MACH

RESTORATION OF VEGETATION AND SUSTAINABLE MANAGEMENT OF THE WETLADS AND WATERSHEDS OF *HAIL HAOR* BASIN AND *TURAG-BANGSHI* FLOODPLAIN

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RESTORATION OF VEGETATION IN THE WETLANDS AND WATERSHEDS OF *HAIL HAOR* BASIN, AND TURAG - BONGSHI FLOODPLAIN

Consultant Report
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Management of Aquatic ecosystem through Community Husbandry (MACH)

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ACRONYMS

AC Land	Assistant Commissioner of Land
BCAS	Bangladesh Center for Advanced Studies
CNRS	Center for Natural Resource Studies
DAE	Department of Agricultural Extension
DoF	Department of Fisheries
ERD	Economic Relations Division of the Ministry of Finance
FD	Forest Department
FY	Fiscal Year
GIS	Geographical Information System
GOB	Government of Bangladesh
HFL	Highest Flood Level
LGED	Local Government Engineering Department
MACH	Management of Aquatic ecosystem through Community Husbandry
MoFL	Ministry of Fisheries and Livestock
MoL	Ministry of Land
MP	Muriate of Potash
NGO	Non-Government Organization
RIMS	Resource Information and Management System
RRA	Rapid Rural Appraisal
RMC	Resource Management Committee
TSP	Triple Super Phosphate
UNO	Upazila Nirbahi Officer
UP	Union Porishod
USAID	United States Agency for International Development
ZMC	Zonal Management Committee

EXECUTIVE SUMMARY

1. Introduction/Background

Restoration of vegetation in the watersheds of *Hail Haor* basin and *Turag-Bongshi* floodplain is an extended program of the MACH project. The original MACH project was developed to demonstrate the viability of a community approach to natural resource management and habitat conservation over an entire floodplain. Activities envisaged under the original project were limited to wetland areas. The activities included floodplain resource development, community organization and supplemental income-generation, and monitoring. While deciding project interventions and formulating program plans, it became apparent from community discussions that improper land use in the watersheds outside the wetland seriously threatened sustainability of the envisaged wetland development programs. The magnitude of the problem and the threat they posed necessitated adoption of demonstration vegetation restoration programs in the watershed.

2. Scope of Vegetation Restoration Activities

Two distinctive tree plantation venues were identified for vegetation restoration program. These are: (i). Demonstration watersheds and riparian zones of at least two active *charas* draining to *Haor* and *Beels*, and (ii). Peripheral shallow water zones of *Haors* and *Beels* where MACH is working, and also forelands of dyke structures in *Haor* and *Beel* situations. MACH will work with and motivate the owners of watershed and stream bank lands, especially the pineapple and lemon gardeners to practice contour farming methods and adopt appropriate soil and water conservation measures.

3. Plantation Models:

Site specific plantation models recommended in this report are as follows:

a. *Riparian Vegetation Restoration Model*

i. Upper reaches of *chara* sections: This includes the hilly terrain of watershed in the upper portion of the catchment . Restoration measures involve both new planting on denuded terrain and protection with enrichment planting in degraded situations. Minimum width of the new vegetation belt on either bank of the stream optimally would be 100m. Species suitable for restoration program are typically hilly species of indigenous as well as domesticated exotic origin. List of recommended species has been provided for in section 6.2.1.

ii. Middle reach of chara sections: Soil and terrain conditions of the middle reaches are almost similar to the upper reaches except that the ground elevation is comparatively lower and slope gradients milder. Middle reach areas are more intensively cultivated with orchards, tea and other agricultural crops. Optimal 100m wide restoration plantation establishment on bank top may pose practical difficulty in many locations. In problematic situations, plantation width may be reduced from 100m to the realistically available widths but not below 20m (1 chain). List of recommended species has been shown in section 6.2.1.

iii. Lower Reaches of *Chara* Sections: This section generally passes through flat terrain which is intensively cultivated and contains human habitation on the chara banks before the chara finally meets the Haor basin. During heavy rainfall, floodwater often spills over the chara bank. Species that can withstand temporary or long duration submersion should be the choice. The list of recommended species are included in section 6.2.1. Because of high intensity cultivation of streambank flatlands, attainment of 20m wide tree plantation belt would be

difficult except when charas pass through khas lands. However, maintaining close liaison with Resource Management Committee (RMC), the stripwidth he adjoining landowners should be established. The plantation depth should in no case be less than 4-5 rows. Alternatively, efforts should be made to cover maximum plantation length with bamboo (see Bamboo plantation model below).

iv. Bamboo Plantation Model along the Chara Bank: Bamboo is the best as riparian vegetation from a soil conservation and bank stability stand point. Because of its numerous fibrous roots, bamboo clumps firmly hold soil mass withstanding erosive scouring action of stream flows. The economic justification of favoring bamboo is that the return from bamboo is much higher and quicker when compared to timber species. Bamboo should therefore be a priority species for *chara* bank planting unless constrained by supply of planting stock.

v. *Chara* slope restoration model: *Chara* slope stabilization measures include planting of reeds and grasses on the slope in its upper half (indicated in the figure in section 6). The desired species with a meter high stub should be planted in March-April and established before the rainy season so that the planted material is not washed away by strong currents of the early season rainfall. March-April planting may need some irrigation.

b. Watershed vegetation Restoration Model

The Watershed is subjected to different land uses that include forestry, tea cultivation, pineapple and lemon gardening and homesteads. While forestry and tea gardening land use models are fairly standardized, the other land uses including pineapple and lemon gardening are yet to be standardized to effectively control soil erosion. Pineapple and lemon cultivation should follow contour cultivation model depicted in figure 2 of this report. For restoration of denuded hilly watersheds, fresh planting should be done. The plantation model involves cleaning ground vegetation of all weeds and brush woods in March-April and planting done in May with man-height seedlings. List of recommended species is included in section 6.2.1.

c. Wetland Vegetation Restoration Model.

Wetland vegetation may be grown in blocks or in strips, depending on the shape of land available for plantation. Plantation spacing should be 2m x 2m. Species selection should be confined only to typical wetland trees, and the list of recommended species is included in section 6.2.1. Seedlings will be planted in the receding flood, usually beginning from October and continuing up to December. To promote bio-diversity, a mixed plantation will be encouraged instead of mono-culture.

Apart from tree species, a number of typical reeds and grasses will also grow well in the wetland. These are economically important and socially appropriate. Important plants are Murta, Vetiver, Nol, Khagra, Ikr, Dhol Kolmi etc. These may be grown as pure reed crop in the forelands of the tree stands at 1m x 1m spacing. All reeds are grown by rhizome planting simultaneously with tree species plantation timing. Dhol Kolmi is grown by planting cuttings in the dry soil.

d. *Roadside Plantation Model*

Roads likely to be available for plantation are UP roads, generally narrow with low elevation and shorter slope width. The general plantation layout plan will be a single row of trees on either side of the carriageway. If wider slope width is available, more than one row may be planted. Planting will be done on slopes above the highest flood level (HFL). Choice of species is indicated in section 6.2.1. To install an in-built mechanism of plantation protection against cattle damage, live hedgerows of Arhar/Boga medula will be established along the edge of the roads. Typical layout plan showing one

and two row of trees and the position of Arhar/Boga medula live hedgerow can be seen in figure 2 and 3 of section 6.

4. Vegetation Restoration Plan

a. Chara Bank: Lands on which restoration plantation are planned on chara banks are privately owned. MACH with the active participation of the local Upazila Porishod, UP, RMC and landowners will organize plantation implementation plans on a benefit-sharing mechanism in which 80% benefit will go to landowners, 15% to UP and 5% to RMC. RMC, UP and MACH motivate the landowners to devote their land for plantation establishment.

b. Watershed: Ownership of the watershed or catchment lands belongs to varied landowning agencies starting from the State to individuals. Vegetation restoration programs and corrective land use practices must done be done through partnership with the land using agencies. The role of MACH will primarily be that of extending techniques and aiding and advising landowners with appropriate land use packages.
Regulation of land use for Forest Department (FD) and Tea Estate controlled areas may be accomplished by maintaining close liaison with these agencies, pointing out their harmful land use practices, maintaining continued coordination, and monitoring changes. Greater attention is to be paid to pineapple and lemon gardening where 'across the contour cultivation method' pursued by the gardeners is causing serious harm to the landscape degrading its fertility and productivity, provoking soil erosion and silting up streambeds and water reservoirs. With these groups, MACH-CNRS efforts will be directed to bring about changes in cultivation practices to "Along the contour cultivation method" and adoption of soil conservation measures through demonstration and motivation.

c. Wetland Vegetation Restoration: Wetlands suitable for planting, whether under public or private ownership, are now mostly cultivated with Boro paddy. Plantation raising on *Khas* land poses no legal problem but social consensus is required. Various committees at Upazila and RMC levels should strive to procure land for wetland vegetation restoration. These committees may however decide in favor of compact block plantation establishment on agriculturally less productive marginal wetlands or allocate a continuous belt of 100-150m wide fringe land all along the outer periphery of the Haor or beel for plantation establishment. Marginal and wastelands along stream banks, slopes of dykes and roads within the greater *Haor and Beel* areas may be immediately available for restoration plantation and will likely not be controversial. One such land type of appreciable magnitude is the Kagaurar Kandi, and should be planted soon.

4. Plantation Venues

Following are the identified plantation venues for the planned vegetation restoration program:

i. Riparian plantation along *chara* banks (upper reaches, middle reaches and lower reaches);

ii. Wetland plantation on *Haor* and *Beel* fringe lands (block, strip or shelter belt type plantation), strip plantation along streams bank or road slope (in Haor situation),

iii. *Chala* land plantation in Turag-Bongshi floodplain; and

iv. Roadside plantation along Union Porishod road.

6. Planting Time and Plantation Maintenance

Except for the wetlands, all planting should be done during monsoon season, starting from April-May and continued up to August-September. Planting in the wetland situations should be done in the receding flood season (October to December). In case of monsoon planting, the earlier the planting is

done in April-May, the better is the success rate and growth recruitment because plants get full growing season of 6-7 months to register growth.

For the receding flood planting season, planting time should not be construed as any time between October and December. Rather to watch for ground permissiveness for planting with water recession. This implies that, planting cannot be done in one go. The proposed planting sites should be regularly visited and whenever the grounds come above water level, and the soil condition is dry enough to permit hole digging and planting, saplings should be planted.

Tree seedlings must be established in dry soil condition so that new root development takes place before inundation occurs. If sapling base is flooded soon after planting i.e., before fresh root development in the new plantation site, transplanted seedling will die. Planting may however be done in mud that has started drying but not in stagnant pool of water.

Plantation success depends on the quality and punctuality of subsequent maintenance. Maintenance include weeding and cleaning, pruning of side branches, vacancy filling, stake replacement, irrigation, mulching, fertilizing, plant protection measures etc. Itemized maintenance job description and year wise activity schedule up to the 15th year of a plantation have been described in sufficient details in section 6 of the main report.

7. PLANTATION MANAGEMENT SYSTEM

Restoration plantations are established on delicate landscapes to serve specific watershed and wetland functions. These plantations should not be viewed as exclusive commercial plantations for maximum financial gains. The project plantations require special treatment and harvesting system that ensures optimum income without causing a harm to the ecosystem. The 3 sets of plantations could therefore be managed under the following systems:

a. **Watershed and Riparian Plantations**: Trees from these plantations will not be felled by clear cutting because this will again expose the watershed and riparian tract floor to degradation. Instead of clear-felling of the plantations, only the largest will be felled during the 15th year on a selective basis. This is called ***Selection Harvesting***. Such felling may be done on a 5 year felling cycle and the gaps created in the plantation due to such felling will be re-stocked by fresh seedling planting, a process called 'Enrichment Planting'

b. **Roadside Plantation**: Felling of roadside plantation is a project commitment for affording benefits to the program participants but clear-felling of such plantations is objectionable from aesthetic and environmental considerations. One formula for management would be leaving a few elite trees at 40-50 m distance. These elite trees will form part of the future crop and may be felled after completion of the next rotation fetching high return to the beneficiaries. If, however, the beneficiaries decide to reap the benefit quickly, these elite trees could be felled at the time of thinning of the second rotation plantations. At that stage, the young plants of second rotation will have grown to sufficient height, and felling of a few elite trees will not make much difference to the landscape and its look.

c. **Wetland Plantation**: Wetland trees will not be felled at regular intervals except when dead or defective or over matured. Instead, branches of wetland tree groves will be lopped above the HFL of the locality so that even during the worst ever flood, tree crowns will not be submerged. This type of harvesting management is called "***Pollarding***". Wetland species with special have an endurance quality to withstand lopping and still recoup the photosynthetic loss by gregarious sprouting of new leaves with the onset of next growing season.

8. Project Nursery Establishment

Typical wetland and submersion tolerant species are usually not quality timber. They have poor

market demand as timber. Common planters hardly show interest to buy or plant such species as their priority or chosen plant. The project plantation sites are subjected to sudden inundation or heavy pressure of cattle grazing and human interference. Man-height tall seedlings beyond reach of man, animals and natural adversities are required. Commercial nurseries do not produce such specialized seedlings as these are not demanded by the common planters. It has become incumbent for MACH to establish its own nursery for implementing the wetland and riparian zone plantation successfully. Such nursery establishment work can be accomplished either directly as MACH staff activity, or implemented through the project participants under staff supervision.

Elaborate guidelines for nursery establishment and upkeep are incorporated as a separate chapter of this reports (Section 10) which should be consulted by the staff entrusted with nursery development. A short training course of about 3 days duration on nursery and plantation establishment and upkeep is recommended for the MACH staff, and also for the project beneficiaries at the project sites.

9. Turag-Bangshi Watershed Management and Vegetation Restoration Program

- **Chala Land Plantation Model**

Depending on the terrain type and their situation, plantation model on *chala* land could be:

(a) Dense block plantations;

(b) Shelter belt type linear plantations along farm boundary or terrace walls;

(c) Scattered trees on farm land; and

(d) Grass on badly eroding sloping terrain.

Each of the tree-type plantation models could be established with both forest/timber yielding species as well as with fruit bearing species.

- **Choice of species:**

Forest/Timber tree species: In the chala land as well, two terrain situations are recognized viz.. *high lands* i.e., land areas not subjected to inundation at all; and *low lands* i.e., lands that are subjected to temporary inundation. For both these terrain situations, suitable timber tree species are available. Choice species have been portrayed in section 7.8.2 of the report.

Fruit Species: Fruit tree species are to be planted on high lands. Fruit species will not grow in waterlogged situations. The general soil type of *Bhawal-Modhupur Gorh* chala lands is iron rich lateritic or red soil, renowned for Jackfruit and pineapple growing. Major supplies of these two fruits to different destinations of the country go from this tract and so their cultivation should continue to be preferred. However, almost all tropical fruits including Mango. Lichi, Guava, Shaddok, Sopheda, Kul (Boroi), Jalpai, Amloki, Lotkon, Kalo Jam, Kamranga, Chalta, Wood apple and Coconut grow well and should be encouraged.

- **Seedling supply arrangement for fruit species:** For fruit tree propagation, the biggest limitation is the serious shortage of quality seedlings. While commendable progress in timber tree seedling production was made in the commercial nursery sector, a break through is yet to be made in fruit. To ensure supply of quality fruit seedling for the project plantations, prior arrangement with the Department of Agriculture Extension (DAE,) various horticulture research institutes and multiplication centers in different regions of the country need be made.

10. Benefit Sharing Mechanisms

Vegetation restoration activities are planned on watersheds, stream banks and *Haor/Beel* lands. Ownership of some of these lands belongs to the State while most of these are privately owned or Leasehold State lands. Plantation and protection activities envisaged under the project should be implemented and managed on participatory principles through benefit-sharing mechanisms. The following are suggested benefit-sharing mechanisms:

- Plantation on privately owned or leasehold lands: 80% of the benefits to participating landowners, 15% to UP, 5% to RMC.
- Plantation on State owned *Haor* or *Beel* wetland: 80% of the benefits participating fisher groups, 15% to UP, 5% to RMC.
- In respect of roadside tree plantations: 40% proceeds to participating beneficiary groups, 40% to the adjacent landowners and 20% to the local UP.
- The promised benefit to different beneficiary partners will be guaranteed by executing formal agreements. Sample copies of the beneficiary agreements enclosed as Appendix 5 of this report.

11. Policy Advocacy

Most of the lemon and pineapple garden lands are government *Khas* lands leased out to gardeners on an annual or periodic lease basis meaning that these leases are subject to renewal. The government reserves the rights to renew or cancel the lease. In view of the great difficulty of getting land for riparian plantation and wetland vegetation restoration program, both being national priority restoration programs, the GOB should review their land leasing policy especially in the watersheds and wetlands. GOB should be advised not to lease out any land within 100m of the stream bank in the watersheds and preserve these sites as protected areas for soil and water conservation purpose. Such lands should be designated as protected areas in the official gazette to guarantee their proper use. In respect of State owned watershed lands, the lease conditions should also incorporate terms and conditions regulating cultivation practices prohibiting all forms of 'across the contour' cultivation and the legal compulsion to undertake soil and water conservation measures by the lessees. In respect of wetlands, reasonable blocks of strategically located *Khas* lands, inherently poor quality site from paddy cultivation, should be excluded from the purview of annual or periodic lease, and allocated for wetland vegetation restoration program.

1. INTRODUCTION

Located at the confluence one of the mightiest river systems of the world - the Ganges, the Brahmaputra and the Meghna river systems - Bangladesh is a veritable deltaic country. The inland fisheries and floodplains in Bangladesh form one of the world's most important wetlands. Home to hundreds of species of unique tropical plants, fish, birds and other wildlife, as well as critical habitat for thousands of migratory birds, these wetlands are important source of income and nutrition for the millions of Bangladeshis. However, in the past decades, the inland fisheries and floodplains catch of the country as well as the overall plant and animal diversity within the floodplains have declined. The government, NGOs, and all floodplain users have long recognized that the wetland habitats are not only in the decline but critical in most situations. Given that, Bangladesh's already mammoth population is steadily increasing at a high growth rate of over 2%, the declining trend of the wetland habitats and fisheries resources are very severely affecting its economy as well as health and nutrition of the citizens especially rural populace. This declining trend is a matter of grave concern for the nation and sounds far reaching serious consequences particularly for those whose livelihood and/or nutrition is directly dependent on the catches and income from inland fisheries and floodplains.

Recognizing that pragmatic solution to intricate watershed problems needed community-based approaches to the management of such resources, the Government of Bangladesh (GoB) and United States of America (USA) jointly developed a program called "Management of Aquatic ecosystem through Community Husbandry (MACH)" to demonstrate the plausible participatory development approach. The *Hail Haor* Basin in Moulvi Bazaar District and Turag-Bongshi River Basin in Gazipur-Tangail Districts had been chosen as the pioneering venues for program implementation. Should fund permit, the project program was sought to be extended to Sherpur District.

MACH project was initially conceived to promote environmentally sound management of floodplain resources (fisheries and other wetland products). But while formulating implementation details of the project, it revealed that apart from fisheries and dry season water scarcity problems in the wetland proper, abuse of watersheds by various land using agencies had been seriously threatening potentiality of the wetlands itself as active aquatic ecosystem. Huge quantity of silt drains to the *Haor/beel* bottom annually from the upper watershed (over 100,000 tones/annum to *Hail Haor*) and the siltation is progressively reducing the depth and water storage capacity of the wetlands directly affecting potential fish retention and fish bio-diversity. Appropriate watershed management interventions were urgently called for, else all investment in the aquatic ecosystem development will go waste.

The present consultancy is aimed at examining the state of *Hail Haor* basin, the adjoining wetlands and surrounding watersheds from sound ecosystem management perspectives; recommend MACH project with technically sound, ecologically desirable and socially appropriate watershed management package for the watershed areas and wetlands. The overall recommendations are intended to include interventions like soil and water conservation measures, decreased surface runoff and increased percolation of rain water in the watershed sub-soil thereby facilitating increased dry season stream flow eventually making greater water availability for fisheries and irrigation. The consultant report is also intended to recommend restoration of wetland and wildlife habitats through rehabilitation of Haor vegetation and bio-diversity. Examination of the existing participatory approach to resource management and recommendation for appropriate community-based management practices are the other outputs desired. Detailed terms of reference (TOR) of the consultant is enclosed as Appendix-I of this report

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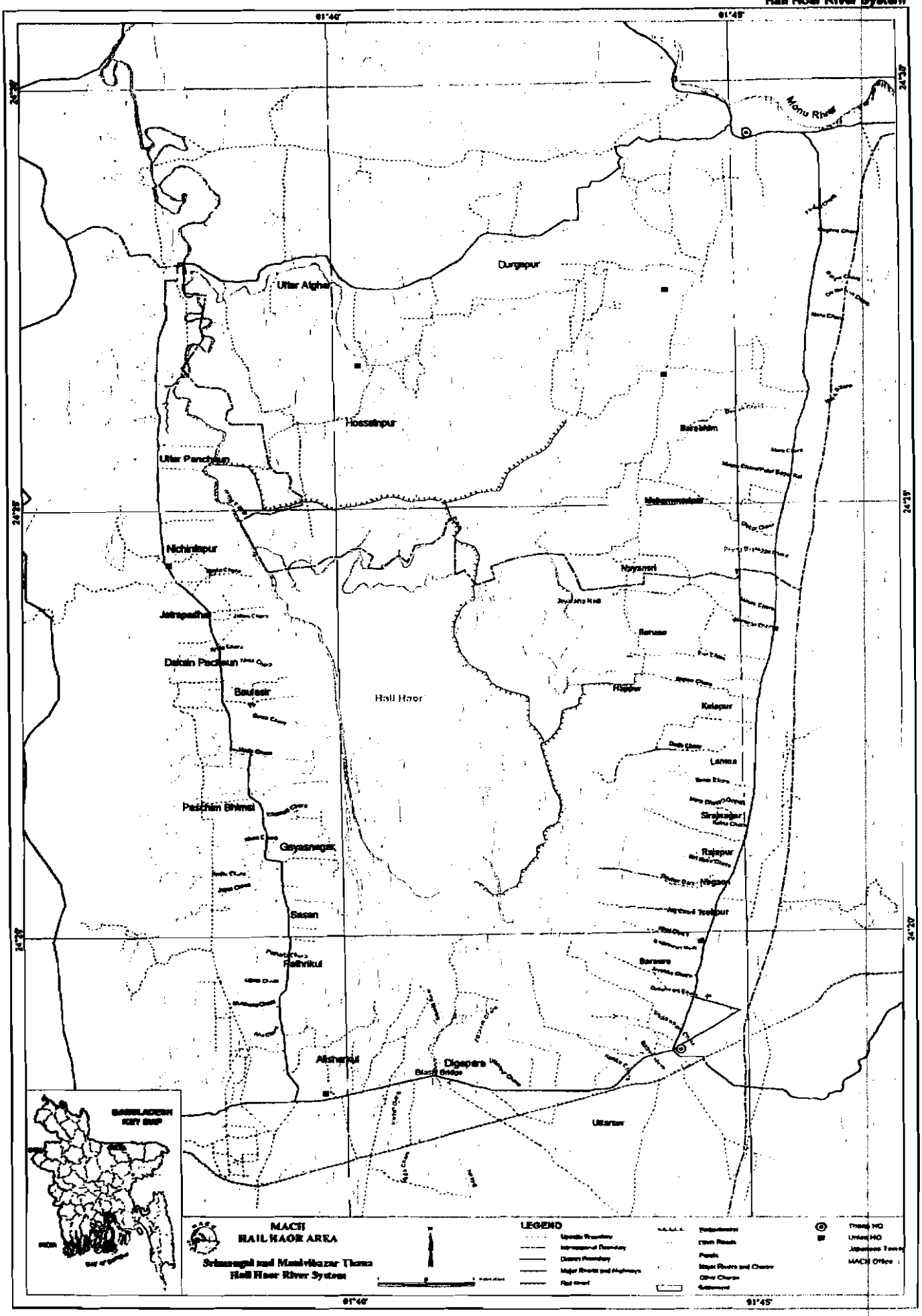

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2.0 OVERVIEW OF THE HAIL HAOR WETLAND AND WATERSHED

2.1 Wetland: Principal Vegetation:

i. Aquatic Vegetation

The *Haor* supports rich aquatic vegetation, which varies in composition from season to season, and from *beel* to *beel*. In pre-monsoon period, the margins of the *beels* and fallow low lands between the beels are converted into rice paddy cultivation. CNRS carried out dry season vegetation survey between 1.11.99 to 30.11.99 and found 84 species of aquatic vegetation. List of these are included as Appendix-2. The dominant aquatic vegetation includes *Typha elephantina, Trapa bispinosa, Nelumba nucifera, Hygrorhiza aristata, Eichhornia crassipes* and species of *Utricularia, Ceratophyllum, Vallisneria, Najas, Potamogeton, Nymphoides, Pistia, Lemna* and *Azolla.*

CNRS also carried out wet season vegetation survey between 5-17 August 2000, and observed 86 species of vegetation. Lists of these are included as Appendix-3. Among the wet season vegetation, 11 species are dominant viz., *Oryza rufippgon, Hygroryza aristata, Eichbornia crossipes, Psendo raphis spp, Nympaea spp., Nelumtro nucifera, Monochoria hastata, Hydrillaverticillata, Najas graminea, Ceratophyllum spp,* and *Utricularin auria.* Among the 86 species of hydrophytes identified, people commonly use some 15 varities for multiferious needs viz., 3 for fishmeal (Hydrilla, Najas and Azolla), 6 for cattle feed (Jhoradhan, Paura, Arail, Jarmini,, Oogla,Choto chera), 2species for bio-fertilizer (Jarmonia and Futki), 3 for human food (Sapla, Poddo and Singari). The Hindu community use leaf and flower of Poddo for their festible.

ii. Woody Vegetation

The *Haor* wetland currently does not appear to support any original tree species of natural origin. The living memory can not also specifically say the type of tree species existed in this wetland and their composition and density. But it is probable that, like *Hakaluki* and other neighboring *haors*, typical wetland species viz., Hijal (*Barringtonia aquatangula*), Koroch (*Pongamia glabra*), Borun (*Crataeva nurvulla*), Sheora (*Streblus asper*), Bot (*Ficus* spp.), Pitali (*Trewia nudiflora)* etc. species were indigenous tree species in this wetland in the distant past which, in course of time, had been destroyed by local the community people primarily for fuel wood, fishing trap, and ground clearance for expansion of rice paddy cultivation. However, the current plant communities in the *Haor* periphery and adjoining areas including settled homesteads consists of Bambusa species, Musa species, Erythrina spp, Borun (*Crataeva nurvulla*), Ficus heteraophylla, Pitali (*Trewia nudiflora)*, *Stox tetrasperma, Tamarix* species.

2.2 WATERSHED: HISTORICAL PERSPECTIVES AND CURRENT STATUS

2.2.1 The Watershed before the Advent of Tea Growers

Historical evidence reveal that, till the middle of nineteenth century, Hail Haor watershed was in equilibrium with its biota; the watershed had dense cover of multi-storied natural forests of tropical mixed-evergreen and semi-evergreen type having rich diversity of flora and fauna. The highest story tall trees were mostly deciduous in winter and the lower stories (medium to shorter trees) were mostly evergreen so that the forest floor remained covered through out the

year. Species composition of the main tree crop was Chani/chapalish (*Artocarpus chaplasha*), Jam (*Eugenia species*), Rata (*Amoora walichii*), Gamar (*Gmelina arborea*), Rongi/Poma (*Cedrela toona*), Semul (*Salmalia malabaricum*) Bonak/Konok (*Schima walichii*), Awal (*Vitex* spp.), Bodruk (*Vitex* spp), Jarul (*Lagerstromia speciosa*), Hargoza (*Dellenium Pentagyna*), Chalta (*Dillenium indica*), Koroi (*Albizia procera, A. lebbek, A. odorotissima*), Bohera (*Terminalia belerica*), Bon Belpoi/Jalpai (*Elaeocarpus floribundus*), Kanchan (*Bauhinia species*) etc. in varying proportions. The under story also comprised of various wild bamboo species viz., Kali (*Oxytenanthera nigrociliata*), Muli (*Meloccana baccifera*), Zai bansh (*Bambusa vulgaris*). Various canes (*Calamous* species), though scattered in occurrence, also constituted economically important understorey vegetation.

Important under growth comprised of thick growth of the seedlings, saplings, and pole crops of the over wood tree species, and varieties of herbs, shrubs, climbers, canes, ferns, etc. The forest was reach in fauna, both terrestrial and bird population. Elephant, Bison, Tiger and various other wild cats, Deer, Wild boar, Hare, Rabbit, Monkeys and Apes, Jungle fowls and Birds were numerous. The forest floor was moist and cool as sunshine could scarcely reach forest floor because of dense crown cover.

A few settlement of indigenous community belonging to Tippra tribe from the adjoining Hill Tippara (presently Indian State of Tripura), lived in the forest and practiced shifting cultivation (*Jhooming*) with long fallow period so that fertility lost due to forest clearance was recouped in the meanwhile.

2.2.2 Beginning of Tea Cultivation Era and Organized Forest Damage

From the second half of the 19th century (around 1870), the colonial government took steps to introduce Tea as a totally new crop in this region and this pioneering program started from the neighborhood of Sreemongal gradually spreading to other parts of greater Sylhet district. That was the beginning of systematic and organized destruction of natural forests of Hail Haor watersheds at the behest of the government. About 30% natural forests in this watershed were cleaned of natural forest vegetation and the indigenous people were forcibly thrown out of the tract earmarked for tea cultivation whereupon most of them retreated to their original abode, Hill Tippera. Presently only about 100 Tripura families are living within the watershed of Hail Haor. Organized tea cultivation with Sreemongol as the tea capital had been the first invasion of the Hail Haor watershed by man and such clearance never figured out as a serious problem.

As an intensively cared for crop, tea needed regular tending operations and the services of earnest labor force. The colonial government imported a big work force from Orissa, Bihar & Assam provinces and settled them in Tea Estate areas. For accommodating workers housing, kitchen garden and small scale agriculture, more areas of natural forests were cleared and the composition and character of landscape was changed altogether. The area of Hail Haor watershed is about 56,960 ha (CNRS, GIS unit) of which the area of Tea Estate is substantial, about 20,633 ha.

2.2.3 Partition of British India and Post-partition Over-exploitation of Watershed Forests

An outstanding political event, the partition of British India in 1947 into two independent country viz., Pakistan and India, also greatly contributed to the over-exploitation of forest cover of Hail Haor watersheds, in common with other forest areas of the country. Pakistan was in fact constituted of the undeveloped parts of the then British India. Given that administratively and commercially important cities and industries developed by the colonial government and traditionally accessible best timber forests of Bengal and Assam falling in the Indian share, Pakistan embarked on desperate bids to all out national development including

urbanization, industrialization, communication network, education, housing etc. To cater for the immediate massive needs of timber and other forest products, forests were exploited beyond sustainable harvesting limit. In that melee, the Hail Haor watersheds also became victim of over exploitation, both legal and illegal, and greatly deteriorated.

2.2.4 Population Influx in to the Watershed due to Natural Calamities and Trans-border Communal Disturbance

Subsequent to partition, frequent communal riots in the India Dominion during 1950s and 1960s, and the Indo-Pak war of 1968 triggered an awful exodus of Muslim refugees from the adjoining Assam Province, Hill Tippara State and other areas of India to the then East Pakistan. A bulk of these immigrants took refuge in these otherwise thinly populated watersheds. Human influx to watershed was further exacerbated by the cruelty associated with serious river delluvion inside the country making untold number of otherwise well to do people totally destitute. A part of these ill-fated people also emigrated to, and settled in these watersheds. The watershed population was estimated at 271,038 in 51,163 households (Bangladesh Population Census, 1991).

The destitute new settlers, at the initial phase of their settlement in the jungle terrain, resorted to indiscriminate felling and selling of forest products as a desperate bid to subsist. Simultaneously they also took to forest clearance for cultivation and orchard development. These events transformed an equilibrium watershed into disturbed catchment with rampant soil erosion. It is pertinent to mention here that the communities now living in the watershed (other than a small section of *Monopuri* tribe) are not traditional jungles living community. They became resident to this undulating jungle terrain due to *force majeur*. Naturally, they are yet to acquire the equilibrium hill cultivation techniques. This identifies the strong need for extending appropriate training on Hill Farming technology to the catchment dwelling community (both individual and enterprise). MACH project, to have the envisaged success with watershed and aquatic ecosystem management program, should undertake such extension activities as definite project components.

2.2.5 Urban Growth Centering Sreemongol Township and Watershed Degradation by Settlers and planters

People from different regions of Bangladesh especially from the greater districts of Comilla. Noakhali and Mymensingh came to Sreemongol region for business opportunities centering tea estates that offered lucrative chances. Having done well in business, many continued to permanently stay in and around Sreemongol, and these emigrants contributed to population boom in the otherwise population free jungle terrain. As a stride for greater economic prosperity, many of the emigrants adventured on acquisition of landed property and diversify their earning base through land-based production system because land around here was comparatively cheaper. Also acquisition of government hilly Khas land at a nominal fee was easier and many cashed that opportunity also. Some of the new settlers left business and concentrated mainly on land-based production system, and gradually spread their farming activity on to Balishera, Satgaon and Foyzabad hills. In the process, these migrants did massive hill cutting and deforestation. Reconnaissance survey revealed that pineapple and lemon cultivation started in this region from 1950s and expanded from early 1970s. Presently, some 4% of the watershed areas are under lemon and pineapple cultivation, and many farmers grown wealthy by the cultivation process.

2.2.6 Current Status of Watershed and Streams Draining Therefrom

The current lands uses obtaining in the Hail Haor watershed is a chequered combination of traditional forestry management: tea, pineapple and lemon gardening industry; terraced agriculture; homesteads with multipurpuse, multi-storied tree groves. Of these varied land uses, the cultivation practices in the notified government Reserved Forests, well managed tea gardens, terraced agriculture, common homesteads and *Monipuri* tribal settlements (including their hill farming areas) are tolerable and pose no serious threat to soil and water conservation although scope exists for improvement of various on-going practices. But the most agonizing and harmful land uses are those that are connected with 'across the contour 'pineapple cultivation, derelict tea gardens, denuded public and private undulating lands, non-terraced sloping land agriculture, and ill-managed lemon gardens. The latter categories of lands are the ones degrading progressively due to accelerated soil erosion and loss of productivity

Cleaning of the forest cover and steep slopes of watershed has also resulted in degradation of different types of habitats over the entire watershed. The soil became loose, exposed and erodible, and subsequently washed down by the rainwater and carried to the Haor basin. Thus, nutrient rich topsoil is continuously lost leaving unfertile substrate and poor supporting vegetation. Clearance of forest flora contributed to the loss of rich plant bio-diversity of the region. Destruction of the riparian vegetation now resulted into segregated patches of a few remaining wildlife habitats. The wildlife corridor for movement is really scarce in the area. Thus, loss of habitat caused survival of the fauna difficult and hastened extinction of many common wildlife species that were abundant in this tract. Increased runoff, decreased groundwater recharges resulted in dry season water scarcity and wet season flash flood. The ecological harmony of the watershed has been disrupted. On the other hand, siltation of the wetlands resulted in degradation of the wetland habitat in the Haor basin for fish population and fish bio-diversity.

These are the locations where appropriate interventions are required under the project. The project program, through adoption of soil conservation measures, contour cultivation methods, rehabilitation of denuded landscape by tree cover re-establishment, decreasing soil erosion and increasing stream flow in dry season, and reintroduction of wetland vegetation should make earnest endeavor to restore habitat equilibrium for enhanced productivity and sustainability in the interest of the country and its people.

3 REVIEW OF MACH PROJECT RESTORATION PLANS

The participatory watershed management pilot project began functioning in the fiscal 1999-2000 and the following three type of plantation activities have been undertaken under the project:

- Riparian Plantation along Chara Bank;
- Wetland plantation in the Haor situation (along chara banks and roadsides); and
- Vetiver grass nursery establishment in the project area.

3.1 Riparian Plantations along Chara Bank

i. **Pilot Project Sites**: Riparian vegetation restoration through new plantation establishment has begun along the chara banks of four charas viz., *Jaita chara, Jaag chara, Boula chara,* and *Alia chara*. The consultant visited a few sections of these new plantations along the first three charas. The project program identifies three

spatial sections for each chara viz., the upper reach, middle reach and lower reach. In general, the section of charas downstream of the metal roads, pass through more or less flat terrain cultivated for paddy and other tillage crop. This can be described as the lower reach. The topmost hilly section is the upper reach while the middle section passing through the undulating terrain with gentle hill slopes is the middle reach.
Planting in lower reaches of Jaita chara (in the downstream of Bhonobir-Mirzapur metal road) was found to have been done on top of the chara bank as well as on the upper slopes of banks in the month of June 2000. The species planted are Mahogony (*Swietenia magogony*), Rain tree (*Samania saman*), Kala Koroi (*Albizia lebbek*), Bakain (*Melia azadirach*), Jam (*Euginia jambulana*), Jackfruit (*Artocarpus hyterophylla*) and Akashmoni (*Acacia auriculiformis*). Seedling height varies from 1 to 2 meters. No new growth seems to have taken place on the plants in the new site. Roughly 40-50% seedlings are surviving now in this section. The major casualty has been observed in Rain tree and Baking species. Tall seedlings of these species were planted that mostly died-back indicating damage to rooting earth ball, possibly due to jerking at the time of long distance transportation and repeated handling at different points (seedlings are reported to have been brought from the *Belabo* area of Noroshingdi District).

ii. **Species Selection**: Tree species selection for planting on the stream bank sites that invariably suffers inundation during high rainfall and flood was not proper. Ecologically ideal species for such stream/riverine situations should have been the typical indigenous tree species like, Jarul, Arjun, Pitali, Chalta (*Dellinia pentagyna*), Sil Koroi (*Albizia procera*), Kainjal Bhadi, Bandarhola (*Duabanga sonneratoidis*), Rongi (*Cedrela toona*), Sissoo, Bamboo (Borua, Jai and Makal species). Binna (Vetiver) and Khagra (Saccharum species) ought to have been planted on the inner slopes especially on eroding spots and gentle slopes. The chara section that becomes part of the greater Haor area in rainy season should have been planted with typical wetland species like Hijal, Koroch, Pitali (Mera), Borun, Bot, Jarul, Arjun, Kadam. Murta, Dhol Kolmi, Nol, Khagra, Ikr could have been the most suited plant as bank stabilizer against erosion.

iii. **Seedling supplies Problem**: Discussion with local peoples as well as members of the Resource Management Committee (RMC) revealed that CNRS local staff was very earnest and serious to make the plantation successful. But lack of appropriate CNRS backstopping technical support was the primary reason for inappropriate species selection and their poor response. Lack of nursery plants close to the planting site necessitated long distance transportation of seedlings and at times, careless handling at different loading and unloading points caused damage to their rooting earth ball that ultimately manifested in poor survival or die back of tall seedlings. The initial setback is however not beyond recovery. At the time of vacancy filling operations in the next April-May 2001, the failed planting positions should be restocked with the most appropriate species listed in sub-paragraph ii above.

iv. **Staff Motivation**: The RMC members and local community members also appeared to be quite enthusiastic and earnest about the chara and watershed restoration program, and expressed commitment to protect the plantations in a bid to make the program successful. They appear to have understood the significance of the program and evinced keen interest in the riparian plantation establishment and chara management. They expressed their full commitment and promised full cooperation to the local project staff, and extend help for achieving plantation target. This is a very healthy sign, a significant and encouraging social participation in the program, and as such essential prerequisite both for initial success as well as future sustainability of the program. However, this enthusiasm and earnestness will last only when physical success could be achieved with plantation and the promised benefit accrues to the

local people. The physical success will be achievable with the program proposed in this report.

v. **Plantation Watchers not Performing Well:** Watchers engaged for upkeep of the plantations were found on duty but lacked proper maintenance knowledge and skill, and were not doing any tending operation except keeping away cattle trespassing in the plantation area. The planted saplings were thus not getting the much needed tending operations. The watchers as well as the CNRS local staff need short training on plantation and nursery establishment and upkeep so that essential maintenance jobs are done without any extra cost.

vi. **Improper Fixation of Supporting Stake:** Stake fixation along the planted saplings was found wrongly done all throughout. Stakes were fixed touching the saplings and then tied tightly with the sapling. As a result, the saplings have no freedom of movement and became absolutely stake dependent. When the stake is removed (either damaged or stolen), the sapling lean down to be ultimately damaged or destroyed. Stake should be fixed about 15 cm away from the foot of the seedling, and tied loosely to the seedling with a sling so that the plants can move freely and stand on their own backbone, supported by the stake only when high wind or weakness of the stem tend to lean the sapling (details of stake fixation technique may be seen under para 7.4.4).

vii. **Plantation Success:** In the middle reach of Jaag chara, riparian plantation was raised with Akashmoni (*Acacia auriculiformis*), Mahogony (*Swietenia macrophylla*), Minjiri (*Cassia siamea*), Arjun, and Sissoo. Plants appeared comparatively healthier and survival percentage is 70-80%. Plantation quality is better in this section. On inquiry into the cause for marked variation in the quality and success rate of plants between lower and upper reaches plantations of the same chara, the staff disclosed that the lower reaches plantations were the first planting activities for them in this region when they themselves lacked tree plantation experience and did not meticulously follow planting and maintenance techniques and schedules. Apart from this, the species selection for lower reaches was not proper so that the species planted did not respond well. Upper and middle reaches were planted at a later time and by then, they gained some experience. Seedlings for the latter plantation was also qualitatively better which is manifested through better survival and growth. The general planting pattern was linear planting of two rows of saplings on either bank of the stream, and at times on the bank slopes, at a plant to plant and row to row distance of 2m

viii. Species choice and plantation techniques in respect of riparian plantations along *Jaag chara* and *Boula chara* are similar to those for *Jaita chara* because the same set of CNRS staff, following the same plantation norms and using seedlings from the same sources, carried out program implementation. However, the success rate was somewhat different in the two situations. While survival percentage of seedlings at *Boula* chara section was observed in the range of 70-80%, the same along *Jaag chara* was 85-90%. Planting along Boula chara was too close together (plant to plant and row to row distance is only one meter). This is unnecessary and a wastage of resource and energy. Such close planting should be avoided in future.

ix. **Plantation Potential of Chara Bank not fully utilized**: Stream bank plantation along *Jaag chara* was found discontinuous at places. Again, full potentials of planting space were also not utilized in many locations and the marginal lands are still lying fallow. When asked about such apparently unsystematic and disorganized planting pattern, the staff reported that the discontinuity was due to objection of some landowners not to plant in the terminal end of their land. Complying with oral objections of a few landowners was bad for the project as other landowners might follow the suit, and if such objections were heeded to, no land would be available for chara bank protective plantation. The

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disputing landowners should be approached this year again through local UP chairman/members and RMC, motivated and convinced for allowing riparian vegetation establishment for the grater interest of the community. Apart from unsystematic planting, only 2 rows of saplings were seen planted on the chara bank although scope existed for 3 to 4 or even more rows of planting. In future wherever sufficient space is available for planting, full potential of the space should be utilized to establish plantation. This is essential to secure greater stability of the chara bank, to afford greater earning opportunity to the beneficiary group members and RMC, and incidentally, also to facilitate increasing crown covered area in the country that is deficient in forest cover.

In certain locations, under planting below bamboo clump or dense tree crown was observed in the riparian plantations. These saplings planted under bamboo neither get enough sunshine for their photosynthetic activity nor overhead growing spaces to go up and in course of time will die out. In future planting under bamboo clump or dense crowned over wood must be avoided because such plants will never establish, and as such it is an extravagance and a wasteful exercise.

3.2 Wetland Plantation in Hail Haor

Wetland plantation with typical wetland tree species was attempted under this pilot plantation program at two sites; one at the Haor section of the Ichamati chara banks (0.46 km stretch), and the other at the Haor section of the Kalapur-Hail Haor road slopes (1.42 km stretch). At both the sites, Koroch (*Pongamia pinnata*) was planted in December 1999. The planting stuff for these plantations was procured from Jamalgonj (Sunamgonj district). The planted saplings at both the sites were very weak; none has any leading growing shoot, only died-back stubs of 1-1.5m. These appeared to be moribund. The plants appear to have registered little or no growth at the new site. If any fresh leaf at all sprouted, those might have been browsed by cattle so that remnant gives a desolate look; cattle in big numbers were found grazing all around.

Probing into the causes of poor performance by Koroch in both the plantation sites revealed that the stump and root sections of these plants are quite thick suggesting plant age of over 5 years. The aerial portion of the plants do not have the original stem or promising leader; these are rather clump of top-dead coppice shoots, about a meter high. A few old leaves are present in the stubs but no fresh sprouting or leading shoot. These planting stuff were actually uprooted stumps of young plants whose original stem and subsequent coppice shots had been repeatedly cut over at the parent sites so that they have lost their vigor and became stunted, and thus not producing energetic stool shoots. Using such stunted material as planting stuff for new plantations is not a good plantation practice and must not be repeated in the future. Instead, fresh seedlings should be raised in the project nursery and planted in appropriate time for achieving tangible results.

Planting of Pitali (*Trewia nudiflora*) along the Haor approach roads and canal banks have been observed. These plants stood inside the Haor and were found to be growing well. Therefore other typical wetland species also have every reason to grow well if planted at appropriate time with good planting stuff.

3.3 VETIVER NURSERY

MACH-CNRS established a Vetiver grass nursery at Bhunobir village on a rented private land. The site is not an ideally suited nursery spot because of shading effects from dense tree grove located on one side of the nursery plot. Nursery site must receive sunshine throughout the day. Else seedling growth is uneven and frail. Vetivar stock in the nursery appeared

Thick weed growth was observed right at the foot of the planted saplings. Clear weeding around 30 cm radius of every planted saplings should be carried out as and when weed growth is observed (the interval may be 15-20 days during rains and 1-1.5 months in dry season). The weeded out grass should be spread over the ground around plant collar to act as mulch. This would deter quick regrowth of grass and prevent moisture loss in drought months. Weeding should be done with a weedier (Nirani) or tip of sickle; grass has to be uprooted and not cut. If timely application of fertilizer and regular weeding were done, the plants would have certainly responded with fresh growth at the planting site. However, the loss is not beyond redemption. Heavy vacancy filling is needed in next April-May 2001. At the time of new planting, manure @ 2 kg decomposed cow dung, 100gm TSP and 100gm MP per plant should be applied in the planting pits. Subsequently (after 3 weeks of planting), granular urea @ 30 gm/plant/ application should be applied by pegging method to the surviving seedlings from May- October 2001 on a monthly dose basis.

All throughout the plantation, the supporting stake fixation was done improperly (defects elaborately explained in paragraph 4.2.1). Stake fixation should be done following the technique laid down in paragraph (7.4.4).

3.5 Swarupkati Nursery plants

During discussion with Caritas staff it transpired that, the nursery stuff used by them for the above mentioned two roadside plantations was from Swarupkati (greater Barisal). These Swarupkati origin seedlings were probably the primary cause for growth not taking place on them because of the under-mentioned faulty nursery practice adopted by Swarupkati nursery traders:

The Swarupkati nursery traders in general grow seedlings in earthen pot which is a small cup having less than 10cm depth, an extremely shallow rooting depth. Seedlings are grown in these shallow pots for 1-2 years and when the seedlings are marketed, although the above ground sapling height is over 2 meters but because of the shallow pot, the root is a scanty 8-10 cm deep. That means, in this practice a disproportionate root: shoot ratio in the plant growth occurs which is bad for future plant growth and stability. What happens in the process being that: the saplings having failed to register vertical root growth in the shallow hard pot, start coiling its primary root inside the pot. It is a conspicuous characteristic of most tree species that if root coiling take place in its early age due to obstructed root growth, such plants respond very poorly to height growth after transplantation. The dimensional stability of such plants is also very poor, they being easily wind thrown during storms. It is pertinent for all planters to know that in the whole of the country, the nursery practice of the Swarupkati commercial nurseries is probably the poorest. **MACH and Caritas tree plantation programs should take special precaution not to buy shallow earthen potted seedlings of Swarupkati or any other origin.** Instead, polypotted seedlings of 25 cm or more in rooting depth, or even uprooted seedlings with a ball of earth (30-50 cm deep), well enveloped with gunny bag or closely woven textile net, is better (provided the clod of earth around the primary root is not broken).

3.6 Beneficiary Agreement for Participatory Roadside Plantation Not Executed

The roadside tree plantation program executed by Caritas is implemented on a benefit sharing mechanism in which 40% benefit is committed to the local beneficiary groups, 40% to the adjacent agricultural land owners and 20% to the Union Porishod. But no formal benefit sharing agreement was executed as yet between the parties. On being asked about the delay in execution of benefit sharing agreement, the local staff reported that they do not possess any approved agreement format to execute such agreement. They requested to incorporate benefit-sharing agreement in the consultant report so that formal agreement between the relevant parties could be enter into. Accordingly, an agreement format has been developed and

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appended to this report. Benefit sharing agreement for the past plantations should be executed in this format as quickly as possible. In future, wherever participatory plantation programs are undertaken, beneficiary agreement should be executed forthwith. Such agreements, in reality, dispel all misgivings from the minds on the participants and establish credibility of the program encouraging them to enthusiastically participate in plantation upkeep activities.

4. Wetland and Watershed Land Tenure and Use

4.1 Hail Haor Watershed: Land Tenure and Land Use.

The major portion of the Hail Haor watershed is located in Srimangal and Moulvi Bazaar Thanas of Moulvi Bazaar District. Some of the upper catchment is also located in the Kamalganj Thana of Moulvi Bazaar district, as well as in the Chunarughat and Nabiganj Thanas of Habiganj District. The southernmost region of the watershed reaches into the Indian State of Tripura (LGED 1994).

Since political, economic, and cultural activities and values affect the surrounding land use practices, and land tenure refers to their manifestation, it is important to assess the land tenure and social environment obtaining in the haor watershed.

Most of these watershed lands are *KHAS* lands (meaning ownership rests with the State). Some of these lands are leased on long term basis (Tea Estate lands) while some on short-term basis (pineapple, lemon and other plantation uses), and some still remain in *Khas* possession of the government. Because of the very low man to land ratio, and consequent shortage of farming land and farm products available in the country, the governments at different times adopted State policies and drawn national regulations encouraging use of all land including watershed delicate lands through permanent or temporary lease system. These state policies, formulated to prevent non-use of land and promote land-based production systems, exacerbated human pressure on these delicate watershed landscapes.

In the upper elevations of each chara catchment, apart from the government Reserved Forest locations, the majority of khas land is leased for the purpose of lemon, pineapple, and tea cultivation; and in the lower elevations, land is leased for boro rice and other agricultural crop cultivation. The hillock khas land is available for lease periods up to 35 years duration. The lessee is responsible for paying a one time "Capital value" fee determined by government revenue officials, as well as a yearly prescribed per unit area tax. The terms of lease of non-cultivable khas lands has changed four times in the past two decades with respect to price and duration; the most recent set is found in the 1995 Gazette. Also, much of khas land is encroached upon and put under cultivation before any terms of lease are settled. Status of different land uses are reviewed hereunder:

4.1.1 Government Reserved Forests

In the upper catchments of Satgaon and Balishera hills, there are about 3353 ha of government Reserved Forest lands. The present land use pattern of these forestlands has been shown in Appendix 4. These are primarily secondary forests i.e., plantations except about a hundred hectares of degraded natural stands, scattered in various locations. There exists some encroachments as well in the reserved forests but their extent is very small.

The reserved forests are government property owned, controlled and managed by the Forest Department. These Forestlands are more or less covered with vegetation although there is scope for improvement of stocking and quality. There is a recent government policy to declare some of these plantation forests, especially those located in the Bhanugach Reserved Forests (popularly known as Lawachara forests), to constitute a National Park (Protected

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Area). Accordingly, no fresh felling is done therefrom. The present land uses of the reserved forest are not provocative of soil and water conservation, should therefore be no cause of concern for sustainable management of Hail Haor.

4.1.2 Tea Garden Khas Land

Khas lands that are leased to tea estates are uniform and consistent in its tenureship. Most of these lands have been under tea garden management since the second half of nineteenth century or early part of the twentieth century. Since infrastructures have already been established in the tea estates, tea cultivation is continued although most of the tea garden management expressed concern that production had decreased in some areas. Should a tea garden not renew its lease, one can assume that the Ministry of Lands would encourage cultivation of some other crop on that land. Also, the tea companies operate rubber tree plantations on parts of their excess land. The management of the rubber gardens is carried out in much the same manner as the tea gardens with respect to their effects on the chora.

Management of tea gardens requires strict attention to the hydrological network. Tea plants are damaged by saturated soils, therefore every efforts is made to flush the hydrologic system of high water levels. As well, reservoirs are used in some areas to store water for dry season water use. Some tributaries to the chora are excavated trenches between tea garden plots, for the purpose of draining high water levels. In other areas, low-lying areas such as the chora floodplain are converted to paddy cultivation by tea garden laborers and the chora water is networked through irrigation canals alongside. Tea gardens extend right up to the chara bank and tea managers usually allow riparian vegetation to grow, but it is cropped when it shades any tea plants. For this reason, almost no trees are present near the chora while shrubs and herbaceous groundcover is usually abundant.

4.1.3 Hillock Orchard Land

Lemon and pineapple orchards constitute the majority of non-tea, upper elevation khas land in the watershed. Respective lessee manages each garden and there is little variation in the management practices between gardens. Typically, the leased plots range in size from a quarter hectare to two hectares each, and constitute several steep hills and the enclosed valleys.

Lemon plants are grown on as much area as possible, as they yield the highest profit for most farmers. Lemons are sold at auction houses in Sreemongol. The income from lemons fluctuates throughout the year, but has remained relatively stable for the past 15 years. It is not unusual to see lemon trees growing on the chora banks. Where this occurs, riparian herbaceous and shrub vegetation is cleared annually or bi-annually to reduce root competition. No trees are allowed to grow above the lemon trees, unless they also produce a profitable product. The steepest areas are used for pineapple and jack fruit cultivation. Pineapples are grown in across the contour vertical rows, often times with wide spacing. Jackfruit trees are often grown along the crest of the hill, at the upper end of the pineapple rows. This garden is cleared of weeds twice per year, once at the end or the monsoon (August through October) and again before the onset of the monsoon (March through April).

Lemon orchards are however intensively managed and reasonably well cared for. Land use under lemon does not promote soil erosion in the fashion that pineapple does. Of course, there exists scope for adopting appropriate soil and water conservation measures by constructing pucca/ earthen/brush and weed piled cheek dams at delicate points to trap the silt that is washed down the hill slopes, and to combat landslide and sheet erosion. Such contrivances would not entail much of extra expenses to the owners but the benefit accrued will be enormous towards retention of ground fertility and sustainable management of the orchards. Exercise of carefulness and proper conduct of orchard maintenance job by the maintenance crews would accomplish marked improvement in the land fertility and higher return from the orchard.

Major wrongdoing has been observed in pineapple cultivation in which the local practice involves positioning of the pineapple rows across the contour instead of along the contour. This practice is provocative of soil erosion. The vacant land in between two pineapples rows functions as watercourse for draining run off, and uninterrupted gushing down of runoff from hilltop to its down hills cause serious soil erosion. Such across the slope drainage cause gully formation on hill surface degrading the land for future use.

The majority of pineapple gardeners expressed dissatisfaction in production and profit margins of the crop. In many small gardens, pineapple is being phased out of plantation and being replaced with lemon, jack fruit, and other fruit producing plants. Investigation into the causes of dissatisfaction among pineapple growers found that production was highest in the 1970's, during the first decade of pineapple planting, and has steadily decreased. Only one farmer interviewed continues to rely on pineapple gardens for profit, and it is because he has increased production with the help of hormone injection to stimulate two crops per year.

The remainder of the leased khas land is made up of sun grass (*Imperata arundinacea and I. cylindrica)* and bamboo plantations. Bamboo is grown in low-lying area, where it has access to available water supplies. Incidentally, bamboo naturally grows very dense and covers the chora banks as well as the floodplain and terrace. Sun grass is grown on hills and valleys often times adjacent to tea gardens and forest areas. It is harvested for the purposes of roof thatching and after harvest, the area is burned to promote fresh growth. Tea estate lands are almost exclusively bordered by sun grass plantations, as it is in high demand by the tea garden laborers.

Oftentimes, the process of leasing khas land is initiated after encroachment, and therefore not necessarily conforming to the Gazette Rules. Most of the hills and surrounding land other than the tea estates of Satgaon, Faizabad and Balishera hills, were encroached by the people who are now settled there. In many cases, the few people who hand private land in the Faizabad hills started pineapple and lemon gardens on their lands and the surrounding khas lands.

Cultivable khas land is mostly flat land and suitable for paddy, wheat, vegetable etc. In recent years, Government does not lease this land to anybody or everybody but instead, distributes the land among the landless people on permanent settlement basis. There is in fact a government committee for watching out not to lease this category of land to landed individuals but distributes the land among the landless people. The committee includes local UP chairman, UP members, local elite, teachers, NGO workers, commander of the freedom fighters association, Assistant Commissioner of Land (AC land), Upazila Nirbahi Officer (UNO) etc. The committee makes a list of the landless people and then lands are distributed among them for 99 years by accepting a notional value of Taka one. One person may get maximum 1 acre of this category of land.

The ownership of all chora lands is retained by the State, and no chara could be settled to non-government organization or individuals.

4.1.4 Khashia Settlement: Khashia Punji:

Some Khashia/Monipuri Tribal community abounds in the Hail Haor watershed. These tribal are originally immigrants from the neighboring Monipur hills (now part of India) and by nature, shifting cultivators, but now transformed into settled agricultural community, and became more or less permanent in this watershed. Of course, scattered population of Khashia community could also be seen elsewhere in the hilly region of the greater Sylhet district. If scope exist, they even now practice 'slash and burn' agriculture but otherwise practice perennial cultivation of tree-based crop viz., tree-climbing varieties of betel leaf, black pepper,

betel nut, bay leaf etc. Theirs is actually a poly-culture and when done in right earnest, does not appear to provoke soil erosion. They are also found to adopt some soil conservation measures like check dam construction with wooden billets, plant leaves and grasses, and dyking to contain soil loss.

Life style and cultivation activities of the Monipuri community appear not too adversely affect the watersheds from soil erosion and silt transportation points of views. The banks of streams passing through khasia Punji (village) jurisdiction appear fairly densely covered with overhead vegetation. Sunshine has restricted access to chara banks and beds. Scope for riparian vegetation establishment is thus limited along charas passing through Khashia Punjis nor is there much necessity to undertake such restoration program. No intervention at this moment is called for in the Punji situations except extension services to regulate odd practices.

4.1.5 Sand Mining

The mining of sand from chara beds is a widespread practice in the charas draining from Hail Haor watershed. The sands are commercially valuable for the construction industry, road fill, water filters, etc. Leasing of the right to mine sand from a particular chara is overseen by the Than level office of the AC Land. Each chara is leased for a term of one year beginning from the Bengali month of *Baishakh* through *Chaitra* (15 April-14 April). The lease is not automatically renewable. The price of the lease is determined by auction, and the minimum starting price is required to be ten percent higher than the previous year's rate. The lease prices vary greatly from chara to chara depending upon the average size of the grains, the quality of grains and ease of access for extraction. The majority of the extraction occurs during the Monsoon, from May-September. Accessibility and local landowner's consent determine the location of extraction site except in special cases where the AC Land Office has interests.

The primary method of sand extraction is by manually digging depressions in the chara bed during the dry season thereby allowing sand to accumulate there during high flow events. Some temporary diking is used in this process. It appears that sand and soil is also removed from the chara bank and floodplain area if it is profitable to do so. During the monsoon, between storm events, sand is manually extracted from the channel basins, and usually stored by miners on the floodplain or on the road above the floodplain until loaded into trucks. The sand is carried by basket on laborers' head to the roadside, where it is left to be loaded into trucks. The cost of mining and loading sand into trucks is Tk. 300 per truck. One truckload of sand is reported to fetch Tk. 400 per truck. In past years, sand has also been mined from an upstream location accessed by the Tea Garden Road, but a dispute arose over the cause of flooding nearby, and that location is now unavailable for auction.

4.2 Wetland: Tenural Status and Land Use

The Haor basin is, by and large, government Khash land (State property). Some freehold/ settled land also exist in the peripheral region where water depth is shallow and the ground comes up above water level with the advent of dry season. These freehold lands as well as similar categories of khas lands are cultivated with Boro paddy during winter months; the Khas lands being leased out on an annual/seasonal lease basis after realizing prescribed tax by AC Land. Cases of unauthorized cultivation on Khas land are also not uncommon. The fringe of the Haor at this time of the year (winter months) gives the look of a vast expanse of productive agricultural farm that is again transformed in to veritable sea in the rainy season.

Land areas suitable for wetland tree plantation are the shallow inundated grounds in the outer periphery of the lake basin. But these are also the lands seasonally cultivated for rice paddy and thus not freely available for exclusive tree cultivation. Although legally there is no bar on tree plantation raising on Khas lands, but socially such plantation activity will be resisted by the local community as they would be losing seasonally cultivable land that gives them a

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good crop of paddy which is highly valued. Politicians and local leadership will also side with the cultivating community. Thus, wetland tree plantation program on potential land base is not a free from encumbrance activity. Such plantation programs could be a reality only through consensus with the local community. The tree plantation program in wetland should therefore explore its potential on three strategies viz.,

i. identify marginal lands like stream banks; slopes of dykes, embankments and terrace walls with extended shoulder width for plantation raising;
ii. establish rapport with local community members, and motivate them to earmark agriculturally less productive fringe lands and foreshores of wave-endangered hinterlands for tree plantation; and
iii. in view of the land hunger obtaining in the country, as an alternative to second strategy, aim at establishing linear strip plantations of 100-150 m width all around the Haor periphery instead of going for traditional large block plantations.

5. Analysis of the Problems and Opportunities

All the *charas* draining from the watersheds have been heavily impacted by inappropriate land use activities both in the riparian zones as well as in the upper watersheds. Deforestation combined with faulty agricultural practices, grazing and burning caused serious soil erosion and landslide throughout all chara catchment. Erosion has also been exacerbated by water diversion for different cropping patterns (e.g., two rice crop systems in the upper watershed and three rice-boro crop systems adjacent to the haor basin). Diversion has also caused dropping of dry season water table and channel flow exposing more stream bank and further impacting riparian vegetation.

The *chara* restoration interventions should therefore focus on re-establishing riparian vegetation on all critical reaches of charas with a view to primarily conserving the soil and moisture, to restore favorable water regime in the water table and stream flow. However, to be realistic, the whole watershed cannot also be addressed by one go because proper knowledge base and intervention technologies to successfully accomplish the desired restoration results are yet to be standardized for this watershed. Therefore, rationale for initiating pilot scale activity is well conceived and should continue in the watersheds, riparian zones and Haor situations of the 4 charas already identified by CNRS. By focusing attention and concentrating restoration efforts on worst-case or most sensitive reaches of charas, real improvements in erosion reduction during the wet season and increased stream discharge and water flow during the dry season could be expected. Careful selection and rehabilitation of watershed reaches that provide maximum buffering and filtering effect can significantly reduce upland and upstream sediment transport.

The interventions should also identify and include the most relevant stakeholders in the program, and embark on organization of Resource Management Committees (RMC) with effective local representation to install sustainability mechanism for the plantations established especially when direct project interventions through project staff and funding will not be there. The RMCs will assume responsibility to manage the watersheds, riparian zone and wetland plantations, undertake maintenance and protection, regulated grazing, promote high water table retention, and manage forestry income benefits from the plantation activities. This management intervention would demonstrate not only how to reduce soil erosion and increase water infiltration/retention in the watershed but also the ability of the restoration program to generate some income through the harvest of trees, grasses, and other vegetation for the benefit of local stakeholders and downstream communities.

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The composition, character, density and stratification of vegetation cover in the watersheds directly influence rainfall dynamics. The higher the extent and complexity of vegetation in the watershed is, the more effective is the raindrop interception, less runoff, greater rain water infiltration into the sub-strata, and eventual promotion of the water holding capacity of the catchment. Greater infiltration rate in the wet season enhances dry season water flow in the streambed through seepage, and maintains higher ground water table. Vegetation is also the natural barrier to soil erosion of stream banks. The tangle mass of plant root system serve as contrivance to bind soil particles as well as provide a permeable access of rain water to sub-strata thus replenishing the underground aquifer layer and maintaining higher water able. To be very specific, vegetation canopy helps to reduce the kinetic energy of raindrops before they impact the topsoil. A lack of vegetation canopy allows the raindrops hitting the ground directly causing dissolution of soil particles into colloidal mass and suspending them in gravitational sheet flow eventually to the streambed and thence to the Haor basin, primarily when precipitation exceeds infiltration. Restoration of multi-storied, dense vegetation cover holds enormous promise to mitigate problems associated with denuded watersheds.

Analysis of the existing land uses in the watershed and riparian zones revealed serious abuses in the sloping land agricultural practices. Among the bad practices, 'across the contour' cultivation of pineapple, and clearance of steep hilly lands right upto the stream banks by all planters including tea, pineapple and lemon gardeners are the two most dangerous systems of cultivation practiced in the watersheds. Opportunities for introducing improved land use and land management interventions exist in these and other similar cases, and should be undertaken with willing participation of local community.

The total aspect of deleterious cultivation of pineapple was discussed with two leading gardeners of Faizabad hills viz. M/S. Askir Ali and Monotosh Pal, and caretakers of Satgaon Tea Estate. These gardeners, while appreciating the national concern about provocative soil erosion in the currently practiced 'across the contour cultivation' system, also expressed some reservation regarding 'along the contour' cultivation methods suggested by us. Their major apprehension to switch on to "along the contour' cultivation method being that: when pineapple bears fruit and plants become top-heavy, there is a chance of the plant tilting towards the down slope and get damaged. When that happens, the farmers apprehend incurring heavy loss.

However, this apprehension of the gardeners is not based on practical experience with contour cultivation. When contour planting technique and the advantages inherent in the system in regard to soil, water and land fertility conservation as well as better yield from orchard were presented to them, they were appreciative of the new idea and promised to co-operate with CNRS/MACH project staff should the project take initiative to layout any contour planting experiment in their garden. This is a very positive response from the gardeners and should be deemed as opportunity to remedy the seriously degrading land use problems obtaining in the watershed.

For better consolidation and stability of banks, ideally streams should have 80-100m of intact natural vegetation on either bank especially in the catchment area situations. The developed countries of the world rigidly implement this type of nature conservation and bank protection obligations through legislation and social motivation. But in the Hail Haor watersheds as well as elsewhere in the country, intact riparian vegetation is hardly met with the exception of remote natural high forest situations. The harmful impact of such ignorant and injudicious vegetation clearance is manifested through serious bank erosion and landslide often blocking the original stream course and at times pierce through garden lands opening alternative channel at a dangerous cost of the landscape. This scenario is particularly common in the tea estates, pineapple and lemon orchard situations. The mischief has already been created and reverting back to the ideal 100m wide text book type of bank vegetation restoration program would be extremely difficult because it would mean firstly, abandoning immediate benefit

enjoyment from the established gardens in favor of distant benefits from composite tree vegetation. Secondly, direct tangible benefit from composite tree vegetation would be comparatively lesser although such protective plantation promises long tem sustainability of benefit from rest of the production system both at the watersheds and down riparian zones (wetlands). Patient and persistent motivation as well as tactful negotiations with all categories of gardeners and local community is necessary for achieving success with riparian vegetation restoration program.

So far as restoration of wetland vegetation is concerned, the main problem is the availability of suitable land free from encumbrances for plantation establishment. Currently, wetlands in the upper fringes of the Haor basin is cultivated for transplanted *Amon* paddy and that in the middle section is cultivated for *Boro* paddy. But these are also the land areas suitable for restoration of wetland vegetation. Although the fishers and other local community members now appreciate that absence of wetland tree and reed vegetation seriously affected the safety and security of Haor fish population, impoverished fish nutrition and harmed bio-diversity, but when *trade off* between fish and paddy arise, they tend to give greater weightage to rice paddy over fish. This is possibly because of the fact that, return from paddy goes directly to the individual while Haor fish is a common property to which no one could claim absolute ownership nor is there is any guarantee that one would harvest and enjoy a given quantity of common reservoir fish. The land scarcity issue has to be resolved through intensive consultation with AC Land, UP Chairman, RMC, local elite and representatives of various professional groups, and land is made available for wetland vegetation restoration. The technical problems with regard to wetland vegetation re-introduction should pose no insurmountable problem provided the social problems of land availability for plantation is acceptably resolved. This calls for activation of various implementation committees, and spear heading the initiatives by CNRS Sreemongol office staff.

Inside the *Hail Haor*, there exists 7-8 km long embankment like dilapidated elevated structure, the ownership of which rests with the State. The local term for embankment is *kandi* and since this kandi is located at Kagaura, so the kandi goes by the name *'Kagaurar Kandi'*. The kandi looks like embankments of an artificial canal dug sometimes in the distant past. The present day memory cannot say who dug the canal, when it was dug and for what purpose? But the canal and Kandi are definitely artificial structures that were abandoned. The Kandi is discontinuous due to damage caused to it by wave action. The kandi is submerged during rainy season and at full rainy season, the maximum water depth above the kandi crest is reported to be over a meter. During our visit, about 30-50 cm height of the Kandi from its crest downward was surfaced above water. With Haor water drying out in December, the whole Kandi is said to dry up. At that time, profuse weed growth, especially of Dol Kolmi, Hogla and other varities of reeds, is reported to be taking place forming a tangle mass of almost impenetrable jungle through which walking becomes difficult. The canal is now almost jam packed with waterhyacinth. This Kandi appeared free from ownership dispute and no planned land use is currently done on the kandi. The kandi is thus a potential site for wetland plantation., and such plantation activities may be started right from this season, should suitable planting stuff be available.

Ocular examination of the Kandi soil revealed that the topsoil is clayey, fertile and impregnated with nitrogen rich humus. Gregarious growth of Dolkolmi, Hogla, other reeds and grasses and other water plants give the testimony of soil fertility. Typical wetland tree species like Hijal, Koroch, Borun, Mera, and economically important reeds and grass like Nol, Khagra, Ikr, Murta, Rotton (cane), if established before monsoon, will in all probability survive and grow to a sizeable grove of wetland vegetation. The Kandi is *Khas* land, free from ownership dispute and could be straight away planted avoiding urgent use conflict. The canal in between the kandi should be re-excavated and the damaged kandi repaired so as to give a continuous ground for plantation establishment.

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For achieving the much desired success with wetland plantations in this physiologically adverse terrain and edaphic conditions, the following preconditions have got to be observed in the planning and implementation of plantation programs:

The seedlings for initial plantation establishment should be man-height tall to safeguard their sudden inundation and damage by flooding that is a systematic annual phenomenon in *Haor* situation. The plantation must be established in the receding flood (October to December period); planting being done at successive stages as the water recedes and the ground is surfaced. Plantation activity on such tricky sites is a time slice job and calls for finalization of all pre-planting preparations in advance. The planting stuff, especially seedlings of wetland tree species, is not likely to be available for procurement from commercial nurseries. The most pragmatic solution for overcoming seedling availability constraint appears to lie in the MACH project raising its own seedlings, a process accomplished either through its staff directly executing nursery raising scheme or intimately overseeing seedling production by participating group members.

Depending on the availability of requisite planting stock at the disposal of the project, actual plantation activity should begin from the crest of the *Kandi* and extended gradually to the down slope but should not be proceeded on to too low terrain situations at the initial plantation trial phase. For gaining experience and watching out success pattern, about 25 to 30 meters wide stretch of Kandi land centering its crest on either side should be planted with tree and reed/herb species. Tree species planting may be done at 2m x 2m spacing while in respect of reeds/herbs, spacing may be 1m x 1m.

Nol, Khagra, Ikr & Murta will be propagated by planting rhizome clumps. Carefully uprooted rhizomes with two to three aerial stems will be the planting stuff. Such materials, of course, will have to be procured from the wild stocks wherever they are available. Surma Valley (Sylhet & Sunamganj districts) has plenty of these reeds growing naturally (locally called *Pajubon*). If stems of the parent stock of Nol, Khagra and Ikr are too long, top section of such plants should be cut over leaving 1.5 to 2m stubs with the rhizomes to be planted.

If the proposed plantation site contains Dol Kolmi, Hogla or other herbaceous seasonal new growths, clearing of the entire ground of weeds as a preparation for plantation establishment will be required because the area is reported to have serious infestation of rats that damage young plants by sub-soil cutting. The same prescription will be applicable for all wetland situations in the Haor whether kandi or flat land. The extent of suitable area likely to be available for wetland plantation in the Haor area should be reconnoitered my MACH staff in this dry season, and accordingly nursery program planned in advance.

It should be clearly borne in mind that tree species could not be established by planting underwater like transplanted paddy crop or reeds. Tree species have got to be planted and established in dry soil condition, and root development of saplings must take place before rainy season inundation occurs. If sapling base is submersed soon after planting before new root development taking place in the new plantation site, the plant will die. Planting may however be done in mud but not underwater.

6. PLAN FOR RESTORATION OF WETLAND AND WATERSHED VEGETATION

6.1 RATIONALE FOR INTERVENTION

6.1.1 Watershed and Riparian Vegetation Restoration Rationale.

The rationale for watershed and riparian vegetation restoration/rehabilitation vis-à-vis amelioration of soil erosion, landslide and dry season water output from the watersheds should be appreciated from the following dynamics of rainfall and sub-soil infiltration:

- Vegetation canopy in a given situation intercepts the raindrops before they reach the ground and thus help reducing their kinetic energy before impacting the surface soil. A lack of overhead vegetation canopy causes the raindrop hitting the ground directly with full velocity that has splashing action on the topsoil. Such raindrop impact physical dislodgment of the soil particles from the ground surface, dissolves and suspends them in the run off ultimately carried through gravitational sheet flow to river/stream/Haor bed particularly when precipitation exceeds infiltration.

- Because of the interception by vegetation canopy, the entire quantum of rainfall does not reach the watershed floor by one go. A portion of the rainwater remains temporarily stored in tree canopy and gradually descends down the tree trunk or drops from the leaves, branches and twigs long after cessation of rainfall. The watershed floor thus finds longer time to absorb greater portions of the rainwater into its substrata, which would otherwise be lost as run off. The forested catchment therefore greatly reduces the chances of higher run off and facilitates increased percolation so that greater quantum of dry season seepage into the streambed resulting in greater stream flow becomes a possibility.

- Forested watershed floor receives high charge of leaf litters that create ideal environment for microbial activity. The microorganisms through their intense activity make the topsoil friable, porous and spongy. Water absorption capacity of such porous soil is much greater than the hard soil surface of the deforested, eroded watershed floor so that the quantum of run off from forested watershed is reduced, infiltration increased with promise of greater stream flow in the dry season.

- The runoff in a forested watershed is obstructed in its flow by the leaf litters, tree trunks and exposed tree roots and this way, prevented from gushing down the forest floor, or gaining run off momentum eroding soil particles. These natural barriers reduce the speed of the runoff thereby affording greater time for the suspended soil particles to settle down as sediment and in the meantime, facilitate greater quantum of water to infiltrate into the sub-soil. Consequently the quantum of both the runoff and soil erosion is reduced.

- Best stability of stream bank could be expected if undisturbed vegetation is maintained over 80-100m wide stretch on either bank of the streams. Manifestation of such ideal 'stream and watershed equilibrium' condition could be witnessed in the forested catchment where the streams are almost in perfect shape so far as bank stability is concerned. But in the tea, pineapple and lemon garden sections of the watershed as well as in the farm land sections, vegetation clearance had been carried out right up to the stream bank. As a result, streams in these situations are unstable, and bank erosion and landslides are common. Reasons being simple: while the living tree root systems in the forested catchment has the sheet piling effect on the soil column underneath and strongly

hold the bank soil against erosion or landslide, the cleared forest areas are devoid of any such protective natural anchoring devices. Consequently, bank erosion and landslides are frequent and markedly visible in these non-forest catchment sections of the stream course.

- For effectiveness of stream bank rehabilitation programs, attempt should therefore be made to establish riparian vegetation over as much wide riverbank strips as practicable. But under Bangladesh condition, because of high population pressure and land scarcity for other competing uses, 80-100m wide stretch of plantation on either bank of streams may not be feasible especially where streams adjoin privately owned agricultural or horticultural gardening land. In these situations, lesser width of vegetation strip may have to be accepted but no where strip width should be less than 20m (one chain). If the vegetation strip width is further lessened, it will lose its effectiveness as bank stabilization contrivance. **One or two row of trees planted on stream banks will not be as effective a bank stabilization as a diverse range of grasses, shrubs and trees.**

6.1.2 Wetland Vegetation Restoration Rationale

The local fishers and surrounding local community firmly believes that a cogent inherent linkage exists between wetland tree vegetation and fish output in the haor aquatic ecosystem. With the declining of trees and reed vegetation from the wetland habitat, the fish output and bio-diversity has also declined markedly. Tree vegetation helps conserving and improving the aquatic ecosystem directly in a number of ways of which the following are outstanding:

- Tree leaf, flower and fruit constantly drop into the lake water which when rot, constitute fishmeal nourishing fish population. Fleshy and succulent fruits and flowers of trees are relished by many fish species. With destruction of tree and reed vegetation from the wetlands, this natural source of fishmeal is lost with declining fish health and fish bio-diversity.

- Tree leaves, fruits, twigs and branches when drop in water, form excellent base materials for plankton growth. Plankton is the universally recognized sought for fishmeal. This natural fishmeal source had also been lost with total destruction of wetland tree and reed vegetation from the Haor ecosystem.

- Tree root system and dropped out tree leaves, twigs and branches serve as hiding places for many species of fish. These natural safety devices protect many fish from being too easily eaten up by their predator enemies or caught by human beings, and thus serve as excellent conservation contrivance. Absence of such natural conservation devices exposed the fish population to easy and indiscriminate harvesting with consequent population decrease.
- Trees attract insects and birds as a source of food and refuge, and as a safe nesting abode. The dead and live insects, their eggs, droppings of insects and birds are nutritious fishmeal sources. Wetland tree groves and reed vegetation having been destroyed, *Hail Haor* virtually ceased to be a habitat for tree-living insects and birds. Naturally, cost-free natural fishmeal source has been cut off altogether adversely affecting fish health and fish bio-diversity. This has made the *Haor* vegetation restoration bid an essentiality for accomplishing the sustainable fisheries ecosystem development and management envisaged by the MACH program.

These pragmatic rationale justify the emergent national need and priority for rehabilitation of the tree cover in the watersheds, riparian zones, and wetlands of *Haors* and *Beels*, and call for launching pragmatic rehabilitation/restoration program.

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6.2 THE PRESCRIBED PLANTATION MODELS

6.2.1 RIPARIAN VEGETATION RESTORATION MODELS

- **Upper Reaches of Chara Section:**

Such situations are the typical hilly terrain of Watersheds with high elevation. Restoration measures in such locations may involve both new plantings (on denuded terrain) and simple protection or protection with enrichment planting (in degraded situations). Here establishment and maintenance of 100m wide belt of vegetation on both banks of charas may not pose problem. Some locations are already forested catchments where no intervention is needed. No chance of inundation of stream bank by water exists. Species suitable for upper reach restoration program are typically hilly species of indigenous as well as domesticated exotic origin. Suitable indigenous species include Garjan, Chapalish, Sal, Koroi, Bhera, Horitaki, Bonak (Konok), Champaful, Rangi, Jam, Chikrassi, Jalpai, Amloki & Bamboo. Among the domesticated exotics, Mahogany, Akashmoni and Mangium are the suitable ones.

Nursery grown polypotted seedlings of man-height specifications belonging to the prescribed species list should be planted at 2m x 2m spacing.

- **Middle Reach of Chara Section**

The soil and terrain conditions of these situations are more or less similar to the upper reaches except that the ground elevation is comparatively lower and slope gradients are milder. The middle reach is more intensively cultivated with orchards, tea and other agricultural crops. Establishment of 100m wide restoration plantations on bank top may pose practical problem in many situations. In problematic situations, plantation width may be reduced from 100m but should not be brought down below 20m (1 chain). At times temporary inundation of chara bank may take place. Species suitable for middle reach situations are: Chapalish, Gorjan, Chikrassi, Arjun, Bonak (Konok), Jam, Champaful (*Michelia champaca*), Rongi, Horitoki, Bohera, Jalpai, Amloki, Jarul, Kainja Bhadi, Mahogony, Akashmoni and Mangium.

- **Lower Reaches of *Chara* Section: (Down stream of Metalled Road).**

For all Charas, this section passes more or less through flat terrain with cultivated lands and habitations on either bank, and finally meets the Haor basin. Here, in relation to chara beds, the bank elevation is low compared to upper reaches. At the time of heavy down pour in the watersheds, the chara is often full to the brim with runoff water and naturally the chara slopes are submerged. Too heavy rainfall might cause spilling over of floodwater on the banks. Attainment of lowest 20m wide bank top plantation belt in this section would be difficult except when the charas pass through khas lands after entering haor basin. Maintaining close liaison with Resource Management Committees (RMC), as much wide strip of riparian plantation as agreed by local people should be established but plantation depth should not be less than 4-5 rows. Alternatively, efforts should be made to cover maximum linear distance in the lower reaches with bamboo plantation established on bank top (see Bamboo plantation model below).

Tree species selection for lower reaches of riparian section should be done on the basis their inundation tolerance characteristics. Species that withstand temporary or long duration submersion should be the choice. Else plantation efforts will not strike the desired success. There are again two distinct terrain situations in the lower reaches, viz.,

i). **Chara section down to human habitation limit**: Species most suitable in this section are: Jarul, Arjun, Kainjal Bhadi, Kadam, Semul, Bandarhola (Duabanga grandiflora), Koroi, Jam,

Sissoo, Rongi, Chalta, Rata (Amoora rohituka), Babla, Pitali (Mera) and Bamboo (homestead growing variety viz., Borua, Jai, Makla/Bakal).

ii) Chara section beyond human habitation limit (close to or part of haor basin): Species choice should be confined to only the typical wetland vegetation viz., Hijal, Koroch, Pitali (Mera), Borun, Bot, Jarul, Arjun, Kadam.

Murta, Dhol Kolmi, Vetiver, Nol, Khagra, Ikr may be planted in both situations of stream to curve down bank erosion.

- **Bamboo Plantation Model along Chara Bank**

Bamboo (all species, domestic and wild) has been found to be the best as riparian vegetation so far as soil conservation and bank stabitity is concerned. In reality, in the field situations, wherever bamboo clump is standing by river/chara bank, the bank is exceptionally stable and almost intact even though the slope gradient is very steep (as high as 70^0-90^0). This stability has been caused because of the enormous extent of fibrous roots set forth by bamboo clumps, which firmly hold the soil mass withstanding erosive scouring action of stream flows. Bamboo should therefore constitute a priority species for chara bank planting unless constrained by availability of planting stuff, which is of course scarce.

The other valid justification for favoring bamboo as a river/chara bank plantation species being that: as a resource, bamboo is versatile in its use ranging from domestic to industrial purposes, and return from bamboo is much quicker and appreciable compared to any timber tree species. Bamboo matures in 3 years while trees take decades to be useful and valuable as timber. Bamboo thus always has strong case in its favor with the planters and CNRS/MACH vegetation restoration project should encourage bamboo planting both from the considerations of better stability of river/chara banks as well as from the economic valuation of resource created for the community.

Bamboo plantation could be raised by planting off set (off set consists of about 2m long butt log of bamboo plant with uprooted rhizome) or by planting seedlings raised from cuttings of branchlets. If off set is planted, the sucker developed from the parent stock has more or less the same size (diameter and height) as the parent stock. From the considerations of quick resource production, off set plantation is desirable. But procurement of large number of off set is a practical limitation for large-scale bamboo plantation program with off set because one bamboo plant gives only one off set. Too many off set sellers are not available in any locality because selling bamboo plant by uprooting whole rhizome weakens the bamboo clump. Off set supply limitation should therefore be borne in mind while drawing up bamboo plantation program using off set as the planting stuff. But the propagation method is simple and common village folk are familiar with it. For off set planting, the best planting time is March-April (Bengali months of *Boishakh* and *Joishtha*).

The second method of bamboo propagation is by seedling produced from branch cuttings.

This method is applicable only for 2-3 varieties of homestead grown bamboo and the nursery technique though standardized by research but yet unknown to villagers or commercial nursery traders. Therefore, if bamboo propagation by cutting is contemplated, the Bangladesh Forest Reseach institute, Chittagong and its Field Reseach Centre at Lawachara, Sreemongol shall have to be contacted a year in advacnce and contracted for the required number of seedlings. However, offspring produced from branch bank top cutting is very thin in the first year, slightly thicker than the cutting itself, and this way takes 4-5 successive years reproduction to come to parent size. Thus with seedlings of branch cutting origin, the planters have to wait for 6-7 years to reap the resources of full-grown bamboo size. Planting time for cutting origin seedling is the common planting season beginning with rain (i.e., May-June). Plantation spacing should be the same as for off set planting.

A few bamboo species (from amongst both wild and domestic varieties) bear fruit but such fruiting usually occurs at a longer interval of time (e.g., for Muli bamboo, the interval is 35-40 years). When fruit is available, bamboo nursery program could be undertaken like tree seedling production nursery. Seedlings raised in polypots are then transplanted in the desired plantation sites. Once established and developed to full-grown bamboo size, subsequent upkeep of bamboo plantation is rather simple and straightforward. The harvesting method involves selective removal of mature bamboo; the maturity age being a minimum of 3 years.

Bamboo plantation whether raised with off set planting or transplantation of seedlings, should be done in linear planting pattern at a spacing of 3m plant to plant distance. At this spacing, seedling requirement per kilometer length of plantation is 334 #. Total seedling requirement for a given years plantation should be calculated accordingly and planting stuff arranged. However, if greater space is available, block plantations of bamboo may also be raised; spacing for block planting should be 4m x 4m.

- ***Chara Slope Restoration Model***

Charas originating from the Haor catchment areas are the drainage channels. The load of water carried by a chara cannot be appreciated fully except in the rainy season. The width of *charas* may be big or small depending on the load of water it carries in the peak hours of the rainy season. Thus, by observing the big width of a *chara* in dry season with little or no water flowing through its bed, none should be tempted to plant the entire chara slope as a riparian vegetation establishment program. Despite this warning, if planting is done on slope, it will be at the cost of obstructing the rainy season stream flow. And when that happens, the obstruction will lead to escalated bank erosion due to obstructed flow. The riparian plantation should be confined to *chara* bank-top and upper reaches of bank slopes covering maximum a row or two only of plants, depending on bank height and availability of suitable mild gradient allowing such planting. Planting must not be done all along the *chara* slope down to the dry season flow point. Instead, soil conservation measures should be undertaken in the inner slope, especially where serious bank erosion is observed, by planting reeds and grasses as the ecological situation permits. Such grassy vegetation will not cause obstruction to stream flow but protect the soil from the erosive action, on account of their fibrous root system. Figure 1 below gives a typical cross-section of the chara plantation model:

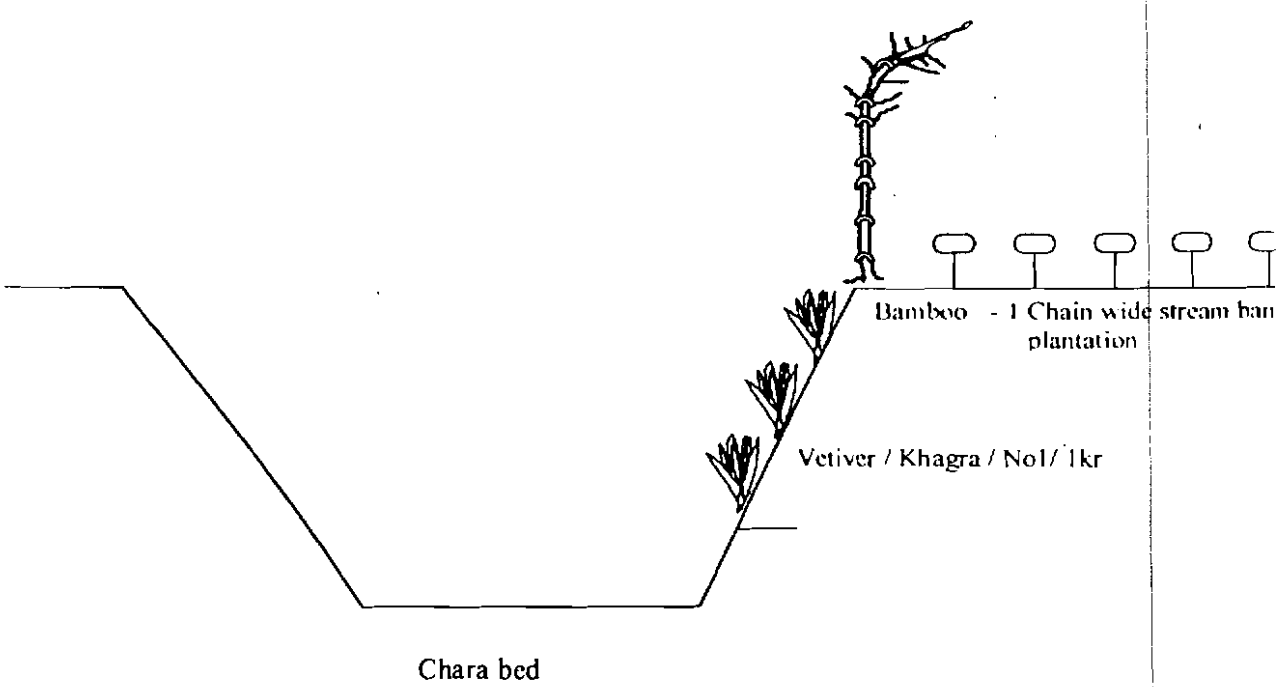


Fig-1: Typical chara section showing position of various riparian plantation species

Planting of Vetiver and Hogla grasses will be done at 0.50m x 0.50m spacing while that of Khagra, Nol, Ikr and Murta will be at 1mx1m. At this spacing, Vetiver/Hogla slip requirement per hectare is 40,000 #, and that of Khagra.Nol, Ikr, Murta is 10,000 #. It is but natural that, the entire inner slope lengths of a chara will not be fit for planting for various practical reasons like, badly eroded banks, dense shading by over woods, hard/stony soil surface etc. The proposed charas should therefore be reconnoitered physically every year in advance, grass seedling requirement assessed, and accordingly vetiver nursery program for slip production as well as rhizome collection for other reeds/grasses should be organized timely so that shortage of planting stuff do not stand in the way of achieving successful plantation target.

The reed/grass plantation on river/stream bank slopes should be established before onset of monsoon rains, preferably in April-May so that sudden flooding inundation does not damage the newly planted seedlings/rhizomes by submersion or physical uprooting by strong water currents. When planted early, and if needed, occasional irrigation should be arranged to establish the grass cover plantations.

6.2.2 WATERSHED VEGETATION RESTORATION MODEL

Depending on the land owning /land using agencies, the watershed is subjected to different land uses viz., forestry, Tea cultivation, pineapple and lemon gardening. Homestead and tree groves etc. While forestry and tea gardening land use models are fairly standardized, other land use models including pine apple and lemon gardening are yet to be standardized to successfully guard against harmful soil erosion hazards that are concomitant with improper cultivation of delicate hilly terrain. The pineapple and lemon cultivation will follow contour cultivation model described in paragraph 6.3.2.3 and 6.3.2.5.

The denuded hilly watershed will be restored with fresh planting following forestry plantation models. The plantation practice involves: cleaning of ground vegetation of all weeds in March-April and planting in May- June with man-height seedlings of primarily indigenous species like Chapalish, Gorjan, Chikrassi, Arjun, Bonak (Konok), Jam, Champaful (*Michelia champaca*), Rongi, Horitoki, Bohera, Jalpai, Amloki, Jarul, Kainjal Bhadi. The domesticated exotics like Mahogony, Akashmoni and Mangium are also locally favored species.

6.2.3 Wetland Vegetation Restoration Model

- The typical wetland tree vegetation is practically missing in the Hail Haor basin. From the historical evidence as well as remnant vegetation in other similar situations in greater Sylhet district, species suitable for the Haor wetland situations should be confined to typical wetland tree species only. These should include Hijal, Koroch, Pitali (Mera) and Borun in the deeper inundation and long duration water logging situations, while Jarul, Arjun, Kadam, Bot, Sheora in shallow water or temporary submersion positions. The deeper inundation situation species will also thrive well in shallow or seasonally inundation situations.

- Seedlings of the prescribed tree species will have to be grown in the project nursery one to two years ahead of actual planting in the selected site so that seedlings of man-height are produced to withstand sudden inundation. Seedlings will be planted in receding flood, usually beginning from October and continued up to December. To promote biodiversity, mixed plantation of the above species will be raised instead of monoculture. The **plantation spacing** will follow the standard **2m x 2m spacing**. At this spacing, plant requirement per hectare of plantation is 2500 #. Nursery program should be organized on the basis of hectares to be brought under a given year's plantation program.

- Apart from tree species, a number of typical herb and reed species grow well in the Haor wetland. These herbs and reeds are economically important and socially much in demand. Important ones are Murta, Vetiver, Nol, Khagra, Ikr, Dhol Kolmi etc. These may be planted as pure reed crop in the forelands of the tree crops at 1m x 1m spacing. Except Dhol Kolmi, all other reed/grass species are grown by rhizome planting with long stubs (about 2m long) simultaneously with tree plantation timing. Dhol Kolmi is however grown by planting cuttings in the dry season, along with other species establishment.

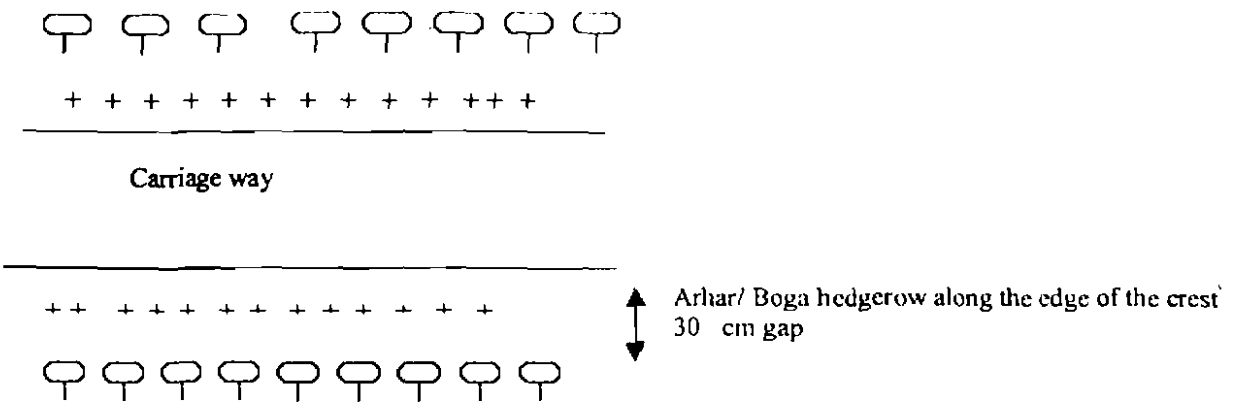
6.2. 4 Roadside Plantation Model

- Roads likely to be available for tree plantation by MACH-Caritas are the Union Porishod roads which are, in general, narrow roads with low elevation and consequently of shorter slope width. The general layout plan of plantation on such roads will be a single row of trees on either side of the carriageway. If, however, wider slope width is available in any section of the road and the terrain permits planting of more than one row, planting of two or more rows should be undertaken on those positions.

- Ordinarily planting will be done on road slopes in positions that are above the highest flood level (HFL). Species usually planted are quick growing, high valued trees, non-tolerant of water logging conditions. But under Bangladesh conditions, the lower slopes of almost every road go under water at certain times of the rainy season and remain submerged for varying length of time. If a second or more rows of planting becomes feasible, the lowest row will almost invariably go under water and remain submerged for some period of the year which may vary from 1-4 months: such submersions may be occasional or continuous. Planting on slopes below HFL may be permitted but species planted must invariably belong to water- logging tolerant group (viz. Jarul, Arjun, Sissoo, Kadam, Kainjal bhadi), and planting of these water-logging tolerant species is carried out before approaching flood (April-May) or in the receding flood (October-December).

- To install an in-built mechanism of plantation protection against stray cattle, live hedgerows of Arhar/Boga medula will be established along the edge of the road on both sides of the carriageway. Live hedgerow will be established by sowing seeds in hoed lines in April before planting seedlings of tree species. Typical layout plan for single and double row of tree plantation on roadside, together with establishment of live hedge of Arhar/Boga medula, is depicted in the following plan and cross-sectional elevation:

ROAD SIDE PLANTATION MODEL – SINGLE ROW OF TREES ON EITHER SIDE OF THE CARRIAGE WAY



Typical Plan of Single Row Tree Plantation along Road

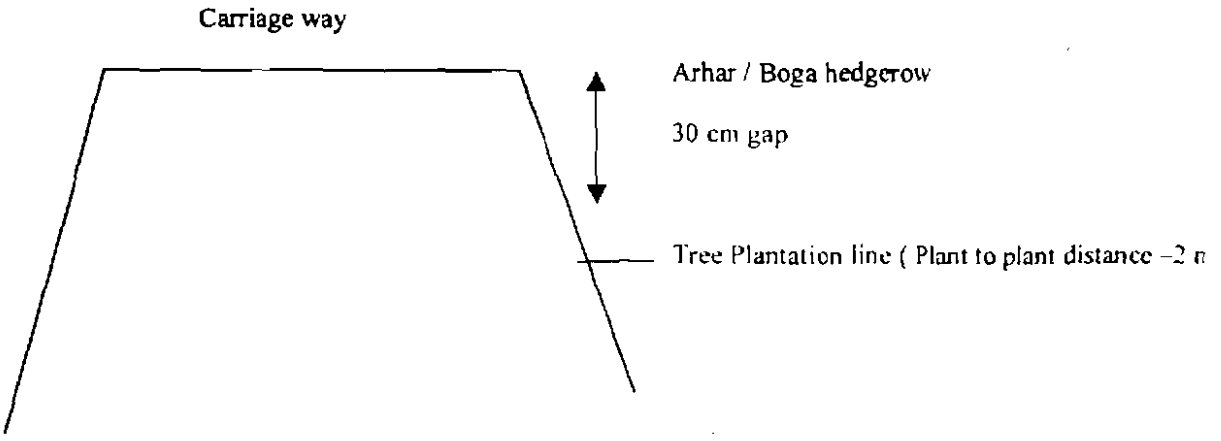
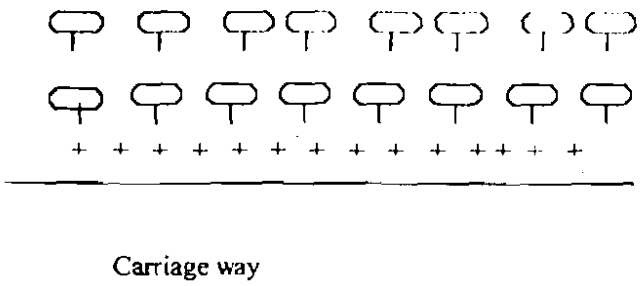
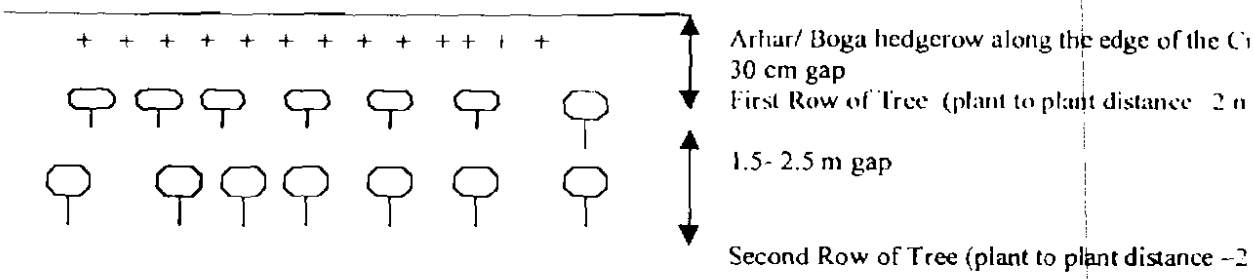


Fig-2: Typical Cross- Section of Single Row Tree Plantation Along Road

ROAD SIDE PLANTATION MODEL – TWO OR MORE ROW OF TREES ON EITHER SIDE OF THE CARRIAGE WAY





Typical Plan of Two Rows Tree Plantation along Roads

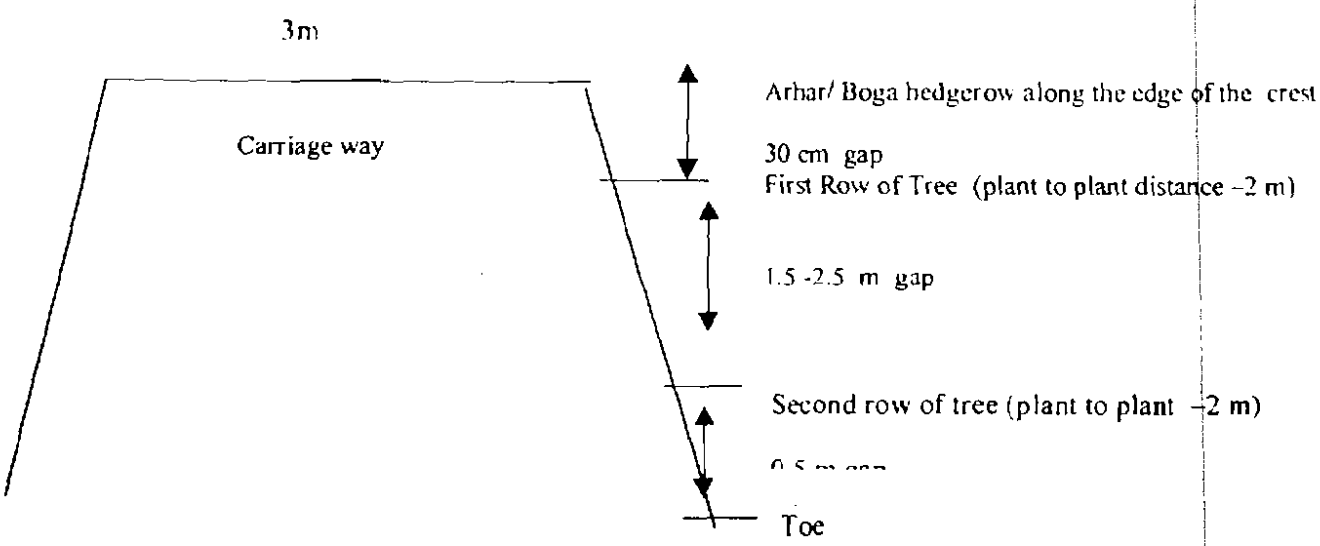


Fig-3: Typical elevation showing two rows tree plantation along road

Plantation Note:

- Arhar/Boga medula hedgerow will be grown in continuoue line at the edge of the road crest.
- Tree seedlings will be planted on the slope 30cm below Arhar/Boga medula hedgerow. Plant to plant distance should be 2m along the planting line.
- Monoculture (planting of a single tree species over large stretch) must be avoided as a preventive measure against wide spread disease susceptibility or epidemics. Mixed plantation with systematic sequence of short, medium and long rotation species should be the spatial distribution of tree seedlings in the plantation line.
- Wherever a second or more row of planting is feasible, the species in the lowest row should be tolerant of temporary submersion or water logging (viz. Jarul, Arjun, Sissoo, Kadam, Kainjal bhadi).
- Turf on the roadslopes must not be removed/damaged except for pit digging for tree seedling planting or agroforestry crop production. Proper and timely action must be taken by the beneficiary group members to stop soil erosion due to rain water.

6.3 Planned Watershed Restoration Interventions

6.3.1 Chara Vegetation Restoration

In the vegetation restoration component, the original MACH project envisaged restoration of only wetland vegetation in the Haor basin, while the subsequent 'Particpatory Pilot Watershed Management Project' contemplates activities outside the lake proper. So far as ownership of different restoration venues is concerned, the chara channel ownership, like any other streams and rivers, is vested with the State. Ordinarily, no agency other than the State organs would assume responsibility or evince interest for disciplining the State owned property except the concerned State Department or some other agency consented to assist the State in this regard. Thus, implementation of vegetation restoration program of State owned charas would be undertaken by CNRS under MACH project, of course with participation of local Union Porishods, RMCs and freehold land owners adjoining the chara bank on a benefit-sharing mechanism already agreed upon between the concerned parties (80% of the benefits to go to land owners, 15% to local Union Porishods and 5% to the RMC).
The benefits committed to different beneficiary partners will be guaranteed by executing a formal written agreement, and this agreement to have legal standing and force of law, must be signed on 150 Taka denomination Non-judicial Stamp.

CNRS and RMC/Union Parishads will be required to motivate the chara adjacent landowners to devote their chara bank lands for riparian plantatin according to the prescribed plantation model for establishing ideal restoration plantation.

6.3.2 Watershed Vegetation Restoration

- In case of watershed lands, by and large, the ownership/usufructuary right rests with private institutions or individuals. Consequently, vegetation restoration program as well as land use corrective measures have got to be accomplished through partnership with these land-using agencies. Here, the role of project sponsoring agencies (MACH-CNRS) will be primarily be that of extension and motivating agents aiding and advising the land users with appropriate technological package. The various land using agencies in the watersheds, as already mentioned earlier, are government Forest Department (FD), private Tea Estates, Pineapple and Lemon growers, Khashia Punji, private homesteaders, and scattered Khas lands not yet leased out. Out of these, the FD lands are mostly covered with plantations; very little natural forests being left there. The quality of these FD plantations are of course not uniformly good all throughout; there is scope for better stocking and also preserving some these plantations on delicate landscape un-felled for affording nature conservation and preventing soil erosion and landslide. The FD is learnt to have future plans and programs to accomplish such corrective land use objectives in reserved forests.

As such, MACH project does not have much to do on FD lands as direct interventions except monitoring land use and reminding/warning FD of any specific land use problem.

- **Tea Estate**

The Tea Estate lands, in large part, are under tea bush while some areas of a few tea esates are also under rubber gardens and plantation forests, or under original timber forests that are degraded. Although plantation lands in tea estate are, in general, fairly well looked after but some of the estates do have uncared for, denuded areas subjected to soil erosion and landslide. The eroded stuff ultimately find their disposal to Haor basin, silting up the beds of streams and reservoir. This type of badly denuded lands should be identified through reconnaissance survey and the concerned tea estate management should be approached to undertake corrective measures to discipline the land use. In these cases too, the role of CNRS/MACH would be limited to the extension and motivational aspects of fostering and promoting appropriate land use.

- **Pineapple and lemon gardening**

Apart from forestry and tea cultivation, the two other prominent land uses of the Haor watershed are pineapple gardening and lemon orchard. Major cultivation of Lemon and Pineapple crops are done in Faizabad Hills although scattered cultivation could be witnessed in other areas. While lemon cultivation is confined to valleys and lower reaches on fairly flat to gentle slopes, pineapple is generally devoted to upper reaches of hills irrespective of gradient steepness.

Lemon orchards were found intensively managed and reasonably well cared for. Land use under Lemon is not seriously provocative of soil erosion. Of course, there exists scope for adopting appropriate soil and water conservation measures by constructing pucca or earthen or brush and weed piled cheek dams at delicate points to trap the silt that is washed down the hill slopes, and to combat landslides and sheet erosion. Such contrivances are not likely to entail much of extra expenses to the owners but the benefit accrued will be enormous towards retention of ground fertility, better water regime in dry season, and sustainable productivity of the orchards in future years. Exercise of carefulness and proper conduct of orchard maintenance job by the maintenance crews would accomplish marked improvement in the land fertility and higher return from the orchard with no extra investment.

However, major wrongdoing has been observed in pineapple cultivation in which the local practice involves positioning of the pineapple rows '*across the contour*' instead of 'along the contour'. This practice is provocative of soil erosion. The vacant land in between two pineapple rows functions as water course for draining the runoff, and uninterrupted on-rush of runoff from hill top to hill bottom cause serious soil erosion. Such across the slope drainage often cause gully formation on hill surface degrading the pineapple land for future use.

The total aspect of deleterious cultivation of lemon and pineapple was discussed with some leading gardeners of Faizabad Hills (M/S. Askir Ali and Monotosh Pal, and caretakers of Satgaon Tea Estate in particular). They seem to have some reservation about contour cultivation and the major objection is based on some apprehension i.e., when pineapples bear fruit and become top heavy, there is a chance for the fruit bearing plants to tilt down slope. And when that happens, the planters apprehend incurring loss that they want to avoid. This apprehension is empirical and not founded on practical experiment with contour planting. This apprehension needs to be dispelled or established through practical experiments.

- **Experimental Contour Gardening of Pineapple**

The idea of contour planting and its advantages, in substitution of the existing practice of 'across the contour' cultivation, was presented and explained to the above mentioned two

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progressive gardener gentlemen. They were appreciative of the new idea and promised to cooperate with MACH-CNRS project should the project be prepared to layout some experiment in their garden. They went further ahead to suggest that, in December 2000, they will embark on new plantations of pineapple and would be ready right from this year to undertake experimental contour gardening of pineapple in the new plantation. This is a very encouraging response from pineapple gardeners and CNRS/MACH project should take full advantage of self-motivated positive attitude of the growers and arrange to physically layout contour planting experiment, at least in the gardens of the aforementioned two enterprising gardeners who opted to be the innovators.

Laying out contour lines on the hill slope is an expert job and ordinarily undertaken with sophisticated leveling instruments. But facilities both instrument and manpower wise, are not currently available with MACH-CNRS. However, an improvised method, using 'A-Frame', could be a reasonably good substitute for costly leveling instruments and applied with reasonable accuracy to layout plantation contour line. During field trip, CNRS local staff (M/S Shamsur Rahman Shamim and Raquibul Haque Monu) were given a practical field demonstration on the use of *A-Frame* followed by an exercise on contour line layout on hill slopes. They felt confident that they could do it themselves whenever needed. However, any worker of ordinary prudence and good common sense can apply this technique in the field.

Instead of a single row planting of pineapple, as is practiced now in 'across the contour' cultivation method, three close rows of pineapple suckers at a row to row distance of 30 cm, and a plant to plant distance of also 30 cm in the line should be planted. The distance between two successive row clusters should be 1m vacant space to function as passage for labor movement between row clusters and also to allow dumping of ground cleaning weeds. Open corridors, 1 to 1.5 m wide, at every 40 to 50 m distance may be left vacant in pineapple row cluster to function as passage for upward and downward movement of workers across the gradient and also to act as runoff passage for rain water should excessive rainfall occurs.

The local Upazila Agriculture Extension Officer (Mr. Proddut Bhattacharjee), was met at his office on 9 November 2000 and his cooperation and technical assistance were sought for experimental cultivation of pineapple and lemon in the watershed. He assured all possible technical help and personal cooperation for establishing contour plantation experiment, follow that up with regular visits. Sreemongol MACH office should coordinate and establish rapport with Upazila Agriculture Extension Officer, and layout the experiment.

The contour gardening pineapple experimental plots should be closely observed and followed up by MACH-CNRS project staff. Various parameters needing special attention and data collection from these experimental gardens should include: recording stability of pineapple plants in contour lines as against the control areas of traditional 'across the contour cultivation' practices; convenience/ inconveniences in the labor movement inside the garden; working efficiency; plant health, plant productivity and fruit size; erosion control capacity of contour planting model, and silt load carriage by runoff etc.

- **Hedgerows Establishment to Prevent Pineapple Overturning**

To guard against plausible overturning of the fruit bearing pineapple plants due to its own weight, as apprehended by some of the gardeners and their caretakers (though not formally established by experiment), the following cultivation technique should be followed:

Parallel to each row cluster of pineapple, a row of Boga medula (*Taphrosia candida*) or Ipil-Ipil (*Leucaena leucocephella*) in thick line sowing 30cm below the pineapple line clusters should be done in April and the hedgerow should be established through the needed tending operations. Boga medula/Ipil-Ipil plants should be clipped regularly and maintained at a

height of about 1m in order to develop it into a stout hedgerow. Should any pineapple plant ever tend to tilt downward, the same will find a stout support at the back to rest on and will not be thrown down on the ground. Boga medula/ Ipil-Ipil being leguminous crop will enrich the soil fertility through nitrogen fixing and decomposition of leaf mole. Tender branch lopping from Boga medula/Ipil-Ipil will also rot quickly adding organic manure to the soil besides the plant providing support to tilting pineapple plants. Figure-2 depict a typical contour plantation pineapple cultivation model.

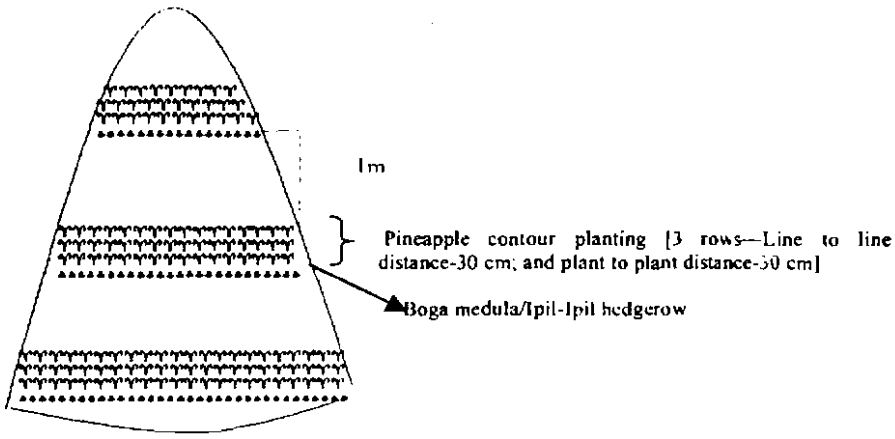

Figure – 2 : Pineapple Contour Cultivation Model on Hill Slopes)

- **Black Pepper Cultivation in Orchard**

This tract also produces good black pepper, and the crop is familiar and favorite with Monipuri tribal community. The pineapple and Lemon gardeners could venture black pepper cultivation using shade trees as climbing support. Alternatively, suitable tree groves may be created in some convenient corners of the pineapple and lemon gardens as support trees for black pepper cultivation.

6.3.3 Wetland Vegetation Restoration

Ready non-availability of land for plantation raising, as analyzed earlier (paragraph 6), is the major problem for restoration of wetland vegetation in the Haor situation because land suitable for plantation establishment, whether under public or private ownership, are now cultivated for Boro paddy production in winter months. Lands that could however be available for vegetation restoration without much of people's resistance are the marginal and wastelands by stream banks and slopes of dykes and roads within the greater Haor areas. One such suitable land of appreciable magnitude, immediately available for wetland plantation, is the Kagaurar Kandi, and should be planted. In other situations, attempts should be made to establish extended plantation on marginal land situations like shelterbelt having width ranging from 20m to as much wide as practicable.

Plantation raising on *Khas* land in Haor situation poses no legal problem but confronts serious social problem that is insurmountable without social consensus. Therefore, consensus in the various committees at Upozila and RMC levels could only make vegetation restoration programs on wetland situations realistic and possible. These committees may decide in favor of block plantation on agriculturally less productive marginal wetlands or allocate continuous

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belt of 100-150m wide land all along the outer periphery of the Haor for plantation establishment with typical wetland species. Restoration of such vegetation belt is essential for creating an ecologically congenial environment for bird re-introduction in the Haor environment in the interest of fishery and tourism. The extent of land availability for plantation raising can not be estimated/guessed at this stage without intensive dialogue and negotiations between land users and local committees with CNRS acting as mediating and motivating agency. When land becomes available, plantation will be raised following plantation models described in paragraph 7.2.3.

6.4 PLANTATION TECHNIQUE

6.4.1 Plantation Venues

The identified plantation venues for the expanded MACH project program are the following:

i. Riparian plantation along *chara* banks (upper reaches, middle reaches and lower reaches);

ii. Wetland plantation on *Haor* and *Beel* fringe lands (block, strip or shelter belt type plantation), strip plantation along streams bank or road slope (in Haor situation);

iii. *Chala* land plantation in Turag-Bongshi floodplain; and

iv. Roadside plantation along Union Porishod road.

6.4.2 Planting Time

- Planting in the watersheds, riparian vegetation restoration zones, roadsides, and *chala* lands will be implemented in the normal planting season that usually begins countrywide with the advent of monsoon starting from late April to early May, and continued upto August-September. Planting in the *Haor* and *Beel* wetland situations should be done in the receding flood season i.e., from October to December period. In the first case i.e., monsoon planting, the earlier the planting is done in April-May, the better is the success rate and growth recruitment because the plant gets full growing season of 6-7 months to register growth. Such early season planted saplings often put in unbelievably high growth performance so that, at the close of the growing season, a current year's sapling may give the look of two or more years plant. All attempts should, therefore, be made not to miss the early planting opportunity that brings big economic gains for the planters.

- In the second case i.e., receding flood planting season, planting time should not be construed as any time between October and December. Rather, the time span is to watch on the ground conditions and assess the permissibility of planting with water recession. This implies that, the plantation venues will be constantly visited by the project staff and whenever the wetland grounds come above water level, and the soil condition is dry enough to permit digging of holes and planting comfortably in dry soil , saplings from the prescribed list of species will be planted. The planting process will continue progressively till the site conditions do no longer permit success in planting due to drought and other unfavorable conditions.

  Every one concerned with planning as well as implementation of plantation program on wetland needs to appreciate that tree species can not be established initially underwater like transplanted paddy crop or reeds. Tree species have got to be planted and established in dry soil condition; root development of saplings must take place before flood inundation occurs. If sapling base is submersed soon after planting i.e., before fresh root development in the new plantation site

occur, root rot will start and the plant will die. Planting may however be done in mud that has started drying but not underwater.

6.4.3 Pit Digging and Planting

About two weeks before the actual planting operation, pits of size 30 cm x 30 cm x 30 cm should be dug at 2m center to center distance in lines; the line to line distance will also be 2m. The top fertile soil of the first half of the pit depth should be kept in the right-hand side, while the comparatively less fertile bottom-half of the pit soil on the left-hand side. The pit and dugout soil should be allowed to dry for one week. Thereafter, the clods of dugout earth should be fine broken, debris removed therefrom, and manure @ 2 kg decomposed cowdung, 100 gm MP and 100gm TSP per pit should be mixed intimately with the dugout soil, and the pit is refilled with this manure-mixed earth. At the time of refilling dug out pits, soil dumping will be done in the reverse order i.e., the fertile topsoil should be put at the bottom of the pit and the bottom-half soil on top.

- **Planting operation: All plantation Situations other than Wetland** - Usually a few good showers of early monsoon rain is received in late April and early May period in greater Sylhet region, while a little later i.e., in May and early June in Gazipur and Sherpur tracts. After these showers, the soil becomes saturated, soil moisture remains plentiful and moisture stress is no longer a limiting factor for seedling survival. At this point in time, hole large enough to accommodate the earth ball of the potted/ uprooted seedling is opened at the center of the planting pit, the polyethylene bag is removed carefully, and the seedling is planted carefully and decently. Precautions have to be taken so that the clod of earth around the potted/uprooted sapling roots are not broken or fall apart; when that happens, there is less chance that the seedling will survive.

- **Planting operation: Wetland Situation** - In wetland situations, planting suitability conditions are reverse of the dry land situations. In wet season, the wetlands are unfit for planting due to water logging. Sites have to dry up to permit planting, and the condition starts turning favorable from late September. Usually wetland sites become ready for planting from early October and conditions remain favorable up to the close of December. Planting in typical wetland situations should therefore be done in October-December period. Planting technique is the same as for any other planting technique (sub-para 6.4.3.17 above).

6.4.4 Stake Fixation

After planting of a sapling, stout supporting bamboo stake, about 2m in height, should be fixed on the ground at a distance of 15-20 cm from the sapling base. The direction of stake fixation is also important to derive full benefit from the stake. Stake should be fixed in the direction from which stormy wind blows in the storm season so that the stake functions as an anchor that constantly keeps on pulling the sapling against wind thrust and makes it to remain vertical. The sapling is then tied loosely with the stake at 2/3rd height of the plant with a jute or plastic sling, 15-20 cm long, so that the plant has a movement freedom and stands on its own axis in normal weather but held straight by the stake in stormy weather. Sapling must not be fastened tightly with the supporting stake like strangulation bid, which is inordinately the case normally observed in most situations. If tightly tied, the bark of the sapling is injured due to constant friction of the sapling stem with the stake, which is undesirable. More importantly, the adverse effect of tight fastening of saplings is that: plant become support dependent, and when the support is no longer there (due to rotting or being stolen), the plant lean down and may be broken or damaged otherwise. The loop length of the fastening sling should be the same as the footing distance of the plant from the stake (i.e., 15-20 cm).

6.5 MAINTENANCE AND MANAGEMENT

6.5.1 PLANTATION MAINTENANCE

Weeding

The weeding process involves cleaning all grassy; tendrilling and woody undesirable plants that are competing with planted seedlings for food, nutrition and growing space. Weeding could be accomplished by removing all unwanted plants within a radius of 30 cm around the collar of planted saplings. Simultaneously with weeding, the weeded out ground soil shall also be hoed with weedier, clods of earth broken, and pulverized. This helps in greater aeration to the root zone of the plant enhancing symbiotic microbial activity, greater percolation of precipitation and less desiccation in the dry season due to severance of capillary tubing system

Pruning

Pruning means chopping off some of the lower branches of planted trees whose removal on one hand will not weaken the plant but on the other hand, help shaping tree trunk to defect-free round timber log of good quality. Depending on the branching habit of individual plant species and prevalence of the number of branches in a tree, **one-sixth to one-fourth number of branches from the lowest rung could be safely cut.**

Pruning should be done close to the main trunk of the tree. Depending on the size of the branch to be cut, pruning should be done with a sharp-teethed sickle, or sharp scissors or pruning saw so that no exfoliation of bark takes place, the cut is sharp and smooth, and the wound is quickly occluded. Machete (*Dao*) should be avoided as pruning blade as it tends to injure the plant through inexact striking blows. Pruning may be started from the second year of plant life and continued as long as hands from the ground could reach the undesirable branches without climbing trees.

Vacancy Filling / Failed Plant Replacement

All dead / dying / severely damaged seedlings should be replaced whenever such situation is observed. Replacements must be done with healthy seedlings of the same height as their neighbors so that the taller neighbors do not suppress the replacements. The best time of vacancy filling is June-September. If drought follows replacement, watering should be done till the plant is established, setting new leaf and root, or until rain sets in.

Stake Replacement

Fixation of a supporting stake is indispensably required to keep the plants erect till they are stout enough to support themselves. Often supporting stakes are either broken or stolen or rot, and the seedlings lean down either growing to a deformed tree, or even may get damaged unless straightened with a fresh support. Thus stakes of the same height as the planted sapling is, shall have to be provided with every plant at planting or replacements, or whenever becomes necessary

Irrigation

In the high elevation watershed situations, planting when done in appropriate time (May-June), and the whole growing season (which coincides with rainy season) having passed without moisture stress, the seedlings will have established firmly in the new situation by the end of the growing season with roots ramified further down and laterally, and thereby needing no additional irrigation. If, however, abnormal drought succeeds planting in May-June or late planting is done in October- November when growth ceases and seedlings could not establish

by setting new root systems in the new situations, irrigation may be needed in the dry period during the first year of the plantation.

In case of wetland situations, the ground is usually moist to very moist, and unless planting is too much delayed beyond December, watering of the newly planted seedlings may not be necessary. However, if the planted seedlings receive pre-planting shocks or the site is too dry at planting time, watering would be necessary till the plants show signs of recovery by setting new sprouts and appear fully stable.

In most locations, water is available in the canals, ditches, ponds, wells etc. close by the plantation sites and caretakers could easily irrigate the planting pit by hand watering from these sources. In other situations, water may have to be carried a distance from the source. Watering is not needed every day. Depending on the intensity of drought, watering may be done every alternate day or once in 2-3 days. No irrigation is needed from the second year of the plantation.

However, to reduce the ultimate cost and arduous labor for irrigation, and to minimize the risk of failures, all out efforts should be made to plant bigger sized polypot raised seedlings (> 25 cm rooting depth) in May-June period. Thereafter, take appropriate care in the next season so that plants are well established in the very first year, and the need for painstaking irrigation does not become a necessity.

Mulching

Covering the base of the plants with organic residues (straw, weed, grass etc.) protects the pit soil from scorching sunshine and slows down evaporation process thereby greatly reducing moisture loss from the planting pit. Such a contrivance, termed as mulching, greatly reduce the need for frequent irrigation. Mulching should, therefore, be resorted to from the advent of dry season succeeding the planting season. Mulching could be effected without extra cost if the caretakers are advised to cover the plant base with the very same grasses they weed out.

Fertilizing

The recommended dose of organic manure and chemical fertilizer prescribed (para 7.4.3); if applied in the planting pit at the time of original tree planting, additional fertilizer application may not be necessary. However, to promote accelerated growth for quick establishment of the young seedlings in the disturbed public places and delicate landscapes, a dose of urea fertilizer in every month of the growing season (July-October) should be applied. The fertilizer dose should be 30 gm of urea/plant/month, applied through pegging method that involves striking 4 holes in four sides of the plant, 10-15 cm away from the plant base and 5-7 cm deep, with sharp pointed peg/stake and applying granular urea in the holes, and finally closing the holes by pressing the surrounding earth. This method of application helps slow release of the fertilizer and hence greater availability of the fertilizer to the plant).

Plant Protection Measures

- **Physical Protection:** Physical protection against cattle grazing and human damage will be ensured by engaging whole time caretaker during the project period. Each caretaker will be in charge of 1000 # planted seedlings in a plantation. Besides guarding against plausible damage and ensuring plant safety against cattle and humans, the caretakers will also nurse the plants by weeding, cleaning, soil working, fertilizer application, pruning, replacements, irrigation etc.
- **Protection Against Pests and Diseases:** Plantation is infested by the same type of insect and fungal diseases as the nursery plants but with lesser intensity. The pest control measures suggested for nursery plants (Para 11.12) are also applicable to plantation seedlings, and should be adopted as and when pest control measures becomes necessary.

6.5.2 YEAR WISE PLANTATION MAINTENANCE OPERATIONS

Plants need regular care and attention for their healthy growth, desired shaping of trunk, crown, and reduced susceptibility to disease. Following are the year wise major tending and cultural operations that must be carried out unfailingly as the plantation advances in age.

Plantation Year-1 (FY-2)

i. Weeding: 4 thorough weeding (one in every month from July to September and one in May-June in case of watershed and riparian plantations; and from December-May in case of wetland plantations) will be required. The weeding process has been described in paragraph 7.5.1.

ii. Fertilizing:One dose of Urea fertilizer @ 30 gm/tree/application should be administered after every weeding and cleaning by pegging method (described in paragraph 7.5.7).

iii. Irrigation: If drought condition succeeds seedling planting or prolonged drought occurs in the following dry season (December-June), watering may be necessary and should be none by the caretakers. Watering procedure has been described in paragraph 7.5.5)

iv. Vacancy filling: All dead/dying/badly damaged plants should be replaced with tall healthy substitutes of equal height as the neighbors soon after death or damage is noticed

v. Pest control: Constant care of seedlings against pest and disease will have to be taken, and control measures undertaken as soon as any pest attack is observed. Usually IPM method should be employed for pest control until the attack situation goes beyond control when pesticide application may become unavoidable.

vi. Live fence Maintenance: If too dense germination of Arhar/Boga medula takes place in the live fences established along roadside plantation, thinning out of weaker seedlings and spacing out of remaining Arhar/Boga at 20-30 cm distance apart should be done for affording healthy growth. Arhar/Boga plants should also be lopped at mid-height if they over grow and tend to suppress the nearby planted tree seedlings.

vi. Harvesting of Arhar/Boga: Ripe/mature pods of Arhar/Boga should be harvested by sharp cutting of fruit bearing branches so that the plant is not damaged and continue for second year affording both fencing protection and a second crop of lentil from Arhar or seed from Boga.

Plantation Year – 2 (FY-3).

Vacancy Filling: Replacement of all dead/dying/badly-damaged plants should be replaced with tall healthy substitutes of equal height as their neighbors soon after death or damage is noticed in the plantations.

i. Weeding: Three weeding and cleaning in May-June, July-August, and September-October for Watershed and riparian plantation; and in November-December, January-February, and March-April for wetland plantations following the same work specification as for Year-1.

ii. Pruning: Pruning of the lower branches in May-June (pruning procedure described in paragraph 7.5.2). If any double stem is observed from any plant, the weaker stem should be cut and removed.

iii. Fertilizing: 3 doses of urea fertilizer applied in May-June, July-August, and September-October for watershed and riparian plantations; and in November-December, January- February, and March-April for wetland plantations following the same specifications and application method as for Year-1.

iv. Harvesting of Arhar pods is first done by branch cutting. Thereafter, the entire Arhar plant will be harvested by cutting at the ground level, and utilized as fuel by the beneficiary group members.

Plantation Year-3

i. Weeding and Cleaning: 3 weeding and cleaning in May-June, July-August, and September-October for watershed and riparian plantations; and in November-December, January- February, and March-April for wetland plantations following the same work specifications as for Year-1 and 2.
ii. Pruning: Pruning of lower branches and double stem cutting in May-June following the same procedure as for year-2.

Plantation Year-4

i. Climber and creeper cutting and cleaning plantation floor.
ii. Pruning of lower branches as far as could be reached by hand. Pruning by climbing trees may not be feasible and should not be attempted.

Plantation Year-5

i. Thinning: After 5 years of growth, plants will have grown to bigger size and become congested, needing spacing out. At this stage, first thinning of the plantations will be carried out in which the weaker and suppressed plants will be removed by felling. The thinning outturn will be fit for utilization as fuel wood and some may become fit for use as small house post. From this point in time, income would start flowing to the participants and should be distributed to the beneficiaries according to the executed formal agreement.
ii. Pruning should be done in the remaining stock of standing trees.

Plantation Year-10

A second thinning may be done in 10th year of the plantations to allow still greater space for the most prospective plants to put in price increment. At this stage also, diseased, suppressed, leaning and weaker plants will be removed by felling in a bid to ease out competition. Efforts should me made to maintain uniformity of plant spacing allowing uniform growing space to all the remaining plants. The thinning principle being: allow the fittest to survive and grow still bigger. The sale proceeds from these thinned out materials will be shared by the beneficiaries according to committed benefits as per formal agreement between the parties.

Plantation Year - 15

The plantations will be fit for exploitation felling at year 15. But final felling will take different shape in different plantation locations. The felling plan for different plantations has been detailed in the succeeding paragraph 7.6.8 (Plantation Management System).

6.5.3 PLANTATION MANAGEMENT SYSTEM

Since vegetation restoration plantations under this project are raised on delicate landscape, and also to serve specific watershed and wetland protection and fishery development objectives, these plantations should not be viewed as typically commercial plantations for maximum financial gains from wood products or money outturn. These plantations need special treatment and harvesting system so that substantial income is derived from them but at

the same time without causing harm to the ecosystem on which they are located. The three sets of plantations will therefore be managed under 3 different systems as outlined below:

- **Watershed and Riparian Plantation Management System**

All the trees from these plantations will not be felled by one-go, what in traditional forest management system called 'Clear-Felling System, because this practice will again expose the watershed's floor to all the vagaries and degrading impacts of nature including soil erosion and landslide. Thus, instead of clearfelling of the plantations, only the most fat trees from the plantation will be felled at 15th year and the product disposed of in accordance with agreed decision of the RMC. Gaps created by such felling will be re-stocked by fresh seedling planting, a process called 'Enrichment planting' with suitable *shade bearing* species (meaning species that will grow under the shade of the over wood). This implies that the watershed and protected areas will never be devoid of tree cover; only certain specified categories of trees will be selectively removed. This system of management of forests and plantations are called ***Selection System*** meaning that, every time when felling is done, only certain specified type of trees will be felled selectively for reaping benefit from the plantations but never exposing the ground altogether. Felling of bigger trees may be done on a 5 year felling cycle and the gaps so created will be regenerated by enrichment planting method.

- **Roadside Plantation Management**

Roadside plantations, when established and tended properly, create a soothing physical and ornamental environment that is appreciated by citizens. People would not like to see such ornamental plantations clearfelled thereby creating a desolate look and adverse ecological situation. But again, felling of the roadside plantations to distribute benefits promised to the participating groups and adjacent landowners is a commitment of the project's plantation program. As a compromise formula, therefore, at the felling age of these plantations in year 15, a few elite trees at some 45 to 50 m distance should be left unfelled so that the landscape does not give a dejecting look and the management is not subjected to public criticism. These elite trees will form part of the future crop and may be felled in the next rotation fetching high return to the beneficiaries. If, however, the beneficiaries are impatient and all out to reap the benefit quickly, the elite trees could be felled at the time of thinning of successor plantations. At that stage, the young plants of second rotation will have grown to sufficient height, and felling of a few elite trees will not make much difference to the landscape and its look.

- **Wetland Plantation Management System**

Establishment of such plantations being very difficult because of the delicate physiological conditions of the wetlands soil, trees of the wetland plantations will not be felled altogether at a regular interval except when dead or defective or over matured. Instead, the branches of wetland tree groves will be lopped above the highest flooding height of the locality so that even during the worst ever flood, the tree crown will not be submerged. This type of harvesting management of tree groves is called ***Pollarding System.*** Nature has bestowed the wetland tree species with special endurance quality in that, they can withstand heavy lopping and is again full of new branch and leaves in the next growing season. Incidentally, the Forest Department in some of their wetland forests in sylhet basin (*Ratargul Reserved Forests)* is currently practicing pollarding system.

6.6 NURSERY ESTABLISHMENT PROGRAM

6.6.1 Tree Seedling Nursery

- Conspicuous feature of this pilot plantation program being that: tree species which are biologically and physiologically suited for growing in the wetland and riparian situations,

and also effective for erosion control and bank protection as well as good as fishmeal and fish protection hideouts are usually not quality timber species. Naturally, such species have poor market demand and product value as timber. Common planters thus ordinarily show little interest to buy or plant such tree species in their homesteads or village groves as their priority or chosen species.

- MACH project so long depended on commercial nurseries for seedling supply for the project plantations. But seedling production in commercial nurseries, and for that matter in any other business, is always demand driven. Since plant species suitable for wetland and riparian situations are not commercially valued as good timber, these species are not ordinarily demanded by common planters and quite expectedly, seedlings of species recommended for wetland plantations are not produced in commercial nurseries. Consequently, species suitable for planting in riparian and Haor situations are not available in the commercial nurseries for procurement by the project.

- Appreciating the reality obtaining in the country regarding non-production of wetland suited tree species seedlings in the commercial nurseries, it has become incumbent for MACH project to pragmatically think about the most feasible and practicable strategy of seedling supply. Analysis of the various pros and cons of seedling production and supply options suggest that, if ready availability of site specific wetland plant species of the right mix, scale and specifications are to be ensured, establishment of project's own nursery is the most feasible, dependable and cost effective method for production and supply of such planting stuff. Such nursery establishment could be accomplished either directly under the control of local MACH-CNRS and MACH-Caritas staff, or in the homesteads of the project participants, both groups being adequately trained in nursery raising technique and upkeep.

- The project site is either subjected to sudden inundation (wetlands and lower reaches of stream section) or to heavy pressure of cattle grazing and human interference (riparian zone and roadsides). Protection of planted saplings by engaging watcher is never a full proof system. Man-height seedlings beyond the ordinary damage reach of man, animals and natural phenomena (sudden inundation and luxuriant weed suppression) are needed as planting staff to overcome these natural hazards and human induced problems. But production of bigger seedlings means longer duration caretaking in the nursery which commercial nursery traders would not prepared to undertake for specialized species not ordinarily demanded by common planters. Therefore, such specialized seedlings with required height specifications, of necessity, have got to be produced in the project's own nursery.

- Detailed guidelines for nursery establishment and upkeep are incorporated as a separate chapter of this reports (Paragraph 9). These guidelines will be very helpful for the project staff charged with nursery establishment and should thus be consulted. It is recommended that a short training course of 2-3 days duration on nursery and plantation establishment and upkeep should be organized for the MACH-CNRS and MACH-Caritas staff, and also for the project beneficiaries at suitable project sites (Sreemongol. Kaliakoir and Sherpur). When organized, such training course will prove very useful and effective in accomplishing the standard of activity.

- MACH-CNRS and MACH-Caritas staff already evinced keen interest in nursery establishment under their direct supervision and control, and was found taking mental and physical preparations to collect seeds of recommended species as and when they ripen. The recommended training at this stage will be appropriate and should be organized.

- The types of plantation activities envisaged under this program are block plantations, shelterbelt type plantations, and single or multiple line linear plantations. In the block plantation type of activity with 2m x 2m plant spacing, seedling requirement per hectare is 2500 #. In case of linear planting pattern, for a single row of line planting with plant to plant distance of 2m, seedling requirement per kilometer length is 500#. For single row planting on both sides of road carriage way or stream bank, seedling requirement is 1000#. This way, total seedling requirement for a given year or plantation activity should be calculated, nursery program planned and nursery raising activity organized.

- Nursery raising technique, space requirement for nursery seedling production, and other relevant information have been provided for in the nursery chapter (para 9) of this report which should be consulted for necessary related detailed information.

6.6.2 VETIVER NURSERY

- Vetiver grass, locally called *Binna ghansh or Binna chon*, is a versatile and aggressive soil binder/soil conservation contrivance. This grass has a wide ecological adaptability in that, it grows in water logged wetlands as well as on slopes in dry hilly terrain. It is indigenous to Bangladesh but not widely available in every location. It grows in rainfall range of 200 mm to 5000 mm/year. Vetiver grows both on highly acidic (pH 4) as well as highly alkaline soils (pH 9).

- Vetiver is a recommended plant species for soil conservation and erosion control on delicate landscape situations like stream/river banks, hill slopes and badly eroded undulating terrain as well as in the wave ward direction in wetlands to break rolling waves.

- *Nursery propagation method:* Vetiver can be propagated by means of slip and pantalets at nodes of the stem; its propagation by seed is not easy. Since vertiver grass is not available locally in large quantities, and in every locations, it would be necessary to establish vetiver nursery to produce the required quantity of planting stuff (slip/tiller) to meet the plantation requirements of the project. For convenience of supplying planting stuff, at least one vetiver nursery would be established in each sub-watershed jurisdictions to cater for the needs of combating intervention as well as for demonstration.

- *Time for starting vetiver nursery*: Monsoon is proper time for starting nursery. Land preparation should be started in May after receiving a few good showers of early rain that accompanies n'wester. Ploughing should be done deep and soil is well pulverized by repeated ploughing. Deep ploughing and good manureing help production of greater number of tillers from each slip. After completion of ploughing and ground leveling, seedlings or individual slip of vetiver should be planted at 15 cm apart in the line and distance between two adjacent lines will be 30 cm. To make the sunlight available for each vetiver, distance between the lines should be slightly higher. Rainfall helps vetiver to grow fast and multiply by setting new slips and shoots, and hence full advantage of rainy season (June-September) should be taken in synchronizing nursery timing. One slip of vetiver can produce 4-5 new slips per month only in the favorable soil and climatic condition.

- *Source of Vetiver Slip*: Vetiver is scarcely found in various wetland situations in greater Dhaka, Mymensingh and Sylhet District. However, the incidence of occurrence is reported to be more in the Hoar areas of Sunamgonj district. Local persons with wider acquaintance of wetland situations should be contacted, nursery raising stuff collected, and nursery developed quickly. Once a good nursery stock is developed, subsequent seedling source for nursery extension will not pose serious problem.

- *Nursery Care and Attention*: Young vetiver slips are much relished by cattle. Therefore, fencing around the nursery plot would be essential and should be done to protect the young nursery from cattle damage. If drought condition prevails following nursery establishment, watering will be benecessary and shall have to be arranged. If nursery plants are healthy and have attained greater height, the top leaves should be pruned. Leaf pruning will help reducing competition for sunlight and facilitate production of more tillers in the clump.

7.0 TURAG-BONGSHI FLOODPLAIN WATERSHED AND WETLAND VEGETATION RESTORATION PROGRAM

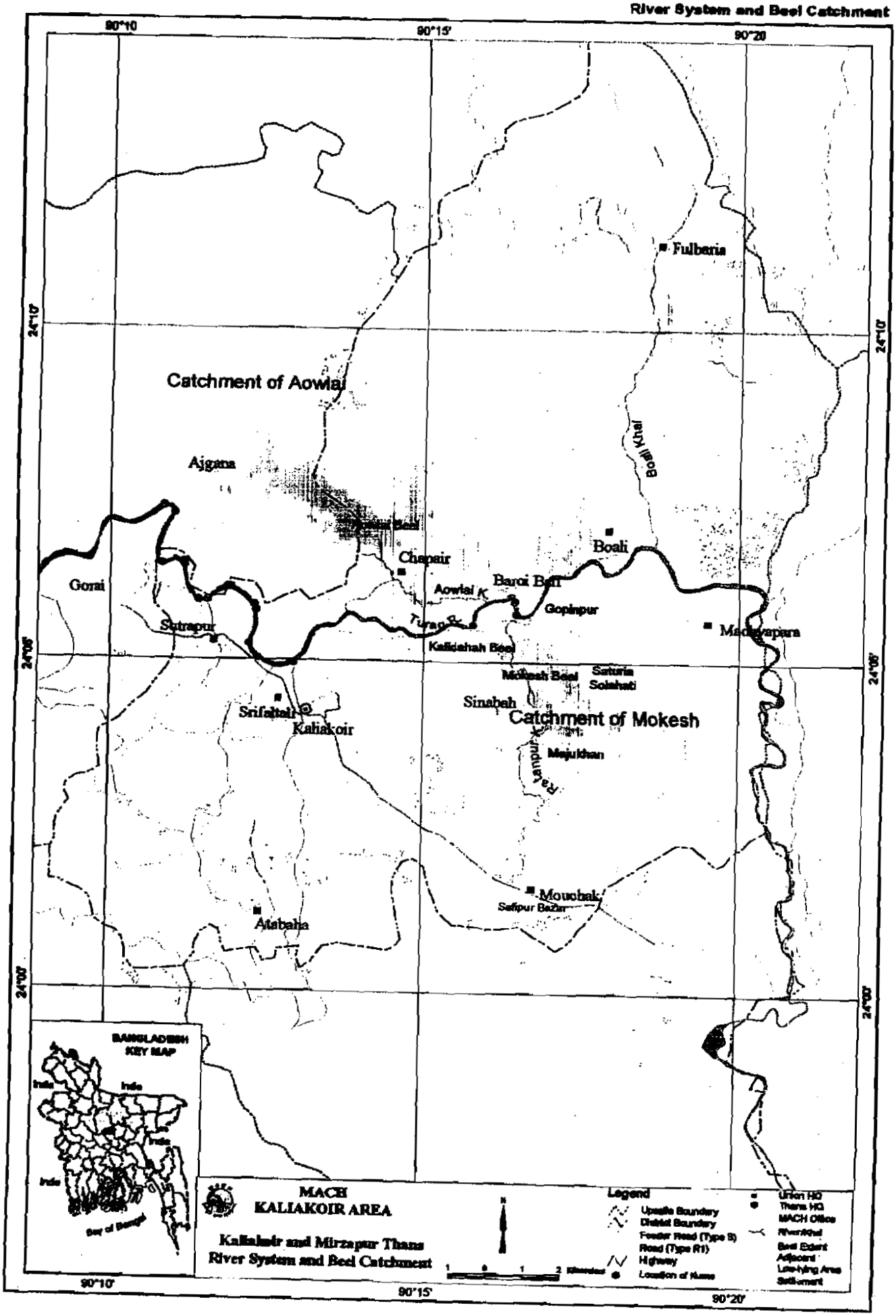
7.1 Introduction:

Turag-Bongshi floodplains are located in the central region of Bangladesh. In their present setting, the southern fringes of the Turag-Bangshi floodplains and watersheds may be identified as the distant suburbs of Dhaka, the capital city of Bangladesh. This region is bounded by Jamuna, Padma, Old Brahmaputra and the Sitalak-kha river; Jamuna on the west, Old Brahmaputra on the north and northeast, and Sitalak-kha in the east. Other important waterways of this floodplain are the Dhaleswari-Kaliganga River, which crosses the southwestern part of the region. Besides these main rivers, the region is also drained by many small rivers such as Bongshi, Pungli, Banar etc. (Figure-2).

In the southeast of the central region, Turag and Balu River flow southwards. Their slope gradient is rather low and their connection through Tongi khal helps alleviate floods. Floods in Turag river are caused by rain fall on the western and southern parts of Modhupur Tract and by high level of Padma and Meghna river, causing a back water thrust effect to Turag river through its lower reach known as Buriganga river. Upper Bongshi River drains an important part of the Modhupur tract. It is subjected to flash floods due to heavy rainfall on its left bank.

7.2 Historical Background and Current Status

7.2.1 Unlike the hilly and mountainous catchment of the country's major river systems (that are, by and large, located outside the international boundary), the watersheds of Turag-Bangshi floodplains are primarily the surrounding tracts of bumpy lands. This tract, once upon a time, had been deep forests and historically recognized as the famous *Bhawal* and *Modhupur Gorh* Forest Tracts. Most of the present day human habitations in the high lands of Turag-Bangshi floodplain catchments actually grew on the deforested sections of *Bhawal* and *Modhupur Gorh* Tract, cleared of the forest vegetation in the distant as well as recent past, for human settlement. Remnants of original vegetation, the *Sal* (*Shorea robusta*) forests (locally called *Gozari Bon*), could be seen in scattered patches in the villages, now being preserved by the people as valuable tinber source. Though highly degraded and degenerated, the Forest Department presently manages some scattered sections of the historical Bhawal and Madhupur Garh forest, as forest. These forests are intimately mixed and alternate with dense human habitation and cultivated fields, and are under heavy pressure from encroachers for a variety of purposes including expansion of dwelling homesteads, farming and orchard establishment, industrial plant setting etc. A reappraisal of the State policy for continuance of these degraded forestlands as forests, and their transformation to valuable wood resource with people's participation is urgently called for so that sustainable forest protection mechanism is



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developed, nationally important bio-diversity base is preserved, and the forest play its due role as ideal watersheds for active floodplain management.

7.2.2 The deforested sections of the historical *Bhawal-Modhupur Garh* Forest Tract, though now constitute busy human settlement with intensive farming, industrial and other land use activities, they constitute very important parts of watersheds of the river systems and floodplains around here. Earth cutting and other soil disturbances as well as various improper land uses of deforested sections of the *Garh* lands tend to get lesser appreciation of the people and administration. As a result, watershed management aspects of these 'outside forest Gorh lands do not get proper importance. Since both the forested as well as deforested chala lands are the active watersheds of the Turag-Bongshi floodplains and Beel system, and this strategic drainage situation will continue for eternity, the watershed management of the chala lands in the outside forest situations should be included in the project intervention programs with immediate priorities being given to those areas draining to the MACH project sites.

7.3 The Landscape Pattern of Turag-Bongshi Floodplain

The landscape of the tract is an admixture of what is locally called '*Chala*' and '*Baid*' lands, meaning respectively elevated lands and low lands. The current land use of the *Chalas* are primarily for dwelling houses and homestead gardening, round the year vegetables cultivation, orchards with preponderance of jack fruit and pineapple, and woodlots. The *Baids* are cultivated primarily for rice paddy although a short *Rabi* season crop of vegetables, spices, lentils, peanuts etc. are also grown as additional crop in the gap period of the principal paddy crop. The riverbank low flats and the outer fringes of *Beels* that come up above water level in winter months, are cultivated for Boro paddy in *Rabi* season while in the rainy season, these floodplains are vast expanse of water bodies that serve as extended natural fish rearing ground. The river, khal and Beel beds that do not dry up in winter are the permanent water bodies serving as fish refuge. The typical landscape of Turag-Bongshi watersheds could be pictorially depicted as follows (Figure-5).

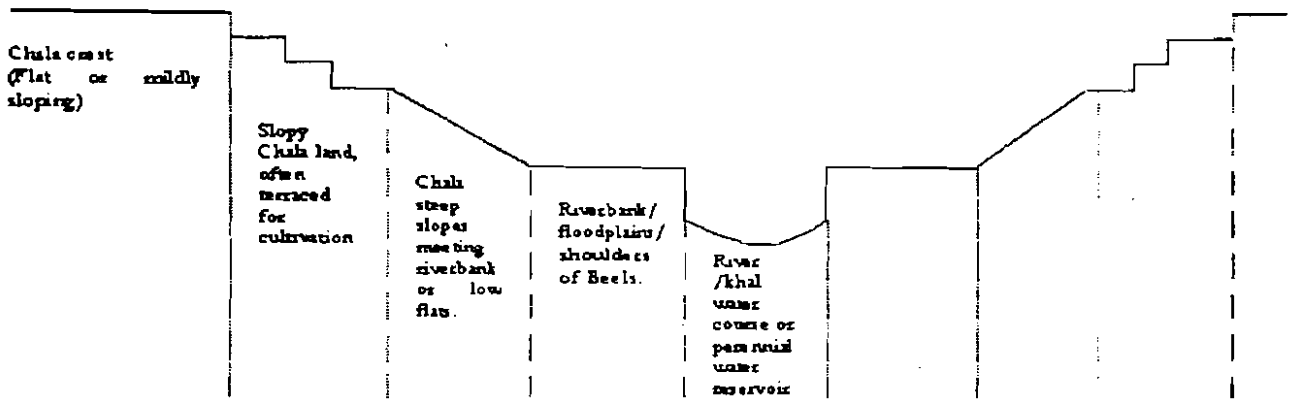

Figure-5: Turag- Bangshi floodplains landscape

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7.4 Review of the *Mokosh Beel* Project of MACH Program

- Mokosh is a perennial *beel* located to the south of the Turag River in Mouchak Union Porishod of Kalialoir Upazila in Gazipur District. The catchment area of the *beel* is about 46 sq. km. The Beel areas, estimated as 1463 ha in monsoon is only about 37 ha in dry season. The beel is surrounded by 10 village viz., Taltoli, Boroibari, Saturia-Sholahati, Saturia chala, Laskar chala, Mazukhan, Rotonpur, Kouchak, Matikata, and Sinabau. The beel water also receives industrial waste. The beel is connected with Turag River by Saturia-Sholahati canal which is about a kilometer long.

  This Beel is about 45 minutes drive from Dhaka City by good road system. The south, east and western watershed of the Beel is gradually becoming suburbs of the capital city through establishment of new industries and various other establishments, and also for housing because of the lovely undulating landscape.

- The current MACH project interventions in the Mokosh Beel are limited to regulation of fishing at different times of the year and fish sanctuary establishment for dry season secure fish abode through consensus of the participating communities organized through local committees. Smallscale efforts were also made towards wetland vegetation restoration. One such spot, locally recognized as *Burir Tek* was visited. This is a small island like outcrop inside the *Beel* which, in peak Monsoon is submerged entirely by flood water but comes up above water level in dry season. Some experimental tree plantation was however done on this island by MACH project wherein Mahogony and Mango was planted in June-July 2000 planting season.

- A close look at the existing indigenous vegetation of the island revealed that the remnant vegetation is typically wetland species. The tree species presently growing in Burur Ter are: Hijal, Sheora, Koroi, Bot, Kul and Gila lata (a robust climber). The grassy vegetation in the periphery of the island touching beel water is Binna chon (*Vetiver* spp.), Kashia (*Saccharum* spp.), Ulki chon (*Imperata* spp.), Kolmilata (*Ipomea* spp.), Shola (*Aeschynomene* spp.) etc. Underneath a mature Hijal tree however profuse natural regeneration of Hijal was observed in this Tek. The wildlings are of current season and looked pretty healthy indicating that the site still remains absolutely suitable for this and similar other wetland species. The dense natural regeneration like a seedbed was due to the fact that, floating Hijal seeds were driven by winds and rolling water waves, and got stranded in the elevated land and grass barrier under the Hijal tree. With water receding, the seeds germinated in situ and continued growing unabated as no grazing has been started yet.
- Mahogony and Mango were inappropriate species for Burir Tek island. Future planting is to include only ecologically appropriate species for the site.
- MACH-CNRS Kaliakoir staff were seen preparing to undertake wetland planting in Mokosh Beel in this winter (November-December 2000) with Koroch and Hijal species reportedly procured from Sunamganj district. It is high time that the staff has fair appreciation of the plantation sites and the strong requirement of matching site with species so that ignorance is not presented as an excuse for costly failures.
- The siltation problem of *beels* and streambeds originate primarily from the mismanagement of the near and distant watersheds. The current MACH project activities for Mokosh beel fisheries development do not include any watershed management intervention in the adjacent chala lands which are in reality the nearest watersheds. It is admitted that without initiating simultaneous improvement program in the close by watersheds, the *beel* excavation and winter refuge improvement devices will be short lived and belie the expectations set behind the fisheries development project. There is thus a cogent need for undertaking watershed husbandry simultaneously with fisheries

improvement works in the beel proper. Since the watershed lands around Mokosh beel are primarily privately owned, the MACH project activities on these watersheds would be advisory/extension activities. These will include motivating people to undertake soil and water conservation measures in their cultivation and other land use programs. Changes in the land use culture may involve either abandoning tillage cultivation of sloping land in favor of overwhelmingly tree-based land uses like horticulture or forestry or combined. Alternatively, if terrain gradient and the owner's financial solvency permit, intervention measures may involve terracing of sloping lands for safe cultivation.

7.5 Boali Khal Floodplain Management Program

- A quick reconnaissance of the Boali khal (also known as Guillar Khal) floodplain from Roghunathpur Bazaar to Fulbria Bazaar was made by the consultant along with the project staff to explore the possibility of expansion of MACH project interventions in both wetland and watershed situations. The Boali khal basin appeared to be a fairly big tract of about 10 km long floodplain, under water then, giving the look of a large beel. The Khal itself was found lost in the middle of the *Beel* water and could not be identifiable. However, it was reported by staff and local people that the floodplain except the Khal bed would dry up in winter period when Boro paddy cultivation would be done in the entire beel area.

- This long stretch of water body, though an extensive fish rearing ground in the rainy season, its potential as dry season fish protection habitat and sanctuary is meager because of the absence of deep water storage reservoir in the streambed except 1or 2 small ones at the starting point near Roghunathpur Bazaar and one near Fulbaria. The Fulbaria UP Chairman and a few locals informant however told us about the presence of 3 to 4 deep wells in the same Boali Khal bed in the upstream of Fulbaria Bazaar within a stretch of 3-4 km. According to them, these deep wells retain high water depth during dry months and could be useful as fish refuge for dry season fish sanctuary. The Kaliakoir MACH office staff will arrange to physically survey this tract and if found suitable reservoir, steps should be taken to initiate process for sanctuary establishment in this tract.

- The Boali *Khal* basin is in reality a floodplain of the surrounding undulating watersheds that was, as mentioned earlier, a part of the *Bhawal Garh* Forest tract since deforested and settled for permanent habitation. A fairly big block of existing Sal forests that begins almost next to Fulbaria Bazaar (Kachighata Forest Range), connects Ghatail and Shokhipur Sal tracts of Tangail district. These Sal forests virtually constitute upstream catchments of Boali *khal*. The down stream watersheds of this Khal is however thickly inhabited, sparsely vegetated and soil erosion is rampant. While travelling through the Khal, exposed red soil is a common scene to be witnessed on the slopes of chala lands on either side of Boali *Khal*. These exposed slopes constantly wash out huge load of silt into the floodplains and streambeds reducing their reservoir capacity. **The section of the watershed, which drains to the Boali Khal, need appropriate land use management through regulation of cultivation practices according to the terrain type and restoration of protective chala land vegetation that facilitates soil and water conservation.**
- Peaks of high stream banks were observed along Boali Khal in certain parts of the floodplain, specifically near Pagolnath locality. With water receding from the floodplain, these embankments will come up above the dry season water level. These stream banks are now discontinuous possibly due to soil erosion and lack of maintenance works. These embankments are supposed to be State property and scope exists for their repair by excavating the Khal bed that is mostly silted up and local people requested for their re-excavation. After embankment repair, suitable plantations may be raised on these stream bank lands. Apart from the high stream banks, wetland plantations could be possible in

the flat/undulating land along the Khal bank. It is not known if there is any Khas land in the floodplain to allow wetland plantation. The records of right (*Khatian*) should be consulted from the office of the UNO/ AC Land to ascertain if there is govt. Khash land in this floodplain. If available, those should pose no problem in planting up with due approval of the UNO/AC land, and of course with participation of the local people.

- Scope of tree plantation was observed on flat lands along Mokosh khal and Turag rivers that are not cultivated. Marked bank erosion was observed along the Turag River. But conspicuously, erosion protection measures by some enterprising local farmers through dense planting of Dolkolmi and castor plants was found to have saved the riverbank in many spots. **This is a lesson to be learnt from indigenous practices and it dictates replication by MACH project. The project should therefore undertake in its future intervention programs, specific bank erosion control measures along rivers and Khals.** Dol Kolmi, Caster plant, Vetiver, Nol, Khagra, Ikr etc. many be planted as river/Khal bank erosion protection contrivance against strong water currents.
- Because of the time constraint, the consultant could not ascertain by field reconnaissance the extent of land availability for wetland plantation in this zone. Nor the field trip time was the most appropriate season for estimating the area availability because of the high water level in the floodplain. However, when the water recedes in dry season, a better appreciation of the land type and extent of area availability would become possible. **The MACH-CNRS Kaliakoir staff should undertake a reconnaissance survey in the dry season and come up with a reasonably realistic figure of available and suitable public and freehold land for wetland vegetation restoration.** However, an intelligent guestimate suggest that some 200 hectares of public and private land may become available in the whole of Mokosh Beel and Boali khal floodplain for wetland plantation. Assuming a 2m x 2m plant spacing at the initial plantation establishment stage, this area of wetland would require half a million seedlings of wetland species to be raised in project nursery which is not a very big deal and as such, conveniently achievable.

7.6 Turag-Bangshi Watershed Management

- Watershed management of the *Chala* lands that drain to the beels and wetlands of Turag-Bongshi floodplains so long has not been the subject of MACH project intervention. But because of the impending danger of siltation of the winter refuge and sanctuaries of beel fishery, watershed management of *Chala* lands became imperative. Without considering an appropriate soil and water conservation management of *Chalas* (the watersheds of the basins), the fishery management would be a only lopsided program incapable of yielding the long-term benefit envisaged for the fishery and wildlife (Bird). **It has to be appreciated by the project sponsors that any development activity envisaged for wetland and fishery development in the rivers/streams/beels in this tract, to be successful and sustainable, must take into cognizance the conspicuous management needs of all the entities that make up the ecosystem in its totality i.e., watersheds, wetlands, and streams/beels, and accordingly formulate program activities to implement the most suited interventions. It is therefore recommended that watershed management of the adjoining *Chala* lands of Mokosh Beel as well as other extended wetlands development project areas should be included as a definite component of the MACH project along with fishery and wetland interventions.**
- In respect of *Chala* lands, watershed management interventions should primarily include land use extension services i.e., impressing upon the landowners to appreciate the damage to beels and floodplains, and ultimately to the fishery potentials of the region that may be ensue as a result of improper land use of *Chala* lands. The major concern is for sloping

lands that is currently either remaining barren or improperly cultivated provoking soil erosion and landslide. Continued ill use of delicate watershed landscape has got to be focused to the citizens and their implications brought home.

Potential Management Intervention in the Turag-Bongshi Watershed

- Sloping lands of the watershed must not be cultivated for agricultural crop by ploughing or other methods of soil disturbing tillage that provoke soil erosion. Instead such land should be devoted for permanent tree crop in which fruit species obviously would be the first choice followed by timber trees in default.

- If gentleness of terrain gradient and also economy of the landowners permit, sloping lands should be terraced and usual tillage agriculture practiced on the leveled bench top. In such case, appropriate measures for consolidation and protection of terrace walls through tree plantation and live hedgerow establishment would be required, and essentially undertaken to prevent landslide.

- To break the rolling water waves and to counteract scouring wave actions originating from beels and floodplains in full rainy season, wetland tree species and reeds should be planted on the slopes, toes, and forelands of delicate slopes that meets the beel/ stream.

- Intensive and extensive public relation and extension activities amongst the watershed inhabiting community would be required by the MACH project staff to aware them of the damages taking place to their farming land as weel as to the fish habitat, and its present and future adverse implications. They should be motivated to cooperate with project recommended watershed management interventions in their own interest as well as in the greater interest of the nation.

- Project initiated nursery program to supply seedlings for restoration of watershed vegetation component would not be necessary because commercial nurseries producing species suitable for *Chala* lands are plenty around Kaliakoir. But for typical wetland species, project initiated nursery will be needed because, as mentioned earlier, such seedlings are not produced by commercial nurseries. Apart from nursery program, **backstopping support of Horticulture and Forestry Specialist will be required in this extension program to advise and guide the watershed population on proper land use and site-species matching art at all situations during project implementation period.**

7.7 Recommended Intervention For Turag-Bongshi Watershed

Rationale:
In any geographical situation, as long as the watersheds (land and vegetation), the flat countryside, and the river/stream/wetland basins are in equilibrium situation with respect to appropriate land use and management of the biota, best performance and sustainable product harvest could be expected from all situations. If this equilibrium is disturbed by biotic interference, abnormality sets in the system and that impact and implicates every other component of the system, and the total environmental health is in disorder. This environmental health is very much comparable with human health in that, if the body resistance of an individual somehow deteriorates, he/she becomes susceptible to attack by all conceivable diseases simultaneously affecting total body fabrics. Until and unless timely and appropriate action is taken to quickly and effectively remedy the faults and bring things in order, the overall health situation is ever on the decline.

Deforestation of Turag-Bongshi watersheds, past and present, and also the current improper land uses of *chalas*, especially non-terraced sloping sections and berms are provoking serious soil erosion and causing problems in the floodplains. Both the forestlands and the *chalas* are neither appropriately nor adequately vegetated, nor the sloping lands are scientifically cultivated. Soil erosion and loss of fertile topsoil are regular features that have the vices of degrading the watersheds progressively as well as silting up of the beel and stream/river beds. **Any project program with wetland and fishery development in the rivers/streams/beels in this tract, to be successful and sustainable, must therefore take into cognizance appropriate management needs of all the entities of the ecosystem in totality i.e., watersheds, wetlands, and streams/beels. This recognition should be followed by the formulation of appropriate program interventions and implementation of the most suited interventions that are deemed proper and beneficial by participating project partners.**

Such interventions may include soil conservation measures; vegetative cover reestablishment; aquatic habitat improvement and rehabilitation; fisheries protection, enhancement and management; and addressing the social problems that are already existing or new problems ensuing from the various program related interventions. Viewing beels or river/stream beds for development interventions in isolation of appropriate watershed management interventions will not be a prudent long-term resource development strategy. Unabated torturous use of watersheds may, some day, find the beels and water courses silted up beyond all calculations dwindling altogether the potentials of future fish culture especially due to loss of the dry season secured fish refuge and sanctuaries.

7.8 Plantation Models

7.8.1 Wetland Plantation sites

Two types of wetland situations will be commonly met with. Recommended plantation models for two situations are indicated below:

a. **Deep inundation ground (depth > 1 m and long duration of ground submersion:**
   i. Tree species: Hijal (*Barringtonia acutangula*), Koroch (*Pongamia pinnata P.glabra*), Pitali/ Pitkuli (*Trewia nudiflora*), Borun (*Crataeva nurvala*).
   ii. Grass species: Nol (*Phragmitis karka*), Khagra (*Saccharum spontaneum*). Ikr (*Erianthus ravennae*), Murta (*Clinogyne dichotoma*), Hogla (*Typha elephntina*).

b. **Shallow inundation ground (depth < 1m and occasional to 2-3 months** duration of ground submersion):

(i). Tree species: Jarul (Lagerstromia flosregine), Arjun (Terminalia arjuna), Kainjal Bhadi (Bischopia javanica), Mander (Eritrina indica), Kadam (Anthocephalus cadamba), Semul (Salmalia malabarica), Bot (Ficus Spp), Jam (Syzygium cumini), Sheora (Streblus aspar), Koroi (Albizia procera), Sissoo (Dalbergia sissoo), Babla (Acacia nilotica). Species indicated under model (a) i. above are also suitable for shallow inundation sites.

(ii). Grass species: Nol, Khagra, Ikr, Murta, Hogla, Dolkolmi (*Ipomea spp.*), Dhaincha (*Sesbania sesban*), Binna chon (*Vetiveria zezenioides*)

7.8.2 Chala land Plantation Model

Depending on the land type and their situation, plantation on chala land could be:

(a) Dense block plantations;

(b) Shelter belt type linear plantations along farm boundary or terrace walls;

(c) Scattered trees on farm land; and

(d) Grass on badly eroding sloping terrain.

Again, each tree-type of plantation could be established with forest/timber yielding species as well as with fruit bearing species.

7.8.3 Choice of species

a. **Forest/Timber Species:** Two situations recognized:

i. *High lands* i.e., land areas not subjected to inundation: Species suitable are: Sal (Shorea robusta). Teak (Tectona grandis), Sil Koroi (Albizia procera), Gamar (Gmelina arborea), Boro Jam (*Eugenia jambulana*). Chapalish (Artocarpus chaplasha), Garjan (Diptreocarpus turbinatus), Telsur (Hopea odorata), Arjun (Terminalia arjuna), Bohera (Terminalia belerica), Horitoki (Terminalia chebula). Eucalyptus (Eucalyptus camaldulensis), Akashmoni (Acacia auriculiformis), Mangium (Acacia mangium).

ii. *Low lands* i.e., lands that are subjected to occasional inundation: Species suitable are: Jarul (*Lagerstromia flosregine*), Arjun (*Terminalia arjuna)*, Kainjal Bhadi (*Bischopia javanica)*, Mander (*Erithrina indica*), Kadam (*Anthocephalus cadamba)*, Semul (*Salmalia malabarica*), Koroi (*Albizia procera*), Sissoo (*Dalbergia sissoo)*, Babla (*Acacia nilotica*).

b. **Fruit Species:**

Only one situation of planting, the high lands; fruit species will not grow on waterlogged situations.

The general soil type of *Bhawal-Modhupur Gorh* chala lands is the lateritic (iron rich) soil and has typical red color. This soil is renowned for Jackfruit and pineapple growing, and major supplies of these two fruits to different destinations of the country go from this tract. Therefore, Jackfruit and pineapple should continued to be preferred on chala land. However, almost all tropical fruits grow over here. So planting of other fruit species like Mango. Lichi, Guava, Shaddok, Sopheda, Kul (Boroi), Jalpai, Amloki, Lotkon, Kalo Jam, Kamranga, Chalta, Coconut etc. should be enormously encouraged.

7.8.4 Seedling procurement program for Fruit Species propagation

In the case of fruit tree propagation, the biggest limitation is the meager supply of quality seedlings for planting. The country though made commendable progress in timber species seedling production in commercial nurseries but break through is yet to be made in the fruit nursery sector. Better quality of fruit and early fruiting could be expected only from trees of graft/clonal origin. Besides, the farmers are also required to be encouraged to replace their existing overwhelming stock inferior fruit trees with superior varieties. But lack of adequate supplies of quality fruit seedlings is the biggest limitation for achieving break through in

quality fruit multiplication. However, MACH project can not venture to initiate fruit nursery establishment because grafting and cloning are vegetative propagation methods requiring expert hands to accomplish success, and the expertise can not be acquired by a quick short

training to individuals, as is possible for timber species. Apart from the expertise aspect, quality mother trees for scion/budding materials are also not available in and around the project surroundings in the right quantity. Therefore, in order to ensure supply of quality fruit seedling for the project, advance arrangements through formal contracts have got to be made with Agriculture Extension Department and various horticulture research institutes including specialized research and multiplication centers in different regions of the country.

7.9 Plantation Technique

Plantation principles, techniques and timings for both high land and low land situations have been elaborately described in paragraph 6.4. Similarly, plantation maintenance items have also been covered in detail under paragraph 6.5 and 6.6. These prescriptions should be followed and properly applied for deriving maximum benefit from the plantation ventures.

The best planting strategy for wetland situations is to establish plantation in the receding flood condition i.e., when the water level is falling with the advent of winter season and the ground is rising above water. The planting time for *Haor*, *Baor* and *Beel* wetland situations in Bangladesh start from October and may continue up to December. This nature-dependent plantation strategy also conveys the message for planners and implementers that planting of such wetlands can not be done by one go; plantation activities perforce have to proceed in stages as the water recedes. Planting will be done when the soil is wet so that plants do not suffer water stress; else painstaking watering of plants will be necessary in dry months.

7.9.1 Plantation spacing

The initial plantation spacing for timber species should be 2m x 2m. For fruit species, the spacing may be variable. In case of big-sized tree species like mango, litchi, jackfruit, tamarind, jalpai, kalo jam, coconut etc., the spacing for single row line planting may be 8 to 10 m, while that for orchard like block plantation should be 10m x 10m. For medium-sized fruit trees like guava, shaddock, star fruit, sopheda, kul etc., the spacing for block plantation should be 6m x 6m.

7.10 Wetland seedling non-availability problem and nursery raising program

The local staff presented the problem of non-availability of seedlings of wetland tree species in the commercial nurseries. This is of course a genuine and valid problem already discussed under Hail Haor plantation and nursery strategies. Of the total number of plants annually planted in the country, wetland species do not figure out to any countable percentage. The commercial nurseries do not grow any wetland species because such species are hardly demanded by common planters. **The remedy for wetland tree seedling supply problem therefore lies in the MACH project taking steps to raise its requirement of seedlings in its own nursery. This could be effected either by the project staff themselves undertaking nursery raising program under their direct control. Alternatively, the participating local beneficiaries of the project may be organized to raise seedlings in their homestead situations, technically and financially aided by MACH project, and with commitment to buy back such seedlings for the project plantation programs.**

8.0 PARTICIPATORY WATERSHED AND WETLAND MANAGEMENT APPROACH

8.1 Rationale

- The soil and climate of Bangladesh are ideal for luxuriant plant growth. Technological knowledge base for plant propagation and successful plantation establishment is also adequately available in the country. Even the common village folks have fair knowledge of plant propagation in their own situations; the rich homestead tree groves in the nooks and corners of the country are the manifestation of such technical know-how. Establishment of successful plantation from common edaphic, ecological and technological points of views therefore poses no insurmountable problem. But availability of undisturbed tract of land for plantation establishment, and sustainability of such plantation from deliberate damage by man and his domestic animals are the real problems that haunts plantation programs especially on marginal public land. Many technically sound, financially viable, and socially desirable plantation programs in the past have failed due to failure to install viable sustainability mechanism.

- The goal of the MACH project has been set to promote ecologically sound management of the watershed and wetland resources for the sustainability of the production systems as well as sustainable supply of wood, food and income especially to the poor of Bangladesh. However, sustainability of any program involving people's welfare again depends largely on the active and earnest participation of the stakeholders in all stages of the project implementation right from the beginning of planning, through execution and monitoring of the implementation phases. The conceptual base of this project is to demonstrate the viability of an active community management approach to the common property composite watershed and floodplain resources management in Bangladesh. "*Community*," in this context, is intended to include those people dependent either economically or nutritionally and environmentally on the watersheds and floodplains, and on their products. The project emphasizes and works with poorer groups, particularly fisher communities in the wetland situations and freehold/leasehold landowners (individuals as well as organizations including tea estates, pineapple and lemon gardeners) in the watersheds and riparian zones as stakeholders of the system. To be specific, the stakeholders will include farmers, local elite, local management committees and local government officials in order to make the project programs sustainable, and the investments worthwhile benefiting the community for whom these are meant.

- Although public roads in this country are long time managed public property whose ownership and control norms are defined and understood, but the non-navigable streams especially those draining from hilly catchments suffer ownership identity and effectiveness of control. The control culture therefore has to be established through participatory management committees at various levels and invoking benefit-sharing mechanisms. Participatory management approach is thus very important for bringing the hitherto uncontrolled public property to management control and production.

8.2 Project Participants and Participatory Management Approach

i. Vegetation restoration activities are likely to be undertaken on the following categories of public and private lands:

- Stream banks (upper and middle reaches) where the envisaged riparian plantation sites on either bank are government property (not leased out to any individual or institution).

- Haor/Beel lands (such as, block lands/stream bank lands/Kanda lands/road slopes) where the envisaged wetland vegetation restoration sites are public property (not leased out to any individual or institution).
- Sites where only stream channel belongs to the State but adjoining bank lands on which riparian/ wetland plantations are contemplated under the project are private property (all types of terrain situations involved viz., upper, middle and lower reaches of streams, and also in the lake proper).
- Privately owned riparian or wetland situations where plantations are required to be raised for restoration of wetland ecosystem.

Roadside marginal public lands (along UP, Upazila or Zila Porishad roads) offering scope for raising strip plantation.

ii. Plantation activities on all these five categories of land should be implemented and managed on participatory principles through benefit-sharing mechanism as per procedure detailed below:

- In the first category lands, plantation program will be executed by organizing the local landless/destitute men and women into beneficiary groups who will also constitute work force for execution of plantation activity. The beneficiary groups will carry out plantation activities in return for wages according to the scale provided for in the project document under the guidance of RMC; the RMC being comprised of the representatives of local UP, local elite and those of the participating landless groups. Apart from the participating destitute groups, the other shareholders of the proceeds from the plantation program are: local UP and the RMC. The benefit sharing mechanism being 15% to UP, 5% to RMC and 80% to the destitute group members.
- In respect of plantations on the second category lands, the same primary groups of fishers as constituted for floodplain fishing regulations will be involved as beneficiaries for the plantation activity as well. The benefit sharing mechanism in this case is also the same as for first category i.e., 15% of benefit to UP, 5% to RMC and 80% to destitute fisher groups.
- For category three and four lands, the landowners on whose lands restoration plantation is being established, will replace the landless/destitute group of participants of the first and second category lands, as beneficiary of the production system. Hare, the benefit sharing mechanism would be: 15% to UP, 5% to RMC and 80% to participating landowners.
- In respect of category five lands (i.e., roadside tree plantations), the local UP, adjoining landowners and landless/destitute beneficiary groups, preferable women members, will share the proceeds from the production system. The share of benefits to different participants will be 40% to beneficiary groups, 40% to the adjacent landowners and 20% to the local UP.
- he promised benefit to different beneficiary partners of this participatory production program will be guaranteed by executing formal agreements between the parties hereto. To have the force of law, all such agreements will be executed on 150 Taka denomination non-judicial stamp. Sample copies of the beneficiary agreements are enclosed as Appendix 5 of this report.

High priority should be placed on community-based resource conservation and enhancement strategies. In each of the intervention sites, organized community groups, who are also direct beneficiaries of the production-sharing program, will be also directly involved in the implementation process which includes carrying out resource management planning, field execution of approved programs and close monitoring of activities. These groups take the form of primary groups, supported by a number of committees comprising of the community members representing various organizational levels and State organs.

The project implementation should always attempt to incorporate indigenous knowledge and local capability to strengthen formalized technical and institutional assistance. Inventory of the local knowledge and beliefs, as gathered by MACH-CNRS through RRA during the participatory planning phases of the pilot project should, as far as practicable, continue to be followed for resource conservation and development strategy formulation in the future. During the participatory resource planning processes of the subsequent programs, the following issues should be carefully explored.

Existing social hierarchy, including the roles of key stakeholders

- Local knowledge of, and attitudes toward resource management
- Problems and constraints inherent to the watershed and floodplain ecosystem
- Livelihood dependence of the local community in general and vulnerable groups in particular, on the watershed and floodplain ecosystem.
- Possible intervention packages to enhance community welfare, including resource conservation and management
- Possible action plans for implementing interventions as well as for resource monitoring
- Potential for local institutional capacity building.

8.3 Project Implementation and Management Committees

All societies worldwide, developed or developing, admit that natural resources and community welfare are inherently interdependent constructs. In essence, both aspects are vitally important in the day-to-day life of the surrounding community. Thus, natural resource management should reflect the major ecological features of an area as well as the social interaction with the area's resource system. This means that the community should simultaneously identify options and strategies for community welfare and resource management, and whenever possible, crave for new resource creation. The natural resource management options and strategies of the instant project will be based largely on the biophysical and socioeconomic conditions unique to the selected sites. At each of the project sites, resource management committees will be formed with the broader task of restoration of habitat and ecosystem including soil, water and fish conservation and enhancement as per guidelines contained here and also to be further developed, jointly, by the local communities and MACH project staff.

Potentially, committees will be formed at three different levels.

i. *Primary Groups*: According to the vegetation restoration intervention sites identified in paragraph 8.2.1 and beneficiary groups identified in paragraph 8.2.2, individual beneficiary groups should be formed around each specific Chara or water body or road. These groups would be termed as the primary groups. The primary group members will include the landless/destitute from within the community, the poor fishers, and landowners adjacent to the stream course/road/beel/haor situations.

ii. *Resource Management Committee (RMC)*: For each specific chara or individual water body or road, a separate RMC will be formed to organize and manage the envisaged project activities. The RMC will comprise of the representatives from each of the primary groups, UP, and local elite. The local UP chairman or any other member of the RMC unanimously elected to head the RMC, will be the head of the RMC. This committee will identify plausible interventions, draw up intervention plan, implement and monitor project activities for its own project area. RMCs are in fact the most important implementation bodies in the chain of committees and the number of

RMCs at each project site will be based on the size of the site and the number of streams/ water bodies it has.

The RMC will meet twice in a moth during peak plantation season (i.e., from May–September in respect of watershed and riparian plantations, and October-December in case of wetland plantation program), while once in a month for the rest of the year. In these monthly meetings, the progress of work implementation reviewed and problems analyzed and sorted out at local level. Problems that can not solved at RMC or UP chairman level, should be referred to the Zonal Management Committee (ZMC) for redress.

iii. *Zonal Management Committee (ZMC)*: It will be formed at the Upazila level. The committee members will include UP/RMC chairmen; representatives of Tea, lemon and pineapple growers; local elite. Ex-officio members of ZMC will include Upazila AC Land, Upazila Agriculture Extension Officer, Forest Officer, Cooperative Officer, Engineer (LGED) and WDB Engineer. The UNO will head the ZMC. The ZMC will be involved in the overall planning, overseeing implementation and monitoring of project activities within the project area that would spread over a number of UPs. ZMC will also spearhead awareness-raising activities, maintain contacts with government departments and the union porishods to ensure sustainable management of the delicate watersheds and floodplain ecosystem of the area.

The ZMC will meet once in every two months, take full stock of implementation progress for which the RMC will submit monthly progress report to the ZMC. The ZMC will monitor implementation progress, make it convenient to visit different project sites, if not possible by the whole body, at least by a cross section of members or by constituting expert sub-committees. ZMC will promptly come in of aid the RMC should any problem demand higher level intervention so that project implementation does not suffer.

iv. All primary groups and resource management committees will be organized by Caritas-Bangladesh under the community development component of MACH. MACH-CNRS will simultaneously be involved in the organization of resource management committees. The primary groups will be the direct recipients or beneficiaries of the project. All of the inputs in the form of training, education, credit (alternative income generation) and other support services will be targeted to them. These groups will also be involved in the planning and implementation of resource management activities in their respective locations. The participatory watershed and floodplain resource planning and management exercises will be conducted with these groups at the various levels. This will include the identification of problems and possible solutions and implementation of appropriate interventions to alleviate the problems. Communities will be guided through resource mapping exercises to identify the areas and issues that need to be addressed. They will then prioritize the activities and address them systematically in order to alleviate the problems. Most of this resource planning and management will be done by the resource management staff (MACH-CNRS staff) with the assistance of community development staff (MACH-Caritas) at the field level.

v. During the community planning meetings, the following basic issues will be discussed with the aim of building a consensus for the project interventions.

- Is there a consensus about the identified issues (do all of the stakeholders of the area consider it to be a problem)? Are local resource user/owner groups interested in the identified project activities?
- Are the proposed rehabilitation measures acceptable to resource user/owner groups?
- Would the proposed intervention bring benefits to the user/owner groups?

- Would the activities exacerbate economic inequities/ increase social conflicts?
- Who are the principal beneficiaries of the project (in particular, what impact will the project have on the poorer sections of the society)?
- How will the project effect women and how will they be involved in the various phases of project design, implementation and development?

8.4 Community Monitoring

One of the key aspects of development projects is the monitoring of changes in indicators induced by the project interventions. Documentation of these changes is equally important. The MACH project places due emphasis on monitoring and database development. It considers these elements are critical to basic program planning. To ensure that it occurs, MACH will incorporate community monitoring with which the community can take the major role in designing and implementing the project. The resource management staff, jointly with each community, will develop a customized monitoring program. This process ensures that the communities, themselves, decide on the indicators to be monitored in order to determine changes in resource quality and quantity alongside the impact these changes have on their livelihood security. Additionally it will ensure that management committees will be able to sustainably monitor their watershed and wetland resource after completion of the program.

8.5 Gender Considerations

Like other developing countries, in rural Bangladesh societies also, the daily activities of poorer women are based on micro-level natural resources. Thus, they constitute a major stakeholder group. Moreover, their activities lead to better health care of family members and overall family well being.

The participation of women in the project planning implementation, and monitoring processes is expected to manifest through the following measures:

- Women will be involved in resource inventory and project planning meetings at each site
- Women will be involved in resource enhancement/rehabilitation activities, and in their conservation.
- Women will participate in increasing levels in conservation training sessions and workshops.
- Women will become involved in the resource-monitoring program.
- Capable and enthusiastic female members will be developed as conservation educators
- Approximately 25% of all primary group members should be women.

8.6 Conservation Education and Information Dissemination

Awareness among the target community and other stakeholder groups regarding the complexity of the watershed and floodplain ecosystem is insufficient. There is also a lack of understanding among the stakeholders regarding their role in the management and protection of the resource base. Awareness-building activities at the local and national levels to stimulate policy reform and advocacy toward community-based management of floodplain resources emphasized in the original project should therefore continue. The awareness program will be held at the local and national levels in the form of workshops, awareness-raising sessions for the gardeners, fishers, farmers and other users-including school children, teachers and Upazila council members as well as national-level planners and policy makers. The project will

highlight the overall production systems and system linkages, existing problems and threats, project achievements, potential directions and the role of the stakeholders in sustaining watershed and floodplain ecosystems management.

8.7 Policy Advocacy

Most of the lemon and pineapple garden lands are government Khas lands leased out to cultivators on an annual or periodic lease basis. That means, these leases are subject to renewal, and the State Government reserves the rights to renew or cancel the lease. In view of the great difficulty of getting land for riparian plantation and wetland vegetation restoration program, both being national priority restoration programs, the GOB should be approached to review their land leasing policy especially in the watershed and Haor/Beel areas. GOB should be advised not to lease out any land within 100m of the stream bank in the watersheds and preserve these sites as protected areas for soil and water conservation purpose; rather notify the areas to be so in the official gazette to guarantee their misuse at any time. In respect of State owned watershed lands, the lease conditions should also incorporate terms and conditions regulating cultivation practices prohibiting all forms of 'across the contour' cultivation and the compulsion of undertaking soil and water conservation measures by the lessees. In respect of Haor/Beel lands, reasonable blocks of Khas lands that are of poor quality and not considered highly productive for rice crop cultivation, should be excluded from the purview of annual or periodic lease, and allocated for wetland vegetation restoration program.

9.0 General Recommendation

9.1 Forestry Professional Staff to Perform Plantation Activities

Forestry is admittedly a professional field of applied science. Everywhere in the world, nations entrust their forestry jobs to be taken good care of by forestry professionals, specialized in the science and art of forest estate management. Organized tree plantations, whether on enterprise or national level, whether for production or protection or research purpose, should always be done by professional Foresters who possess the requisite knowledge and expertise of the discipline.

In the instant case, the vegetation restoration activities envisaged in the original MACH project, the subsequent Participatory Pilot project and the current extended MACH project programs are jobs of more intricate nature than ordinary forestry management and development activities. These vegetation restoration programs are intended for areas that once upon a time had been tree covered areas but since denuded or badly degenerated by human interference. This means, vegetation restoration activities envisaged for the Hail Haor, Turag-Bongshi and Malejee-Kongsha river basin watersheds and aquatic zones are much more tougher and challenging jobs demanding in-depth professional wisdom and skills to successfully overcome the edaphic and social adversities obtaining in the project sites. The job specifications and work perspectives demand that forestry professionals with working experience in similar tracts should be included in the inner core of the CNRS, Caritas, and MACH program staffing. Very recently one individual with Forestry academic background is learnt to be appointed in the CNRS. This is a healthy sign and the efforts should continue.

All the above organizations should however assess their need for Forestry professionals, create adequate positions of such Forestry Professionals in their organizational staffing pattern, and recruit experienced incumbents in these positions to strengthen the organizations so as to better perform and accomplish higher success standard.

9.2 Training of NGO Staff and Project Participants in Nursery and Plantation Activities

The CNRS and Caritas field staff, currently assigned with implementation of plantation works, do not have forestry background or appropriate training on seedling raising, plantation establishment and upkeep. These are professional jobs and certainly cannot be accomplished skillfully by any individual without appropriate training. Most of the staff members do not have biological or even natural science academic background but doing plantation jobs. This could not be a desirable mechanism for implementing a professional job.

As recommended under paragraph 8.1 above, the ideal arrangement should be to have requisite number of regular Forestry Professionals in the CNRS and Caritas organizational staffing pattern to professionally carryout nursery raising, plantation establishment and maintenance jobs. However, as a quick fix to tide over the existing emergency situations, it is recommended that the NGO staff currently engaged for implementing plantation and nursery programs should be given a 2-3 days intensive training on theoretical background and practical demonstration about these activities. Professionally sound trainer should conduct the training. The quicker such training is organized, the better it would be for the project so that the staff could confidently undertake implementation of the jobs entrusted to them. Some of the smarter individuals from amongst the beneficiary group members of the project participants may also be trained up in nursery and plantation techniques along with NGO staff so that they could execute the jobs in the community nursery and plantation groves, and better perform.

9.3 Development of Mokosh Beel as a Demonstration Model of Ideally Managed Aquatic Ecosystem

The Mokosh Beel is an aquatic ecosystem situated in close contact with its watershed and in that context, an ideal site for studying floodplain and watershed interactions. The site is very close to Dhaka, the capital city of Bangladesh. The site is also well communicated by all weather road system and takes hardly 45 minutes to an hour to reach the spot. Often important visitors from home and abroad express their desire to see and appreciate ideally managed wetlands that are in excellent harmony with their watersheds. But such visitors have serious time constraints to visit distantly located project sites although the distant projects might have accomplishment outstanding success in all aspects of management. The visitors would however be prepared to make a quick dash if a typical site is available close by Dhaka and could be negotiated in about half-a- day's trip. This strategic necessity warrant development of a typical aquatic ecosystem management project close to Dhaka to exemplify the imagination of an organization and demonstrate its capability to do the required job professionally. Such an idea is definitely worth implementing by an organization that works in this field, and also for the people who are desirous of extending helping hands towards similar programs by appreciating demonstration of works already done. In true spirit, such close by demonstration site is mutually beneficial for the donors and recipients and for the policy makers as well.

It is, therefore, recommended that MACH-CNRS should prepare a special all embracing project for Mokosh Beel and make best endeavors to develop it into a model demonstration site of aquatic ecosystem management that has superbly taken good care of all aspects of wetland and watershed management problems in conformity with text book models but tailored to suit local needs.

10.0 A GUIDELINE ON NURSERY DEVELOPMENT

10.1 Introduction

- Raising successful plantation is squarely dependent on good nursery stock. This is true from theoretical points of views as well as from practical considerations. With other factors remaining uniform, the quality of nursery stock used for initial plantation establishment makes tremendous difference in both qualitative and qualitative success, and subsequent growth initiation pattern of plants in a plantation.
- Best plantation result with species-mix planned for and biodiversity desired, and with seedlings of specified height and health requirements could be accomplished only when the project develops its own nursery stock with advance planning, and establish such nurseries in close proximity of the proposed plantation site. This is necessary to avoid the risk of injuries and casualty to seedlings that is otherwise inevitable in case of long distance transportation and repeated handling.
- In the context of Bangladesh, a country with the highest population density in the world, the best success with plantation program on highly disturbed public land situations like road sides, canal banks and common prperty wetlands is accomplished when saplings beyond the ordinary damage reach of cattle and human beings are used as planting material. The MACH project plantation program on such lands should therefore adopt the strategy of planting taller seedlings (of man height) for achieving surer success by withstanding ordeals of reckless treatment to marginal public lands otherwise termed as 'no man's property'. But tall seedlings of such specification and of the right species-mix are not ordinarily available in the commercial nurseries. Apart from the non-availability factor, the taller seedlings are also more prone to damage in course of long distance transportation and repeated handling. These vulnerability perspectives warrant production of specified planting stock by the project implementing agency as close to the plantation site as possible so that right species-mix of right specifications are available in right time, and long distance transportation with too many handling are avoided.
- Apart from the technical and strategic advantages of having project's own nursery, established close to the plantation site, such program is also financially attractive on two accounts. Firstly, it is cost effective for the project as seedling cost is not likely to exceed Taka five per plant whereas the purchase cost of such seedling would be no less than Taka fifteen. Additional advantage of close by nursery being safety from high mortality and avoidance of poor plantation success that might ensue from long distance haulage. Secondly, the nursery program when executed through project participants is an attractive self-employment business for them, practicable at homestead situations on marginal homestead lands. Nursery is also not a very high-tech cultivation activity and as such, the rural farming community with appropriate training and practical demonstrations could acquire the art of the trade.
- The above pragmatic considerations being taken in to purview, the MACH project should adopt the policy of establishing its own nursery close to its plantation sites as a program either directly implemented by the project staff or executed through the project beneficiary groups or Resource Management Committee (RMC). If the latter courses are pursued, it will promote rural self-employment and help technology transfer to remote rural areas with opportunities and scope created for continuance of rural nursery program in the future also when the project will not be there.

10.2 Rationale for nursery Establishment.

- The venue of MACH project tree plantation program is the rural public roads, canal banks or wetlands frequented by heavy traffic of human beings and their domestic animals. The plantation venue is thus highly disturbed situations. Preventing cattle movement on plantation road or canal bank and wetlands is an absurd proposition because the roads are used by people as passage to reach their distant agricultural fields or traveling to and from market places with cattle head. At times of floods, the roads and embankments may be the only high enough places in a locality for shelter of man and their animals. Further more, because of the scarcity of pastureland in the country, people traditionally use roadside, canal banks and wetlands (in dry season) as community-grazing grounds for stray cattle grazing. Securing grater success in any tree plantation effort especially on busy public places like the project sites, therefore, call for adopting a technical solution to the social problem rather than administrative or stringent policing strategy. That implies planting of bigger seedlings with their tender foliage beyond the ordinary damage reach of cattle and human beings at the time of plantation establishment. This objective is best accomplished when seedlings of above man height (2 m and above) are planted on such busy public places. But seedlings of these specifications are not available in the required quantity and quality in the open market.
- Tree species that are biologically and physiologically feasible for growing in Haor and river/stream (*Chara*) bank situations, and also effective for bank protection/erosion control, are not usually high quality timber species. Naturally timber of such species have poor market value and as such people ordinarily show little interest to plant such trees in their private land. For this reason, commercial nurseries commonly do not produce seedlings of these typical wetland species. Consequently, species suitable for growing in MACH project plantation areas can not be procured from the commercial nurseries. If plantations of biologically feasible species for wetland in the required scale and specifications are to be successfully established, project nursery program is a prerequisite.
- Wetland tree species being slow in growth, production of seedlings of man height standard calls for raising seedlings in the nursery a year or two prior to the actual date of planting. Bigger seedling production also necessitates raising of seedling in big sized pots so that proper root development takes place and root : shoot ratio for healthy growth and plant stability is maintained, harmful root coiling does not take place and injury to roots through uprooting and transportation is safeguarded eventually ensuring greater success with plantation program. Commercial nurseries are not tuned to the production of such quality seedlings. This necessitates establishment of project's own nursery to produce its planting stuff.
- MACH project recognized the need for community-based approach to aquatic resource management. The project implementation strategy therefore accepted the policy of people's direct participation in program options and their execution, and in sharing of benefits accruing from the project. Establishment of tree plantation in strategic locations both as ecosystem rehabilitation contrivance as well as building new resource for the beneficiaries is a discrete program component of the MACH project. In that pursuit, setting up nursery is an important prerequisite for successful plantation raising especially in the context of ready non-availability of typical wetland tree species saplings in the open market. Nursery training and skill endowment to project beneficiaries will prompt the project in its immediate tree plantation program implementation but more importantly, will help the participating local community to go for self-employment nursery business which is now very much lacking in the Sylhet region as a whole.

10.3 Selection of Nursery Site: Site Criteria

- Nursery should be as close to the planting site as possible. This would make the delivery and transport of seedling easier and cheaper, and reduce the risk of damage to seedlings due to transportation hazards and careless handling.
- Nursery site should be easily accessible by common transportation route (land and / or water), in all weather for transportation of nursery materials and seedlings, to and from the nursery.
- Nursery should be located where abundant water supply is available throughout the year. Source of water could be river/stream, pond/tank, irrigation channel, tube well etc. If existing water supply source is absent but development of water supply source pose no problem by sinking tube wells, damming canal, extending water supply line etc, such spot may also stand suitable for selection as nursery site. Nursery must not be established in a place without ensuring regular water supply source.
- The area of nursery must be large enough to accommodate the number of seedlings planned for raising in a given year. If designed to be a permanent nursery, the site should have enough space for accommodating at least 3 years anticipated seedling production stock.
- The area should be level ground or gently rolling, well drained and not flooded nor water logged at any time of the year.
- Space needed for a nursery site should be computed from the following calculation:

a). The number of seedling that can be accommodated in one square meter of seed bed is as follows:

(i) *Potted seedlings*

Pot size	# Seedlings/sq. m (10 sq. ft)
10 cm x 15 cm	225
15 cm x 25 cm	100
25 cm x 30 cm	36

(ii) *Bare root seedling in seed bed:*

Post size	# Seedlings/Sq. m (10 sq. ft)
5 cm x 5 cm	400
5 cm x 10 cm	200
10 cm x 10 cm	100

b). Additional space should be added to the above mentioned area calculation to accommodated for roads, pathways, drainage channels, and that comes almost equal to the area needed for seedling production.

c). Space for watcher / caretaker shed, office, quarter etc. have to be added which calculates roughly to 10% of the total of 11.3.6 and 11.3.6

Example of area calculation for nursery space:

Seedling to be raised = 50,000 #, in 15 cm x 25 cm sized ploypots.

i). Area needed for pot bed = $\frac{50,000 \text{ seedlings}}{36 \text{ seedlings / sq. m.}}$ = 1388.89 m^2 = say, 1389 m^2

ii). Area of paths, roads, drains etc. (Approx. equal to nursery area) = 1389 m^2

iii). Sub-total of area needed for seedling + path = 2778 m^2

iv). Add space for sheds, office etc. (10% 2778 sq. m) = 278 m^2

v). Total area needed = 2778 + 278 = 3056 m^2 say 3100 m^2

d). ***Soil Characteristics***: The soil is fertile, sandy loam to loam, and p[H] 5.5 to 7.5. However, if only potted seedlings will be raised, than nursery ground soil may be of lower fertility. Fertile soil from outside may be brought but an adequate source of good potting soil should be available nearby.

10.4 PREPARATION AND LAYOUT OF NURSERY

Site preparation:

- Clear all vegetation viz., trees, shrubs and grasses; uproot all stumps of trees; clean ground of stones, roots etc. especially if occurring in the seedling growing ground.
- Fill-up depressions and level mounds. Level the whole nursery ground by dressing.

Bed layout:

- In the nursery, seedlings are raised in elevated beds to protect them from inundation should heavy rainfall occur and cause temporary inundation. Beds are usually raised about 15 to 20 cm from the general ground level of the nursery site.
- For nurseries located on level ground, beds should be laid out in East-West directions to provide the seedlings uniform exposure to sunlight throughout the day length. For convenience of working, in Bangladesh, the usual bed size is 1.2 m x 12.2 m (4 ft. x 40 ft.). The length of bed may however be less than 12.2 m according to the availability of space for bed layout.
- On sloping lands, orient the beds along the contours. However, the northern hilly aspect should be avoided as a nursery site because in most part of the day, it remains shaded.
- If the nursery is a big one, divide the growing area into blocks, each block containing 10-12 beds. Number each block and also beds in a block for identification and record maintenance.
- Provide 40-50 cm space in between two successive nursery beds to function as walking trails for bed maintenance as well as to drain out runoff from the nursery surface.
- Construct drainage canal at least 30 cm wide x 30 cm deep at both sides of the nursery inner pathways/roads all along their length to quickly drain out rain water outside the nursery.

10.5 Preparation of Seedbeds and Transplant Beds

- Cultivate seedbed with a spade or hoe to a depth of 20-30 cm. Break up lumps of soil, pulverize, and level the surface. Sort out and remove all roots, grasses, and stones.

- Raise the seedbed level by about 15-20 cm by adding topsoil dug from pathways and drainage canals.
- Construct a border frame, called edging, all around the nursery bed to keep the soil eroding from the raised bed. Bed edging could be done by fixing bamboo slats, wooden planks or bricks fixed vertically along the edge.
- To improve soil fertility, add compost or pulverized cowdung at the rate of $1m^3$ (35 cft) compost or decomposed cowdung per 10 m^2 of bed. Incorporate the compost/cowdung into the soil by turning over the soil again and again before leveling. Also apply 0.75 kg TSP and 0.75 kg MP fertilizer per 10 m^2 of seedbed.

10.6 Preparation of Potted Seedling Beds (for seedlings stacking)

- Construct bordering frame 15-20 cm high all around the nursery bed of the specified size (1.2m x 12.2 m) . This could be accomplished with bamboo slats, bamboo tubes, bricks, wooden planks, or poles etc. to keep the pots from toppling down. This is also called edging.
- Raise the bed level by the same height as the bordering frame (15-20 cm) by adding topsoil dug from pathways and drainage canals. Then level the bed surface to provide a level ground for stacking the pots and make it ready for reception of the pots.

10.7 Protective Fencing Around Nursery:

Fencing around the nursery center is a must to save the seedling from stray cattle and other animal grazing damage. Construct a fence around the nursery, particularly the seedling growing area. This could be done with bamboo slats, reeds, thorny bushes in case of temporary nursery, and with barbed wire or pucca brick walling for permanent nursery.

10.8 Seed and Seedling Production Technology

Importance of good quality seed

i. Trees are usually produced from seeds, either planted or naturally sown. A prerequisite of any planting program therefore is an adequate supply of quality seeds: quatity from seed soundness as well as genetic origin points of views. The higher the quality of the seeds:

- the greater the number of good quality seedlings produced;
- the higher the survival and the faster the growth of the plantations; and
- the better the quality of the trees produced.

ii. Good quality seeds:

- are full, firm and comparatively large, and of good shape, color and lusture;
- have a high percentage germination; and
- come from good quality mother trees. Straight and vigorous trees usually come from seeds collected from straight and vigorously growing trees, while stunted, cooked or malformed trees will produce trees of similar characteristics. Seed collection from the latter groups of mother trees to be avoided.

Source of Good Seed

Seed orchards: These are special plantations established only for seed production purposes; the planting materials came from "Plus" trees or trees with outstanding characteristics such as fast growth, straight and cylindrical stems, resistant to pest and diseases, etc. As much as

possible, seeds produced by the orchards should be collected and used for nursery raising or direct sowing in plantations.

- *Seed Stands*: These are existing plantations or natural forests of not less than 5 ha area in which most of the tree exhibit above average growth characteristics. Inferior trees are thinned out, to provide remaining trees with more space for higher seed production. These stands generally produce larger quantity and satisfactory quality seeds.
- *Plus Trees*: "Plus" trees are individuals or trees selected in a stand for their outstanding characteristics such as fast growth, straight and cylindrical stem form, good branching habits and natural pruning , free from pests and diseases etc. For a large scale-planting program, it would be difficult and expensive to collect seeds from *"plus"* trees as they are usually scattered all over the plantations/forest. Moreover, the quantum of seeds produced will not be sufficient.
- *Other Seed Sources*: Seeds may also be collected from sources other than the natural forests and forest plantation viz., from roadside plantations, tea gardens, parks and urban ornamental plantations homestead groves, etc. When collecting seeds from these sources, collection should be made only from trees with:
    - above average diameter and height growth;
    - generally straight, cylindrical stems, horizontal branching habits and good natural pruning qualities;
    - no apparent pest and disease attack;
    - away from poor trees of the same species to eliminate scope for cross-breeding with poorer quality trees;
    - mature, seed bearing tree.
- *Imported Seeds*: Seeds may be imported from foreign countries for propagation of highly valued plants. Before importing, credibility of the supplier must be known. Order just enough quantity needed. Insist on certified seeds only.

Seed Collection Time.

a. *Important points to consider*:

i) Collect seeds when they are mature. Immature seeds have low or no germination capacity, and will not keep well in storage, rather have every chance of decaying and damage in storage.

ii) The first and last fruit/seed fraction of a tree to mature or fall, are usually defective and of poor quality. Such fruit/seed fraction should be discarded. The middle fraction should be collected and used.

b. *Judging fruit/seed maturity:*

i). Mature seeds are firm and hard, not soft and milky. Examine a few seeds by cutting.

ii). Fruits become dry when mature. Example: Pod of legumes, capsules of eucalyptus and mahogany, and fruit of teak.

iii). Fleshy fruits become soft when ripe. Example: Fruits of gamar, chapalish, Jackfruit, mango, kadam, guava.

iv). Fruits as they mature or ripe change in color. The color change is generally from green to brown, yellow, and pink. red or black. Color transformation of some important tree species is indicated below.

Example: Gammar-green to yellow; Acacia species–green to brown; Hijal, Koroch and Arjun - green to grayish black; Koroi-copper color to maroon; Mango – green to yellow; Kadam – green to yellow.

SEED CALENDER

Local name	Scientific name	Seed collection time	# seed/kg
Akashmoni	*Acacia auriculiformis*	Jan-April	38,000-42,000
Babul	*A. nilotica*	April-June	7,000-11,000
Sil koroi	*Albizia procera*	March-May	22,000
Kadam	*Anthocephalus chinensis*	Aug-Oct	2,600,000
Chapalish	*Artocarpus chaplasha*	June –Aug	1,800-2,000
Neem	*Azadirachta indica*	June-Aug	3,300
Bariala bans	*Bambusa arundinacea*	July	75,000-100,000
Simul	*Salmalia malabarica*	March-April	1,700
Toon	*Cedrela toona*	April-June	352,000
Chikrassi	*Chikrassia tebularis*	Jan-Feb	100,000
Sissoo	*Dalbergia sissoo*	Nov.-March	53,000
Teli Garjan	*Dipterocarpus turbinatus*	May-June	154
Red Gum	*Eucalyptus tereticornis*	Sep-Oct.	660,000
Red River Gum	*Eucalyptus camaldulensis*		730,000
Gamar	*Gmelina arborea*	May-Jun	1,800
Telsur	*Hopea odorata*	May-June	260
Jarul	*Lagerstroemia speciosa*	Jan-Feb	160,000-230,000
Ipil-ipil	*Leucaena leucocephala*	Jan-April	22,000
Mangium	*Acacia managius*	Jan-May	80,000-110,000
Sal	*Shorea robuta*	May-July	600-1000
Mahogany	*Swietenia macrophylla*	Dec.-April	1,600-2,000
Dakijam	*Syzygium grande*	June	1,200
Rain Tree	*Samanea saman*	June-July	4,400-7,700
Hijal	*Barringtonia aquitangula*	July-August	6,500-8,500
Koroch	*Pongamia glabra*	Nov.-Jan.	2,200-3,500
Borun	*Crateava nurvula0*	July-August	-
Pitali	*Trewia nudiflora*	July-Sept.	-
Kainjal	*Bischopia javanica*	Nov. - Dec.	15,000-17,500

Methods of Seed Collection

- *Seed collection from the ground* : This is the recommended method for species whose fruits do not open-up (dehisce) and scatter the seeds over wide areas. Examples are: Teak, Garjan, Dhakijam, and species with fleshy fruits like Chapalish and Kadam. Seed collection from ground is best done the following way:

  - first clear the ground of grasses, shrubs, small trees, and other debris;
  - discard seeds or fruits that fall first;
  - collect seeds daily;
  - discard small or infested seeds/fruits.

- *Collection from standing trees*: This is recommended for species with small seeds contained in pods (legumes), capsules (Jarul, Mahogany, Chikrassi, Eucalypts), cones (Jhau, pines) that dehisce when mature and scatter the seeds over wide areas, and are lost in the process. Such seeds are collected directly from trees by harvesting fruit in the following manner:

  - climbing the tree;
  - use of long poles with knives or pruning saws attached at the end;
  - use of pole pruners;
  - use of tree cycles.

Seed Extraction and Processing

- **Seeds that are sown as whole fruits** – like Hijal, Koroch, Arjun, Borun, teak, garjan, sal, and other Dipterocarps species. In the case of teak fruit which contains up to 5 seeds, individual seeds can be removed by cracking the hard shell with a nutcracker. This is laborious and in practice, the whole fruit is sown. However, if quality seeds are in short supply, cracking of hard shell and picking of seeds just before sowing are advisable. Extracted teak seeds have very short period of viability (4-7 days) and must be sown immediately after extraction.

- **Fruits which open when dry**: Fruits of jarul, chikrassy, eucalyptus, toon, mahogany, ipil-ipil, koroi, akashmoni, mangium, babul,etc. belong to such category. Such fruits are spread in thin layers over dry surface such as concrete, bamboo mats, canvas or boards and dried under the sun for 1-2 days or until fruit opens releasing the seeds. Mild thrashing may be done and seeds cleaned by screening/sieving and winnowing.

- **Pods that do not open easily**: like those of rain tree and pynkado. Pods dried under the sun and mild beating done to open up pods and seeds then picked individually. Seeds will require further air-drying.

- **Fleshy fruits with large seeds** – such as dhakijam, gamar and chapalish. Extract seeds immediately after collection. Soak fleshy fruits in water for 1-2 days, then separate seeds from pulp by maceration, clean wash. Air dry seeds.

- **Fleshy fruits with fine seeds** --- like kadam. Outer portion of fruit containing fine seeds is rubbed lightly against ½ inch wire mesh. Macerate pulp with seeds over 1/16 inch screen in container filled with water. Seeds sink to the bottom while fine pulp floats. Drain out water and pulp, then collect seeds, clean by washing, and air dry.

Seed Storage

- *Seeds, which cannot be stored and must be sown immediately after collection*: Recalcitrant seeds or seeds which retain their viability only at high moisture content. Examples are chpalish, garjan, sal, telsur, chikrassi, champa, and dhakijam, pitali, borun, jack fruit, mango, jam.
- *Seeds with hard seed coat and normally low moisture content:*
  - Immediately after drying, put the seeds in airtight containers and store in cool, dry place.
  - For longer storage of more than six months, keep seeds in airtight container, and when possible, in cold storage.

Seed Viability

- **Cutting Test:** Pick at random, 4-5 lots of seed samples, 50-100 seeds/lot. Cut seeds and examine kernel. Good seed is full, firm and sweet smelling. Bad seed is shriveled, wormy, and rancid, the embryo itself may be withered.
- **Floatation method**: Put sample of seeds in water. Good seeds usually sink while empty and defective ones will float. This is an empirical method and will generally give an over estimate of germination. So provide adequate extra allowance while sowing such seed.
- **Germination Test:** Pick seed samples and germinate seeds in seedflats/trays. Count number of seeds that germinate daily until germination is completed. This is the most reliable method, and should be done just before regular sowing in nursery bed/pots.

Seed Treatment to Hasten Germination

- **Soaking in normal Water**: Seeds are soaked in cold water overnight (12 hours) or up to 48 hours to soften the seed coat and allow the seeds to imbibe water. Often used for hardcoat seeds of legumes like koroi, rain tree, babla etc. , pines, gammar, etc.
- **Hot water treatment**: For hard-coated seeds like ipil-ipil, akashmoni, mangium and other leguminous species, boil water in a pot and when bubbling, take off from hearth, put the seed in hot water, leave immersed for 8-10 minutes, decant the hot water and wait over night, sow on the following day.
- **Nicking:** Nicking means cutting the testa or seed covering from the apex just enough to expose a small portion of the cotyledon. Generally used for large seeded species like mango. A special nicking procedure has been developed for seeds of cane. Removal of hilar cover hastens the process of germination.
- **Burying the seeds in the ground**: This technique also known as the *Pit Process* is widely used for teak seed treatment. A pit is dug about 50-60 cm deep and 1 meter square and filled with water. When the water is drained down through percolation, the sides of the pit are lined with teak leaves. The seeds are first soaked in outside situations (in pond or tank or canal) for 48 hours, then placed into the pit in thick layers, 10-15 cm deep, separated by 2-3 layers of teak leaves, and finally covered with 20 cm of soil. Bamboo pipes with drainage holes at different layers are laid out for watering from outside. The seeds are watered daily through the bamboo pipes to keep them just moist and facilitate microbial activity, and after 10-15 days, seeds start dehiscing hard testa when they are removed and sown in nursery bed or pots.

Seed Sowing in Nursery

- ***Seed Sowing Schedule***:

  ♦First determine germination capacity as explained in section 9.8. This is important to determine how much seed will be sown.

  ♦Schedule the sowing in accordance with planting, providing optimum time to produce well conditioned seedlings with well hardened and strong stems, and fibrous root systems.

- ***Seed Sowing Methods***

  i. **Sowing in germination trays, seedflats or seed boxes**: This method is recommended for germination of fine seeds like Kadam and eucalyptus. Perforated plastic trays of various sizes and shapes, which are cheap and available in local market, can be used:

  ♦Line the sides and bottom of the tray with 2-3 layers of old newspaper (printed on newsprint), or a single layer of perforated plastic sheet.

  ♦Fill the tray with a mixture of sand and topsoil, sterilized by high temperature heating, and level the surface. Water the germination medium to saturation and allow to drain.

  ♦Place seeds in a coffee bottle with holes punched in the lid. Add fine dry sand equivalent to 2-3 times the volume of seeds, and mix thoroughly.

  ♦Sprinkle the sand/seed mixture evenly over the germination media in the tray.

  ♦Water by sub-irrigation i.e., submerge the germination tray to about 3/4th depth of the soil in the tray, and allow water to rise to the surface by soaking (capillary action). Then return the tray to the germination shed.

  ii. **Sowing directly in pots**:

  ♦This technique is used for bigger seeds with at least 50% germination capacity.

  ♦Number of seeds sown per pot are as follows:

No. of seeds / pot	% germination
2	80% or higher
3	60-80%
4-5	50-60%

  ♦Water pots thoroughly before seed sowing so that pot soil is fully saturated.

  ♦Place seeds on the surface of the potted soil and press down with fingertip or stick up to a depth approximately equal to the seed diameter/thickness. Cover seed with soil.

  ♦Water once or twice a day to keep the soil moist but not wet. Use sprinkler with fine sprays. If too wet, fungus may development may take place and seed damaged.

  ♦Provide over head shade until germination is complete.

  ♦Thin out excess seedlings from each pot when seedlings are 10-15 cm high. If scope exists, replant thinned out seedlings in new pots.

  ♦Sow small amount of seeds in trays, boxes, or seedbeds for filling up vacant pots should poor germination take place and some pots are vacant.

Sowing in seedbeds for transplanting:

- Pulverize soils of seedbeds by breaking clods and level the surface after cultivation.
- Water the beds thoroughly before sowing.
- Broadcast seeds evenly on the bed surface. Thump seeds lightly with a flat board after which cover the seeds with a thin layer of soil. (Note: fine seeds of Kadam and Eucalyptus need not be covered)
- Another way is to sow the seeds in drills or furrows: Make furrows about 2-3 cm wide, 2-3 cm deep, and 5-10 cm apart. Then sow the seeds in the furrow, firm them down with piece of wood and cover with fine sand or soil.
- Provide over head shade until germination and pricking out is completed.
- Water once or twice daily as required, but do not make it wet.

Sowing in seedbeds for bare-root plants/stump seedlings

- Pulverize and level surface after deep cultivation to 20-25cm depth.
- Water seedbed thoroughly.
- Sow the seeds at desired spacing, 1-3 seeds per spot depending on seed germination capacity or evenly broadcast. Seeds may be sown in drills of 2-3cm deep and 2-3cm wide.
- Fill-up vacant spots with excess seedlings from other pots, or those germinated simultaneously for the purpose or from spots where dense germination took place.
- Provide overhead shade until germination is completed.
- Water once daily preferably in the evening.

Pricking Out Seedlings for Transplanting

- This is done when seeds are germinated in germination trays or seed beds. The operation is carried out as soon as practicable after the seed germination is completed. In general, seedlings are ready for pricking when the cotyledons have dropped off or 4-6 primary leaves have emerged.
- Water the seed tray or germination bed well before pricking out/lifting of the seedlings. Carefully uproot the seedlings using a dibbling stick so that its roots are not torn or injured. Each seedling is gently handled by holding leaf, never by the stem.
- Transfer the prick out seedlings, one at a time, in a small container (cup or coconut shell), half filled with water so that the seedlings will not dry out. About 15-20 seedlings should be uprooted at one time and then transferred to the pot or transplant beds following steps mentioned in 8.12.4.
- Water pots or transplanted beds before pricking out seedlings from tray or seedbed. Use a dibbling stick, make a hole large enough in the center to accommodate the roots of the pricked out seedling.
- Place roots of the seedlings in the hole, making sure that roots are not bent or coiled.
- Carefully press the soil firmly around the roots with the index finger, making sure that the root collar is in level with the bed surface.
- Pour a little water to ensure that no air pockets are left around the roots of transplants.

- Pricking should be carried out under shade, preferably in the evening. The transplant beds or pots should be sha44ded over head before pricking out/transplanting.

10.9 Raising Potted Seedlings

Rationale: The Use of polyethylene pots for raising potted seedlings has revolutionized plant nursery raising throughout the world especially as a technique for transplanting delicate plant species that do not tolerate transplantation shock. Plants raised in polypots when carefully transplanted do not feel disturbed and survive as if nothing has happened to it.

Good Potting Soil Mixture: A good potting soil should have good drainage and aeration, adequate water holding capacity, fertile, free from soil-borne pests and pathogens. The mixtures could be readily and cheaply available. A satisfactory potting soil used in Bangladesh should consist of the following:

- 3 parts fertile topsoil (sandy loam or loam)
- 1 parts decomposed cow dung or compost
- 1.5 kg of chemical fertilizer (0.75 kg TSP and 0.75kg MP) per cu.m (35 cft.) of soil mixture.

Mix the above ingredients together very intimately and make a heap. Excavate the heap at the base from one side to make a new heap. Always pass the soil to the apex of the new heap. Repeat this process of mixing at least 3 times. This potting soil may be used immediately. Better result is obtained if stored in heap under shade for a month or two when microbial activity quickly transform the soil nutrients in the available form for plants. This process of heaping soil in shade for nutrient metamorphosis is called *Soil Maturing*.

Collection of Good Potting Soil:
The best soil for pot nursery is an organic matter-rich loamy soil. Such soil could be procured from the top 10-15cm depth of fertile farming lands, forest floor, alluvial deposits along riverbanks, beds of derelict ponds/tanks etc. If on touch the soil gives the feeling of more sand it, certain proportion of clayey soil may be added to improve its texture. Likewise, if the soil is heavily clayey, certain proportions of sand may be added to improve its texture and porosity.

Volume Requirements of Potting Soil:

Pot size	Vol/Pot	Total soil vol/100 pots
10 cm x 15cm	0.050 cu cm	5.00 cm^3
15 cm x 25 cm	0.188 cu m	18.87 cm^3

Pot Filling and Stacking of Pots on Beds

- Punch 6-10 drainage holes/weep holes, about 3 cm from the bottom of the polypots in the upward direction, in 2-3 layers at 5-6 cm intervals. This could be done using an office puncher. However, pots with drainage holes of desired specifications may be ordered to the suppliers.
- Fill polypots with dry potting media; filling to be done in three installment: each time filling 1/3rd depth and compacted by dodging on the ground. A funnel fashioned from bamboo or made of metal sheet may be used for quick filling job.

- Add more soil to fill up to the brim of the bag to account for subsequent settling.
- Stack the earth filled polypots in pot beds. Space requirement is about 225 pots/m^2 for pot size 10cm x15cm, 100 pots/m^2 for pot size 15 cm x 25cm and 36 pots/ m^2 for pot size 25cmx30cm. Construct border frame/edging with bamboo slats, bamboo tubes, wooden planks or bricks to keep pots uprights.

AVOID

- Inadequate filling of pots. This will results in seedling drop too low in pots when soil settles. Also may result in deformity of the bags with consequent deformity of roots.
- Poor stacking of polypots in beds, leading to bent seedlings.

Seedlings Raising in Pots :

a. Take mixed pot0ting soil from the maturing heaped mound from one side, break clods further to fine grains and sieve through fine mesh sieve (*Balu Chalni*). The sieved soil is used for pot filling. Polypots of size 25cm x 15cm x 0.08mm thickness should be used as nursery pot for MACH project program. Each pot should have two to three rows of weep in its lower half starting from the bottom at an interval of 5-6 cm upwards, to drain out excess water from irrigation or rainfall. If no weep hole is present, excess water can not drain out, and stagnate in the pot bottom resulting in damping off fungus growth that would kill the plant.

b. Seeds are either sown directly in the earth filled polypots (Section 8.9.2.2) or newly germinated seedlings pricked out individually from germination tray or seed bed, and transplanted in pots.

10.10. Care and Maintenance of Seedlings

Watering

- Water young seedlings with gentle spray.
- Water at least once a day, during summer.
- Watering is best done either during early morning or late afternoon.

Shading

i. General Considerations:

- Shading is often necessary to protect young seedlings and germinating seeds from being damaged by direct sunshine and heat.
- The need for shading varies according to species, stage of seedling development and season of the year.
- Most tree species require shade during germination to keep the soil moist. On the other hand, a few light demanding species like teak and Gamar usually germinate and establish without shade.
- As a general rule, newly pricked-out and young seedlings will require about 70% shade. However, depending on species, the shade is gradually reduced until the seedlings are fully exposed, or partial shade is maintained.

ii. The shading requirements of some species are as follows:

- Jhau, Eucalyptus, and Pines: usually needs no shade after two weeks from pricking-out.
- Akashmoni, mangium, hijal, koroch, ipil-ipil and similar species: usually needs no shade once the seedlings have attained 4-5 cm in height.
- Teak, gamar, mahagony, dhakijam: usually do not need shade.
- Garjan and other dipterocarp species-usually required shade throughout the nursery period. Full shade is needed during germination stage, which can then be reduced to 50% after 2-3 months.

iii. *Construction of shade:* Make shade from local materials: sungrass and palm leaves can be used to make full shade while bamboo slats are convenient in making partial shades.

- Shade should be at least 50 cm wider than the nursery bed being shaded.
- Slant the shed towards the north, at 30^0 - 45^0 angle, to allow some sunshine in the bed which is also needed for good photosynthesis.

10.11 Grading of Seedling

- Seedlings should be sturdy and strong to survive and resume growth immediately after planting in the field. The roots should be well developed to support the stem and the crown. One month to one week before planting, segregate seedlings based on their height and health as different grades such as plantable, medium, small and cull.
- Cull seedlings should be thrown away outright and should never be planted.
- As much as possible, only plantable grades should be planted. Medium grade and small seedlings should be allowed to grow for some time more with extra care. In the grading process, sort out the plantable grades after 1 or 2 months. Apply fertilizer to medium and small seedlings. These seedlings can be utilized sometimes later in the season or during vacancy filling/beating up operation.

10.12 Prevention and Control of Pests and Diseases

Insect and Insect Damage

- Common insect pests in the nursery include ants which eat or carry away the seeds; defoliators which feed on leaves; and mites and other sucking insects which suck the sap of tender shoots and leaves killing the plant altogether in the process.
- Spray seedbed or seed boxes with insecticide solution like Malathion, Parathion, Sumathion, Libacid, Diazinon, Sevin, etc. in prescribed doses usually indicated in the labels of insecticide container.
- Take great care to meticulously follow all instructions on insecticide container labels. Dispose of empty containers very carefully so that these can not be used for any other purpose. Wear protective clothing covering whole body and nose while handling pesticides, and wash thoroughly with soap and water afterwards.
- Nursery seedlings should be regularly inspected to guard against disease and insect attack. If disease or pest attack is observed, prompt action should be taken for affording remedial

measures. The nearest forest/agricultural officials should be consulted in case of pest attack and their advice sought and acted upon.

Fungal Diseases

a. *Damping-off Fungi :* The most common of nursery diseases, especially in tender seedlings, is the damping off fungi attack. The attack symptom is manifested through grounding of the tender seedling on the nursery bed or pot due to rotting at the collar level while the stem color still remaining green. The best way to control damping–off disease is to prevent its occurrence by:

- ♦Sterilizing the germinating medium.
- ♦Drenching germination trays, seed beds, seed boxes with fungicide solution such as cupravit or diathane
- ♦Not excess watering
- ♦Removing shade as soon as possible.
- ♦Not sowing seeds too densely

- Other fungal disease viz., root rot, tip-die back, leaf spot, etc.
  - ♦spray with fungicide
  - ♦remove and burn all infected seedlings.
- Keep nursery always clean and maintain a healthy and robust growth of the seedlings

- ***BORDEAUX Mixture*** *to Control Most Fungal Disease:*

  The most effective fungicide against most fungal diseases of plant is a simple chemical mixture called *BORDEAUX* mixture. It is prepared by mixing three components viz., copper sulphate (*toonte*), lime and water as follows:

  i. Take 10 gallons of clean water in an earthen or plastic container (no metal container), and dissolve ½ kg of copper sulphate (*toonte*) in it.

  ii. Take 10 gallons of clean water in another earthen or plastic container and dissolve ½ kg lime in it.

  iii. Stir both the solution well and slowly pour the two mixtures in a third container (earthen or plastic) in equal proportion and stir the third mixture constantly during mixing. Bordeaux mixture is made.

Apply *Bordeaux* mixture to plant leaf and stem by using a sprayer. This is effective against fungus in both young and old plants.

Caution:

a. Do not put all three ingredients i.e., copper sulphate, lime and water, together in one container and mix to make the mixture. If done, the mixture will not be effective as a fungicide.

b. Do not use metal container/bucket for mixture preparation.

Terms of Reference (TOR) of the Consultant

Activities to be Performed by the Consultant are as follows:

I. Conduct Discussion with MACH and project implementation partners to identify the expectation and needs.

II. Review of the existing plans (i.e.,Chara watershed management demonstration plans) for hail haor site for plantations, on riparian area, restoration of wetland and discuss with project staff

III. Reconnaissance field visit to project sites to assess scope of work and to get overview of the present status (assess land type and land use practice); the visit to include discussion with the various stake holders.

IV. A report on the history of the wetland plant species in the project areas and their current status.

V. Prepare in consultation with the stakeholders and project staff a 3-year plan of wetland, riparian and high land tree shrub and other vegetation restoration by area (Land type – Soil condition) for the site. The plan should include a map designating the areas to be restored or planted and species to be used.

VI. Identify and select the suitable plant species (herbs, shrubs and trees) for wetland and high land plantation and recommend the activities of each required to be undertaken early.

VII. Prepare a guideline on plant nursery development at project level

Appendix-2 :List of Charas draining into the Hail Haor with source of origin and approximate length.

Serial #	Name of Chara	Source of Origin	Main Chara length (m)	# Tributaries	Tributaries Length (m)
1	Kalni/Raypan chara	Satgaon	3,235	-	-
2	Bangua chara	Satgaon	4725	3	4993
3	Pagri chara	Satgaon	1365	4	965
4	Pagla chara	Satgaon	2044	8	2,169
5	Bar chara	Satgaon	5366	4	8,125
6	Maura chara	Satgaon			
7	Chang chari	Satgaon	1764	-	-
8	Kaila chara	Satgaon	4822	-	-
9	Taka chara	Satgaon	1436	-	-
10	Jaulam chara	Satgaon	5378	2	3820
11	Duma chara	Satgaon	1044	-	-
12	Kali chara	Satgaon	3092	-	-
13	Mura chara	Satgaon	4884	2	1780
14	Boula chara	Satgaon	7045	-	-
15	Gandarbpur	Satgaon	2461	-	-
16	Haira chara	Satgaon	3548	-	-
17	Burchungi chara	Satgaon	4726	2	1284
18	Ichamati chara	Satgaon	7925	9	6535
19	Nauli chara	Satgaon	3311	-	-
20	Andhi chara	Satgaon	4774	4	2132
21	Joita chara	Satgaon	7595	2	3259
22	Maura chara	Faizabad	2450	-	-
23	Patri chara	Faizabad	4644	1	1468
24	Sharia chara	Faizabad	5187	1	1360
25	Makri	Faizabad	5612	-	-
26	Alia	Faizabad	8806	4	7103
27	Kodali Gung	Faizabad	13712	-	-
28	Bilas chara	Balishera	23544	4	11137
29	Fulchari chara	Balishera	12238	2	4956
30	Kaikka chara	Balishera	9450	-	-
31	Burburi chara	Balishera	12467	2	8545
32	Shakhmora chara	Balishera	7122	-	-
33	Dablechari chara	Balishera	7333	-	-
34	Jainkha chara	Balishera	9709	-	-
35	Badeswari chara	Balishera	2647	-	-
36	Khai chara	Balishera	5883	2	3172
37	Jaag chara	Balishera	9873	4	7587
38	Akali chara	Balishera	1035	-	-
39	Kalkalia chara	Balishera	6095	-	-
40	Kaika chara	Balishera	1825	-	-

41	Maura chara	Balishera	-	-	-
42	Chang chara	Balishera	5931	2	3775
43	Sonai chara	Balishera	1770	-	-
44	Duduchari gung	Balishera	1723	-	-
45	Maurashaon chara	Balishera	2011	-	-
46	Shaon chara	Balishera	5593	-	-
47	Shial chara	Balishera	6036	3	1837
48	Maura chara	Balishera	-	--	-
49	Narayan chara	Balishera	1880	-	-
50	Maura chara	Balishera	-	-	-
51	Dangddingi chara	Balishera	4082	-	-
52	Gabur chara	Balishera	6735	2	3523
53	Moura chara	Balishera	3998	-	-
54	Maura chara	Balishera	-	-	-
55	Dewa chara	Balishera	5460	-	-
56	Moura chara	Balishera	-	-	-
57	Dudchari chara	Balishera	3557	-	-
58	Meghna chara	Balishera	2729	1	1193
59	Kodali char Gung	Balishera	6277	-	-
Total			**287, 954**	**68**	**90, 697**
Following are the Important Tributaries that Meet With Bilas Chara					
1	Barma chara	-	24431	3	31199
2	Udna chara	-	32632	3	22921
3	Laingla chara	-	11743	1	7751
Total			**68,806**	7	**61,871**

[Source: CNRS Document on Participatory Watershed Management for Hail Haor Watershed]

Appendix-3 : List of Observed Dry Season Plant Species in the Hail Haor
(Surveyed between 1.11.1999 to 30.11.1999)

[redacted]	[redacted]	[redacted]	[redacted]	[redacted]	[redacted]
1.	Chrysopogon aciculatus	Premakata/ Chokata	Gramieae	FP	
2.	Cynodon dactylon	Durba/ Boro durba ghas	Gramieae		
3	Hygrorrhyza aristata	Futi/Futki Ghas	Gramieae		
4.	Eleusina induca	Ghas	Gramieae		
5.	Echinochloa stagnina	Parua/ Paura Ghas	Gramieae		
6.	Echinochloap sp.	Tandera ghas	Gramieae		
7.	Pseudoraphis spinesces	Bagh eral/erail ghas	Gramieae		
8.	Pseudoraphis brunoniane	Dudheral/ erail ghas	Gramieae		
9.	Pseudoraphis sp.	Erail/ erail ghas	Gramieae		
10.	Oryza rufipogon	Jhara dhan	Gramieae		
11.	Oryza sp.	Dhan (cultiver)	Gramieae		
12.	Hemarthria protena	Laitta/ birani ghas	Gramieae		
13.	Digitaria sp.	Ghas	Gramieae		
14.	Axonopus compressur	Ghas	Gramieae		
15.	Rottboelus sp.	Jabir ghas	Gramieae		
16.	Sporobolus	Jabri ghas	Gramieae		
17.	Phagmites Karka	Khagra/ nol/ nol Khagra	Gramieae		
18.	Desodium sp	Ghas	Leguminosae	OR	
19.	Aeschynomene sp	Shola/ Vatshola	Leguminosae		
20.	Cyperus rotunds	Mutha	Cyperaceae	FP	
21.	C. tenuispca	Ghas	Cyperaceae		
22.	C. tegetum	Ghas/ Chati Hogla	Cyperaceae		
23.	Cyperus sp.	Chesra ghas	Cyperaceae	OT	
24.	Fimbristylis miliacea	Ghas	Cyperaceae		
25.	Eleocharis chaetaria	Ghas	Cyperaceae	OR	
26.	E. dulcis	Boro Chesra ghas	Cyperaceae	OT	
27.	Eriocaulon setaceum	Soto Chesra	Cyperaceae		
28.	Schoenoplectus articulatus	Soto Chesra	Cyperaceae		
29.	Hydrilla verticillata	Kata shayola	Hydrocharitaceae	FP	
30..	Ottelia alismoides	Panikola	Hydrocharitaceae		
31.	Vallisneria spiralis	Pata shayola	Hydrocharitaceae		
32.	Blyxa sp	Pani ghas	Hydrocharitaceae		
33	Utricularia exoleata	Shayola	Lentibulariaceae	FP	
34.	U. aurea	Shayola	Lentibulariaceae		
35.	U. inflexa	Shayola	Lentibulariaceae		
36.	Utricularia sp	Shayola	Lentibulariaceae		
37.	Utricularia stellaris	Shayola	Lentibulariaceae		
38.	Limnophila heterophylla	Pani chapra ghas	Scrophulariaceae		
39.	L. cana	Pani chapra ghas	Scrophulariaceae	OR	
40.	L. sessiliflora	Pani chapra ghas	Scrophulariaceae		
41.	Limnophila sp	Pani chapra ghas	Scrophulariaceae		
42.	Polygonum lanatum	Kora/ Saka kokra	Polygonaceae	FP	
43.	P. barbatum	Boro lal kokra	Polygonaceae		
44.	P. tomentosum	Boro kokra	Polygonaceae		

45.	P. stagninum	Lal kokra	Polygonaceae		
46.	P. glabrum	Lal Kokra	Polygonaceae		
48.	P. Pedunculare	Lal kokra	Polygonaceae		
49.	Nymphaea nouchaali	Nil Shapla	Nymphaeaceae		
50.	N. pubescens	Sade Shapla	Nymphaeaceae	OR	
51.	N. rubra	Lal Shapla	Nymphaeaceae		
52.	Nelumbo nucifera	Padma	Nymphaeaceae		
53.	Euryale ferox	Fokol/ Makhna/ Tal makhan	Nymphaeaceae		
54.	Myriophyllum sp	Shayola	Hallorgaceae		
55.	Ceratophyllum sp.	Biral lazur/ Tokma shayole	Ceratophyllaceae		
56.	Najas graminea	Shayola	Najadaceae		
57.	Najas sp.	Shayola	Najadaceae		
58.	Azolla pinnata	Kutipana	Salviniaceae		
59.	Slvinia cucullata	Edurkani pana	Salviniaceae		
60.	S. natans	Tetul pata pana	Salviniaceae		
61.	Ludwigia repens	Keshordam/ Panichapra	Onagraceae		
62.	L. adscendens	Keshordam/ Panichapra	Onagraceae		
63.	Echhornia crassipes	Kachuri pana	Pontederiaceae		
63.	Monochoria hastata	Kechor	Pontederiaceae		
64.	Alternanthera sessilis	SechiShak	Amaranthaceae		
65.	A. philoxeroides	Helencha	Amaranthaceae		
66.	Enhydra fluctuans	Helencha	Compositae		
67.	Eclipta sp.	Kella ghas	Compositae		
68.	Mikania cordata	Zermani/ Janpani lata	Compositae		
69.	Trapa bispinosa	Singair/ Singara/ Panifol	Trapaceae		
70.	T. maximowiczz	Singair/ Singara/ Panifol	Trapaceae		
71.	Mersilea quadrifolia	Amrail shak	Merileaceae		
72.	Ipomoea fisrulosa	Dhol Kolmi/ Deu Kolom	Convolvulaceae		
73.	I. aquatica	Kolmi lata	Convolvulaceae		
74.	Evolvulus sp	Lata/ Babni lata	Convolvulaceae		
75.	Dentella repens	Bhui pat/ Noricha ghas	Rubiaceae		
76.	Nymphoides cristatum	Zinari gas	Menyanthaceae		
77.	N. indicum	Zinari gas	Menyanthaceae		
78.	Pistia stratiotes	Topa/ Toka pana	Araceae		
79.	Aponogeton appendiculatus	Baitha pata	Aponogetonaceae		
80.	Aponogeton sp.	Chechu	Aponogetonaceae		
81.	Phyllanthus sp	Sitka/ Sitki			
82.	Phyllanthus sp	Pisas/ Pishas /Sitka	Euphorbiaceae		
83.	Elatine sp.	Ghas	Euphorbiaceae		
84.	Ceratopteris sp	Fern	Elatinaceae		

Appendix - 4 : List of Observed Wet Season Plant Species in the Hail Haor
(Surveyed between 5.8.2000 to 17.8.2000)

Sl.	Botanical name	Local name	Family	Use
1.	Cynodon dactylon	Durba ghas	Gramineae	FP
2.	Hemarthia protensa	Chail	Gramineae	F P
3.	Oryza sp	Dhan	Gramineae	FP
4.	Axonopus affinis	Chapta pata	Gramineae	FP
5.	Echinochloa sp	Tandera	Gramineae	FP
6.	Hygroryza aristata	Futki	Gramineae	FP
7.	Oryza rufipogon	Jhora dhan	DhanGramineae	FP
8.	Echinochloa cruss golli	Paura	Gramineae	FP
9.	Pseudoraphis brunoniana	Bammidopra	Gramineae	FP
10.	Paspalum scrobiculatum	Panigoicha	Gramineae	FP
11.	Panigoicha Conjugatum	Ful ghas	Gramineae	FP
12.	Panicum Paludosum	Ful ghas	Gramineae	FP
13.	Pseudoraphis spinescens	Arail	Gramineae	FP
14.	Sporbolus holvulus	Ful ghas	Gramineae	FP
15.	Sporbolus airroides	Ful ghas	Gramineae	FP
16.	Limnopoa meeboldies	Bamnidopra	Gramineae	FP
17.	Sacciolepis interrupta	Ghash	Gramineae	FP
18.	Cyperus roundus	Ful ghash	Cyperaceae	FP
19.	C. tegetun	Chatiogol	Cyperaceae	FP
20.	Fimbristylis miliacea	Ghash	Cyperaceae	FP
21.	Fimbristylis SP	Ghash	Cyperaceae	FP
22.	Kyllinga melanosperma	Ful ghash	Cyperaceae	FP
23.	Cyperus SP	Ful ghash	Cyperaceae	FP
24..	Eriocaulon acutangula	Boro chesra	Cyperaceae	OT
25.	Pycreus straming	Chesra	Cyperaceae	FP
26.	Fimbristylis scaberrima	Ful ghash	Cyperaceae	FP
27.	Scirpus articulaties	Choto chesra	Cyperaceae	FP
28.	Cyperus rotang	Ful ghash	Cyperaceae	FP
29.	Hydrilla verticillata	Kata shaola	Hydrucharitraceae	FP
30.	Blyxa japonica	Shawla	Hydrucharitraceae	OT
31.	Ottelia alismoides	Panikola	Hydrucharitraceae	FS
32.	Vallisneria spiralies	Pattern	Limnaceae	OT
33.	Utricularia exoleata	Shawla	Lentibulariaceae	OT
34.	U. aure	Bicha shaola	Lentibulariaceae	OT
35.	Utricularia SP	shaola	Lentibulariaceae	OT
36.	Lemnophila heterophylla	Panichaora	Scrophulariaceae	OT
37.	L. Sessiliflora	Panichaora	Scrophulariaceae	OT
38.	Limnophila SP	Panichaora	Scrophulariaceae	OT
39.	Dopartrium junceum	Pani ghas	Scrophulariaceae	OT
40.	Polygonum tomentosum	Boro Kokra	Polygonaceae	OT
41.	P. lanatum	Sada kokra(choto)	Polygonaceae	OT

42.	P. glabrun	Lal kukra	Polygonaceae	OT
43.	P. Pedunculare	Lal kukra	Polygonaceae	OT
44.	Pesicaria dribotoma	Lal kukra	Polygonaceae	OT
45.	P Ocreocarpa	Lal kukra	Polygonaceae	OT
46.	Nymphaea pubescens	Sada Shapla	Nymphaeaceae	OT
47.	N. stellata	Nil shapa	Nymphaeaceae	OT
48.	N. nouchali	Shapla/ vat	Nymphaeaceae	OT
49.	Nelumbo nucifera	Padma	Nymphaeaceae	OT
50.	Myriophyllum SP	Pani ghash	Haloragaceae	OT
51.	Myriophyllum SP	Pani ghash	Haloragaceae	OT
52.	Myriophyllum SP	Gach shaola	Haloragaceae	OT
53.	Ceratophyllum demersum	Biral lazur	Ceatophyllaceae	OT
54.	Ceratophyllum SP	Shawla	Ceatophyllaceae	OT
55.	Najas graminea	Gura shasla	Najadaceae	OT
56.	Najas SP	Gura shasla	Najadaceae	OT
57.	Salvinia euculata	Idue kani	Salviniaceae	OT
58.	Salvinia natans	Idue kani	Salviniaceae	OT
59.	Azolla pinnata	Idue kani	Salviniaceae	OT
60.	Ludwigia adscendens	Painaga	Onagraceae	FP
61.	L. repens	Painaga	Onagraceae	FP
62.	Eichhornia crassipes	Jarmoni	Ponte deriaceae	FV
63.	Monochoria hastata	Khechur	Ponte deriaceae	FV
64.	Alternanthera sessilis	Shechishak	Amaranthaceae	FV
65.	A. philoxeroides	Shechishak	Amaranthaceae	FV
66.	Enhydroides fluctuans	Helencha	Compositae	FV
67.	Enhydroides SP	Helencha	Compositae	FV
68.	Eclipta Prostta	Helencha	Compositae	OT
69.	Trapa bispinosa	Shingrai	Trapaceae	FF
70.	Mersilea minuta	Kolmi Shak	Convlvulaceae	FV
71.	Ipomoea aqutica	Dhol Kolum	Convlvulaceae	OT
72.	I. Fistulosa	Zinari ghash	Menyanthaceae	OT
73.	Nymphoides indicum	Zinari ghash	Menyanthaceae	OT
74.	N. Cristatum	Topa pana	Araceae	
75.	Pistia strateotes	Kochu	Araceae	OT
76.	Colocasia escullenta	Boithapata	Aponogeto raceae	OT
77.	Aponogeton appendiculatus	Boithapata	Aponogeto raceae	OT
78.	Aponogeton SP	Tiki okra	Sterculiariaceae	OT
78.	Melochia corchori folia	Pani ghash	Scrophulariaceae	OT
79.	Lindernia rotundifolia	Pani ghash	Scrophulariaceae	OT
80.	Lindernia SP	Vat shola	Scrophulariaceae	OT
81	Aeschynomene aspera		Papilionaceae	OT
82.	Lippia geminata		Verbenaceae	OT
83.	Ceratoteris chauctroides		Pteridophyta	OT
84.	Nitella SP	Shola	Algae(BGA)	FP
85.	Sagitteria guaynensis	Pani khuhur	Allsmataceae	

Appendix – 5: Land use Status of Government Reserved Forest Lands Located in the Watersheds of Hail Haor Basin

Name of Forest Beat	Present Land Use	Area (ha)
Lawa Chara	Agriculture	30.4
"	Bamboo Plantation	18.25
"	Cane	3.37
"	Encroach/ Forest Village	116.37
"	FRI Area	127.32
"	Others (HEED)	19.88
"	Short Rotation	169.36
	Long Rotation	778.64
	Sub. Total	1263.59
Chautali	Bamboo	4.02
"	Failed Plantation	16.27
"	Short Rotation	67.1
"	Long Rotation	333.69
	Sub. Total	421.08
Kalachara	Agriculture	170.62
"	Failed Plantation	81.08
"	FRI Area	8.58
"	Natural Forest Village	6.3
"	Short Rotation	418.96
"	Long Rotation	229.96
	Sub. Total	915.5
Satgaon	Agriculture	28.12
"	Open Area	50.98
"	Sungrass	41.09
"	Bamboo Plantation	72.34
"	Short Rotation	477.03
"	Long Rotation	76.75
	Sub. Total	746.31
	Grand Total	3,346.48

[Source: Forest Department Headquarters Data Base (RIMS / GIS Unit)]

ইউনিয়ন পরিষদ রাস্তার ধারে বৃক্ষচাষ কর্মকান্ডে অংশ গ্রহনকারী পক্ষ সমূহের মধ্যে উপকারভোগের চুক্তিপত্র।

(১৫০ টাকা মূল্যমানের নন- জুডিশিয়াল স্টাম্পের উপর এইচুক্তিপত্র সম্পাদন করিতে হইবে)

যেহেতু ....জেলার .. ..থানার..... .. ..ইউনিয়ান পরিষদ অত্র চুক্তিপত্রর তফসিল অংশে বর্নিত রাস্তার ধারে বাংলাদেশ সরকার ও মার্কিন যুক্তরাষ্টের আন্তর্জাতিক উন্নয়ন সংস্থার অর্থায়নে 'উইনরক ইন্টারন্যাশনাল' এর সহযোগীতায় ও কারিতাস- বাংলাদেশ এর তত্তাবধানে MACH প্রকল্পের আওতায় বৃক্ষচাষ ও আনুসঙ্গিক কৃষি ফসল উৎপাদন কর্মকান্ড বাস্তবায়নে সম্মত হইয়াছ, সেহেতু অদ্য ২০০০ ইং সনের.....শে..... তারিখে উক্ত ইউনিয়ন পরিষদের পক্ষে চেয়ারমান (যাহাকে অতঃপর অত্র চুক্তিপত্রে প্রথম পক্ষ বলিয়া উল্লেখ্য করা হইবে) এবং অত্র চুক্তিপত্রের সাথে সংযুক্ত তালিকায় বর্নিত প্রকল্পের কর্মকান্ডে অংশ গ্রহনকারী বিত্তহীন উপকারভোগী সমিতির সদস্যগনের (যাহাদিগকে অত চুক্তিপত্রে অতঃপর দ্বিতীয় পক্ষ বলিয়া উল্লেখ করা হইবে) মধ্যে নিম্নে বর্নিত শর্তাধীনে অত্র চুক্তিপত্র সম্পদান করা হইল।

চুক্তিপত্রের শর্তাবলী

১) এই চুক্তিপত্র.....তারিখ হইতে.....তারিখ পর্যান্ত বলবৎ থাকিবে। পক্ষ সমুহের মধ্য আলাপ-আলোচনা ও ঐকমত্যের ভিত্তিতে এই চুক্তিপত্র পরবর্তী মেয়াদের জন্য নবায়ন করা যাইবে।

২) প্রথম পক্ষ এই চুক্তিপত্রের তফসিল অংশে বর্নিত রাস্তার স্বত্তাধিকারী পক্ষ এবং রাস্তার ধারে বৃক্ষ চাষ ও আনুসঙ্গিক কৃষি ফসল উৎপাদন কর্মকান্ড বাস্তবায়নকারী মূখ্য সংস্থা হিসাবে দ্বিতীয় পক্ষকে রাস্তার ঢালের ভূমি ব্যবহারের জন্য এতদ্বারা অনুমতি প্রদান করিলেন। বর্নিত অনুমতি প্রদানের কারনে প্রথম পক্ষ অত্র চুক্তিপত্রের ১০ নং দফায় বর্নিত উৎপাদনের অংশ ছাড়া দ্বিতীয় পক্ষের উপর অন্য কোন প্রকার কর বা খাজনা ধাজ্য করিতে পারিবে না।

৩) কারিতাস-বাংলাদেশ প্রকল্প বাস্তবায়নের পরিকল্পনা ও বাস্তবায়ন নির্দেশকার নিয়ম ও নীতি অনুসরস পূর্বক স্থানীয় বিত্তহীন দরিদ্র কর্মীদের নিয়া অত্র চুক্তিপত্রের তফসিলে বর্নিত রাস্তার ধারে কৃষি-বন পদ্ধতির চাষাবাদ কার্যাক্রম বাস্তাবায়নের লক্ষে উপকারভোগী সংগঠন গড়িয়া তুলিবে, যাহারা তফসিলের রাস্তার ধারে উৎপাদিত বৃক্ষ ও অন্যান্য ফসলের সার্বিক যত্ন, পরিচর্যা ও নিরাপত্তার জন্য দায়ী থাকিবে।

৪) তফসিলে বর্নিত রাস্তার ঢালের জমি ব্যবহারকালীন দ্বিতীয় পক্ষ এই মর্মে নিশ্চয়তা বিধান করিবেন যে, তাহাদের ব্যবহারের মাধ্যমে রাস্তার কোন প্রকার ক্ষতি সাধিত হইবে না। তবে প্রাকৃতিক দুর্যোগ, নাগরিক অসন্তোষ বা দ্বিতীয় পক্ষের সাথে সংশ্লিষ্ট নয়, এমন কোন ব্যক্তি বা গোষ্ঠী দ্বারা রাস্তা নষ্ট বা ক্ষতিগ্রস্থ হইলে তজ্জন্য দ্বিতীয় পক্ষ দ্বায়ী থাকিবে না। তবে এইরূপ ক্ষয়ক্ষতির সংবাদ দ্বিতীয় পক্ষ তাৎক্ষনিক ভাবে প্রথম পক্ষকে জানাইতে বাধ্য থাকিবে।

৫) দ্বিতীয় পক্ষ তফসিল ভূক্ত জমিতে বৃক্ষ চাষ কর্মসূচী বাস্তবায়নকালীন প্রথম পক্ষ ও কারিতাস-বাংলাদেশ তাহাদিগকে সম্ভাব্য সকল প্রকার সাহায্য ও সহযোগীতা প্রদান করিবে এবং উদ্ভূত সকল প্রকার স্থানীয় সমস্যা সমাধানের ব্যবস্থা গ্রহন করিবে। তদসত্বেও তফসিল ভূক্ত ভূমি বা উহার ফসল যদি কাহারও দ্বারা ক্ষতি গ্রস্থ হয় বা উৎপাদিত ফসল চুরি হয়, তবে সকল পক্ষ এই সব বেআইনী কার্যকলাপ প্রতিকারের নিমিত্তে পুলিশ কর্তৃপক্ষ ও আইন- আদালতের শরনাপন্ন হইতে পারিবে।

৬) প্রথম পক্ষ ও কারিতাস-বাংলাদেশ বৃক্ষরোপন ও পরিচর্য্যা এবং কৃষি ফসল উৎপাদন কর্মকান্ড গ্রহনে দ্বিতীয় পক্ষকে উদ্বুদ্ধ করিবে এবং এই সব কর্মকান্ড দক্ষভাবে বাস্তবায়নের জন্য প্রয়োজনীয় কারিগরী ও সাংগঠনিক নির্দেশনা এবং প্রশিক্ষন প্রদান ও অর্থায়নের ব্যবস্থা গ্রহন করিবে। দ্বিতীয় পক্ষ MACH প্রকল্পের পরিল্পনা ও বাস্তবায়ন নির্দেশিকায় বর্নিত ভূমি ব্যবহার মডেল অনুসরনে বাগান সৃজন, পরিচর্যা ও ফসল কাটা, এবং অন্যান্য চাষাবাদ করিতে বাধ্য থাকিবে।

৭) দ্বিতীয় পক্ষ তফসিলে বর্নিত জমিতে বৃক্ষ চাষের সাথে অন্তর্বর্তীকালীন অর্থকরী ফসল (যথা অড়হরডাল, মাসকলাই, মরিচ, বেগুন, তরিতরকারী, লাউ/কুমড়া, নেপিয়ার ঘাস ইত্যাদি) চাষ করিতে পারিবে।কিন্তু এই ফসল উৎপাদনের জন্য রাস্তার চালের ভূমি কর্ষন পূর্বক আবাদ করা যাইবে না। তবে ছোট ছোট থালা (অনুর্ধ ৩০ সেন্টিমেটার ব্যাস পরিমিত) আকৃতিতে মাটি কোপাইয়া কৃষি ফসল উৎপাদন, এবং গাছের চারা রোপণকল্পে নির্ধারীত আয়তনের গর্ত খোড়ার জন্য দ্বিতীয় পক্ষকে এতদ্বারা অনুমোদন প্রদান করা হইল। MACH প্রকল্পের পরিকল্পনা ও বাস্তবায়ন নির্দেশিকা অনুসরনে পক্ষ সমূহের মধ্য আলোচনার প্রেক্ষিতে ঐকমত্যের ভিত্তিতে বৃক্ষের প্রজাতি ও বিবিধ ফসল উৎপাদনের প্রকৃতি ও ধরন নির্ধারন করা হইবে।

৮) দ্বিতীয় পক্ষ তফসিলে বর্নিত রাস্তার চালে কোন স্থায়ী বা অস্থায়ী ইমারত নির্মাণ করতে পারিবে না, তবে উৎপাদিত বৃক্ষ ও অন্যান্য কৃষি ফসলের নিরাপত্তা বিধানের জন্য অস্থায়ী চালাঘর নির্মাণ করা যাইবে, যাহা প্রয়োজন শেষে অথবা চুক্তি মেয়াদ শেষে (যেইটাই আগে ঘটিবে) ভাঙ্গিয়া নিতে হইবে।

৯) তফসিলে বর্নিত রাস্তার উভয় পার্শ্বস্থ জমির আইন সম্মত মালিকগণকে (কেবল মাত্র সেই সব জমির যাহার সীমানা প্রকৃতই রাস্তাকে স্পর্শ করিয়াছে) অত্র চুক্তিপত্রের তৃতীয় পক্ষ হিসাবে স্বীকার ও অন্তর্ভূক্ত করা হইল এবং তাহারাও এই উৎপাদন ব্যবস্থায় সৃজিত বাগানের মধ্যবর্তীকালীন ও চূড়ান্ত ফসলের ভাগ নিম্নোক্ত ১০ নং দফায় বর্নিত অংশ হারে পাইবেন।

১০) তফসিলে বর্নিত জমিতে উৎপাদিত সমুদয় কৃষি ফসল এবং বৃক্ষ পরিচর্য্যার মাধ্যমে প্রাপ্ত গাছের কাটা ডালপালা, মরা গাছ/ ডাল ইত্যাদির পুরা অংশ দ্বিতীয় পক্ষ একক ভাবে ভোগ করিবে, তবে ফলবান বৃক্ষের ফল দ্বিতীয় ও তৃতীয় পক্ষ সমান আর্ধাআর্ধী হারে ভোগ করিবে। মধ্যবর্তী সময়ের ও চূড়ান্ত ফসল হিসাবে কর্তীত গাছের কাঠ বা বিক্রয় লব্ধ অর্থ নিম্নে বর্নিত অংশাহারে পক্ষ সমূহের মধ্য বিলি বনাটন করা হইবে।

পক্ষ সমূহ	প্রাপ্তব্যঅংশ
ক) ইউনিয়ন পরিষদ (প্রথম পক্ষ)	২০%
খ) বিত্তহীন উপরাভোগী সমিতি (দ্বিতীয় পক্ষ)	৪০%
গ) রাস্তা সংলগ্ন ভূমি মালিক (তৃতীয় পক্ষ)	৪০%

১১) তফসিলে বর্নিত রাস্তার উপর বা চালে মৃত্তিকা ক্ষয় বা অন্য কোন কারনে যদি ভাঙ্গন বা গর্তের সৃষ্টি হয়, তবে দ্বিতীয় পক্ষ সঙ্গে সঙ্গে এইরূপ ভাঙ্গন ও গর্ত মাটি দ্বারা ভরাট করিয়া প্রয়োজনীয় মেরামত কাজ সম্পাদনে বাধ্য থাকিবে।

১২) পক্ষ সমুহের মধ্যে আলাপ- আলোচনা ও সমজোতার মাধ্যমে বৃক্ষ ফসল কাটার উপযুক্ত সময় নির্ধারন, বেচা-বিক্রির পদ্ধতি ও পরিমান ইত্যাদি বিষয়ে সিদ্ধান্ত গৃহীত হইবে।

১৩) অত্র উৎপাদন ব্যবস্থায় প্রাপ্ত সকল প্রকার ফসলের পরিমান ও মূল্য সংক্রান্ত যাবতীয় সঠিক পরিসংখ্যান প্রথম পক্ষ ও কারিতাস- বাংলাদেশ সংগ্রহ ও সংরক্ষন করিবে। দ্বিতীয় ও তৃতীয় পক্ষের পারিবারিক ভোগকৃত ফসলের বৃত্তান্ত ও এই সব পরিসংখ্যানের অন্তর্ভূক্ত থাকিবে। সংগৃহীত পরিসংখ্যানের তথ্য প্রথম পক্ষ ও কারিতাস- বাংলাদেশ অন্যান্য সকল পক্ষকে এবং সংশ্লিষ্ট অন্যান্য কর্তৃপক্ষকে সরবারহ করিতে বাধ্য থাকিবে।

১৪) দ্বিতীয় পক্ষের প্রাপ্তব্য অংশ অত্র পক্ষের প্রত্যেক সদস্যের মধ্যে সমান হারে বিলি-বন্টন করা হইবে। পক্ষভূক্ত কোন বক্তি মৃত্যু বরন করিলে বা শারিরীক ভাবে অক্ষম হইলে তাহার মনোনীত উত্তররাধিকারী তাহার অংশের সম্পদের ভাগ পাইবে।এইরূ ক্ষেত্রে মৃত বা অক্ষম ব্যক্তি প্রকল্পের শুরু হইতে মৃত্যু বরণ বা অক্ষমতার দিন পর্যন্ত যতদিন কর্মকান্ডে জড়িত ছিলেন, সেই সময়ের অনুপাতেই আর্থিক সুবিধা পাইবেন। দ্বিতীয় পক্ষের কোন সদস্য যদি স্বেচছায় প্রকল্পের কর্মকান্ড ত্যাগ বা চুক্তি পত্রের শর্তাবলী ভঙ্গ করেন, তবে তিনি কিম্বা তাহার মনোনীত উত্তরাধিকারীর কেহই প্রকল্পের উৎপাদিত ফসলের কোন সুযোগ-সুবিধা পাইবেন না।

১৫) দ্বিতীয় পক্ষের কোন ব্যক্তি স্বেচছায় তাহার সদস্যপদ ত্যাগ / প্রত্যাহার করিলে অথবা তাহার সদস্যপদ বাতিল করা হইলে প্রথম পক্ষ ৩০(ত্রিশ) দিনের মধ্যে দ্বিতীয় পক্ষের সদস্যদের সাথে আলোচনা ক্রমে অত্র চুক্তিপত্রের তৃতীয় দফায় বর্নিত বৈশিষ্ট ও শর্তাবলী অনুসরনে বিত্তহীনদের মধ্য হইতে লটারীর মাধ্যমে শূন্যপদে নতুন সদস্য নির্বাচন করিবেন এবং দ্বিতীয় পক্ষের সদস্যদের তালিকা যথাযথ সংশোধনের ব্যবস্থা নিবেন ও সংশ্লিষ্ট সকল পক্ষকে এইরূপ পরিবর্তনের বিষয়ে অবাহিত করিবেন নির্বাচিত নতুন সদস্য তাহার সদস্যপদ অন্তভূক্তির তারিখ হইতে আনুপাতিক হারে প্রকল্পের উৎপাদিত ফসলের অংশ পাইবেন।

১৬) দ্বিতীয়পক্ষের কোন সদস্য যদি তাহার উপর অর্পিত দায়িত্ব পালনে বারংবার ইচ্ছাকৃত অবহেলা প্রদর্শন করে এবং ইহাতে বাগানের ক্ষয়ক্ষতি হয়, তবে প্রথম পক্ষ ও কারিতাস- বাংলাদেশ তাহার বিরুদ্ধে উপযুক্ত ব্যবস্থা গ্রহন করিবে যাহা তাহার সদস্যপদ বাতিল ও সমিতি হইতে বহিষ্কার হইতে পারে।

১৭) এই উৎপাদন ব্যবস্থায় প্রাপ্তব্য আয় তৃতীয় পক্ষের সদস্যদের মধ্য নিম্নেবর্নিত সূত্র মোতাবেত বিলি বন্টন করা হইবেঃ

তৃতীয় পক্ষের একজন সদস্যের অংশ - ১/২(রাস্তার এক মিটার পরিমিত স্থান থেকে প্রাপ্ত গড় কাঠ বা বিক্রয় লব্ধ অর্থ X চুক্তিপত্রে তৃতীয় পক্ষের জন্য মোট আয়েরস্বীকৃত অংশX সংশ্লিষ্ট ব্যক্তি রাস্তা সংলগ্ন ভূমি খন্ডের মিটারে পরিমাপ)

১৮)এই চুক্তিপত্রের কোন শর্তাবলীর ব্যাখ্যা বা অন্য কোন বিষয়ে পক্ষ সমূহের মধ্যে যদি কোন মত বিরোধ দেখা দেয় এবং পক্ষ সমূহের মধ্যে আলোচনার মাধ্যমে এইরূপ বিরোধ নিষ্পত্তি না হয়, তবে বিষয়টি সংশ্লিষ্ট উপজিলা নির্বাহী অফিসারের নিকট উপস্থাপন করান হইবে। তিনি সংশ্লিষ্ট সকল পক্ষের বক্তব্য শুনিবেন এবং সমস্যা সমাধান করে উপযুক্ত সিদ্ধান্ত প্রদান করিবেন যাহা সকল পক্ষ মানিয়া নিতে বাধ্য থাকিবেন।

রাস্তার তফসিলঃ

রাস্তা নং..... .. .. মোট দৈর্ঘ্য——— —. .. ..কিঃমিঃ। বনায়নকৃতঅংশের দৈঘ্য ..... - - .. ..কিঃমি।

প্রথম পক্ষ
(স্বাক্ষর ও সীল)

দ্বিতীয় পক্ষের সদস্যগণ
(স্বাক্ষর অথবা টিপসহি)

হাইল হাওর অববাহিকা হইতে উৎপন্ন-------ছড়ার ধারে বনায়ন কর্মকান্ডে অংশ গ্রহনকারী পক্ষ সমূহের মধ্যে উপকারভোগের চুক্তিপত্র।

(১৫০ টাকা মূল্যমানের নন- জুডিশিয়াল স্টাম্পের উপর এইচুক্তিপত্র সম্পাদন করিতে হইবে)

যেহেতু .....জেলার .....থানার.....ইউনিয়ান পরিষদ অত্র চুক্তিপত্রর তফসিল অংশে বর্নিত সরকারী মালিকানাধীন ..... ছড়া ধারে বাংলাদেশ সরকার ও মার্কিন যুক্তরাষ্টের আন্তর্জাতিক উন্নয়ন সংস্থার অর্থায়নে 'উইনরক ইন্টারন্যাশনাল' এর সহযোগীতায় ও কারিতাস- বাংলাদেশ এর তত্তাবধানে MACH প্রকল্পের আওতায় বনায়ন কর্মকান্ড বাস্তবায়নে সম্মত হইয়াছ, সেহেতু অদ্য ২০০১ ইং সনের.....শে..... তারিখে উক্ত ইউনিয়ন পরিষদের পক্ষে চেয়ারমান (যাহাকে অতঃপর অত্র চুক্তিপত্রে প্রথম পক্ষ বলিয়া উল্লেখ করা হইবে), সম্পদ ব্যবস্থাপনা কমিটি (Resource Management Committee বা RMC)র চেয়ারম্যান (যাহাকে অত্র চুক্তিপত্রে অতঃপর দ্বিতীয় পক্ষ বলা ইহবে) এবং অত্র চুক্তিপত্রের সাথে সংযুক্ত তালিকায় বর্নিত প্রকল্পের কর্মকান্ডে অংশ গ্রহনকারী বিত্তহীন উপকারভোগী সমিতির সদস্যগনের / ছড়ার পাড় সংলগ্ন মালিকদের (যাহাদিগকে অত চুক্তিপত্রে অতঃপর তৃতীয় পক্ষ বলিয়া উল্লেখ করা হইবে) মধ্যে নিম্নে বর্নিত শর্তাধীনে অত্র চুক্তিপত্র সম্পদান করা হইল।

চুক্তিপত্রের শর্তাবলী

১) এই চুক্তিপত্র.....তারিখ হইতে.....তারিখ পর্যান্ত বলবৎ থাকিবে। পক্ষ সমূহের মধ্য আলাপ-আলোচনা ও ঐকমত্যের ভিত্তিতে এই চুক্তিপত্র পরবর্তী মেয়াদের জন্য নবায়ন করা যাইবে।

২) প্রথম পক্ষ এই চুক্তিপত্রের তফসিল অংশে বর্নিত সরকারী মালিককানাধীন ছড়ার নিয়ন্ত্রকারী পক্ষ এবং ছড়ার ধারে বনায়ন কর্মকান্ড বাস্তবায়নকারী মূখ্য সংস্থা হিসাবে তৃতীয় পক্ষকে ছড়ার চালের ও পাড় সংলগ্ন ভূমি ব্যবহারের জন্য এতদ্বারা অনুমতি প্রদান করিলেন। অত্র অনুমতি প্রদানের কারনে প্রথম পক্ষ অত্র চুক্তিপত্রের ৮ নং দফায় বর্নিত উৎপাদনের অংশ ছাড়া তৃতীয় পক্ষের উপর অন্য কোন প্রকার কর বা খাজনা ধার্জ্য করিতে পারিবে না।

৩) কারিতাস-বাংলাদেশ প্রকল্প বাস্তবায়নের পরিকল্পনা ও বাস্তবায়ন নীতিমালা অনুসরস পূর্বক স্থানীয় বিত্তহীন দরিদ্র কর্মীদের/ভূমি মালিকদের নিয়া অত্র চুক্তিপত্রের তফসিলে বর্নিত ছড়ার পাড় সংলগ্ন ভূমিতে বনায়ন কার্যক্রম বাস্তাবায়নের লক্ষে উপকারভোগী সংগঠন গড়িয়া তুলিবে, যাহারা তফসিলের ছড়ার ধারে উৎপাদিত বৃক্ষ ও অন্যান্য ফসলের সার্বিক যত্ন, পরিচর্যা ও নিরাপত্তার জন্য দায়ী থাকিবে।

৪) তফসিলে বর্নিত ছড়ার চালের জমি ব্যবহারকালীন তৃতীয় পক্ষ এই মর্মে নিশ্চয়তা বিধান করিবেন যে, তাহাদের ব্যবহারের মাধ্যমে ছড়ার কোন প্রকার ক্ষতি সাধিত হইবে না। তবে প্রাকৃতিক দুর্যোগ, নাগরিক অসন্তোষ বা তৃতীয় পক্ষের সাথে সংশ্লিষ্ট নয়, এমন কোন ব্যক্তি বা গোষ্ঠী দ্বারা ছড়া নষ্ট বা ক্ষতিগ্রস্থ হইলে তজ্জন্য তৃতীয় পক্ষ দ্বায়ী থাকিবে না। তবে এইরূপ ক্ষয়ক্ষতির সংবাদ তৃতীয় পক্ষ তাৎক্ষনিক ভাবে প্রথম ও দ্বিতীয় পক্ষকে জানাইতে বাধ্য থাকিবে।

৫) তৃতীয় পক্ষ তফসিল ভূক্ত জমিতে বৃক্ষ চাষ কর্মসূচী বাস্তবায়নকালীন প্রথম পক্ষ,দ্বিতীয় পক্ষ ও কারিতাস-বাংলাদেশ তাহাদিগকে সম্ভাব্য সকল প্রকার সাহায্য ও সহযোগীতা প্রদান করিবে এবং উদ্ভূত সকল প্রকার স্থানীয় সমস্যা সমাধানের ব্যবস্থা গ্রহন করিবে। তদসত্বেও তফসিল ভূক্ত ভূমি বা উহার ফসল যদি কাহারও দ্বারা ক্ষতি গ্রস্থ হয় বা উৎপাদিত ফসল চুরি হয়, তবে সকল পক্ষ এই সব বেআইনী কার্যকলাপ প্রতিকারের নিমিত্তে পুলিশ কর্তৃপক্ষ ও আইন- আদালতের শরনাপন্ন হইতে পারিবে।

৬) প্রথম পক্ষ, দ্বিতীয় পক্ষ ও কারিতাস-বাংলাদেশ বৃক্ষরোপন ও পরিচর্য্যা কর্মকান্ড গ্রহনে তৃতীয় পক্ষকে উদ্বুদ্ধ করিবে এবং এই সব কর্মকান্ড দক্ষভাবে বাস্তবায়নের জন্য প্রয়োজনীয় কারিগরী ও সাংগঠনিক নির্দেশনা এবং প্রশিক্ষন প্রদান ও অর্থায়নের ব্যবস্থা গ্রহন করিবে। তৃতীয় পক্ষ MACH প্রকল্পের পরিল্পনা ও বাস্তবায়ন নির্দেশিকায় বর্নিত ভূমি ব্যবহার মডেল অনুসরনে বাগান সৃজন, পরিচর্যা ও ফসল কাটা, এবং অন্যান্য চাষাবাদ করিতে বাধ্য থাকিবে।

৭) তফসিলে বর্নিত ছড়ার উভয় পার্শ্বস্থ জমির আইন সম্মত মালিকগণকে (কেবল মাত্র সেই সব জমির যাহার সীমানা প্রকৃতই ছড়াকে স্পর্শ করিয়াছে) অত্র চুক্তিপত্রের তৃতীয় পক্ষ হিসাবে স্বীকার ও অন্তর্ভূক্ত করা হইল এবং তাহারা এই উৎপাদন ব্যবস্থায় সৃজিত বাগানের মধ্যবর্তীকালীন ও চূড়ান্ত ফসলের ভাগ নিম্নোক্ত ৮ নং দফায় বর্নিত অংশ হারে পাইবেন।

৮) তফসিলে বর্নিত জমিতে উৎপাদিত বৃক্ষ পরিচর্য্যার মাধ্যমে প্রাপ্ত গাছের কাটা ডালপালা, মরা গাছ/ ডাল ইত্যাদির পুরা অংশ তৃতীয় পক্ষ একক ভাবে ভোগ করিবে, । মধ্যবর্তী সময়ের ও চুড়ান্ত ফসল হিসাবে কর্তীত গাছের কাঠ বা বিক্রয় লব্ধ অর্থ নিম্নে বর্নিত অংশাহারে পক্ষ সমূহের মধ্য বিলি বনাটন করা হইবে।

	পক্ষ সমুহ	প্রাপ্তব্যঅংশ
ক)	ইউনিয়ন পরিষদ (প্রথম পক্ষ)	১৫%
খ)	সম্পদ ব্যবস্থাপনা কমিটি (RMC)	৫%
গ)	ছড়া সংলগ্ন ভূমি মালিকা / বিত্তহীন উপরাভোগী সমিতি (তৃতীয় পক্ষ)	৮০%

৯) পক্ষ সমুহের মধ্যে আলাপ- আলোচনা ও সমজোতার মাধ্যমে বনায়নে উৎপাদিত বৃক্ষ ফসল কাটার উপযুক্ত সময় নির্ধারন, বেচা-বিক্রির পদ্ধতি ও পরিমান ইত্যাদি বিষয়ে সিদ্ধান্ত গৃহীত হইবে।

১০) অত্র উৎপাদন ব্যবস্থায় প্রাপ্ত সকল প্রকার ফসলের পরিমান ও মূল্য সংক্রান্ত যাবতীয় সঠিক পরিসংখ্যান প্রথম ও দ্বিতীয় পক্ষ এবং কারিতাস- বাংলাদেশ সংগ্রহ ও সংরক্ষন করিবে। তৃতীয় পক্ষের পারিবারিক ভোগকৃত ফসলের বৃত্তান্তও এই সব পরিসংখ্যানের অন্তর্ভূক্ত থাকিবে। সংগৃহীত পরিসংখ্যানের তথ্য প্রথম ও দ্বিতীয় পক্ষ এবং কারিতাস- বাংলাদেশ অন্যান্য সকল পক্ষকে এবং সংশ্লিষ্ট অন্যান্য কর্তৃপক্ষকে সরবারহ করিতে বাধ্য থাকিবে।

১১) তৃতীয় পক্ষ বিত্তহীন পরিবারের সদস্য হইলে উক্ত পক্ষের প্রাপ্তব্য অংশ অত্র পক্ষের প্রত্যেক সদস্যের মধ্যে সমান হারে বিলি-বন্টন করা হইবে। পক্ষভূক্ত কোন বক্তি মৃত্যু বরন করিলে বা শারিরীক ভাবে অক্ষম হইলে

তাহার মনোনীত উত্তরাধিকারী তাহার অংশের সম্পদের ভাগ পাইবে।এইরূপ ক্ষেত্রে মৃত বা অক্ষম ব্যক্তি প্রকল্পের শুরু হইতে মৃত্যু বরণ বা অক্ষমতার দিন পর্যন্ত যতদিন কর্মকান্ডের জড়িত ছিলেন, সেই সময়ের অনুপাতেই আর্থিক সুবিধা পাইবেন। তৃতীয় পক্ষের কোন সদস্য যদি স্বেচছায় প্রকল্পের কর্মকান্ড ত্যাগ বা চুক্তি পত্রের শর্তাবলী ভঙ্গ করেন, তবে তিনি কিম্বা তাহার মনোনীত উত্তরাধিকারীর কেহই প্রকল্পের উৎপাদিত ফসলের কোন সুযোগ-সুবিধা পাইবেন না।

১২) তৃতীয় পক্ষ বিত্তহীন পরিবারের সদস্য হইলে এবং অত্র পক্ষের কোন ব্যক্তি স্বেচছায় তাহার সদস্যপদ ত্যাগ / প্রত্যাহার করিলে অথবা তাহার সদস্যপদ বাতিল করা হইলে প্রথম ও দ্বিতীয় পক্ষ ৩০(ত্রিশ) দিনের মধ্যে তৃতীয় পক্ষের সদস্যদের সাথে আলোচনা ক্রমে অত্র চুক্তিপত্রের তৃতীয় দফায় বর্নিত বৈশিষ্ট ও শর্তাবলী অনুসরনে বিত্তহীনদের মধ্য হইতে লটারীর মাধ্যমে শূন্যপদে নতুন সদস্য নির্বাচন করিবেন এবং তৃতীয় পক্ষের সদস্যদের তালিকা যথাযথ সংশোধনের ব্যবস্থা নিবেন ও সংশ্লিষ্ট সকল পক্ষকে এইরূপ পরিবর্তনের বিষয়ে অবাহিত করিবেন। নির্বাচিত নতুন সদস্য তাহার সদস্যপদ অন্তভূক্তির তারিখ হইতে আনুপাতিক হারে প্রকল্পের উৎপাদিত ফসলের অংশ পাইবেন।

১৩) তৃতীয় পক্ষ বিত্তহীন পরিবারের সদস্য হইলে এবং অত্র পক্ষের কোন সদস্য যদি তাহার উপর অর্পিত দায়িত্ব পালনে বারংবার ইচছাকৃত অবহেলা প্রদর্শন করে এবং ইহাতে বাগানের ক্ষয়ক্ষতি হয়, তবে প্রথম ও দ্বিতীয় পক্ষ এবং কারিতাস- বাংলাদেশ তাহার বিরুদ্ধে উপযুক্ত ব্যবস্থা গ্রহন করিবে যাহা তাহার সদস্যপদ বাতিল ও সমিতি হইতে বহিষ্কার হইতে পারে।

১৪) তৃতীয় পক্ষ ছড়ার পাড় সংলগ্ন ভূমি মালিক হইলে এই উৎপাদন ব্যবস্থায় প্রাপ্তব্য আয় অত্র পক্ষের সদস্যদের মধ্য নিম্নেবর্নিত সূত্র মোতাবেত বিলি বন্টন বরা হইবেঃ

তৃতীয় পক্ষের একজন ভূমি মালিক সদস্যের অংশ -১/২(ছড়ার পাছের এক মিটার পরিমিত স্থান থেকে প্রাপ্ত গড় কাঠ বা বিক্রয় লব্ধ অর্থ X চুক্তিপত্রে তৃতীয় পক্ষের জন্য মোট আয়েরস্বীকৃত অংশX ছড়া সংলগ্ন ভূমি খন্ডে সংশ্লিষ্ট ব্যক্তির অংশের মিটারে পরিমাপ)

১৫) এই চুক্তিপত্রের কোন শর্তাবলীর ব্যাখ্যা বা অন্য কোন বিষয়ে পক্ষ সমূহের মধ্যে যদি কোন মত বিরোধ দেখা দেয় এবং পক্ষ সমূহের মধ্যে আলোচনার মাধ্যমে এইরূপ বিরোধ নিষ্পত্তি না হয়, তবে বিষয়টি সংশ্লিষ্ট উপজিলা নির্বাহী অফিসারের নিকট উপস্থাপন করান হইবে। তিনি সংশ্লিষ্ট সকল পক্ষের বক্তব্য শুনিবেন এবং সমস্যা সমাধান করে উপযুক্ত সিদ্ধান্ত প্রদান করিবেন যাহা সকল পক্ষ মানিয়া নিতে বাধ্য থাকিবেন।

ছড়ার তফসিলঃ

ছড়া নং..... .. ..মোট দৈর্ঘ্য..... .. ....কিঃমিঃ। বনায়নকৃতঅংশের দৈর্ঘ্য..... .. .. কিঃমি।

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প্রথম পক্ষ (স্বাক্ষর ও সীল)	দ্বিতীয় পক্ষ	তৃতীয় পক্ষের সদস্যগণ (স্বাক্ষর অথবা টিপসহি)

৪৬

Appendix-8: Tentative Plantation and Nursery Program for 3 Years (2001-2003)

MACH project has three project sites for plantation intervention. These are Hail Haor, Turag-Bongshi, and Kongshow-Malijhi floodplains where restoration of vegetation is required to on wetlands and watersheds. Apart from these areas, roadside plantations are also contemplated along available roads, primarily Union, Upazila and Zila Porishod roads. However, availability of plantation areas in terms of hectares and kilometers are not as yet known with certainty. There is a strong need to carryout reconnaissance survey of the plausible plantation venues by CNRS to ascertain the extent of areas available in different sites for vegetation restoration program.

Types of land ownership to be encountered in all sites are:

i). State owned lands currently under no well-defined use;

ii). State owned land presently under defined use (both authorized and unauthorized use); and

iii). Privately owned land.

Availability of the first category land for planting is not likely to confront unusually complicated problems. Close liaison with UNO and AC Land, who are also respectively chairman and member of the Zonal Management Committees (ZMC) should sort out land availability issues conveniently. The second category land presents use conflict and thus need negotiation with the users as well as with the UNO and AC Land before they become available for tree plantation. However, in fixing priority, the national and environmental need should always get weightage over individual use. The third category of lands is the most difficult one to bring under tree cover. Intensive negotiation and motivation, and compensatory packages are required to convince the owner to devote some of their lands to tree plantation. Trade off between traditional use and tree plantation has got to be demonstrated before a swing in approach and attitude change in favor of tree plantation take place.

Since plantation area in hectare and kilometer is not definitely known at this stage, the future plantation target is set in terms of the number of plants to be planted. The following is the year wise and site wise plantation target set for the project for 3 years (2001-2003).

Year	Type of Plantation activity	Project Site (# Plant)			Total
		Hail Haor	Turag-Bongshi	Kongsa-Malijhi	-
2001	Watershed, stream/ river bank protection plantation (# plants)	25,000	3,000	15,000	43,000
	Swamp/Wetland plantation (# plants)	22,000	2,000	15,000	39,000
	Roadside plantation (km)	7	5	5	17
	Institution Planting (# plants)	1,500	3,000	3,000	7,500
	Nursery establishment (# seedlings)	CNRS-56,000 Caritas-24,000	CNRS- 10,000 Caritas-14,000	CNRS-38,000 Caritas-90,000	CNRS-104,000 Caritas-128,000

2002	Watershed, stream/ river bank protection plantation (# plants)	10,000	6,000	15,000	31,000
	Swamp/Wetland plantation (# plants)	20,000	7,000	15,000	42,000
	Roadside plantation (km)	7	5	8	20
	Institution Planting (# plants)	1,500	2,000	2,000	5,500
	Nursery establishment (# plants)	CNRS-37,000 Caritas-18,000	CNRS-18,000 Caritas-15,000	CNRS-37,000 Caritas- 0	CNRS-92,000 Caritas-33,000
2003	Watershed, stream/ river bank protection plantation (# plants)	Plantation maintenance	Plantation maintenance	Plantation maintenance	-
	Wetland plantation	Plantation maintenance	Plantation maintenance	Plantation maintenance	-
	Roadside plantation (km)	7	7	7	21
	Institution Planting (# plants)	Plantation maintenance	Plantation maintenance	Plantation maintenance	-
	Nursery establishment (# plants)	-	-	-	-