings	27.27	16.67	55.26	33.33	5.26	33.33	8.33	66.67
(d) Water scarcity in canals and beels in dry season	22.73	50.00	42.11	50.00	31.58	16.67	25.00	50.00
(e) High growth of population	18.18	50.00	23.68	50.00	73.68	16.67	83.33	50.00
(f) Building of embankment in and around water bodies	13.64	-	10.53	-	73.68	-	-	-
(g) Use of current net for fishing	-	-	-	-	100.00	100.00	100.00	100.00
(h) Excavatig ponds in the catchment's area	-	33.33	13.16	50.00	-	-	-	-
(i) Excavating of Sonaichari canal	22.72	33.33	-	-	-	-	-	-
(j) Using fishing nets very intensively	-	-	-	-	-	100.00	83.33	83.33

t_{Stat} =-0.32 and $t_{Crit.}$ = 2.09 for villagers. t_{Stat} = -0.19 and $t_{Crit.}$ = 2.09 for ERs of UPs, LLs and VLWs

c) Pond's Status

Number and Area of Ponds: Number of ponds of all villages under the study increased compared to the number that existed four decades ago, whereas average size of pond remained almost similar (Table – 3.19).

Table 3.19: Number and Average Area of Ponds in Study villages

Village	Number of Ponds		t-test	Average Area of Ponds (Acre)		t-test
	Four Decades ago	In 2003		Four Decades ago	In 2003	
Shahpur	11	22	t_{Stat} = -3.36* $t_{Crit.}$ = 3.18	0.43	0.37	t_{Stat} =0.69 $t_{Crit.}$= 3.18
Gazipur	15	28		0.37	0.39	
Alabdi	6	11		0.27	0.25	
Khangshardi	7	10		0.33	0.34	

* Significant at 5 percent level

Causes of Increasing Number of Pond: Village level respondents of the study villages mentioned seven causes for increasing ponds in their villages (Table –3.20).

Table 3.20: Percent Respondents Regarding Causes of Increasing Ponds in the Study Villages

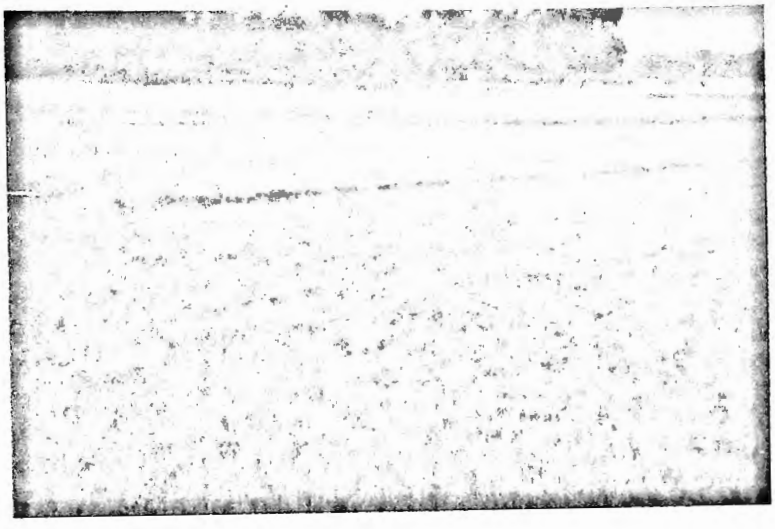
Causes of Increased	Shahpur (%)	Gazipur (%)	Alabdi (%)	Khandgshardi (%)	t-test
(a)For meeting up water of daily need	90.91	68.42	42.11	33.33	t_{Stat} =0.22 $t_{Crit.}$= 2.16
(b) Cultivation of fish is profitable	100.00	100.00	-	75.00	
(c) For increasing demand of fish	4.55	7.89	-	8.33	
(d) For meeting the demand of fish of the family	-	-	21.05	41.67	
(e) Pond cutting is easier in low lying area	-	-	10.53	16.67	
(f) Use of fallow land for pond excavation	-	-	26.32	16.67	
(g) For catching fish natural way	-	-	47.37	-	

d) Catchment's Status

Number and Area of Catchment: There was one catchment area in Shahpur and two catchment areas in Gazipur four decades ago. No catchment exists at Shahpur and part of a catchment exists at Gazipur at present (Table – 3.21).

Table 3.21: Number and Area of Catchment in the Study Villages

Village	Four Decades Ago		2003	
	No. of Catchment	Area of Catchment	No. of Catchment	Area of Catchment
Shahpur	1	3.75	-	-
Gazipur	2	23.00	1	8.00
Alabdi	-	-	-	-
Khangshardi	-	-	-	-



Picture 3.4: Catchment Area Turned into HYV Paddy Field

Picture 3.5: Remaining Portion of Catchment Area After Most of the Land Converted into HYV Paddy Field

Causes of Decreasing Catchments Area: Village level respondents of Shahpur and Gazipur expressed three causes in this regard (Table –3.22).

Table 3.22: Percentage of Respondents Regarding Causes of Decreasing Catchment Area in Study Village

Causes of Decreasing Catchment Area	Shahpur (%)	Gazipur (%)	Alabdi (%)	Khandgshardi (%)
(a) Filling up of water bodies	100.00	92.11	-	-
(b) For bringing water bodies into crop cultivation	54.55	52.63	-	-
(c) Excavation of ponds in catchment area	2.73	57.89	-	-

3.4.3 Amphibian Diversity

a) Availability of Frogs

Conditions of frogs and toads were investigated. Respondents were asked to give details about different species of frogs; and their extent of existence in their villages. Respondents mentioned the names of different frogs and their existence at present and four decades ago. Respondents used a scale of mentioning the existence of frogs, which consisted of 'Sufficient' 'Moderate' and 'A little'. In all study villages, respondents mentioned that different types of frogs were sufficiently available in their villages four decades ago.

Respondents of all study villages commonly mentioned the name of *Bufo melanostictus (Kuno Bang), Hoplobatrachus tigerinus (Kola Bang) and Euphlyctis cyanophlyctis (Bhasha Bang)* (detailed in annexure-8).

All respondents of ERs of UPs, LLs and FLWs study also mentioned similar names of frogs.

b) Causes of Decreasing Frog Population

Village level respondents mentioned eight different causes of deceasing frog/ toad from the villages of which six were common (Table – 3.23).

Table 3.23: Percentage of Respondents Regarding Causes for Decreasing the Number of Frog in Study Villages

Causes for Decreasing Frogs	Shahpur (%)	Gazipur (%)	Alabdi (%)	Khandgshardi (%)	t-test
(a) Catching of frog	68.18	78.95	68.42	66.67	t_{Stat} =2.35 $t_{Crit.}$= 2.13
(b)Use of insecticides and fertilizers in crops	100.00	100.00	63.16	33.33	
(c) Killing of frog without any cause	45.45	44.74	63.16	41.67	
(d) Water scarcity in canal and other water bodies in dry season	40.91	34.21	52.63	25.00	
(e) Scarcity of safe habitat	13.64	31.58	15.79	25.00	
(f) Cleaning of bush and jungles	9.09	28.95	15.79	8.33	
(g) Reduction of water bodies for other use	40.91	31.58	-	-	
(h) Scarcity of food	9.09	34.21	15.79	-	

Significant at 5 percent level

c) Effects of Frog on Environment

Respondents of villagers and ERs of UPs, LLs and VLWs provided six different effects of frog on environment of which two were common. Almost all respondents expressed that frog ate harmful insects of crops and kept environment good (Table – 3.24).

Table 3.24: Percentage of Respondents Regarding Effects of Frog on Environment

Effects of Frog on Environment	Shahpur (%)		Gazipur (%)		Alabdi (%)		Khandgshardi (%)	
	Vil.	ERs.	Vil.	ERs.	Vil.	ERs.	Vil.	ERs.
(a) Frog eats harmful insects of crop and keeps environment good	100.00	100.00	86.84	100.00	100.00	100.00	91.67	100.00
(b) Many wild lives live on frog	27.27	100.00	36.84	83.33	21.05	66.67	25.00	100.00
(c) Frog conserves biodiversity	9.09	-	31.58	-	5.26	-	8.33	33.33
(d) Frog keeps the beauty of environment	18.18	-	-	-	5.26	-	16.67	-
(e) Fish eats the secretion of skin of frog	-	-	-	-	-	-	25.00	-
(f) Feces of frogs enhance soil fertility	-	-	-	-	-	-	-	16.67

t_{Stat} =-0.26 and $t_{Crit.}$ = 2.2 for villagers. t_{Stat} = -0.62 and $t_{Crit.}$ = 2.20 for ERs of UPs, LLs and VLWs

d) Steps Needed to Conserve and Increase Frog Population:

Village level respondents provided five suggestions to increase frog population in their villages of which four were common. Majority of the respondents expressed that killing and catching of frog should be stopped to increase its population (Table – 3.25).

Table 3.25: Percentage of Respondents Regarding Steps Needed to Conserve and Increase Frog Population in Study Villages

Steps Needed for Increasing Frog Population	Shahpur (%)	Gazipur (%)	Alabdi (%)	Khandgshardi (%)	t-test
(a) Killing and catching of frog should be stopped	59.09	52.63	57.89	75.00	t_{Stat} =0.61 $t_{Crit.}$= 2.26
(b) Utilization of insecticides in crops should be stopped	100.00	100.00	31.58	25.00	
(c) Creation of safe habitat of frog (increasing bush/jungle)	36.36	44.74	57.89	33.33	
(d) Killing of frog without any cause should be stopped	18.18	21.05	52.63	50.00	
(e) Building awareness among the common people about conserving frog resources	9.09	21.05	5.26	-	

3.4.4 Reptilian Diversity

a) Availability of Reptiles

Village level respondents of each of Shahpur and Gazipur mentioned names of four reptiles; and respondents of each of Alabdi and Khangshardi mentioned names of three reptiles, which were available in plenty in their villages four decades ago. No extinction of any of those species of the reptiles took place in the study villages but their population decreased seriously during the said period. Respondents of Shahpur and Gazipur mentioned the names of snake mainly *Xenochrophis cerasogaster (Kalo mete dhorashap)*[4], *Varanus flavescens (Gui Shap), Mobuya dissimilis (Anjon) and Calotes rouxii (Rakto chosa)* in this regard. Respondents of Alabdi and Khangshardi mentioned similar names except the name of *Calotes rouxii (Rakto chosa).*

[4] Also Included *Rhobdophis subminiatus (Laldhora) and Macropishodon plumbicolor (Sabujdhora). Many of the respondents mentioned the names of Coluber nigromargindus (Dharajshap) and Dendrelaphis pictus (Gechoshap)* in this regard.

b) Causes of Decreasing Reptile Population

Respodents of both the villagers and ERs of UPs, LLs and FLWs mentioned ten causes for reduction of reptiles in their villages of which five were common. Common causes included large-scale deforestation, hunting and killing of wild lives, high rate of population growth, scarcity of food, lack of safe habitat for reptiles. They expressed the same opinion in case of extinction and reduction of wild mammals in their villages (causes are attached in annexure-9).

c) Steps Needed to Conserve and Increase Reptile Population

Respondents of the study villages suggested twelve measures to be adopted to increase the reptile population in their villages of which three were common. Village level respondents of Shahpur and Gazipur mentioned five steps each for the development of reptile population in their respective villages. Respondents of both Alabdi and Khangshadi suggested four measures for the same. Respondents of the study expressed same measures for conseving and developing wild mammals in the study villages (detail of steps is attached in annexure-10).

3.4.5 Avifaunal Diversity

a) Diversity of Birds

The name list of birds available in the villages four decades ago and at present situation is attached in annexure-11. Number of species of birds reduced from 25 to 17 in Shahpur village in last four decades. Similarly, number of the same reduced from 26 to 18 in Gazipur, from 28 to 20 in Alabdi and from 25 to 17 in Khangshardi during the last four decades.

Village level respondents were also asked to mention the names of migratory birds available in their villages four decades ago and at present. Species of migratory birds, which were available in the study villages four decades ago and were not available at present varied from 7 to 5 (Table – 3.26).

Table 3.26: Number of Species of Birds Available in Study Villages and Their Condition Four Decades Ago

Village	No. of Birds Species		t-test	No. of Migratory Birds Species		t-test
	Four Decades Ago	2003		Four Decades Ago	2003	
Shahpur	25	17	Four Decades Ago t_{Stat} =-0.33 $t_{Crit.}$= 12.7 2003 t_{Stat} =0.5 $t_{Crit.}$= 12.71	5	2	Four Decades Ago t_{Stat} =0.33 $t_{Crit.}$= 12.71 2003 t_{Stat} =-1.0 $t_{Crit.}$= 12.71
Gazipur	26	18		7	-	
Alabdi	27	20		6	2	
Khangshardi	25	17		5	2	

b) Causes of Decreasing of Bird Population

Respondents among villagers and ERs of UPs, LLs and VLWs of the study opined various causes for decreasing bird population in their respective villages. None of the respondents informed that bird population of any species increased in their villages. In total, 9 opinions were available from the respondents of Shahpur in this regard. In Gazipur, Alabdi and Khangshardi, available number of opinions from respondents was 9, 8 and 8 respectively (causes are attached in annexure – 12).

c) Steps Needed to Conserve and Increase Bird Population:

Respondents among villagers and ERs of UPs, LLs and VLWs of the study expressed eight opinions for increasing bird population in their villages of which four were common (Table – 3.27).

Table 3.27: Percentage of Respondents Regarding Steps Needed to Conserve and Increase Bird Population in Study Villages

Steps Needed to be Adopted for Increasing Bird Population	Shahpur (%)		Gazipur (%)		Ababdi (%)		Kahangshardi (%)	
	Vil.	ERs.	Vil.	ERs.	Vil.	ERs.	Vil.	ERs.
(a) Use of fertilizers and insecticides should be limited/stopped	95.45	100.00	100.00	83.33	15.79	50.00	33.33	16.67
(b) Hunting of birds should be stopped and introduced legal actions in this regard	77.27	100.00	92.11	83.33	100.00	100.00	91.67	100.00
(c) Need to increase forest coverage and make protected area for bird	72.73	50.00	94.74	100.00	78.95	83.33	83.33	100.00
(d) Need to plant more fruit trees	54.55	66.67	36.84	66.67	21.05	16.67	-	16.67
(e) Cutting of big trees specially banyan trees should be stopped	-	33.33	-	-	57.89	50.00	33.33	100.00
(f) Cultivation of aus paddy should be reintroduced	-	-	-	-	5.26		25.00	-
(g) Social awareness should be built up	4.55	-	-	-	-	-	-	-
(h) Population control should got more importance	4.55	-	-	-	-	-	-	-

t_{Stat} =-0.62 and $t_{Crit.}$ = 2.13 for villagers. t_{Stat} = -0.32 and $t_{Crit.}$ = 2.13 for ERs of UPs, LLs and VLWs / Significant at 5 percent level

d) Effects on Environment for Decreasing Bird Population

Respondents of ERs of UPs, LLs and VLWs of the study mentioned seven effects on environment of decreasing bird population in their villages of which four were common (Table – 3.28).

Table 3.28: Percentage of Respondents Regarding Effects on Environment for Decreasing Bird Population in Study Villages

Effects on Environment for Decreasing Bird Population/Species	Shahpur (%)	Gazipur (%)	Alabdi (%)	Khangshardi (%)	t-test
(i) Beauty of environment destroyed	100.00	83.33	83.33	100.00	
(ii) Attack of insect and pests to crops highly increased	50.00	50.00	66.67	83.33	
(iii) Bio-diversity destroyed remarkably in the village	66.67	66.67	33.33	83.33	t_{Stat} =0.54
(iv) Decreasing trend of owl population in the village increasing rat population seriously	33.33	33.33	66.67	16.67	
(v) Various joyfull tunes of birds could not be listened any more	50.00	-	-	-	$t_{Crit.}$= 2.16
(vi) Feces of the birds are the manures of soils. So, scarcity of bird reduced the fertility of soils	16.67	16.67	-	-	
(vii) Vulture, crow etc. eat rotten things. Absence of these birds in the village pollute the environment	-	16.67	-	-	

3.4.6 Conditions of Wild and Domestic Mammals

a) Wild Mammal

In the study villages number of wild mammals in terms of species reduced seriously over the last four decades. Number of species of wild mammals extinct was 6 in Shahpur, 6 in Gazipur, 5 in Alabdi and 5 in Khangshardi over the last four decades. Common species of wild mammals extinct from the study villages in the said period included *Panthara pardus (Chita Bagh), Macaca fascicularis (Banor) and Lepus nigricollis (Shojaru).* List is attached in annexure-13.

Table 3.29: Number of Species of Wild Mammals Existed Four Decades ago and in 2003 in Study Villages

Village	Number of Species of Mammals		t-test
	Four Decades Ago	2003	
Shahpur	12	6	Four Decades Ago t_{Stat} =-5.0 t_{Crit}= 12.71 2003 t_{Stat} =3.0 t_{Crit}= 12.71
Gazipur	12	6	
Alabdi	10	5	
Khangshardi	9	4	

Increase of Harmful Wild Mammals and Causes

Wild Mammals: Village level respondents were asked to mention the names of wild animals, population of which increased compared to their existence four decade ago. Respondents mentioned the names of wild animals with their extent and causes of increase. Respondents were asked to mention the increase of wild lives in different five ranges which covered 1-25%, 26-50%, 51-75%, 76-100% and above 100%. Squirrel and rat were found as harmful mammals in this regard.

Table 3.30: Percentage of Respondents Regarding Increase of Wild Mammals in Study Villages

Village	1 – 25%		26 – 50%		51 – 75%		76 – 100%		Above 100%	
	Squi.	Rat	Squi.	Rat	Squi.	Rat	Squi.	Rat	Squi.	Rat
Shahpur	-	-	27.27	27.27	31.58	18.18	36.36	-	-	-
Gazipur	-	-	31.58	-	10.5	-	36.84	-	-	-
Alabdi	-	-	-	31.82	-	10.52	-	-	-	-
Khangshardi	-	-	-	31.58	-	-	-	16.62	-	-

Causes of Increasing Harmful Wild Mammals: Respondents of each of the study villages mentioned four causes for increasing wild harmful mammals in their respective villages (Table – 3.31).

Table 3.31: Percentage of Respondent Regarding Increase of Population of Harmful Wild Mammals and Causes

Village	Wild Mammals	Causes of Increase	% of Respondents
Shahpur	Squirrel and Rat	(a) Difficult to kill them (b) Prolificacy is high (c)Increase number of trees (d) No shortage of food	(a) 95.45 (b) 50.00 (c) 50.00 (d) 18.18
Gazipur	Squirrel	(a) Difficult to kill them (b) Prolifically is high (c) It eats every thing	(a) 68.42 (b) 31.58 (c) 28.95
Alabdi	Rat	(a) Prolificacy is high (b) No effective mechanism exists to kill those (c) No scarcity of food (d) Can survive both in land and water	(a) 52.63 (b) 52.63 (c) 47.37 (d) 26.32
Khangsharid	Rat	(a) No effective mechanism exists to kill those (b) No scarcity of food (c) Prolificacy is high (d) Reduce number of vulture, owl, eagle etc.	(a) 50.00 (b) 41.67 (c)25.00 (d) 16.67

Like village level respondents, respondents of ERs of UPs, LLs and VLWs of the study area also mentioned that squirrel increased remarkably in Shahpur and Gazipur. They expressed that population of rat increased remarkably in all study villages in the last four decades.

b) **Domestic Mammals**

Domestic mammals found in the study villages were cattle, goat and sheep. In Shahpur and Gazipur cattle and goat were the domestic mammals; and in Alabdi and Khangshardi cattle, goat and sheep were the domestic mammals. Village level respondents opined that no increase of population of any of the domestic mammals took place in their villages over the last four decades.

Decreased of Domestic Mammals and Causes

Population of domestic mammals decreased in all villages under the study compared to their population that existed four decades ago.

Decrease of population of cow took place with a range from 20 to 60 percent compared to its population that existed in the last four decades. Reduction of population of cow was much higher in Shahpur and Gazipur compared to the same in Alabdi and Khangshardi during the said period. In case of goat, reduction of

population that took place varied with a range from 20 to 80 percent compared to its population that existed four decades ago. Reduction of lamb population took place to 80 percent in both Alabdi and Khangshardi in the last four decades.

Village level respondents mentioned eleven causes of decreasing domestic animals in their villages of which six were common (detailed in annexure-14).

c) Effects on Environment for Reducing Wild Mammals

Respondents of ERs of UPs, LLs and VLWs mentioned six causes of which three were common (Table – 3.32).

Table 3.32: Percentage of Respondents Regarding Effects on Environment for Reducing of Wild Mammals in the Study Villages

Effect on Environment	Shahpur (%)	Gazipur (%)	Alabdi (%)	Khangshardi (%)	t-test
(i) Beauty of environment destroyed	100.00	66.67	50.00	66.67	t_{Stat} =0.38 $t_{Crit.}$= 2.20
(ii) Bio diversity of the village affected	66.67	83.33	50.00	83.33	
(iii) Balance of the environment of the village also affected	16.67	33.33	50.00	33.33	
(iv) Scarcity of feaces of the wild animal turned soil unproductive	33.33	16.67	16.67	-	
(v) Environment became polluted for existing rotten things exposed here and there in the village	-	-	50.00	-	
(vi) Growth of trees reduced in the village	16.67	-	-	-	

d) Steps Needed to Conserve Domestic Mammals

Respondents suggested seven different measures to be adopted to increase the population of domestic mammals in their villages.

Village level respondents of Shahpur and Gazipur mentioned five steps each; and respondents of Alabdi and Khangshardi expressed five and four steps for the development of domestic mammals in their respective villages (detail of steps is attached in annexure-10).

3.5 Development Works Adopted and Consequences to the Environment at the Upazila Level

a) Development Works and their Consequent Environmental Effects

Respondents from among thana level officials mentioned the development interventions and their consequences on environment which are presented in table-3.33.

Table 3.33: Environmental Effects of Applying Existing Procedures of Development Interventions

Comilla Sadar		Sonargaon	
Development Works	Environmental Effects	Development Works	Environmental Effects
(i) Road construction	(i) Drainage congestion in many cases	(i) Road construction	(i) Free movement of aquatic lives disturbed seriously in many cases
(ii) Excessive use of fertilizers and insecticides in crops	(ii) Quality of soil deteriorated. Breeding place of fish destroyed. Water and air become polluted. Aquatic and inland lives affected	(ii) Excessive use of insecticides and fertilizers in crops	(ii) Aquatic and inland lives affected. Quality of soil deteriorated
(iii) Making of bricks fields	(iii) Destruction of tree coverage	(iii) Making of brick field	(iii) Soil erosion; and soil, water and air pollution took place
(iv) Cutting of trees	(iv) Bird population reduced	(iv) Unplanned plantation and cutting of trees	(iv) Free movement of birds disturbed. Number of birds reduced
(v) Embankment construction	(v) Water flow and movement of fish stopped in many cases	(v) Construction of houses here and there	(v) Deforestation and squeezing of land took place and conservation of wild lives affected
(vi) Small bridge construction compared to the need	(vi) Drainage congestion in the upstream	(vi) Filling up of ponds and other water bodies	(vi) Breeding place of fish affected
(vii) Utilization of poison in catching fish	(vii) Fish resources destroyed	-	-
(viii) Excessive use of insecticides in vegetables	(viii) Common people got various diseases	-	-
(ix) Unplanned and poor planning for road and culvert construction	(ix) Normal movement of fish got disturbed in many cases	-	-

b) Environmental Measures Taken by the Upazila Officials

Feasibility Works Adopted Before Development Works Start: Almost all departments at the upazila level carry out feasibility works before starting a development activity. In total thirty feasibility works were mentioned by the

respondents of which eight were found common in both the upazilas (detailed list is attached in annuexue-15).

Upazila Officials Concerned About Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA): Respondents were asked whether they were aware of IEE and EIA or not. Out of the twenty respondents in both the upazilas, only two respondents i.e. Upazila Engineer in both the Upazilas knew about it. It is known that scope of works and concern of IEE and EIA were not equally important for all departments at the upazila level. But it was expected that all Upazila Officials should have knowledge about these regulatory measures of environmental conservation through IEE and EIA.

Adoption of Environmental Related Measures in Development Interventions: Respondents of Comilla Sadar Upazila mentioned twelve different development interventions and at the same time they informed the environmental measures they adopted for minimizing the environmental effects of those interventions. Similarly in Saoanrgaon Upazila, respondents mentioned ten different development interventions and ten different measures they adopted to minimize environmental effects. Five measures were common in both the upazilas. Most of these measures adopted by different departments at the upazila level in this regard covered advisory services and awareness building of common villagers (table is attached in annexure – 16).

Environmental Policy Adopted by Different Departments: Respondents of the study areas were selected from nine different departments at the upazila level. All respondents expressed their considerations regarding environment during implementing their programmes in rural areas. Respondents of Department of Fishery (DoF), BWDB, Department of Social Welfare (DSW), Department of Livestock (DoL), DAE, LGED, BRDB, BRAC and ASA expressed their respective policies (table is attached in annexure –17).

Suggestions for Changing Environmental Policies: Respondents of DoF, DoL, DAE and LGED provided number of suggestions for changing their existing environmental policies. Respondents of DoF provided four different issues in this

regard. Respondents of DoL also mentioned four different suggestions in this regard. Respondents of DAE suggested one measure and respondents of LGED suggested two measures in this regard (Table – 3.34).

Table 3.34: Suggestions of Concerned Upazila Officials for Changing Environmental Policies of Different Departments

Department	Suggestions for Changing Environmental Policy
(a) Department of Fishery	a.1 Minimizing the use of insecticides in crops through incorporating the issue in Cooperative Law a.2 Regulation on discharging of industrial effluents to open water should be implemented properly a.3 Amount of fish to be harvested should be fixed with the consultation of DoF a.4 Take immediate measures to establish safe habitat for fish
(b) Department of Livestock	b.1 Modernization of equipment for better farm waste management b.2 Enact Act or adopting proper measures of covering dead livestock and poultry with soil; and implement accordingly b.3 Ensure establishment of technology based farms. b.4 Make registration compulsory for every farm
(c) Department of Agricultural Extension	c.1 Formation of Upazila Environmental Development Committee at the upazila level
(d) Local Government and Engineering Department	d.1 Examine all environmental effects in rural areas d.2 Filling up of IEE forms for every project at the upazila level should be made compulsory

c) Committee Concerned with Environmental Issues

Upazila level officials of Comilla Sadar and Sonargaon Upazilas mentioned the names of Upazila Project Implementation Committee (UPIC); and Upazila Development and Coordination Committee (UDCC) where environmental issues were sometimes discussed.

Officials of Comilla Sadar Upazila informed that they reviewed project activities including environmental issues in the meeting of Upazila Project Implementation Committee and took actions accordingly. Upazila Nirbahi Officer is the Chairman and Upazila Project Implementation Officer is the Member Secretary of this committee. Other members of this committee are all UP Chairmen of the Upazila and seven upazila level government officials. The committee sits once in a month to

approve new projects and review the performance activities of different running projects. Chairman of UP woks as Chairman of sub-committee of the project implemented in his own union. Environmental issue like stagnancy of water is generally taken into consideration during planning and implementation of projects at the village level. Officials of Soanrgaon Upazila mentioned that they took decision of adopting of any project after discussion in the monthly meeting of UDCC. UP Chairman of all UPs under the upazila become Chairman of this committee one by one in each month by rotation. Upazila Nirbahi Officer is the Member Secretary of this committee. Other members of this committee are all upazila level government officials and three selected UP female members. Other upazila level officials are present in the meeting as observers. Environmental issues of development works mainly water stagnancy arise if any due to construction of physical infrastructures are discussed in this monthly meeting.

d) Suggestions for Conserving Environment

Officials of Comilla Sadar and Sonargaon Upazilas provided twelve different suggestions for environmental development and conservation in rural areas. Out of these fourteen suggestions, eight suggestions were commonly mentioned both by the respondents of Comilla Sadar and Sonargan Upazilas. Out of rest six suggestions, the respondents of Comilla Sadar and Soanargaon Upazilas made three each (Table – 3.35)

Table 3.35: Percent Respondents among Upazila Officials Regarding Suggestions for Conserving Environment of Rural Areas

Steps Needed	Comilla Sadar (%)	Sonargaon (%)	t-test
(i) DoF should take plantation programme in large scale	40.00	20.00	
(ii) Awareness building about environment through training of common villagers	30.00	20.00	
(iii) Implementation of environment friendly projects only	30.00	20.00	
(iv) Good and effective coordination among concerned departments should be ensured before starting a project	10.00	30.00	
(v) Environmental impacts should be assessed through forming a committee before a project starts	20.00	20.00	
(vi) Department of Fishery, Department of Agricultural Extension and Department of Livestock should play vital roles in helping villagers on various environmental issues	20.00	10.00	
(vii) Consent of local people and local leaders should be considered before a project starts	20.00	10.00	
(viii) Ensure safety of aquatic and inland lives	10.00	10.00	t_{Stat} =1.33 $t_{Crit.}$= 2.16
(ix) Emphasis should be given on applying manures in place of fertilizers in crop fields	30.00	-	
(x)Effective coordination among various departments should be ensured before a project starts	20.00	-	
(xi) Arsenic free water should be provided to common villagers	10.00	-	
(xii) A representative of DoE should be placed at the upazila level	-	10.00	
(xiii) Local Government and Engineering Department should play vital role in environmental conservation	-	10.00	
(xiv) Identification of environmental related problems through circulating of questionnaires among the villagers and measures to be taken accordingly	-	10.00	

3.6 Laboratory Tests

Different soil samples from all the four villages on the basis of land types and crop cultivation were collected and tested at SRDI, Comilla and BAEC, Savar, Dhaka. Water samples from ponds, canals/khals and tubewells were also collected and tested at the Laboratories of DPHE and SRDI, Comilla independently for each village under consideration.

3.6.1 Results of Laboratory Tests of Soil

a) Soil Texture, Organic Matter Content and p^H Value

Soil Texture and Organic Matter Content: Soil samples were collected from different land types for determining the amount of different agriculture production ingredients in the soil. Land types found in the study village were Highland (HL), Medium Highland (MHL), Medium Lowland (MLL) and Lowland (LL). Five distinct soil textures viz. loam, silty loam, silty clay loam, clay loam and silty clay loam were recognized in different villages.

Organic matter content in the soil was scanty compared to the need for better soil fertility and crop growth. In Shahpur and Gazipur, the OM content in agriculture soil varied from 0.76 percent to 1.59 percent. In Alabdi and Khangshardi, OM content in soil was found a little bit more compared to the two villages of Comilla Sadar Upazila. The highest and the lowest OM contents were found in LL and MHL of Khangshardi under Sonargaon Upazila and these were 1.38 percent and 1.04 percent respectively (Table – 3.36).

Soil p^H Value: Soil p^Hs in agricultural soils were slightly acidic in nature The lowest p^H, 4.9 was found in Gazipur and the highest p^H, 5.5 was found in Khangshardi village (Table – 3.36).

Table 3.36: Soil Texture and Organic Matter Content of Agriculture Soil in the Study Villages

Texture	Types of Land (Location)							
	Highland		Medium Highland		Medium Lowland		Lowland	
	OM	p^H	OM	p^H	OM	p^H	OM	p^H
Loam	0.76 (G)	4.9	-	-	-	-	-	-
Silty loam	0.89 (S) 1.59 (S) 0.89 (G)	5.1 5.1 4.9	1.04 (K)	5.4	-	-	-	-
Silty clay loam	-	-	-	-	1.24 (A)	5.2	1.10 (A)	5.3
Clay loam	-	-	-	-	1.10 (A)	5.5	-	-
Silty clay	-	-	-	-	-	-	1.38 (K)	5.2

Note: S,G, A and K stand for Shahpur, Gazipur, Alabdi and Khangshardi village respectively

b) Nitrogen, Phosphorus and Potassium in Agricultural Soils

Status of N, P and K in different soils according to their existence in different land types in different villages after the harvest of amon crops were found through laboratory tests.

Laboratory tests for finding out the status of N, P and K as percent of total nitrogen, phosphorus in µg per gm of soil and potassium in meq per 100 gm soil were carried out (Table – 3.37).

Table 3.37: Nitrogen, Phosphorus and Potassium Ingredients in Agriculture Soils of Study Villages

Village	Crops	High Land			Medium High Land			Medium Low Land			Low Land		
		% N	P µg/ gm	K meq/ 100g	% N	P µg/ gm	K meq/ 100g	% N	P µg/ gm	K meq/ 100g	% N	P µg/ gm	K meq/ 100g
Shahpur	Veg.	0.04	70.5	0.18	-	-	-	-	-	-	-	-	-
	Pady.	0.05	11.04	0.081	-	-	-	-	-	-	-	-	-
Gazipur	Veg.	0.03	87.66	0.20	-	-	-	-	-	-	-	-	-
	Pady.	0.05	14.11	0.07	-	-	-	-	-	-	-	-	-
Alabdi	Pady.	-	-	-	-	-	-	0.18	1.01	0.14	0.04	1.01	0.15
Khangshardi	Veg.	-	-	-	0.13	110.76	0.10	-	-	-	-	-	-
	Pady.	-	-	-	-	-	-	0.17	2.02	0.13	0.15	2.02	0.19

c) Residual Effects of Insecticides in Soils

Respondents used various insecticides under organophosphorus and organocarbamate groups in their crops. No residual effects in soils under the said two groups were found. But residual effects of DDT under the organochlorine group of insecticides were found in two soil samples of Shahpur (Table – 3.38).

Table 3.38: Residuals of Insecticides under Organochlorine Group in Soil Samples

Soil Samples	Name of Insecticides Under Organochlorine Group (µg/kg)							
	DDE	DDD	DDT	Heptachlor	Aldrin	Dieldrin	Lindane	BHC
Shahpur HL(Veg.)	0.563	ND	0.726	ND	ND	ND	ND	ND
Shahpur HL(Pad.)	0.404	ND	Trace	ND	ND	ND	ND	ND
Gazipur HL(Veg.)	ND	ND	ND	ND	ND	ND	ND	ND
Gazipur HL(Pad.)	ND	ND	ND	ND	ND	ND	ND	ND
Alabdi MLL	ND	ND	ND	ND	ND	ND	ND	ND
Alabdi LL	ND	ND	ND	ND	ND	ND	ND	ND
Khangshardi MHL	ND	ND	ND	ND	ND	ND	ND	ND
Khanghardi MLL	ND	ND	ND	ND	ND	ND	ND	ND
Khangshardi LL	ND	ND	ND	ND	ND	ND	ND	ND

Note: a. Detection Limit for GC: 0.01µg/kg b. Detection Limit for HPLC: 10.0µg/kg c. Trace: Very Small Amount (Not Quantifiable) c. ND: Not Detected

3.6.2 Laboratory Tests of Water Samples

Water samples were collected from hand TWs, ponds and canals for testing different parameters of water. Arsenic, total hardness (as total $CaCo_3$) and TDSs tests were carried out for ground water. p^H, SSs, total hardness (as total $CaCo_3$), NH_4^+, P and K tests were carried out for SW both for pond water and canal water of the villages. Besides, colour and smell of SW were noted during water sample collection for the study.

a) Ground Water

Tubewell Specification: Three hand TWs were selected from each of the study villages on the basis of their location in the village. Total length of pipe, length of filter and length of pipe from where filter starts were investigated for each of the TWs. Mean±SD of these parameters are presented in table – 3.39.

Arsenic Contamination of Ground Water: Arsenic contents of GW were found out through laboratory tests. The mean of arsenic ingradiernt in TW's water was 0.01±0.005 at Shahpur, 0.007±0.006 at Gazipur, 0.007±0.001 at Alabdi and 0.225±20.3 at Khangshardi. The standard deviation of mean of arsenic was remarkably higher at Khangshardi due to existence of the same that varied widely in three different TW's water (Table – 3.39).

Total Hardness of Ground Water: Values of TH were found through laboratory tests. The average mean of TH of ground water at Shahpur, Gazipur, Alabdi and Khangshardi were 44.0±5.29, 63.0±15.14, 349.0±30.02 and 303.0±31.24mg per liter respectively (Table – 3.39).

Total Dissolved Solids of Ground Water: Laboratory tests of ground water of different TWs provided the values of TDS. The average mean of TDS of TW's water at Shahpur, Gazipur, Alabdi and Khangshardi were 81.0±54.75, 78.0±10.39, 432.0±24.0 and 364.0±18.33 respectively (Table – 3.39).

Table 3.39: Tubewell Specification and Ground Water Parameter of Study Villages

Village	Total Length (ft.)	Filter Starts at Depth (ft.)	Filter Length (ft.)	Arsenic Content (mg/l)	Total Hardness (mg/l)	Total Dissolves Solids (mg/l)
Shahpur	85.0±12.58	23.33±3.33	61.67±1.09	0.01±0.005	44.0±5.29	81.0±54.75
Gazipur	171.67±29.10	26.67±6.67	145.0±23.0	0.007±0.006	63.0±15.15	78.0±10.39
Alabdi	75.0±8.66	10.0±0.00	70.0±5.00	0.007±0.001	349.0±30.02	432.0±24.0
Khangshardi	72.0±3.0	8.67±1.33	63.33±1.67	0.225±20.0	303.0±31.24	364.0±18.33

b) Surface Water

Colour and Odour of Surface Water: Colour and smell of SW were observed during data collection.. Both pond and canal water were considered in this regard. In Shahpur, water was moderately clean having little algae floating in all the three pond's water; and two of them had slight pungent smell. Water of Sonaichari irrigation canal was clean, algae and odour free. In Gazipur, all ponds' water was clean with a little algae and slight pungent smell. In Alabdi and Khangshardi, all ponds and canal water under the study were clean, transparent and odour free.

Physico-chemical Parameters of Pond and Canal Water

p^H Values of Pond and Canal Water : p^H was measured for determining the status of acidity or alkalinity of water and soil. The average p^H values of pond water of Shahpur, Gazipur, Alabdi and Khangshardi were found as 5.97±0.42, 6.27±0.12, 6.33±0.15 and 6.20±0.36 respectively. Average p^H values of canal water of Shahpur, Gazipur, Alabdi and Khangshardi were found as 6.73±1.02, 6.43±0.06, 6.60±0.13 and 6.60±0.20 respectively (Table – 3.40).

Total Hardness of Pond and Canal Water: Average total hardness of ponds' water in Shahpur, Gazipur, Alabdi and Khangshardi were 45.3±14.1, 41.3±2.31, 72.0±39.4 and 52.0±31.24 mg per liter respectively as $CaCo_3$. Similarly average total hardness of canal water in Shahpur, Gazipur, Alabdi and Khangshardi were 65.3±8.27, 44.0±4.0, 130.0±26.46 and 140.0±34.64 mg per liter as $CaCo_3$ respectively (Table – 3.40).

Suspended Solids of Pond and Canal Water: Average SSs of pond water were 0.028±0.003 mg per liter at Shahpur, 0.022±0.007 mg per liter at Gazipur, 0.002±0.006 mg per liter at Alabdi and 0.001±0.001 mg per liter at Khangshardi village.

The average amount of SSs found in canals of Shahpur, Gazipur, Alabdi and Khangshardi villages were 0.068±0.031, 0.053±0.012, 0.001±0.00 and 0.004±0.005 mg per liter respectively (Table – 3.40).

Nitrogen, Phosphorus and Potassium Nutrients Found in Pond and Canal Water: Major nutrients applied to agricultural crops are N, P and K in the form of Urea, TSP and MP. Urea is highly volatile. TSP and MP are comparatively permanent. Water samples of pond and canal were tested to find out the amount of

phosphorus, potassium and nitrogen in the form of P, K and NH_4^+ respectively (Table- 3.40).

Table 3.40: Physico-chemical Parameters of Pond and Canal Water of the Study Villages

Physico- chemical Parameter	Shahpur		Gazipur		Alabdi		Khangshardi	
	Pond	Canal	Pond	Canal	Pond	Canal	Pond	Canal
p^H Value	5.97± 0.42	6.73± 1.02	6.27± 0.12	6.43± 0.06	6.33± 0.15	6.60± 0.13	6.20± 0.36	6.60± 0.20
Total Hardness (mg/l)	45.3± 14.1	65.3± 8.27	41.3± 2.31	44.0± 4.0	72.0± 39.4	130.0± 26.46	52.0± 31.24	140.0± 34.64
Suspended Solids (mg/l)	0.028± 0.003	0.068± 0.031	0.022± 0.007	0.053± 0.012	0.002± 0.001	0.001± 0.0	0.001± 0.001	0.004± 0.005
Phosphorus (mg/l)	0.162± 0.12	0.157± 0.13	0.145± 0.13	0.028± 0.02	0.025± 0.02	0.042± 0.02	0.074± 0.04	0.043± 0.04
Potassium (mg/l)	1.64± 1.0	0.63± 0.21	1.62± 0.82	1.04± 0.23	0.22± 0.18	0.50± 0.52	0.61± 0.91	0.13± 0.03
Ammonium (mg/l)	0.50± 0.27	0.303± 0.26	0.25± 0.18	0.067± 0.03	0.27± 0.12	0.133± 0.03	0.22± 0.16	0.183± 0.10

Chapter 4
Discussions

From investigations through PRA exercises, surveys and laboratory tests of the study and analysis of the results achieved, the following issues may be analyzed in the following way:

4.1 Implication of Physical Development Interventions

Tampering with a part may affect the whole natural resources (Leopold, 1941). Ecological backlashes or ecological boomerangs evolve due to environmental modification, which cancels out the projected gain and actually creates more problems than it solves. When this happens, it is a double tragedy since not only is the money spent in remaking the landscape lost to the bad investment, but additional sums must then be spent to correct all the new problems created (Odum, 1971). Estimation of resource degradation is not properly addressed in developing countries in most cases. In Bangladesh, the net value of loss of output due to resource degradation (including only rice land, fisheries, forestry and natural gas) was around Tk. 13 billion in 1990, which represented about 1.7 percent of GDP of the country (Asaduzzaman, 2000). In Shahpur village under the study excavation of Sonaichari irrigation canal was carried out in early sixties with the intention of providing irrigation water to the vast area of the village for HYV paddy production.

There prevailed a catchment area in the village before the Sonaichari irrigation canal was excavated which was one of the major causes for very rich biodiversity of the village. Huge traditional fishes, diversified birds, wild lives etc. existed there round the year. After excavation of Sonaichari irrigation canal drained water from hilly areas of India after rain could not cross the excavated canal and came to the catchment area of the village. So, the water body could not get water and ultimately failed to nurse the rich biodiversity of the area. The area turned into paddy field and a vast habitat of inland and aquatic lives destroyed. Now huge amount of fertilizers and insecticides are used there to grow paddy every year. So, rich biodiversity of the village was seriously affected with the establishment of irrigation canal and the catchment area was converted into HYV paddy fields.

4.2 Environmental Consequences of Adopting Modern Crop Cultivation Practices on Soils

a) Soil Organic Matter

The often-unseen important factor in the environment is the soil. Although it may sound unbelievable, studies indicate that soil erosion and land degradation is occurring so fast in Bangladesh that the productivity of our soil is being reduced and irreversible processes are being set into action (Khan, 2003). Organic matter content is a very important ingredient for crop production although the proportion of this is less compared to other ingredients in soil. Clay, soil OM, and management primarily control soil aggregate dynamics. Aggregate size class has very little correlation with microbial activities (ECD, 2005). Organic matter in soil ensures air movement and increases water-holding capacity of soil. Baki (1994) emphasizes that suitable conditions for crop production in soil need 5 percent of OM. It is proved that increasing substitution of organic fertilizer with chemical fertilizer is bound to destroy the inherent quality of health of the soil in the long run. But at the same time, in order to maintain a high yield rate the farmers are being forced to apply more and more fertilizers in the successive rounds of cultivation until the cost becomes unbearable (SHED, 1998). Jansonius et al. (1994) found that 44.5 percent (4.0 Mha) of net cultivable area of the country has less than one percent of OM content which is very low with respect to need.

It was found through the study that on an average three crops were cultivated at Shahpur and Gazipur; and two crops were cultivated at Alabdi and Khangshardi. All crops cultivated at Shahpur and Gazipur villages are modern in nature (newly improved varieties) whereas almost all varieties of the main paddy season (Aman) are traditional in nature. *Khan et al.* (1996) say that use of FIS technology has resulted in the break through in paddy production in our country. But continuous crop cultivation especially cereal production puts stress on agricultural soil as agricultural soil does not give enough scope to retain their OM content. As a result of higher CI, improper cropping sequences and faulty management practices, depletion of soil fertility takes place. Present study revealed that OM contents were around one percent in different types of soils, which is very low in comparison to the need. Again if the data are compared among the flood free and flood affected villages it is found that OM contents were higher in soil of later areas with an exception of paddy field

soil at Shahpur (1.59 percent). Of course the exceptional higher content of OM at paddy field of Shahpur village was found due to application of cow dung in the same year in the same field from where a few samples were collected randomly for the study. Whereas in general the OM contents in agriculture soil of Shahpur and Gazipur varied from 0.76 to 0.89 percent. On the contray, in the flood affected villages, Alabdi and Khangshardi, OM contents in agricultural soils varied from 1.04 percent to 1.38 percent.

Regarding the advantages of using OM in agricultural soils, respondents of all study villages mentioned five common advantages. These included: soils become soft, crops produced are better with the use of manures, number of beneficial insects to soils increases, fertility of soil increases and it needs less price to practice it. At the same time regarding improving agricultural soils, respondents suggested three common measures which included utilization of OM in large scale to agricultural fields; reducing or stopping the use of insecticides in crops; and introducing crop diversification programme. Strengthening of IPM; awareness building among the common villagers about the harmful effects of using insecticides and fertilizers in agricultural crops; and use of proper dose of fertilizers after soil tests were other measures mentioned by the respondents.

The reasons of such low organic matter content in soil was due to very insignificant sources of organic matter like that of most of the other parts of the country. In non-flooding land of Comilla, three crops are cultivated round the year and this left no scope for cultivating green manuring crops to produce OM in soil. Whereas the flood affected land of Sonargaon Upazila is being utilized for cultivating two crops in a year in most cases. The less number of crops cultivation provides scope for cultivating green manuring crops like *Sesbania rostrata (Dhaincha)* to regain the OM. Thus the flood-affected land became richer in OM content, which has also been supported by laboratory test.

b) Soil pH

SRDI and DAE (1994) confirmed that most of the crops grow better in soil where pH ranges from 5.5 to 8.0. Suitable soil pH for crops like rice and potato varies from 5.5 to 6.5. Brammer (1996) says that in case of most seasonally flooded flood plain soils, only the topsoils become acidic and lower layers remain neutral or

alkaline which is seconded by the present findings that soils of Shapur and Gazipur possess soil pH ranging from 4.9 to 5.1 whereas that of flooded soil of Alabdi and Khangshardi ranged from 5.2 to 5.5. This indicates that the soil of flood affected area is less acidic in nature.

SRDI and DAE have already determined suitability of crop growth under different pH condition. Crops like sugarcane, lentil, cowpea, mustard, bean and soybean are not very suitable crops for production in those areas with p^H values 6.0-8.0. In study villages, soil p^Hs in agricultural soils were slightly acidic and thus found suitable for various crop production. It was found that major cropping pattern of these villages does not include these crops in its production rotation.

High chemicals use in crops is one of the causes of enhancing the level of acidity and reducing the pH values of soils in Shahpur and Gazipur where all agriculture land stands above the flood level. On the contrary, inundation of soil in monsoon helps to neutralize soil pH through washing or draining of chemicals from soils of Alabdi and Khanshardi. This was one of the key reasons of lowering pH values and raising acidic nature of the agricultural soils of the non-flooding villages. These findings revealed that human interventions in terms of excessive use of agrochemicals play role in altering the soil p^H value.

c) Major Crop Nutrients

Nitrogen produces a good leaf and helps stem development and gives to plant that luxuriant dark green colour which is desirable in growing crops. On the other hand, phosphorus hastens maturity of crops and makes the grain plump; and potash strengthens the stem and balances the activities of nitrogen and phosphorus for the proper development of vegetables and reproductive parts of plants. It increases the production of grain to straws (Alim, 1974).

Application of fertilizers particularly urea and MP were found less in all types of land of the study villages for cultivating amon and boro paddy compared to the recommended doses of fertilizers of 88 kg urea and 44 kg MP per acre by SRDI, 1999.

But average annual use of fertilizers in Shahpur and Gazipur was much more higher to cultivate rabi crops including vegetables. Again, averages annual use of fertilizers in Shahpur (Urea=378 kg per acre, TSP = 226 kg per acre and MP=123 kg

per acre) and Gazipur (Urea=479 kg per acre, TSP=326 kg per acre and MP=142 kg per acre) were much higher than fertilizers used in all types of land at Alabdi & Kangshardi. Among different types of land at Alabdi village, the highest average annual use of fertilizer was found in MLL (Urea=65 kg per acre, TSP=60 kg per acre and MP=37 kg per acre). Similarly, at Khangshardi, the highest averages annual use of fertilizer was found in MHL (Urea=248 kg per acre, TSP= 193 kg per acre and MP=37 kg per acre). The facts of such differences are due to the extent of adoption of modern varieties of paddy and higher cropping intensity in two villages of Comilla Sadar Upazila than other two villages under the study.

Existence of total nitrogen (%) in agricultural soils up to 0.09 percent is considered as very low and from 0.091 to 0.18 percent is considered as low, whereas existence of phosphorus in soil up to 7.5 µg/gm is considered as very low quantity. It's existence in soils from 7.51 to 15.0, from 15.1 to 22.5, from 22.51to 30.0, from 30.1 to 37.5 and above 37.5µg/gm are considered as low, medium, optimum, high and very high respectively. In case of potassium existence of it in soil up to 0.09 meq per 100 gm is considered very low. Existence of the same from 0.091 to 0.18 and from 0.811 to 0.27 meq per 100 gm of soil are considered as low and medium quantity respectively BARC (1997).

In different soils under the study, values of total nitrogen (%) varied from 0.03 to 0.18 percent. So, values of total nitrogen (%) of different soils under the study remain within the ranges of very low and low. Again, the values of the same in different soil samples in Shahpur at Gazipur were very low (varies from 0.03 to 0.05%) compared to the values of the same at Alabdi and Khangshardi (varies from 0.13 to 0.18%) without an exception of 0.04 percent in low land of Alabdi. Nitrogen in the form of fertilizer is highly volatile. So, nitrogenous fertilizer applied to the field had limited residual effect on soil. In addition, higher CI in two villages of Comilla under the study reflects lower existence of nitrogen in soils.

In Shahpur and Gazipur, the existence of phosphorus in vegetables field was very high and in paddy fields the existence of the same was low. But in Alabdi and Khangshardi the existence of the same was 'very low' without an exception of medium high land in Khangshardi village where its value was very high. Phosphorus is not volatile and remains in soils for longer time. Content of phosphorus generally

found higher where vegetables are cultivated. Farmers try to use maximum TSP for better maturity and good harvest of crops. It is rational that in all vegetable growing areas of the study villages, amount of phosphorus in soil was found very high. But excessive existence of a nutrient in soil created imbalance condition, which is not suitable for better crop growth.

Potash fertilizer is not so volatile like nitrogen. So, when potash fertilizer is used to the soil, its residual effect lasts for months. Existence of potassium was found 'low' and 'medium' in majority cases of soil samples except two soil samples collected from paddy fields of Shahpur and Gazipur where its values remain very low.

It is evident from available data of soil tests that balanced existence of N, P and K were found in soils of Alabdi and Khangshardi compared to the same that existed at Shahpur and Gazipur, which is supported by the information provided by the villagers. Comparatively less use of fertilizers in Alabdi and Khangshardi provide scope of comparatively balanced existence of N, P and K in soils. Use of fertilizers in higher amount and frequency in Shahpur Gazipur increased the level of P and K in soils.

d) Insecticides Used in Crop Fields

Odum (1971) says that the chlorinated hydrocarbon insecticides, now among the world's most widely distributed synthetic chemicals, are containing a substantial part of the biosphere. Their movement and widespread distribution throughout the world is explained by their solubility characteristics and chemical stability, and especially their tendencies to absorb on organic matter, to be transported in air droplets, and to become concentrated in food transfer from plants to herbivores and carnivores. Mohr (1951) expresses that early work with heavy application of DDT resulted in mortality of non-target organisms. Organochlorine groups of insecticides were banned throughout the world at the late seventies for its harmful effects on the environment.

In course of the present study, soil samples were analyzed for residual effects of different insecticides under organophosphorus, organocarbamate and organochlorine groups. Through survey method, it was found that farmers used different insecticides under organophosphorus and organocarbamate groups. In Shahpur and Gazipur villages, average amount of liquid insecticides used for the year 2003 were 1177 and 1152 mg per acre; and powder insecticides were 10.28

and 9.81 kg per acre respectively. In different crops of MHL at Alabdi, used amount of liquid and powder insecticides were 530 mg and 5350 gm per acre respectively. In Khangshardi, among different types of crops and land, highest average of 232 mg per acre of liquid and 4.25 kg per acre of powder insecticides per annum were used. Farmers said that amount of insecticides they used depended mainly on the crop susceptibility to pest attack. Accordingly, sometimes the utilization rate of insecticides is more and sometimes its use is comparatively less.

Soil test provides no residual effects of insecticides under the groups of organophosphorus and organocarbamate. But residual effects of DDT were found in two soil samples of Shahpur. Amount of DDT and DDE were found 0.726 mg per kg and 0.563 mg per kg respectively in vegetable growing areas of the village. In paddy growing area of the same village, trace amount of DDT and 0.404 mg per kg of DDE were found.

Most of the insecticides used in crops under organophosphorus and organocarbamate groups have longevity 15 to 20 days after application. So, residual effects of insecticides were not found under these two groups even though huge amount of the same were used in crops in the same year. Regarding use of DDT, farmers were asked when they used this insecticide for the last time. It was known that a few of them used DDT in 1982 last. In Bangladesh no literature or data were found about the time frame of stability of DDT in crop fields. But it is commonly believed that it has long lasting residual effects. DDT breaks into DDE and DDD over the time. Of course bioaccumulation of DDE in American robins and Peregrine falcon was confirmed after several decades of the last use of DDT in Canada (Harris *et al.* 2000 and Blus, 2003). In the present study, it was found that a portion of DDT breaks into DDE only. So, it can be said from survey and laboratory test results that DDT has been transferring from soil to plants and then to herbivores and carnivores over the last 21 years from the crop field of Shahpur.

e) Crop Cultivation

On an average, three crops were cultivated in almost all agricultural land in Shahpur and Gazipur whereas on an average two crops were cultivated in other two villages. Modern varieties of crops i.e., newly released varieties from research institutes were cultivated in most cases of Shahpur and Gazipur whereas traditional

varieties were cultivated in all cases of amon paddy in Alabdi and Khangshardi. Average rate of fertilizers i.e urea, TSP and MP; and insecticides use was higher in two villages of Comilla Sadar Upazila than other two villages of Sonargaon Upazila. Cultivation of more crops and adoption of modern varieties particularly newly released HYV paddy and vegetables in rabi and kharif seasons in Shahpur and Gazipur compel farmers to use more fertilizers and insecticides which ultimately causes more environmental effects.

It was felt that environmental conditions of Alabdi and Khangshardi villages were better than the same in Shahpur and Gazipur villages under the study. Comparatively low use of chemicals in crops, less number of crop cultivation in a year, cultivation of traditional varieties of amon paddy etc. favoured sustaining better environment in two villages of Sonargaon Upazila than the other two villages of Comilla Sadar Upazila.

f) Opinion of Respondents Regarding Adoption of Modern Agricultural Practices

About two million metric tons of fertilizers and twelve thousand tons of insecticides are used every year in Bangladesh (GoB and UNEP, 2001). Respondents of all study villages expressed that production and income increased with the adoption of modern agricultural practices. On the other hand, fertility of soil deteriorated and water became polluted; grazing land reduced; soils became hard; and physical quality of soil deteriorated with use of insecticides and fertilizers. They also expressed that water became polluted; many aquatic and inland lives were destroyed; common people got various diseases; earthworms and beneficial insects reduced gradually; and fisheries resources and bird became seriously affected with the use of insecticides in modern agricultural practices. They believed that use of these chemicals has major environmental consequences on their villages. But they adopt these modern methods for meeting up their increasing income and demand of more production. They opined that application of sufficient amount of OM could replace the large-scale use of fertilizers to the agricultural fields. But sources of OM are very limited. Cow dung might be the major source of OM in agricultural fields in large scale as it was in the past. But existing conditions of livestock resources are not enough to meet up the demand of agricultural fields. In addition, cow dung is largely used as fuel in rural areas of the

country. Green manure, compost, green waste etc. cannot be applied sufficiently to the field due to various prevailing practical limitations.

Opinion of survey respondents reflected the actual environmental situation of the study villages. Laboratory tests on different parameters of soils and water also support the opinions of the respondents. Respondents rightly feel the concern of the danger of soil environment due to very low existence of OM and application of excess amount of insecticides. But due to intensive and more number of crop cultivation in a year and very low resource base of OM, farmers have little scope to enhance OM content in their agriculture fields. It reveals that though the farmers are quite conscious regarding the degradation of the agriculture soil environment through modern agriculture practices, they have to adopt the same.

g) Micro Credit Led IGAs and Implications to the Environment

Kamal *et al* (1992) express that minor negative impact of IGAs on environment must be taken into consideration to stop long-term ecological damage. Trade related IGAs like paddy storage has positive impact on social, health, ecological and economical aspects. Agro based IGAs like nursery; bee keeping and roadside plantation have positive impacts on social, health, ecological and economic aspects (Kamal, 2000).

In course of the present investigation, it was found that the IGAs adopted through these credit programmes were small trade, agricultural activities and milking cow rearing related activities.

Among all these, the credit utilized in agriculture activities play a role in degrading the soil water qualities to some extent. Accordingly, the researcher agrees with the opinion of Kamal *et al* (1992).

4.3 Ground and Surface Water Qualities

a) Ground Water

Ahmed (2001) in a study expressed that 27 percent of shallow tube well water has arsenic content greater than 0.05 mg per liter – the maximum acceptable level by Bangladesh Standard. Alam *et al* (2002) mentioned that 61 out of 64 districts and municipalities of Bangladesh are facing the menace of arsenic poisoning. Arsenic

toxicity in the water of the affected districts is 25 to 35 times higher than the safety level set by WHO (0.01 mg per liter). According to Chowdhury (1999), permissible level of arsenic in potable water for Bangladesh is 0.05 ppm.

Human poisoning and deaths from arsenic have occurred mostly as a result of drinking water contaminated with arsenic in many countries. The incidence patterns of chronic inorganic arsenic poisoning in the past and in the present show that the arsenic contamination of drinking water is the most frequent cause. High concentration of inorganic arsenic in ground water is a risk of poisoning at any time. Daily consumption of water with greater than 50 microgram per liter of arsenic – less than one percent of the total dose – can lead to problem with skin, and circulatory and nervous systems. If arsenic builds up to high toxic level, organ cancers, neural disorders and organ damage – often fatal – can result (Das *et al.*, 2003).

Presently, arsenic content above 0.05 mg per liter was found 0.225±20 in TWs of Khangshardi. The values of arsenic contents of two TWs were 0.24 and 0.42 mg per liter. So, TWs affected with higher arsenic content was 17 percent under the study (2 out 12 HTWs). Total length of two arsenic affected TWs was 75 and 66ft. Location of filters of these two TWs were at the depth of 65ft and 60ft. Again, three similar TWs with the total depth, one in Shahpur of 60ft and two in Alabdi village of 75 and 60 ft. were found free from arsenic danger. So, no relationship could be developed with the depth of TW and arsenic contamination under this shallow profile of water table. So, geologic formation may be one of the prime causes of arsenic contamination of GW at shallow depth of water table at Khangshardi.

Khan (2001) says that acceptable standard of TH ranges from 200 to 500 mg per liter for potable water. Data found revealed that TH both for SW and GW of all samples was much less than the standard for potable water. Again average mean of TH of GW in Shahpur and Gazipur was (44±5.9 and 63±15.15 80 mg per liter) much lower than the same in Alabdi and Khangshardi (349±30.02 and 303±31.24 mg per litre).

Standard limit of TDS for potable water is 1000 mg per liter (Khan, 2001). Alamgir *et al.* (1999) says that TDS of GW of Modhupur tract ranged from 190 to 280 mg per liter. Test results of various GW samples revealed that TDS of GW in study villages was lower than the standard limit. Average results of TDS of GW for Shahpur

and Gazipur (81±54.75 and 78±10.39 mg per litre) were significantly lower than the same in Alabdi and Khangshardi 432±24.0 and 364±18.33 mg per litre). So, TDS of GW of the study are almost similar to TDS values found in Modhupur tract. TDS of GW is a parameter, which is dependent on the geological formation of aquifer and its surroundings. As it remains much lower than the standard limit of the same of potable water quality in all cases of GW samples, it does not have any negative impact on human health issues.

b) Surface Water

i) Color and Odour: Pure water is colourless, but foreign substances often colour water in nature. The sensations of taste and odour are closely related. Substances that produce an odour in water will almost invariably impart a taste as well. Many substances with which water comes into contact in nature or during human use may impart perceptible taste and odour (Peavy and Tchobanoglous, 1985).

Pond water of Shahpur and Gazipur was moderately clean with little algae floating on it. Canal water in all four villages and pond water of Alabdi and Khangshardi were clean and odour free. Pond water of Shahpur and Gazipur confine over several years. Huge population use pond water for their various needs. In Alabdi and Khangshardi almost all ponds go under water in monsoon of every year. So, water gets flow in the high monsoon and remains clear even in the dry season when actually the water becomes confined in the pond.

ii) p^H values of Pond and Canal Water: Mazid (2002) says that pH standard for normal water varies from 6.5 to 8.5. pH values of all surface water samples were around the lower limit of standard (6.5). pH value of pond water was the highest at Alabdi (6.33±0.15) and the lowest at Shapur (5.97±0.42) which means that pond water at Shahpur was more acidic than the same of Alabdi. Again, pH value of canal water was the highest at Shahpur (6.73±1.02) and the lowest at Gazipur (6.43±0.06). So, it is evident that pond water in Shahpur was the most acidic and contrarily canal water of the same village was the lowest in acidic nature among similar water samples collected from other villages. Utilization of pond water by huge population at Shahpur may be one of the main reasons of higher acidity. So it can be said that no remarkable change took place regarding water pH of both pond and canal water in study villages due to different use or receiving various draining materials.

iii) Total Hardness and Suspended Solids of Pond and Canal Water: The Public Health Service Standard recommended a maximum of 500 mg per liter of hardness in drinking water (Peavy and Tchobanoglous, 1985). According to Environmental conservation Rule (ECR) 1997 of GOB, the standard of total hardness for potable water varies from 200 to 500 mg per liter (Khan, 2001). Again total hardness standard for fisheries varies from 80-120 mg per liter (Mazid, 2002).

It is evident from tests that TH of both pond and canal water under the study was remarkably lower than the standard limit of potable water quality 200-500 mg per liter. TH of pond water under the study varied from 41.3±14.1 to 72.0±39.4 mg per liter. In case of canal water, TH varied from 44.0±4.0 to 140.0±34.64 mg per liter. Again TH of canal water at Alabdi and Khangshardi was significantly higher than the same of Shahpur and Gazipur. Means of TH of canal water of Alabdi and Khangshardi were found higher than the upper limit of the standard of TH fixes for fisheries. Standard deviations of different treatments of each test result of TH both pond and canal water was higher in Alabdi and Khangshardi compared to the same found at Shahpur and Gazipur. Total hardness is mainly dependent on soil characteristics of an area. So, higher TH for both pond and canal water of Alabdi and Khangshard, and their higher standard deviations of test results revealed that soil formation provides more dissolved salts to water at different locations of Alabdi and Khangshardi. As TH was above 120 mg per liter in canal water of Alabdi and Khangshardi, it needs further investigation to what extent fishery resources are affected with this higher content of TH at canal water of the said two villages.

SSs in water are aesthetically displeasing and provide absorption sites for chemical and biological agents (Peavy and Tchobanoglous, 1985). According to ECR 1997 of GoB, the standard limit of suspended solids for potable water is 10 mg per liter (Khan, 2001). SSs of both pond and canal water were very much insignificant compared to the standard limit of 10 mg per liter for potable water. Even the standard deviations of different test results were also very insignificant. So, tests results for SSs express that water was clean both for pond and canal.

iv) Nitrogen, Phosphorus and Potassium Nutrients in Pond and Canal Water : According to ECR 1997, standard limit for phosphorus is 0 mg per liter and standard limit for potassium is 12 mg per liter for potable water.

Test results of surface water for both pond and canal show that phosphorus existed in all samples of water. In pond water, its values varied from 0.025±0.02 to 0.162±0.12 mg per liter and in canal water, it varied from 0.028±0.02 to 0.157±0.13 mg per liter. Standard deviations of different treatments for a particular test were also negligible. Again, values of phosphorus were significantly higher in surface water of Shahpur and Gazipur compared to the same in Alabdi and Khangshardi with an exception in case of canal water of Gazipur villages where the value was lower.

It reveals from the study that phosphorus contents in surface water had a relationship with amount of fertilizer use in crop fields. Phosphorus is not volatile and comparatively stable. Higher chemicals in the form of fertilizers were used in crop fields of Shahpur and Gazipur compared to the same in other two villages. So it can be said that higher use of TSP in crop field affects in higher degree to the surface water of Shahpur and Gazipur. It is remarkable that all surface water is affected with phosphorus. But existence of phosphorus is not allowed to remain in surface water according to the standard limit of potable water.

The values of potassium in soil samples were lower than the standard 12 mg per liter in all cases. But it was found that values of potassium were significantly higher in both pond and canal water at Shahpur and Gazipur compared to the same in other two villages. In pond water, amount of potassium was found 1.64±1.0, 1.62±0.82, 0.22±0.18 and 0.61±0.91 mg per liter at Shahpur, Gazipur, Alabdi and Khangshardi respectively. In canal water, existence of the same was found 0.63±0.21, 1.04±0.23, 0.50±0.52 and 0.13±0.03 mg per liter at Shahpur, Gazipur, Alabdi and Khangshardi respectively. Standard deviations of different treatments for particular test were negligible.

Potassium is also not volatile and it remains stable like phosphorus. Extent of contamination of surface water with potassium was higher in Shahpur and Gazipur compared to the same in other two villages under the study. The results show that higher use of potassium in the form of MP in crop fields of Shahpur and Gazipur

ultimately contaminated surface water of the villages. Whereas less MP was used in crop fields of Alabdi and Khangshardi and subsequent contamination of water with potassium was less.

Amount of NH^+_4 in both pond and canal water was minimum. It varied form 0.22±0.16 to 0.50±0.27 mg per liter in pond water and from 0.067±0.03 to 0.303±0.26 mg per liter in canal water. No significant difference of NH^+_4 content was found among surface water of the study villages except Shahpur where the value of the same for both pond and canal water was comparatively high. Standard deviations of different treatments of tests of NH^+_4 were very insignificant. As nitrogen is volatile and unstable. the amount of NH^+_4 in surface water was minimum. But among the results, more existence of NH^+_4 was found in both pond and canal water of Shahpur due to higher use of urea in crop fields.

It can be said that both pond and canal were polluted with major crop nutrients of N, P & K. More pollution of surface water took place in villages of Comilla Sadar Upuzila than other two villages in Sonargaon Upazila. These findings can be matched with the number of crops and amount of fertilizers in study villages of Comilla Sadar Upazila. Other fact like draining of all nutrients or draining the same by water flow during flood in Alabdi and Khangshardi keep surface water comparatively free from various ingredients applied during crop season. Results found through laboratory tests of water quality on SW pollution from agro chemicals – endorsed the opinions of villagers, ERs of UPs, LLs and FLWs.

Significant difference was found on opinions of respondents about disadvantages of mixing of fertilizers with surface water between non-flooding and flood-affected areas. This problem was more acute in non-flooding areas under the study.

4.4 Effects of Development Interventions on Biodiversity

a) Tree Diversity

ASB (2003) cited that the area covered by village groves or forest is estimated to be about 0.27 million ha. This is not forest as per definition. However, in the context of Bangladesh, this tree cover is quite significant in many ways. Haque (2000) informs that high rate of deforestation affect the biodiversity of the country. Felling of trees for

timber, fuel and encroachment on areas covered by forest has reduced the total reserve forest area in Bangladesh to 50 percent in the last twenty years.

Villagers said that more than fifty percent of total tree population in Shahpur and Gazipur was timber rich plants. Whereas, timber and fruit rich plants covered over forty percent of total plant population in Alabdi and Khangshari. Fruit rich plants; and timber and fruit rich plants covered the second and third majority of plant population of Shahpur and Gazipur. Whereas, fruit trees and timber rich plants covered the second and third majority of plant population in Alabdi and Khangshari. Medicinal plants, ornamental plants and others were almost similar in all study villages. Distribution of trees in terms of types was better in Khangshari. Besides, large-scale plantation of timber rich plants specially *Swietenia mahagoni L. (Mehagini)* and *Tectona grandis L. (Segun)* increase timber rich plant in Shahpur and Gazipur.

Big trees were drastically reduced during last four decades. Trees having diameter above three feet covered 33 percent in Shahpur, 34 percent in Gazipur, 32 percent in Alabdi and 28 percent in Khangshardi villages of the total tree population four decades ago. The population of the same size of trees reduced to 9 percent, 8 percent, 9 percent and 9 percent respectively after the said period. Similarly, other big trees of diameter from two to three feet also reduced remarkably during the last four decades. Villagers and ERs of UPs, LLs & FLWs mentioned a number of consequences of major changes of plant types and sizes such as reduction of bird population; reduction of food diversity of man and bird; and reduction of diversity of fruit trees; reduction of population of wild mammals etc. Respondents expressed that high price of timber; high growth rate of timber rich plants; increasing demand of timber; huge campaign for timber tree plantation; and damaging of fruit trees by cow and goat encouraged common people to plant more timber rich plants than other types of plants.

On the basis of respondents' responses and *in situ* observation, more big trees of more diverse species were found in Shapur and Khangshardi in comparison to other villages. A few big trees were found at Shahpur and Gazipur villages. Timber rich plants were higher in these two villages. Large-scale plantation of timber rich plants specially *Swietenia mahagoni L. (Mehagini)* and *Tectona grandis L. (Segun)* increase timber rich plants in these villages. Comparatively more birds were seen in

the areas having more big trees. Traditional seasonal fruits were available in the local markets near to Alabdi and Khangshardi round the year. Large number of birds was seen in banyan trees, fruits of which are the food of birds of various species. It is well realized by the villagers that reduction of tree diversity ultimately reduced the diversity of fruits of man and birds. Monoculture of trees like planting of timber rich plants reduced the population and diversity of birds. Number of wild lives also reduced with reduction of diversity of trees. Besides, aesthetic scene of diversified trees in Khangshardi village was more attractive than other villages of the study area.

b) Fish Diversity

SHED (1998) reported that wetlands in Bangladesh have reduced to half of its size and fisheries catch has dropped by an average of 9 percent every year over the past decade. According to the Red Book of Threatened Fisheries of Bangladesh (2000), 12 species of inland fishes are critically endangered, 28 species are endangered and 14 species are vulnerable.

During the study, it was found that newly introduced exotic varieties of fishes like *Hypophthalmichthys nobish (Bighead Carp), Etenopharyngodon idellus (Grass Carp), Puntius sarana (Sharputi), Pangasius pangasius (Pangus)* etc. covered majority of the cultured pond fish. Production of these pond fishes increased in folds over the last two decades. On the other hand, extinction and tremendous decrease of natural fish population took place in all the study villages. *Ompok pabo (Pabda), Notopterus chitala (Chital), Gudusia chapra (Chapila)* and *Macrobrachium rosenbergii (Baro Chingri)* were extinct from concerned areas during the last four decades. Moreover, *Gudusia chapra (Chapila), Cirrhinus reba (Bhagna), Bengala elanga (Bangla), Leiognathus equulus (Tekchanda)* and *Anguilla bengalensis (Bain Baush)* are the extinct species in Alabdi and Khangshardi.

Regarding the increase of pond fish in the study villages, respondents opined that culture fish production provided high profit, and could meet up the increasing demand of fish. Number of ponds increased remarkably in the study villages. Regarding reduction and extinction of natural fishes in the study villages, villagers and ERs of UPs, LLS & FLWs expressed that use of insecticides and fertilizers in

agricultural crops; catching of egg carrying mother fishes and fingerlings; water scarcity in canals and beels; and high growth of population were the main causes for natural fish destruction in all study villages.

Observation reveals that traditional fish was almost absent in nearby local markets of the study villages. All fish markets were covered by cultured exotic varieties of fishes. Besides, survey data and field observation during data collection confirmed that farmers produced exotic varieties in their ponds. In rivers and canals of Alabdi and Khangshardi, it was seen that dense nets were placed for fishing. So, considering various opinions of villagers of the study and through observations it is concluded that water pollution due to use of huge insecticides and fertilizers use in crop fields, indiscriminate fishing, and scarcity of water in natural water bodies in dry season etc. were the major causes of reducing natural fishes in the study villages.

Significant difference was found in number of ponds between villages of flood affected and non-flooding areas over the two periods considered in the study.

c) Frogs Diversity

Bangladesh is the home of about 20 species of frogs including the more familiar *Bufo melanostictus (Kuno Bang), Hoplobatrachus tigerinus (Kola Bang)* and *Racophorus maculatus (Gecho Bang).* Frog population is much reduced today due to its export and application of the pesticide in the crop fields. Frog helps to keep crop insect-free as it gobbles 7,000 to 10,000 insects every month (Kabir, 1998). Frog also plays a vital role in keeping rural biodiversity good as it eats harmful insects of crops and contrarily many living beings like Snake, Bengal Monitor etc. live on frogs.

Bufo melanostictus (Kuno Bang), Hoplobatrachus tigerinus (Kola Bang) and *Euphlyctis cyanophlyctis (Bhasha Bang)* were commonly available in all study villages four decades ago. Their population reduced over the period seriously. But no extinction of frog species took place in study villages. *Euphlyctis cyanophlyctis (Basha Bang)* was found very few in number in ponds and Sonaichari irrigation canal at Shahpur and Gazipur villages, whereas the number of the same was found higher in ponds and canals of other two villages under the study. *Bufo melanostictus (Kuno Bang)* was found here and there in the villages particularly in grocery shops and in houses during data collection.

Existence of *Hoplobatrachus tigerinus (Kola Bang)* was commonly realized in the villages after big showers four decades ago as this species of frog shouts after a big rain. The population of *Hoplobatrachus tigerinus (Kola Bang)* decreased seriously in the study villages during the last four decades. Voice of this frog was not listened in the study villages even after a strong rain during data collection in the breeding season. This frog was seldom found in study villages. Although catching of *Hoplobatrachus tigerinus (Kola Bang)* was banned about two decades ago but it could not regain its population size in the past due to other various constraints like use of insecticides in crop fields, lack of safe habitats, lack of water in dry season etc.

Significant difference existed in percentage of respondents regarding causes for decreasing the number of frogs between non-flooding and flood-affected areas of the study.

d) Reptilian Diversity

Total number of reptile species in Bangladesh is 109 of which including gavialis gangeticus (Ghorial) 12 are critically endangered and 58 are threatened (IUCN, 2000, Ullah, *et al.*). In Shahpur and Gazipur, *Xenochrophis cerasogaster (Kalo mete dhorashap), Varanus flavescens (Gui Shap), Mobuya dissimilis (Anjon)* and *Calotes rouxii (Rakto chosa)* were found. Respondents of Alabdi and Khangshardii mentioned names of similar reptiles except the name of *Calotes rouxii (Rakto chosa)*. Although extinction of reptiles did not take place in study villages, but their population reduced seriously in the last four decades. Only a few *Varanus flavescens (Guishap)* and *Mobuya dissimilis (Anjon)* were found during moving around the study villages. Deforestation, scarcity of food and hunting were felt as the major causes of reducing reptile population in the study villages. Trading of wild animal and bird either alive or dead is banned, but along with a few valuable items of wild lives, skin of *Varanus flavescens (Guishap)* has a very high price in the black market. This is also one of the major causes of reducing *Varanus flavescens (Guishap)* population in the study villages.

e) Avifaunal Diversity

IUCN (2000) says that among 388 species of resident and 240 migratory birds, 41 species are threatened in the country. A study revealed that 38 species of birds were found at the Jamuna Multipurpose Bridge Area of Tangail and Sirajganj districts during the study period October 1996 to September 1997 while there were 169 species in 1991(Khan and Islam, 2000). Again, Khan (2003) observed a significant decline in the number of birds, which resulted from increasing human habitation and related economic activities in this region.

Number of species of birds, those were available in the study villages four decades ago and were not available at present varied from 7 to 8 in case of native birds and 3 to 7 in case of migratory birds. It was evident during data collection through field observation that population of birds was very insignificant. Birds like *Ploceus philippines (Babui), Sterna acuticenda (Chil), Sarcogyps calvus (Shakun)* etc. were not found frequently in the study villages during the survey but according to the respondents, these were commonly found there four decades ago. The variation of opinions among the respondents of flood free and flood-affected villages was found mainly on the intensity of problems. In Shahpur and Gazipur, the use of fertilizers & insecticides was the main cause of decreasing bird population. Local practices like stopping of aus paddy cultivation due to introducing HYVs crops was a cause of decreasing bird population in Alabdi and Khangshardi. Birds such as *Amourornis phoenicurus (Dahuk), Gallicrex cinerea (Kura), Phalanoconur carbo (Pankouri)* etc. built their nests and gave birth to offsprings in the aus paddy fields. These birds also ate harmful insects of paddy. So, there was no need to apply insecticide to aus crop. Shallow water of early monsoon in the months of April – May made vast moving ground of various traditional fishes in aus crop fields. Tunes of these various types of birds added charms to the vast area and announced that aus season was going on. But after introducing HYV paddy and ceasing aus paddy cultivation, the total habitat of those birds and moving ground of various traditional fishes were destroyed in the area. Water bodies in these villages were filled up mainly for changing those into agriculture fields. Consequently, congenial habitats for fishes and aquatic birds in this region were lost.

The major disaster took place when insecticide was sprayed from aeroplane in Boro season in 1970 to protect standing paddy from the attack of various insects that killed millions of birds in a day. The continuous effects of using increasing fertilizers and insecticides in crops in the following decades reduced bird population in the study villages in general and some became extinct. This problem was further intensified with the hunting of birds, scarcity of fruit trees and lack of safe habitat as a result of ceasing of Aus paddy cultivation. A few of the migratory birds like *Amourornis phoenicurus (Dahuk), Gallicrex cinerea (Kura), Phalanoconur carbo (Pankouri)* etc. became totally extinct in the concerned area. It was realized that ecology of rural areas was affected in various ways due to reducing bird population. Excessive growth of a few harmful mammals like squirrel, rat etc. had taken place due to drastically reduced population of predatory birds like owl, vulture etc.

f) Mammalian Diversity

IUCN (2000) reported, out of 110 mammal species 10, 21, 13 and 6 species are extinct, critically endangered, endangered and vulnerable respectively. Ali *et al* (2000) say that tigers, deer, wild pigs, monkeys and foxes already disappeared or were seriously reduced due to deforestation.

From Shahpur, Gazipur, Alabdi and Khangshardi 6, 6, 5 and 5 species of wild mammals were extinct during the last four decades. Common species of wild mammals became extinct from the study villages in the said period which included *Panthara pardus (Chita Bagh), Macaca fascicularis (Banor)* and *Lepus nigricollis (Shojaru).*

It was realized that almost all land of the study villages was brought under crop production. Natural resources particularly sources of food of wild mammals were gradually depleted over the time either by introducing share of human being in or destroying the sources through adoption of various development interventions. Huge populations of birds like eagle, vulture and owl over the last four decades have been drastically reduced which facilitated increase in the number of harmful mammals like squirrel, rat etc. in the concerned areas. A number of squirrels were found at Shahpur and Gazipur during observation. Domestic animals like cow & goat were seen in all study villages but their population was very limited. So, the observations at the study villages provided similar impressions on biodiversity that common villagers and other concerned expressed in their interviews for the study.

4.5 Common Villagers' Awareness and Development Workers Views about Environment and Rural Development

In most developing counties, environmental agencies are relatively weak compared to trade and industry agencies and agricultural agencies. Because of these institutional constraints, environmental agencies in most developing counties are unable to build consensus to implement standard (Bianchi, *et al.*, 2005). Again, environmental consciousness is directly related to the economic and educational status of the general public. Consequently, in poor countries with low per capita income, government intervention in pollution control and strict enforcement of environmental standards are needed (Almendras, 2005). In Bangladesh, IEE and EIA are considered as major concerns for environmental quality conservation of development works (Khan, 2001). UP Chairmen and Members as respondents in a study opined that pollution, siltation of water bodies and riverbed, disappearance of wild animals, birds and fish species were the most detrimental impacts on rural environment (Ali *et al.*, 2000).

Villagers and ERs of UPs, LLs and FLWs provided opinions, which reflect their awareness in true sense. They expressed opinion on consequences of development interventions like irrigation canal excavation, adopting of modern agriculture and micro credit led IGAs on soil, water and biodiversity of the study villages and also provided suggestions for the development. It was evident that in most cases their opinions were more or less justified by results of laboratory tests on different parameters of soil and water.

According to ECR-1997, IEE and EIA are compulsory events to be carried out the feasibility for any establishment and development work before a project starts. Though the respondents of upazila level expressed that they provided services to the villagers on agricultural development, fishery development, physical communication development, water development, livestock and poultry development, credit and poverty alleviation related works, health and family planning works; general administrations and data collection and dissemination related works. But only two out of twenty respondents i.e., one from Comilla Sadar and one from Sonargaon upazila know about these important environmental measures for development works, feasibiliy assessment techniques following the principles of IEE and EIA. The study indicates that these issues need to be well known to all Upazila Officials.

Respondents DoF, BWDB, DoS, DoL, DAE, LGED, BRDB, BRAC and ASA provided their adopted polices for addressing environmental issues in their development works. It is realized that policies adopted by these departments in rural areas are not adequate for proper application in fields due to limitations in practical fields. Respondents of Comilla Sadar Upazila mentioned nine of such development works (Table-3.33) and their consequent environmental effects. Respondents of Sonargaon Upazila mentioned six of such development works (Table-3.33) and their consequent environmental effects in rural areas. They suggested that some changes as cited in table-3.34 of their existing environmental policy in development works would help to implement environmental friendly development programmes at upazila level.

4.6 Coordination Committees and their Activities on Environmental Issues at the Upazila Level

According to Anonymous (1990), there are twenty-five committees/ sub-committees/ teams at the upazila level through which various development functions are coordinated and conducted. But virtually, it has been revealed from the survey and observation that there are only two committees i. e., Upazila Development and Coordination Committee (UDCC) and Upazila Project Implementation Committee (UPIC) which are concerned with the environment related issues.

It is realized that UDCC and UPIC can contribute very little for conserving and developing rural environment. These two committees only consider water stagnancy related problems to a limited extent in most cases during implementing development works. Issues like high amount of chemical use in crops, soil and water pollutions etc. are not considered in the agenda of the meeting of these committees.

Chapter 5
Conclusion and Recommendations

5.1 Conclusion

Soil and water quality were assessed through different tests at laboratories to find out its present status with respect to agricultural production requirements. It was found that major crop nutrients i. e., N, P & K was poor in all agricultural soils of the study villages. Organic matter contents were also significantly lower than the required amount. p^H values of soils were around the lowest limit of standard 5.0 for majority of crops. Lower p^H values in topsoils generally occur in flood-affected areas. Residual effects of insecticides under the groups of organophosphorus and organocarbamate were not found under the study. Residual effects of DDT under the organochlorine group were found in soil samples of Shahpur village after almost 21 years of application.

In ground water amount of arsenic was found much higher (0.225+-20.0) than the standard of 0.05 mg per litre for potable water at Khangshardi. Total hardness and total dissolved solids of ground water of all tubewells under the study were much below the standard of potable water quality.

In case of surface water quality, physical appearance like color and odour both for canal and pond water in two villages of Sonargaon Upazila were better than the same of two other villages in Comilla Sadar Upazila. Major nutrients of agricultural crops i.e., N, P and K were found in canal and pond water of the study villages. The existence of these nutrients particularly phosphorus in water is not expected to exist according to standard of surface water quality. So, existence of these nutrients in surface water creates problems for aquatic lives, which need further investigation to findout, the effects of theses to the aquatic lives. The average p^H values of water both for ponds and canals were less than the lower limit of standard 6.5 in majority of cases. Hardness of ground and surface water of Alabdi and Khangshardi were higher in comparison to that of Shahpur and Gazipur. In case

of Alabdi and Khangshardi, it was even above the upper limit of standard 120 mg per litre for fisheries for canal water. Total Hardness of water in a particular area mainly depends upon the geologic formation of that area. Amount of salts dissolved determines the extent of TH of the water.

Deteriorations of soil and water qualities were supplemented by the consequent effects expressed by the respondents of various levels. Excessive plantation of timber rich plants for immediate return enhances the process of rural environment deterioration. Various consequences developed from soil and water pollutions included soil fertility reduction; inland and aquatic lives destructions; fish, reptile, bird and wild mammal extinction and their population reduction. Besides, over exploration of natural resources like excessive pressure on agricultural land and over fishing; hunting of birds, reptiles and wild mammals aggravate the depletion of rural environment. Some common environmental problems were found in all study villages. Moreover, location based problems were also evident between flooding and non-flooding areas. Technology adoption and cultivation of modern practices of rural areas also determine the extent of environmental degradation of a particular area.

Respondents were aware of environmental consequences arised due to implementing development interventions. They provided suggestions for the development of rural environment. Similarly development workers at the upazila level were also very much concerned about the common issues of environmental degradation in rural areas for implementing development activities. Upazila level officials provided various suggestions and felt the need of changing their existing policies of implementing development interventions for conserving and developing the rural environment.

Upazila level officials were not aware of legal measures of environmental conservation and development through ECR-1997. But major regulatory works about environment lie in this Rule. So, awareness building among the upazila level officials about the rules and regulation for conserving and developing environment is essential. Training may play a vital role in this regard for awareness building of the

upazila level officials. Besides, motivational works on the necessity of conserving and developing rural environment among all development workers at upazila and union level; and common villagers are needed to be implemented in large scale.

Finally, it may be concluded that common peoples are realizing the deteriorating state of environment due to the implemented development interventions for uplifting their socio-economic conditions. But they are not properly guided to take effective balanced measures for the conservation of ecofriendly environment. Establishment of sustainable development has become the obligatory task of the development authorities i. e., various Nation Building Departments.

5.2 Recommendations

Environmental problems in rural areas are multidimensional. Environmental disturbance occurs in one area may disperse on other areas. So, comprehensive and coordinated approach to conserve and develop rural environment is essential. Considering the findings of the study the following recommendations may be consider for addressing the rural environment.

5.2.1 Insecticides use in agricultural crops should be limited as minimum as possible for protecting rural environment. Possible all measures should be adopted to apply IPM in large scale for protecting crops from insects instead of insecticides. Special care will be needed to acertain that banned insecticides under the organochlorine groups should not be marketed and used in crop fields. Recycling of farm products in agricultural production systems and adopting of environmental friendly production practices should be introduced.

5.2.2 Reduction of fertilizers used in crops with the application of more OMs like cow dung, green waste, manures, compost etc. through developing their sources should be ensured.

5.2.3 Construction works in rural areas should be carried out according to upazila based long term planning. Scattered and location based canal or road construction in rural areas for immediate need should be banned through adopting legal measures.

5.2.4 Credit giving institutions should consider the types of IGAs and environmental issues before sanctioning a credit. Credit giving institutions should also need to inspect and monitor environmental issues at the field level at the implementing stages of different credit lead IGAs.

5.2.5 Water pollution from points and non-points sources should be getting proper protection. Proper application of existing laws i.e., ECR-1997 in protecting point's sources pollution should be ensured. In case of non-points sources of water pollution, chemicals use in crops should be limited as less as possible by formulating and adopting legal measures and motivating common villagers.

5.2.6 Plant diversity in rural areas should be encouraged through using support and sevices of NBDs. Mass media and different extension methods should be used to a large scale for motivating common people in planting different types of plants. Different types and sufficient plant saplings with reduced prices should be available to the common people.

5.2.7 Establishment of safe habitats of frogs in rural areas is an important step for conserving of different species of frogs. Besides, reduction of chemical use in agricultural crops would help to develop frog's population and thus create natural scope to protect crops form attack of harmful insects without using insecticides.

5.2.8 Hunting and killing of birds, reptiles and wild mammals should be stopped with the proper application of existing laws. Mass media like radio, television, leaflets, miking etc. must be used in wider extent for awareness building among the common people about the consequences of killing birds and wild lives to the environment. Also, safe habitats of birds and wild lives need to be established in rural areas through programme implementation and social mobilization.

5.2.9 NBDs such as DAE, DoF, DoL, LGED, BRDB, BWDB, NGOs etc. have own programmmes for plantation and other development works where environmental issues are concerned. Coordination in implementing similar works of these organizations will help to ensure more outputs of works. So, inter and intra departmental coordinations among the concerned departments

for programme implementation should be ensured. In addition to efficient implementation of their individuals plans and programmes in rural areas.

5.2.10 Appointing a representative of DoE at the Upazila level will help to coordinate and monitor environmental issues of various development programmes at the upazila level. Besides, forming a committee for environmental conservation and development at the upazila level with the involvement of concerned departments/officials will help to address environmental issues of development works properly in rural areas.

Major problems like water scarcity and related problems of biodiversity in the dry season need to be solved through regional cooperation. Proper sharing of water among the countries in this region will help to conserve and develop overall environment of the area to a greater extent.

References

AGRAWAL, K. C. 1998. Biodiversity. *Agro Botanica,* Vyas Nagar, New Delhi, India. 150 pp.

AHMED, M. F. 2001. Water Supply. *People's Report on Bangladesh Environment.* Main Report , *The University Press Limited,* Dhaka. **1**: 59 – 63.

AHMED, K. U., 1996. RRA and PRA as Contemporary Techniques of Rural Research in *Environment and Sustainable Agriculture in Rural Development: A Handbook on a Regional Training Programme.* Bangladesh Academy for Rural Development (BARD), Comilla. 252-257 pp.

ALAM, A. M. S., ISLAM, M. A., QUADER, M. A., HOSSAIN, M. G. and SIDDIQUE, M. N. 2002. Level of Arsenic in Water, Soil and Food Samples in Arsenic Affected Area in *Bangladesh Environment 2002.* Bangladesh Poribash Andolon. **1**: 161 – 166.

ALAM, M.S. and HOSSAIN, M. 1998. Farmers' Perceptions on Yield Gaps, Production Losses and Priority Research Problem Areas in Bangladesh in *The Bangladesh Journal of Agricultural Economics.* BAU, Mymensingh. **XXI** (1&2): 21 – 38.

ALAMGIR, M., RABBANI, G., BISWAS, S. K., CHAKRABARTY, K. L., MANNAF, A. and BHUIYAN, A. K. M. A. 1999. Ground Water Quality of Modhupur Tract *J. Asiat. Soc. Bangladesh. Asiatic Civil Military Press*, Dhaka. **25**(1) : 171-174.

ALI, K. T. 2001. Degrading Fish Resources. *People's Report on Bangladesh Environment 2001.* Main Report.*The University Press Limited,* Dhaka. **1**: 83 – 89.

ALI, M.Y. 1990. Open Water Fisheries and Environmental Changes in *Environmental Aspects of Surface Water System of Bangladesh. The University Press Limited*, Dhaka. 145 – 165 pp.

ALI, M. E., KASHEM, M. M. and CHOWDHURY N. A. 2000. *Environmental Management in Rural Areas : Role of Union Parishads.* Bangladesh Academy for Rural Development (BARD), Comilla. 124 PP.

ALIM, A. 1974. *An Introduction to Bangladesh Agriculture.* Directorate of Agriculture, Dhaka. 436 pp.

ALMENDRAS, R.R. 2005 . Case Study on Air Pollution Control in Japan and the Relevance to Developing Counties in East Asia: Philippines in *Local Approaches to Environmental compliance.* The World Bank, Washington DC. 128-129 pp.

ANONYMOUS. 2001. Poison in the Field: Press Reports on Agro-chemicals. *People's Report on Bangladesh Environment 2001: Main Report.* RAHMAN, A., *et al.*. (Edited). *The University Press Limited,* Dhaka. **1**: 44 – 49 pp.

ANONYMOUS.1990. *Upazila Parishad Prashikhkhan Mannual (Bangla).* SIDDIQUI, K and NURUZZAMAN, S. (Edited), National Institute of Local Government (NILG), Agargaon, Dhaka. 818 pp.

APO. 2000. EIA and Agriculture: Measures to Mitigate Adverse Environmental Effects for Sustainable Agricultural Development in *Environmental Impact Assessment for Farms.* Asia Productive Organization, Tokyo, Japan. 53 – 73 pp.

ARNOLD, L. A. and GRUBE, A. H. 1997. *Pesticide Industry Sales and Usage: 1994 and 1995.* EPA, Washington DC, USA. 157 pp.

ASADZZAMAN, M. 2000. "Bangladesh Economy and Sustainable Development in *National Forum on Multi-stakeholder Sustainability Planning in Bangladesh. Proceedings of the National Forum on Multi-stakeholder Sustainability Planning in Bangladesh. University Preess Limuted,* Dhaka. 29 – 33 pp.

ASB. 2003. *Banglapedia : National Encyclopedia of Bangladesh.* Asiatic Society of Bangladesh, Progressive Enterprize Press Limited, Dhaka. **3**: 496 pp.

ASB. 2003. *Banglapedia : National Encyclopedia of Bangladesh.* Asiatic Society of Bangladesh, Progressive Enterprize Press Limited, Dhaka. **4**: 496 pp.

ASB. 2003. *Banglapedia : National Encyclopedia of Bangladesh.* Asiatic Society of Bangladesh, Progressive Enterprize Press Limited, Dhaka. **9**: 511 pp.

BAKI, A. 1994. *Dainandin Krishi Biggan (Bangla).* Narayanganj, Dhaka. 306 pp.

BARC. 1997. *Fertilizer Recommendation Guide – 1997. Bangladesh Agricultural Research Council,* Farm gate, Dhaka. 182pp.

BASHAR, M. A. 2004. *Instant of Basics of Environment.* Colorine, Dhaka. 578 pp.

BARKER, R. J. 1958. *Notes on Some Ecological Effects of DDT Sparyed on Elms.* J. Wildl. Manage, USA. 22 pp.

BARNETT, D. C. 1950. *The Effect of Some Insecticide Sprays on Wildlife. Proc. Ann. Conf. West Assoc. State Game and Fish Comm.* 30, USA. 125 pp.

BERNARD, R. F. 1963. *Studies of the Effects of DDT on Birds.* Michigan State University, Mus. Pub. Biol. Ser. 2, USA. 155 pp.

BHATIA, S. and SINHA, R. K. 2000. Strategies for Eco-Farming for the Protection of Environment and the Agricultural Ecosystems in *Environmental Protection. Pointer Publishers,* Jaipur, India. 21 – 28 pp.

BHUIYA, M.S.U. and HOSSAIN, S.M.A. 1993. Sustaining Crop Productivity Through Organic Matter Management in *Farming System Research.* Bangladesh Agricultural University, Mymensingh. 275 - 280 pp.

BIANCHI, A., CRUZ, W. and NAKAMURA, M. 2005. Environmental Compliance: Case Studies from Japan and Their Relevance to East Asian Developing

Counties in *Local Approaches to Environmental Compliance.* The World Bank, Washington DC. 1-17 pp.

BLUS, L. J. 2003. Organochlorine Pestides in Handbook of Ecotoxicology. *Lewis Publishers,* New York, USA. pp. 314- 339.

BLUS, L. J., HENRY, C. J and GROVE, R. A. 1989. *Rise and Fall of Endrin Usage in Washington State Fruit Orchards: Effects on Wildlife.* Environment Pollution, 60, Washington. 331 pp.

BRAMMER, H. 1996. *The Geography of the Soils of Bangladesh. University Press Limited,* Dhaka. 287 pp.

BROWN, L.R. and YOUNG, J.E. 1991. Feeding the World in the Nineties. *State of the World, 1990.* World Watch Institute, U.K.

CARSON, R. 1962. *Silent Spring.* Houston Mifflin, Boston, USA. 362 pp.

CHALLINOR, D. 1988. Epilogue in *Biodiversity. National Academy Press,* Washington, DC. 493 – 496 pp.

CHAPMAN, J.K. and REISS, M.J. 1995. *Ecology: Principles and Applications. Cambridge University Press,* Great Braitain. 294 pp.

CHOWDHURY, Q. I. 1999. Arsenic Poisoning in Rural Bangladesh in *Bangladesh : State of Environment Report 1999.* Forum of Environmental Journalists of Bangladesh, Dhaka. 41 – 60 pp.

CIRDAP. 2002. *CIRDAP REPORT 2002.* Center on Integrated Rural Development for Asia and the Pacific, Dhaka. 52 pp.

CONWAY, G. R. 1990. Water Resources Development and the Environment: Concepts and Issue in *Environmental Aspects of Surface Water Systems of Bangladesh. The University Press Limited,* Dhaka. 52 pp.

COTTAM, C. and HIGGINS E. 1946. *DDT: Its Effects on Fish and Wildlife.* U. S. Fish and Wildlife Service Circulation, Washington, D.C. 11 pp.

DALE, W. E., GAINES, T. B. and HAYES, Jr. W. J. 1963. *Poisoning by DDT: Relation Between Clinical Signs and Concentration in Rat Brain.* Science, 142, USA. 1474 pp.

DAS, H. K., MALLICK, A.S.M. and SENGUPTA, P. K. 2003. Health Effects of Arsenic Contamination in Ground Water. *Ground Water Resources and Development in Bangladesh : Background to the Arsenic Crisis, Agricultural Potential and the Environment. The University Press Limited,* Dhaka. 419 – 434.

ECD, 2005. *Innovative Soil – Plant Systems for Sustainable Agricultural Practices.* Economic Co-operation and Development, *Google Print Publisher Programme*, Web sighted on the 26th October 2005.

FAO 1999. *Statistics Database: FAOSTAT.* Rome, From Web Site.

FAO 2000, *Fisheries Web Site,* op. cit. note.

FOWLER, C. and MOONEY, P. 1991. *The Threatened Gene. Lutterworth Press,* Cambridge, U.K.

GoB and UNEP. 2001. *State of Environment: Bangladesh.* United Nation's Environmental Programme, Regional Resource Center for Asia and the Pacific, Pathumthani, Thailand. 138 pp.

GOODHAND, J. 2001. Violent Conflict, Poverty and Chronic Poverty. In CPRC Working Paper 2, Chronic Poverty Research Center, UK.

HALLIDAY, T. R. and HEVER, W. R. 1997. The Case of the Vanishing Frogs in *Technology Review.* U.K.

HAQUE, M. 2000. Situational Analysis of Sustainable Development Initiatives in Bangladesh in *National Forum on Multi-Stakeholder Sustainability Planning in Bangladesh: Proceedings of the National Forum on Multi-Stakeholder Sustainability Planning in Bangladesh. Computer Graphic,* IUCN Bangladesh, Dhaka. 22 – 25 pp.

HAQUE, M. 1999. Sustainable Management of Environment in *Bangladesh : State of Environmental Report 1999. Forum of Environmental Journalists of Bangladesh,* Dhaka. 125 – 140 pp.

HARRIS, M. L., WILSON, L. K., ELLIOTT, J. E., BISHOP, C. A., TOMLIN, A. D., and HENNING, K. V. 2000. Transfer of DDT and Metabolites from Fruit Orchard Soils to American robins (*Turdus migratorius*) Twenty Years After Agricultural Use of DDT in Canada, *Arch. Environ.. Contam. Toxicol.,* 39, 205.

HICKEY, J. J. and HUNT, I. B. 1960. *Initial Song Bird Mortality Following Dutch Elm Disease Control Program. J. Wildl. Manage.,* 24, USA. 259 pp.

HOSSAIN, A., CHOWDHURY, M.A.I., ALAM, M.J.B., ISLAM, M.Z. and SOHEL, K.M.A. 2002. Current Status of Water Quality of the River Surma in *Bangladesh Environment : 2002.* Bangladesh Poribesh Andolon, Dhaka. **2**: 883 – 893 pp.

HUQ, S.M.I and HOSSAIN S.A. 2000. Integrated Sustainable Planning and Management of land Resources in Bangladesh in *National Forum on Multi-Stakeholder Sustainability in Bangladesh: Proceedings of the National Forum on Multi-stakeholder Sustainability Planning. Computer Graphic,* IUCN Bangladesh, Dhaka. 167 - 171pp.

IUCN. 2000. *Red List of Threatened Animals of Bangladesh. International Union of Conservation Nature, Bangladesh,* Dhaka. 54 pp.

JANSONIUS, E., KHAN, T. A., SPRENGER, E. and ZEEUW, I. H. 1994. *NGOs and Sustainable Land Use in Bangladesh.* Number 54 in the Series of Program Evaluations of Confinancing Program. The Hague, The Netherlands. 15 pp.

KABIR, J. A. 1998. Frogs Increase Crop Yield and Restore Ecology in Bangladesh: *Environment Facing the 21st Century.* Society for Environment and Human Development, Dhaka. 58 – 59 pp.

KAMAL, G. M. 1995. *Environment and Rural Poor Project.* Rural Poor Programmes Task Force of BRDB, Lalmatia, Dhaka. 35 pp.

KAMAL, M. G., RAHMAN, M. B. and GHANI, A.K.M.A.G. 1992. *Impact of Credit Progamme on Reproduction Behavior of Gramen Bank Women Beneficiaries.* Canadian International Development Agency, Dhaka.

KATYAL, T. and STAKE, P. M. 1998. *Environmental Pollution. Anmol Publications Private Limited,* New Delhi, India.

KATIYAR, V. S. 1997. *Environmental Concerns: Depleting Resources and Sustainable Development. Pointer Publishers,* Jaipur, India.

KHAN, A.M. 2003. Globalization: The Unfair Case on the South in *Globalization, Environmental Crisis and Social Changes in Bangladesh. The University Press Limited,* Dhaka. **1**: 33-47.

KHAN, M. A. A. 2001. *Poribash Ayn (Bangla). New Warsy Book Corporation,* Dhaka. 335 pp.

KHAN, M. M. H. and ISLAM, M.A. 2000. Status and Habitats of the Birds of Tangail, Bangladesh in *Bangladesh Journal of Zoology.* Zoological Society of Bangladesh, Department of Zoology, University of Dhaka. **28** (1): 75-88.

KHAN, T. A., AHSAN, K. and KABIR, Q. A. 1996. *Ecological Farming in Bangladesh With a Case Study in Comilla.* Bangladesh Academy for Rural Development (BARD), Comilla. 42 pp.

KHAN, A. A. and SOLAIMAN, M. 1978. *The Academy at Comilla.* Bangladesh Academy for Rural Development (BARD), Comilla. 108 pp.

LEOPOLD, A. 1941. Lakes in Relation to Terrestrial Life Patterns. In: *A Symposium on Hydrobiology. University of Wisconsin Press,* Madison. 17-22 pp.

MAZID, M. A. 2002. *Development of Fisheries in Bangladesh : Plans and Strategies for Income Generation and Poverty Alleviation. Momin Offset Press,* Dhaka. 176 pp.

MOHR, R. W. 1951. *Toxicity in Orchard Insecticides to Game Birds in Eastern Washington.* Wash Agric. Exp. Circ., 170. USA. 22pp.

NMF 1998. *Fisheries of the United States.* National Marine Fisheries, Department of Commerce, Washington DC, USA.

ODUM, E. P. 1971. *Fundamentals of Ecology.* W. B. Saunders Company, Third Edition, London. 574 pp.

PC. 1997. *The Fifth Five Year Plan: 1997- 2002.* Planning Commission, Ministry of Planning, Government of Bangladesh, Dhaka. 570 pp.

PC. 1990. *The Fourth Five-Year Plan: 1990 – 1995.* Planning Commission, Ministry of Planning, Government of Bangladesh, Dhaka. 480 pp.

PC. 1985. *The Third Five-Year Plan: 1985-90.* Planning Commission, Ministry of Planning, Government of Bangladesh, Dhaka. 444 pp.

PEAVY, H., ROWE, D and TCHOBANOGLOUS, G. 1985. *Environmental Engineering.* Mc Graw-Hill International Editions, Singapore. 699 pp.

PORTER, S. 2000. Pesticide Trade Nears New High. *Vital Signs 2000.* World Watch Institute, UK. 48 – 49 pp.

POSTAL, S. 1999. *Pillar of Sand. W.W. Norton & Company.* New York, USA.

QUDDUS, M. A. and MULLEN, J. 1996. *Introduction* in *Environment and Sustainable Agriculture of Rural Development.* Bangladesh Academy for Rural Development/ Commonwealth Secretariat, Comilla. 1 – 7 pp.

QUDDUS, M. A. 1995. Introduction in *Poverty Focused Rural Development: A Hand Book on a Regional Training Program* Bangladesh Academy for Rural Development/ Commonwealth Secretariat, Comilla. iii – iv pp.

RAO, J. M 2000. Whither India's Environment in *Environmental Management: An Indian Perspective. Rajkamal Electric Press,* Delhi, India.

SARKER, M. M. R., ALAM, M. S. and AKTHAR, N. 2002. Pesticides Use in Modern Rice Production: The Issue of Farmer's Health and Environment in *Bangladesh Environment: 2002.* Bangladesh Poribash Andolon, Lalmatia, Dhaka. 1: 571 – 583 pp.

SHAFI, M. 1993. Perspective on Environment and Development in *Environment and Development: Views from the East and the West. Concept Publishing Company,* New Delhi, India. 59 - 68pp.

SHED. 1998. *Bangladesh: Environment Facing the 21st Century.* Society for Human and Environment Development, North Dhanmondi, Dhaka.341 pp.

SOH, K.G. and ISHERWOOD, K.F. 1999. Short Term Prospects for World Agriculture and Fertilizer Use presentation at 25th Fertilizer Industry Association (FIA) Enlarged Council Meeting, 30th November-3 December 1999. Rome, Italy.

SRDI 1999. *Land and Soil Survey Mannual for Comilla Sadar Thana (Bangla).* Soil Resources Development Institute, Dhaka. 123 pp.

SRDI and DAE. 1994. *Trainers Guide on Thana Land and Soil Resources Utilization Manual (Bangla).* Soil Resources Development Institute & Department of Agriculture Extension, M/O Agriculture, GoB, Dhaka. 50 pp.

STICKEL, W. H. 1984. *DDE in Birds : Lethal Residues and Loss Rates.* Arch. Environment Contam. Toxicol., 13, 1.

STICKEL, W. H., STICKEL, L. F. and COON, F. B. 1970. *DDE and DDD Residues Correlated with Mortality of Experimental Birds.* Pesticide Symposia, 7th International American Conference Toxicol. Occupational Med., Deichmann, W. B.,Ed, Helios and Association, Miami, Florida, USA. 287pp.

STICKEL, W. H., L. F. STICKEL and SPANN, J. S. 1969. *Tissue Residues of Dieldrine in Relation to Mortality in Birds and Mammals in Chemical Fallout : Current Research on Persistent Pesticide.* Miller M. W., and Berg, G. G., Eds., Charles C Thomas, Springfield, IL, USA. 174 pp.

STICKEL, L. F. and STICKEL, W. H. 1969. *Distribution of DDT Residues in Tissues of Birds in Relation to Mortality, Body Condition and Time.* Ind. Med. Surg.,38, USA. 44 pp.

STICKEL, L. F., STICKEL, W. H. and CHRISTENSEN, R. 1966. *Residues of DDT in Brains and Bodies of Birds that Died on Dosage and in Survivors.* Science, 151, USA. 1549 pp.

WCED 1987. *Our Common Future.* The World Commission on Environment and Development, Oxford University Press, Oxford.

WAKE, D. B. 1991. *Declining Amphibian Population.* Science. UK.

WAKE, D. B. 1998. Action on Amphibians in *Trends in Ecology and Evolution,* UK.

WURSTER, C. F., WURSTER D. H. and STICKLAND, W. N. 1965. *Bird Mortality After Spraying for Dutch Elm Disease with DDT.* Science, 148, USA. 90 pp.

ULLAH, M., CHOWDHURY, J. K., SIDDIQUI, R. and JOHRA, F. 2001. *Jibo Baichittra (Bangla).* Centre for Sustainable Development, Dhaka. 100 pp.

UNEP.1996. *Ground Water: A Threatened Resource.* United Nation's Environment Programme, Nairobi, Kenya.

USGS. 1999. *The Quality of Our Nation's Water – Nutrients and Pesticides.* US Geological Survey, Reston, VA, USA.

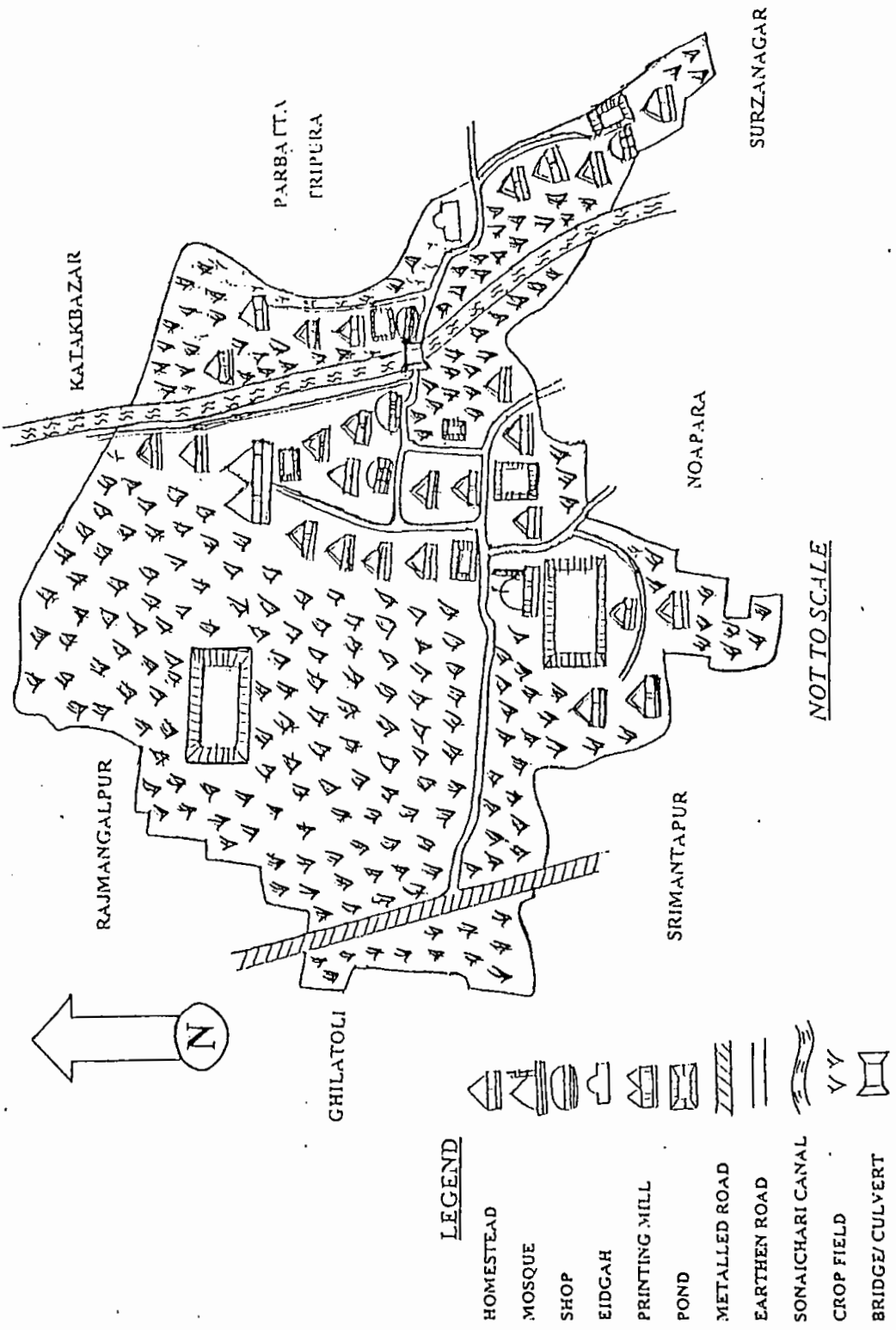
Annexures

Annexure – 1

Detail of Social Mapping and Ranking Exercises on Major Environmental Problems of Study Villages

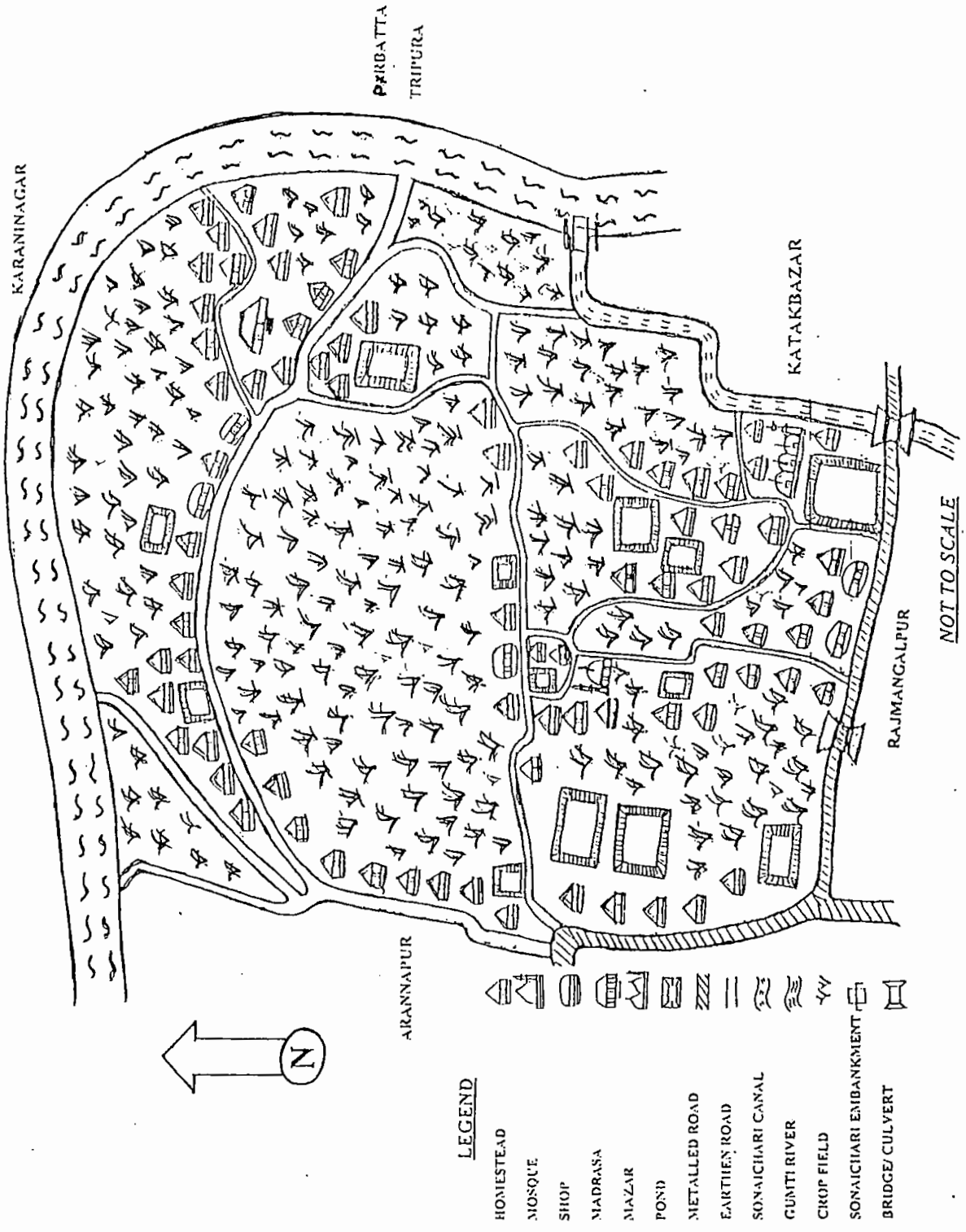
Social Map

a) **Social Map of Shahpur Village:** Social Mapping activities were carried out by the villagers at the premise of the shop of Md. Bahar Mia.



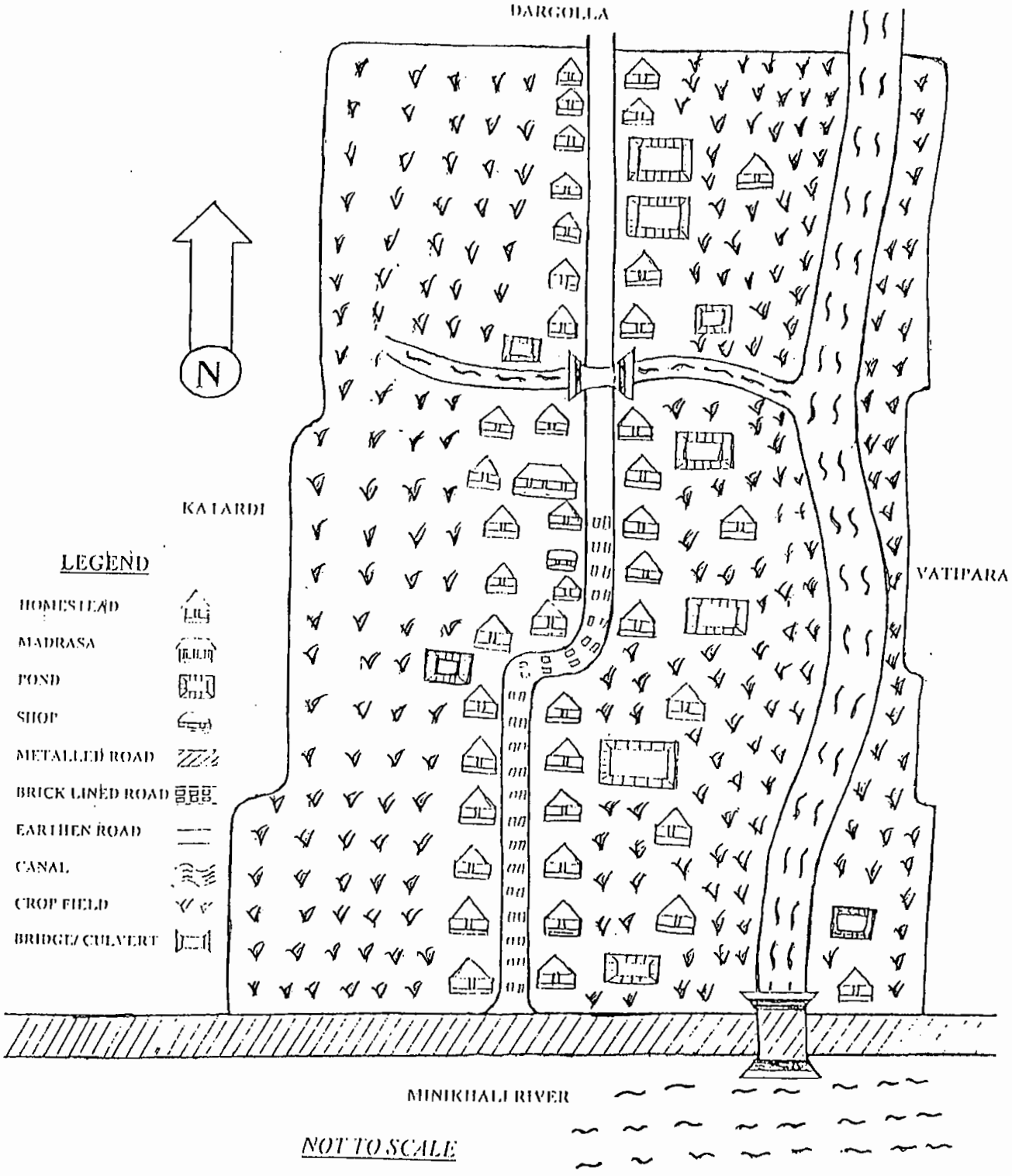
Map No.-4: Social Map of Shahpur Village Under Comilla Sadar Upazila

b) **Social Map of Gazipur Village:** Social mapping was done by the villagers at the premise of the shop of Md. Abul Kalam Azad.



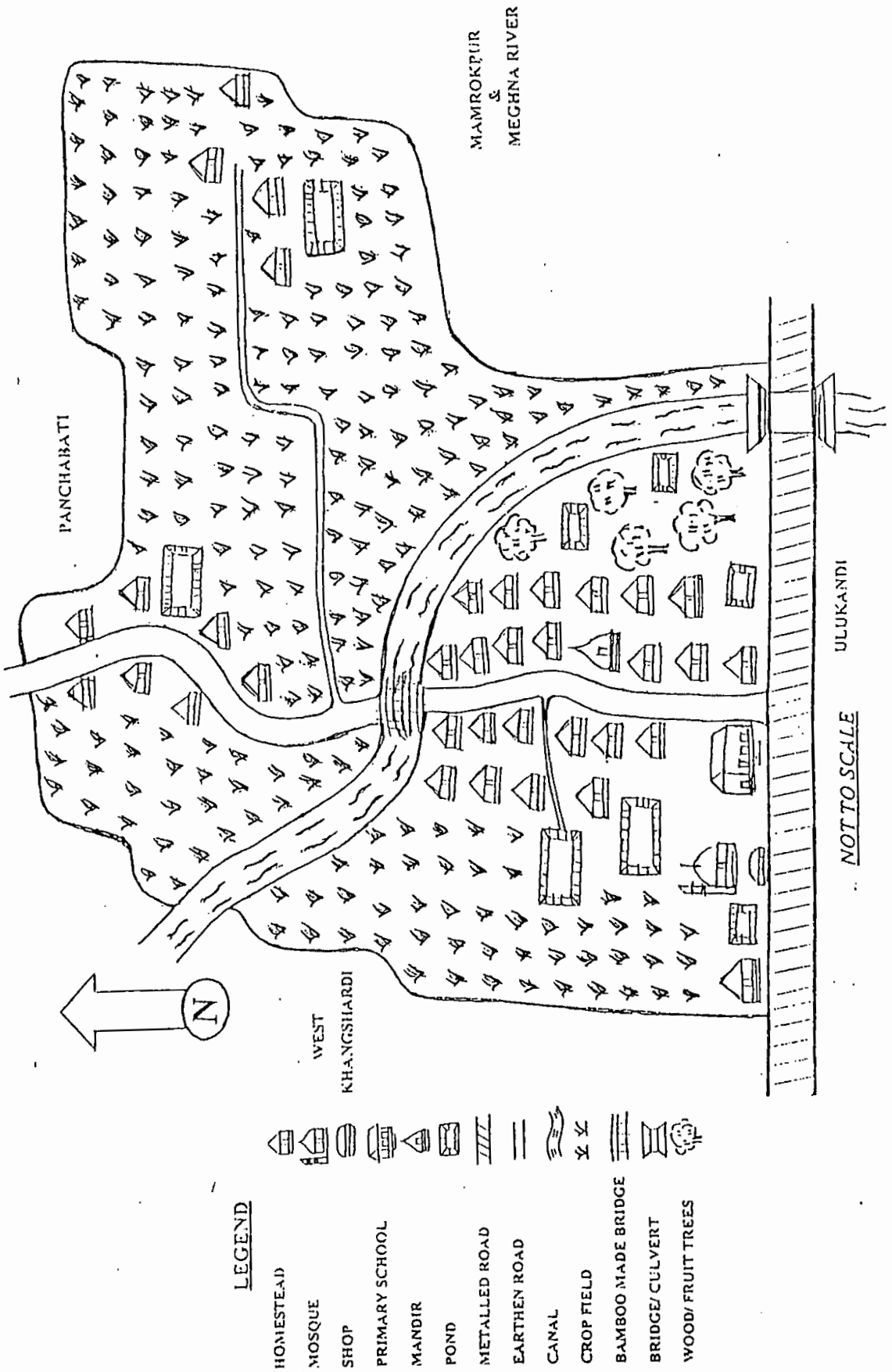
Map No.-5: Social Map of Gazipur Village Under Comilla Sadar Upazila

c) **Social Map of Aladi Village:** Social mapping was carried out by the villagers in front of the shop of Md. Ali Noor at Alabdi village.



Map No.-6: Social Map of Alabdi Village Under Sonargaon Upazila

d) **Social Map of Khangshardi Village:** Social map of the village was prepared by the villagers in front of the Khangshardi Government Primary School.



Map No.-7: Social Map of Khangshardi Village Under Sonargaon Upazila

Ranking Exercise

a) **Ranking Exercise on Major Environmental Problems of Shahpur Village:** Six major environmental problems of the village were identified and ranked by the villagers through ranking exercise as below:

Problem	Rating by Villagers							Rank
	1	2	3	4	5	6	Total	
(i) Use of chemicals in crops	*** ***	*** ***	*** **	*** **	*** **	*** **	32	1st
(ii) Non availability of big trees	**	***	***	***	**	***	16	5th
(iii) Existing of too much squirrel in the village	***	**	*** *	*** *	*** ***	*** *	23	4th
(iv) Scarcity and pollution of water in the dry season	*** **	*** *	***	*** ***	*** *	**	24	3rd
(v) Degradation of agriculture land	*** *	*** **	*** ***	**	***	*** ***	26	2nd
(vi) Killing of wild lives	*	*	**	*	*	*	7	6th

b) **Ranking Exercise on Major Environmental Problems of Gazipur Village:** Villagers identified six major environmental problems of the village and ranked those according to the intensity of the problem as bellows:

Problem	Rating by Villagers							Rank
	1	2	3	4	5	6	Total	
(i) High population growth	*** ***	*** ***	*	*	*** ***	*** ***	26	1st
(ii) Use of Chemicals in crops	*** **	*** **	*** **	**	*	*** **	23	2nd
(iii) Decreasing productivity of soil	*** *	**	**	*** ***	*** *	*** *	22	3rd
(iv) Scacity & pollution of water in dry season	**	*** *	*** ***	*** **	*** **	*	23	2nd
(v) Decreasing habitats of birds	***	*	*** *	*** *	***	**	17	4th
(vi) Non existence of forest	*	***	***	***	**	***	15	5th

c) **Ranking Exercise on Major Environmental Problems of Alabdi Village:** Five major environmental problems were identified and ranked by the villagers through ranking exercise as below:

Problem	Rating by Villagers						Rank
	1	2	3	4	5	Total	
(i) Degradation of agriculture land	*** *	*** **	*** **	*** **	*** **	24	1st
(ii) Damage & loss of fish resources	*** **	***	*** *	*** *	*** *	20	2nd
(iii) Reduction of plant population	**	**	**	***	**	11	4th
(iv) Killing of wild lives	*	*	***	*	*	7	5th
(v) High population growth	***	*** *	*	**	***	13	3rd

d) **Ranking Exercise on Major Environmental Problems of Khangshardi Village:** Five major environmental problems were identified and ranked by the villagers through this exercise as below:

Problem	Rating by Villagers						Rank
	1	2	3	4	5	Total	
(i) Degradation of agricultural land	*** **	*** **	*** *	*** *	*** *	20	1st
(ii) Scarcity & pollution of water in dry season	*** **	*	*	**	***	12	4th
(iii) Loss of wild lives	*	***	**	*	**	9	5th
(iv) Damage & loss of fish resources	*** *	*** *	***	***	*** **	19	2nd
(v) High population growth	**	**	*** **	*** **	*	15	3rd

Annexure – 2

Major Cropping Pattern According to Different Land Types in Study Villages

Village	No. of Res.	Cropping Pattern and Land Types (% of Respondents Adopted)			
		High Land	Medium High Land	Medium Low Land	Low Land
Shahpur	22	(a)Amon+Rabi+Boro (86.36%) (b)Amon+Boro+ 0 (68.18%) (c)Kharif+Rabi+Kharif (36.36%) (d)Kharif+Rabi+Boro (31.82%)	-	-	-
Gazipur	38	(a)Amon+Boro+0 (100%) (b)A mon+Rabi+Boro (68.42%) (c) Kharif+Rabi+Boro (13.16%)			
Alabdi	19			Amon+Rabi+0 (10.57%)	(a) Rabi+Boro+0 (63.16%) (b)Amon+Rabi+0 (57.89%) (c)Amon+Boro+0 (52.63%) (d)0+Boro+0 (31.58%)
Khangshardi			Kharif+0+ Rabi (33%)	Amon+ Rabi+0 (75.0%)	(a)Amon+Boro+0 (66.67%) (b)0+Boro+0 (25.00%)

Annexure – 3

Amount of Major Fertilizers Used in Crop Production in Different Types of Land During 2003

Crops	Fertilizer	Shahpur	Gazipur	Alabdi		Khangshardi		
		HL (kg/A)	HL (kg/A)	MLL (kg/A)	LL(kg/A)	MHL (kg/A)	MLL (kg/A)	LL (kg/A)
Amon	Urea	58.41	55.13	32.27	32.27	-	26.25	26.25
	TSP	42.05	43.42	35.00	35.00	-	25.00	25.00
	MP	21.14	19.11	21.25	21.25	-	12.50	12.50
Boro	Urea	75.91	86.05	-	46.84	-	-	75.00
	TSP	54.10	52.89	-	38.42	-	-	54.00
	MP	25.00	25.13	-	22.79	-	-	22.00
Rabi	Urea	133.66	177.60	32.69	-	125.00	30.00	-
	TSP	92.63	125.60	33.85	-	97.50	30.00	-
	MP	41.32	51.40	15.38	-	42.50	16.67	-
Kharif	Urea	110.00	160.00	-	-	122.50	-	-
	TSP	77.00	104.00	-	-	95.00	-	-
	MP	35.33	46.00	-	-	42.50	-	-

Annexure – 4

Use of Insecticides in Agriculture Crops in 2003

Liquid insecticides used in boro paddy were Dursban 20 EC, Marshal, Tafgor, Ripcord, Sobicron, Nogos, Phyphanon 57 EC, Dimacron and Melatheon. Ripcord, Phaddy 50 EC, Ridomil MZ, Sobicron, Sobatheon, Hiltheon etc. were used as liquid insecticides in rabi crops. Sunfuran was used in Kharif crops. Granular insecticides used were Furadan and Tafgor 40 EC; and powdered insecticide used was Diazinon.

Use of Insecticides in Different Crops of Land Areas of Study Villages in 2003

Village/ No. of Respondents	Major Crops	Average Rate of Insecticides Used								
		Four Decades Ago	(HL)		(MHL)		(MLL)		(LL)	
			Liqd. (mg/ A)	Powr. (gm/ A)	Liqd. (mg/ A)	Powr. (gm/ A)	Liqd. (mg/ A)	Powr. (gm/ A)	Liqd. (mg/ A)	Powr. (gm/ A)
Shahpur/ 22	Amon	-	126	1750	-	-	-	-	-	-
	Boro	-	211	2290	-	-	-	-	-	-
	Rabi	-	426	3270	-	-	-	-	-	-
	Kharif	-	413	2970	-	-	-	-	-	-
Gazipur/ 38	Amon	-	127	2000	-	-	-	-	-	-
	Boro	-	181	2480	-	-	-	-	-	-
	Rabi	-	404	3000	-	-	-	-	-	-
	Kharif		440	2330	-	-	-	-	-	-
Alabdi/ 19	Amon	-	-	-	-	-	-	-	-	-
	Boro	-	-	-	-	-	-	-	84	2130
	Rabi				-	-	113	2250	113	2250
Khangshardi/ 12	Amon	-	-	-	-	-	100	-	-	-
	Boro	-	-	-	-	-	-	-	165	2250
	Rabi	-	-	-	280	2600	200	2000	67	2000
	Kharif	-	-	-	250	2750	-	-	-	-

Annexure – 5

Advantages and Disadvantages of of High Rate of Fertilizers Use in Study Villages

Village	No. of Respondents	Advantages	Disadvantages
Shahpur	22	(a) Production increases (68.18%) (b) Income increases (13.64%)	(a) Soils become hard (86.36%) (b) Fertility of soil reduces (63.63%) (c) Water and soil become polluted (36.36%) (d) Attact of insects and pest increases (18.18%) (e) Aquatic and inland lives become affected (13.64%)
Gazipur	38	(a) Production increases (100.00%)	(a) Fertility of soil reduces (84.21%) (b) Soils become hard (68.42%) (c) Aquatic and inland lives become affected (42.11%) (d) Water and soil become polluted (36.84%) (e) Attact of pest and insect increases (21.05%) (f) Quality of crop becomes affected (10.53%) (g) Water and nutrient holding capacity of soil reduces (10.53%)
Alabdi	19	(a) Production increases (100.00%) (b) Poverty reduces (31.58%)	(a) Soils become hard (47.37%) (b) Fertility of soil reduces (36.36%) (c) Taste of crops reduces (26.32%) (d) Input cost is high (26.32)
Khangsharidi	12	(a) Production increases (100.00%) (b) Poverty reduces (25.00%)	(a) Fertility of soils reduces (75.00%) (b) Soils become hard (66.67%) (c) Taste of crops reduces (33.33%)

Annexure - 6

Advantages and Disadvantages of Insecticides Used in Crop Production in Study Villages

Village	No. of Respondents	Advantages	Disadvantages
Shahpur	22	(a)Attack of insects on crops reduces (95.45%) (b)Crop production increases (59.09%) (c)Crop diseases reduce (40.91%)	(a) Water and soil become polluted (90.91%) (b) Common people get various diseases (86.36%) (c) Many aquatic and inland lives are exhausted (77.27%) (d) Earthworm and beneficial insects are decreasing (31.82%) (e) Fish resources and bird become seriously affected (31.82%) (f) Quality of soil deteriorated and soils become hard (27.27%)
Gazipur	38	(a) Attack of insects on crops reduces (65.79%) (b) Production of crops increases (39.47%) (c) Loss of crops reduces (28.95%)	(a) Many aquatic and inland lives are decreasing (94.74%) (b) Water and soil become polluted (84.21%) (c) Fish and bird are reducing (73.68%) (d) Common people are attacked with various diseases (57.90%) (e) Quality of crops becomes retarded (31.58%) (f) Quality of soils deteriorates seriously (31.58%) (g) Earthworms are exhausted (28.95%) (h) Ecology balance disturbs seriously (26.32%)
Alabdi	19	(a) Production of crop increases (100.00%) (b) Attack of insects reduces (89.47%) (c)Attack of pests reduces (47.37%)	(a) Water and soil become polluted (73.68%) (b) May aquatic and inland lives are decreasing (52.63%) (c) Common people are attacked with various diseases (52.63%) (d) Earthworm and beneficial insects are exhausted (52.63%) (e) Fish resources become seriously affected (42.11%)
Khangsharidi	12	(a) Attack of insects on crops reduces (91.67%) (b) Production of crops increases (58.33%) (c) Attack of pests reduces (33.33%)	(a) Many aquatic and inland lives are decreasing (58.33%) (b) Water and soil become polluted (58.33%) (c) Common people are attacked with various diseases (33.33%) (d) Fish resources become seriously affected (25.00%) (e) Earthworm and beneficial insects are exhausted (16.67%) (f) Quality of soils aredeteriorated (16.67%)

Annexure - 7

Decrease of Traditional Fish Production in Study Villages

Village	Name of Tradtional Fish Decreased Over the Last Four Decades				
	1-25%	26-50%	51-75%	76-99%	Extinct
Shahpur	*Amblypharyngodon microlepis (Mola)*	*Batasio tengana (Tengra), Puntius terio (Puti)* and *Channa punctatus (Taki)*	*Anabas testudineus (Koi), Heteropneustes fossilis (Shingi)* and *Clarias batrachus (Magur)*	*Notopterus notopterus (Foli) and Channa striatus (Shol)*	*Ompok pabo (Pabda), Nandus nandus (Meni), Channa marulius (Gozer), Wallago attu (Boal), Notopterus chitala (Chital), Bengala elanga (Bangla), Gudusia chapra (Chapila), Colisa faciatus (Khalisha), Macrabrachium rosenbergii (Baro Chingri)* and *Aorichthys aor (Ayer)*
Gazipur	*Amblypharyngodon microlepis (Mola)* and *Macrabrachium rosenbergii (Baro Chingri)*	*Annandal loach (Bat Rangi)*	*Clarias batrachus (Magur), Heteropneustes fossilis (Shingi), Anabas testudineus (Koi) and Channa punctatus (Taki)*	*Notopterus notopterus (Foli), Anguilla bengalensis (Baim), Channa striatus (Shol), Batasio tengana (Tengra), Eleotris fusca (Bailla), Pseudambassis ranga (Chanda), Osteobrama cotio (Dhela)* and *Puntius sarana (Shar Puti)*	*Nandus nandus (Meni), Channa marulius (Gozer), Ompok pabo (Pabda), Notopterus chitala (Chital), Bengala elanga (Bangla), Wallago attu (Boal), Gudusia chapra (Chapila), Ailia coila (Batashi), Colisa faciatus (Khalisha), Labeo calbasu (Kalo Baush)* and *Macrabrachium rosenbergii (Baro Chingri)*
Alabdi	-	*Puntius terio (Puti), Amblypharyngodon microlepis (Mola)* and *Channa punctatus (Taki)*	*Batasio tengana (Tengra), Channa striatus (Shol)* and *Anguilla bengalensis (Baim)*	*Channa marulius (Gozer), Wallago attu (Boal), Heteropneustes fossilis (Shingi), Clarias batrachus (Magur), Anabas testudineus (Koi), Nandus nandus (Meni), Notopterus notopterus (Foli), Labeo rohita (Rui),*	*Ompok pabo (Pabda), Notopterus chitala (Chital), Leiognathus equulus (Tekchanda), Aorichthys aor (Ayer), Gudusia chapra (Chapila), Bengala elanga (Bangla), Macrabrachium rosenbergii (Baro Chingri), Cirrhinus reba (Bhagna), Mystus cavasius (Gulsha), Salmostoma*

				Catla catla (Katla) and *Cirrhinus mrigala* (Mrigal)	*bacaila (Baro Kataira), Colisa faciatus (Khalisha), Cirrhinus reba (Tatkini), Labeo calbasu (Kalo Baush), Puntius sarana (Shar Puti), Labeo gonius (Ghoinna), Osteobrama cotio (Dhela)* and *Anguilla bengalensis (Bain Baush)*
Khangshardi	*Amblypharyng odon microlepis (Mola)*	*Batasio tengana (Tengra),* and *Puntius terio (Puti)*	*Heteropneus tes fossilis (Shingi), Clarias batrachus (Magur), Anabas testudineus (Koi), Nandus nandus (Meni), Anguilla bengalensis (Baim)* and *Channa punctatus (Taki)*	*Channa marulius (Gozer), Wallago attu (Boal), Channa striatus (Shol), Labeo calbasu (Kalo Baush)* and *Notopterus notopterus (Foli)*	*Ompok pabo (Pabda), Leiognathus equulus (Tekchanda), Notopterus chitala (Chital), Bengala elanga (Bangla), Aorichthys aor (Ayer), Cirrhinus reba (Bhagna), Ailia coila (Batashi), Anguilla bengalensis (Bain Baush), Macrabrachium rosenbergii (Baro Chingri), Gudusia chapra (Chapila)* and Mystus cavasius (Gulsha)

Annexure - 8

Availability of Frog in Study Villages

Village	Name of Frog	Availability of Frog (Four Decades Ago)			Availability of Frog (2003)			
		Sufficient	Moderate	A little	Sufficient	Moderate	A little	Extinct
Shahpur	*Bufo melanostictus (Kuno Bang)*	100.00%	-	-	-	45.45%	54.55%	-
	Hoplobatrachus tigerinus (Kola Bang)	100.00%	-	-	-	-	100.00%	-
	Euphlyctis cyanophlyctis (Bhasha Bang)	100.00%	-	-		63.64%	36.36%	-
	Rana talpehensis (Gach Bang)	54.55%	45.45%	-	-	-	13.64%	86.36%
Gazipur	*Bufo melanostictus (Kuno Bang)*	100.00%	-	-	-	21.05	78.95%	-
	Hoplobatrachus tigerinus (Kola Bang)	100.00%	-	-		-	100.00%	-
	Euphlyctis cyanophlyctis (Bhasha Bang)	100.00%	-	-	-	52.63	47.37	-
Alabdi	*Bufo melanostictus (Kuno Bang)*	100.00%	-	-	15.79	57.79	26.32	-
	Hoplobatrachus tigerinus (Kola Bang)	100.00%	-	-	15.79	73.68	10.53	
	Euphlyctis cyanophlyctis (Bhasha Bang)	100.00%	-	-	10.53	63.16	26.32	
Khangshardi	*Bufo melanostictus (Kuno Bang)*	100.00%	-	-	16.67	75.00	8.33	-
	Hoplobatrachus tigerinus (Kola Bang)	100.00%	-	-	16.67	66.67	16.67	
	Euphlyctis cyanophlyctis (Bhasha Bang)	100%	-	-	33.33	50.00	16.67	

Annexure - 9

Causes of Decreasing Reptile Population and Decreasing and Extinction of Wild Mammals in Study Villages

Causes of Extinct and Decrease	Shahpur %)		Gazipur (%)		Alabdi (%)		Khangshadi (%)	
	Vil.	ERs.	Vil.	ERs.	Vil.	ERs.	Vil.	ERs.
(a) Large scale deforestation	90.91	100.00	89.47	100.00	100.00	83.33	100.00	83.33
(b) Hunting/ killing of wild lives	90.91	83.33	97.37	100.00	100.00	16.67	75.00	33.33
(c) High rate of population growth	6818	100.00	63.16	83.33	–	66.67	58.33	83.33
(d) Scarcity of food	59.09	50.00	78.95	83.33	84.21	50.00	50.00	66.67
(e) Use of fertilizers and insecticides in crops	40.91	66.67	42.11	50.00	–	–	–	–
(f) Lack of safe habitat for wild lives	36.36	33.33	47.37	50.00	68.42	33.33	33.33	66.67
(g) Disturbning or killing of wild lives without any cause	–	66.67	–	66.67	–	100.00	–	100.00
(h) Left the area for getting fear during heavy fighting in the war liberation	18.18	–	–	–	–	–	–	–
(i) Dense houses in the Village	–	–	–	–	63.16	–	–	–
(j) High frequency of flood	–	–	–	–	–	–	16.67	–

Annexure - 10

Steps Needed to Increase Reptiles and Wild Mammals and Domestic Animals of Study Villages

Village	Steps Needed to Develop Reptiles and Wild Mammals		Steps Needed to Develop Domestic Animals	
	Steps	% of Responde-nts	Steps	% of Responde-nts
Shahpur	(a) Stopping hunting/ killing of wild lives with adopting legal measures	(a) 100.00	(a) Creation of pasture land for livestock	(a) 100.00
	(b) Creation of more forest coverage	(b) 77.27	(b) Increase treatment facilities for livestock	(b) 59.09
	(c) Creation of safe habitat for wild lives	(c) 72.73	(c) Reduce the price of cow feed	(c) 45.45
	(d) Use of fertilizers and insecticides should be stopped	(d) 31.82	(d) Enhance security for preventing of livestock from stealing	(d) 18.18
	(e) Need to create social awareness.	(e) 9.09	(e) Enhance credit facilities	(e) 13.64
Gazipur	(a) Stopping hunting/killing of wild lives with adopting legal measures	(a) 92.11	(a) Creation of pasture land for livestock	(a) 92.11
	(b) Creating of more forest coverage	(b) 65.79	(b) Increase treatment facilities	(b) 44.74
	(c) Creation of safe habitat for wild lives	(c) 63.16	(c) Reduce the price of cow feed	(c) 36.84
	(d) Common people needs to aware through programme implementation	(d) 31.58 (e)	(d) Enhance security for preventing stealing of livestock	(d) 13.16
	(e) Use of insecticides should be stopped	(f) 21.05	(e) Enhance credit facilities	(e) 5.26
Alabdi	(a) Stopping hunting/ killing of wild lives with adopting legal measures	(a) 100.00	(a) Creation of pasture land for livestock	(a) 78.95
	(b) Creation of more forest coverage	(b) 68.42	(b) Increase treatment facilities	(b) 57.90
	(c) Creation of safe habitat for wild lives	(c) 52.63	(c) Reduce the price of cow feed	(c) 57.90
	(d) Common people needs to aware through programme implementation	(d) 10.53	(d) Loan should be provided without interest	(d) 15.79
			(e) Low land should be filled up and make place for keeping cow	(e) 10.53
Khangshardi	(a) Stopping hunting/killing of wild lives with adopting legal measures	a) 100.00	(a) Create pasture land for livestock	(a) 66.67
	(b) Creation of more forest coverage	b) 91.67	(b) Price of cow feed should be reduced	(b) 66.67
	(c) Creation of safe habitat for wild lives	c) 50.00	(c) Increase treatment facilities for livestock	(c) 41.67
	(d) Population control should get more attention	d) 16.67	(d) Provide loan without interest	(d) 16.67

Annexure - 11

Available Birds in the Study Villages Four Decades Ago

Birds	Village			
	Shahapur	Gazipur	Ababdi	Khangshardi
(i) Copsychus malabaricus (Doyal)	HA	HA	HA	MA
(ii) Corvus splendens (Kak)	HA	HA	HA	HA
(iii) Ardea goliath (Bok)	HA	HA	HA	CA
(iv) Acridotheres tristis (Shalik)	HA	HA	HA	HA
(v) Falco chicquera (Tuntuni)	CA	MA	MA	PA
(vi) Halcyon smymensis (Masranga)	CA	MA	HA	CA
(vii) Dinopium benghalensis (Kaththukkra)	PA	PA	MA	PA
(viii) Eudynamys scolopacea (Kokil)	PA	PA	MA	PA
(ix) Pycnonotus cafer (Bulbuli)	MA	MA	HA	PA
(x) Ploceus philippinus (Babui)	MA	CA	CA	PA
(xi) Cairina scutulata (Badi Hash)	MA	HA	HA	HA
(xii) Amauromis phoenicurus (Dahuk)	HA	HA	HA	HA
(xiii) Gallicrax cinera (Kura)	HA	HA	HA	HA
(xiv) Phalacrocorax carbo (Pankouri)	PA	PA	HA	CA
(xv) Anastomus oscitans (Shamuk Kasa)	CA	CA	HA	MA
(xvi) Pteropus giganteus (Badur)	MA	CA	MA	CA
(xvii) Sarcogyps calvus (Shakun)	HA	HA	HA	HA
(xviii) Sterna acuticanda (Chil)	CA	CA	HA	HA
(xix) Dicrurus macrocercus (Fingey)	CA	PA	MA	PA
(xx) Passer domesticus (Charui)	PA	CA	CA	PA
(xxi) Bubu nipalensis (Pecha)	MA	CA	CA	PA
(xxii) Streptopelia orientalis (Ghughu)	HA	HA	HA	MA
(xxiii) Psittacula krameri (Tiya)	HA	CA	HA	PA
(xxiv) Gracula religiosa (Moyna)	MA	PA	PA	NA
(xxv) Grus antigone (Sarosh)	NA	NA	MA	NA
(xxvi) Cuculus micropterus (Bou Katha Kou)	NA	PA	PA	NA
(xxvii) Ocyceros birostris (Dhonesh)	NA	PA	PA	PA
(xviii) Treron apicauda (Horikeli)	PA	NA	PA	NA
(xxix) Accipiter trivirgatus (Baj Pakhi)	NA	NA	NA	PA

Note: HA = Highly Available (80-100%) CA = Commonly Available (60-80%) MA = Moderately Available (40-60%)

PA = Poorly Available (Below 40%) NA = Not Available

Available Birds in the Study Villages at Present

Birds	Village			
	Shahapur	Gazipur	Ababdi	Khangshardi
(i) Copsychus malabaricus (Doyal)	HA	HA	CA	MA
(ii) Corvus splendens (Kak)	HA	HA	HA	HA
(iii) Ardea goliath (Bok)	HA	HA	HA	CA
(iv) Acridotheres tristis (Shalik)	HA	HA	CA	HA
(v) Falco chicquera (Tuntuni)	PA	MA	MA	PA
(vi) Halcyon smymensis (Masranga)	PA	PA	MA	CA
(vii) Dinopium benghalensis (Kaththukkra)	PA	PA	NA	PA
(viii) Eudynamys scolopacea (Kokil)	PA	PA	PA	NA
(ix) Pycnonotus cafer (Bulbuli)	MA	MA	MA	PA
(x) Pteropus giganteus (Badur)	MA	PA	PA	PA
(xi) Dicrurus macrocercus (Fingey)	CA	PA	MA	PA
(xii) Passer domesticus (Charui)	PA	MA	MA	PA
(xiii) Bubu nipalensis (Pecha)	MA	CA	PA	PA
(xiv) Streptopelia orientalis (Ghughu)	CA	CA	PA	MA
(xv) Psittacula krameri (Tiya)	CA	PA	MA	NA
(xvi) Sterna acuticanda (Chil)	NA	PA	PA	PA
(xvii) Sarcogyps calvus (Shakun)	PA	PA	NA	NA
(xviii)Phalacrocorax carbo (Pankouri)	NA	PA	CA	MA
(xix) Amauromis phoenicurus (Dahuk)	PA	NA	PA	PA
(xx) Cairina scutulata (Badi Hash)	NA	NA	PA	MA
(xxi) Anastomus oscitans (Shamuk Kasa)	NA	NA	PA	NA
(xxii) Centropus bengalensis (Kukka)	NA	NA	PA	NA

Note: HA = Highly Available (80-100%) CA = Commonly Available (60-80%) MA = Moderately Available (40-60%)

PA = Poorly Available (Below 40%) NA = Not Available

Annexure - 12

Causes Responsible for Decreasing the Number of Birds in Study Villages

Causes	Shahpur (%)		Gazipur (%)		Alabdi (%)		Khangshardi (%)	
	Vil.	ERs.	Vil.	ERs.	Vil.	ERs.	Vil.	ERs.
a) Use of fertilizer and insecticides in crops	100.00	100.00	89.47	100.00	26.32	50.00	41.67	66.67
b) Hunting of birds	81.82	83.33	68.42	66.67	100.00	100.00	100.00	83.33
c) Deceasing the number of fruit trees in the village	50.00	33.33	-	50.00	-	-	-	-
d) Destroying forest and bringing forest area into human habitat	40.91	50.00	36.84	50.00	78.95	66.67	66.67	66.67
e) Scarcity of food	27.27	50.00	68.42	33.33	47.37	66.67	25.00	83.33
f) Lack of safe habitat of birds	22.73	83.33	47.37	83.33	21.05	50.00	33.33	83.33
g) Increase of human population	13.64	16.67	21.05	16.67	52.63	33.33	58.33	50.00
h) Filled up of water bodies	9.91	66.67	18.82	33.33	-	-	-	-
i) Cutting of big trees	9.91	50.00	-	33.33	63.16	66.67	41.67	83.33
j) Stopping of aus paddy cultivation	-	-	-	-	15.79	-	58.33	33.33

Note: No increase of bird population took place in the study villages

Annexure – 13

Extinct and Decreased of Wild Mammals in Study Villages

Village	Wild Lives Extinct	Wild Lives Reduced
Shahpur	*Panthera pardus (Chila Bagh, Macaca mulatta (Banor), Sus scrofa (Buno Sukar), Muntiacus muntjak (Harin), Hystrik indica (Shojaru)* and *Semnopithecus entellus (Hanuman)*	*Vulpex bengalensis (Shiyal), Viverra zibetha (Bagh Dash), Herpestes edwardsi (Begi), Felis chaus (Ban Biral), Lepus nigricollis (Khorgosh)* and *Viverricula indica (Khatash)*
Gazipur	*Panthera pardus (Chita Bagh), Semnopithecus entellus (Hanuman), Macaca mulatta (Banor), Muntiacus muntjak (Harin), Sus scrofa (Buno Sukar)*and *Hystrik indica (Shojaru)*	*Vulpex bengalensis (Shiyal), Viverra zibetha (Bagh Dash), Herpesles edwardsi (Begi), Felis chaus (Ban Biral), Lepus nigricollis (Khorgosh)* and *Viverricula indica (Khatash)*
Alabdi	*Macaca mulatta (Banor), Lepus nigricollis (Khorgosh), Viverra zibetha (Bagh Dash), Hystrik indica (Shojaru)* and *Panthera pardus (Chita Bagh)*	*Vulpex bengalensis (Shiyal), Felis chaus (Ban Biral), Herpestes edwardsi (Begi), Viverra zibetha (Bagh Dash)* and *Viverricula indica (Khatash)*
Khangshardi	*Macaca mulatta (Banor), Lepus nigricollis (Khorgosh), Viverra zibetha (Bagh Dash), Hystrik indica (Shojaru)* and *Panthera pardus (Chita Bagh)*	*Vulpex bengalensis (Shiyal), Felis chaus (Ban Biral), Herpestes edwardsi (Begi)* and *Viverricula indica (Khatash)*

Annexure - 14

Causes Responsible for Decreasing of Domestic Animals in Study Villages

Causes of Reduction	% of Respondents			
	Shahpur	Gazipur	Alabdi	Khangshardi
(a) Adoption of modern method of crop production	(a) 90.90	(a) 71.05	(a) 47.37	(a) 41.67
(b) Reduction of pasture land	(b) 77.27	(b) 94.74	(b) 84.21	(b) 83.33
(c) Goat eats crops of other's and causes quarrel	(c) 63.64	(c) 31.58	(c) 5.26	(c) 33.33
(d) Cost of cow feed is high	(d) 45.45	(d) 34.21	(d) 89.47	(d) 41.67
(e) Inadequate treatment facilities	(e) 31.82	(e) 50.00	(e) 15.78	(e) 16.63
(f) High rate of stealing	(f) 22.73	(f) 47.37	(f)-	(f)-
(g) Space problem for keeping cow	(g) 13.64	(g) 18.42	(g) 73.68	(g) 66.67
(h) Scacity of grasses	(h) –	(h) 28.95	(h) –	(h) 41.67
(i) High rate of mortality	(i) –	(i) –	(i) 5.26	(i) –
(j) High frequency of flood	(j) –	(j) –	(j) –	(j) 16.63
(k) Lack of capital	(k) -	(k) -	(k) -	(k) 16.63

Annexure - 15

Feasibility Works Adopted Before Development Works Start

Feasibility Works Adopted Before Development works Start	Comilla Sadar		Sonargaon	
	No.	%	No.	%
(i) Socio-economic survey	2	20.00	4	40.00
(ii) Survey the surroundings areas of project/ field survey	3	30.00	2	20.00
(iii) Water and soil tests	2	20.00	1	10.00
(iv) Project site visits and discussions with the people of the project area	2	20.00	1	10.00
(v) Survey at the grass root level	1	10.00	2	20.00
(vi) Project feasibility study	3	30.00	-	-
(vii) Sharing of experiences with fishermen	1	10.00	1	10.00
(viii) Contact with UP Chairman at the initial stage of project implementation	1	10.00	1	10.00
(ix) Informing common people of the project area about the project activities before it starts	1	10.00	1	10.00
(x) Check whether the same project was implemented by other organizations in the past	-	-	2	20.00
(xi) Project area selection through field level observations	2	20.00	-	-
(xii) Data collection from project area	-	-	1	10.00
(xiii) Visit ponds in case of providing assistance	-	-	1	10.00
(xiv) Make contact with the villages	-	-	1	10.00
(xv) Feasibility works of farm establishment	-	-	1	10.00
(xvi) Feasibility works of environmental effects during field visit	-	-	1	10.00
(xvii) Fields and farmers survey	-	-	1	10.00
(xviii) Feasibility works and crop production plan	-	-	1	10.00
(xix) Feasibility assessment of technologies to be applied	-	-	1	10.00
(xx) Land use assessment every year	-	-	1	10.00
(xxi) Field assessment of different development activities	-	-	1	10.00
(xxii) Survey on 'Khas' land and landless people	-	-	1	10.00
(xiii) Assessment of agriculture environment	1	10.00	-	-
(xxiv) Crop harvest and data collection	1	10.00	-	-
(xxv) Project implementation through tender	1	10.00	-	-
(xxvi) Assessment of marketing facilities	1	10.00	-	-
(xxvii) Appointing consulting firms for pre assessment of development works in case of big project implementation	1	10.00	-	-
(xxviii) Training on goat raring methods	1	10.00	-	-
(xxix) Social and economic condition assessment of project area	1	10.00	-	-
(xxx) Create common people interest about the development work	1	10.00	-	-

Annexure – 16

Environmental Related Measures Adopted Before Starting Development Works

Comilla Sadar		Sonargaon	
Development Activities	Environmental Measures Adopted	Development Activities	Environmental Measures Adopted
(i) Insecticides application in crops	(i) Minimum use of insecticides in crops	(i) Livestock farm establishment	(i) Biogas, manures, fish feed etc. production
(ii) Fertilizers used in crops	(ii) Balanced fertilizers use in crops	(ii) Sanitation work	(ii) Awareness building and support services
(iii) Species selection of fishes	(iii) Quality of water and soil assessment	(iii) Development of health	(iii) Not use excessive insecticides
(iv) Preparation of pond	(iv) Measures adopted on the basis of water and soil quality	(iv) Providing drinking water	(iv) Awareness building for taking arsenic free water
(v) Construction of road, culvert and bridge	(v) Keeping sufficient space for drainage facilities	(v) Fertilizer used	(v) Application proper dose of fertilizers
(vi) Installation of tube well	(vi) Keeping sufficient distances among TWs and arsenic testing	(vi) Crop production	(vi) Very limited use of insecticides
(vii) Cutting of trees	(vii) New plantation	(vii)Plantation program	(vii)Adoption of Social forestry program
(viii) Crop cultivation	(viii) Adoption of IPM	(viii) Road, culvert and bridge construction	(viii) Ensuring better navigation and migration of aquatic lives
(ix) Farmers awareness	(ix) Awareness development on environmental and plantation	(ix) School and other physical infrastructures construction	(ix) Ensuring sufficient light and air; and beauty of the area
(x) Credit support	(x) Improving sanitation condition	(x) Canal and pond excavation	(x) Ensuring better drainage facilities and conserve aquatic lives
(xi) Health service	(xi) Information dissemination and awareness building	-	-
(xii) Farm establishment	(xii) Proper management of feaces and urine	-	-

Annexure – 17

Environment Policy Adopted by Different Departments at the Upazila Level

Department	Adopted Policy
(a) Department of Fishery	a.1 Carrying out tests on chemical compositions of soil and water a.2. Conserving native and exotic species of fishes a.3 Strictly discouraging of catching all fishes through draining of all waters from water bodies
(b) Bangladesh Water Development Board	b.1 Developing of fish resources b.2 Reducing salinity in the coastal area b.3 Afforestation through planting of different fruits and other tree
(c) Department of Social Welfare	c.1Carrying out sanitation works c.2 Carrying out family planning works c.3 Keeping environment neat and clean
(d) Department of Livestock	d.1 Advising common people on proper utilization of waste developed due to raring of livestock and poultry d.2 Motivating common villagers for covering dead animals and birds with soil, so that environment remain clean
(e) Department of Agricultural Extension	e.1 Carrying out plantation works e.2 Adopting IPM programme for crop protection e.3 Motivating common villagers on using balanced fertilizers
(f) Local Government and Engineering Department	f.1 Conserving free movement of fish and other aquatic lives f.2 Conserving all types of wild lives f.3 Encouraging plantation works and prevent deforestation
(g) Bangladesh Rural Development Board	g.1 Replcing of unhygienic toilets with wate sealed latrin g.2 Planting of fruit, timber and medicinal plants g.3 Keeping area neat and clean
(h) Bangladesh Rural Advancement Committee	h.1 Do not adopt any programme which is not environment friendly
(i) Association of Social Advancement	i.1 No staff of the organization can smoke i.2 No credit is provided for establishing workshop which is not environment friendly i.3 Providing loan for homestead plantation