



SINDH IRRIGATION AND DRAINAGE AUTHORITY
WATER SECTOR IMPROVEMENT PROJECT PHASE – I (WSIP-I)

**Preparation of Regional Plan for Left Bank
of Indus
Project on**

**Protective Plantation of
Mangroves in the Coastal Areas
of Left Bank**



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In Association with
Indus Associated Consultants
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Table of Contents

List of Tables	i
List of Figures.....	ii
Acronyms	iii
Executive Summary	iv
1 Introduction	1
1.1 Background.....	1
1.1.1 Issues and Problems of project area	2
1.1.2 Rationale for Intervention	3
1.1.4 Project Area	3
2 Project Area Profile.....	4
2.1 Climate.....	4
2.2 Physiography and Topography.....	4
2.3 Socio-economic Profile.....	4
3 Impact and Outputs	5
3.1 Project Impact and Outcome	5
3.2 Outputs.....	5
3.2.1 Output 1: Raising of mangroves and salt tolerant container plant nurseries.....	5
3.2.2 Output 2: Raising of protective mangrove plantations on the blank mudflats in the frontage of sea.....	6
3.2.3 Output 3: Block and linear plantation of salt tolerant species in the supra-tidal zone	6
3.2.4 Output 4: Protective mangrove plantation along the tidal link and wetlands	7
3.3 Investment and Financing Plans.....	7
3.3.1 Implementation Arrangements.....	8
4 Due Diligence & Technical Preparatory activities	8
4.1 Site identification and selection.....	8
4.2 Collection of seed.....	8
4.3 Raising of nurseries	9
4.4 General Work Procedures of Nursery Flow Chart	10
4.5 Protective mangrove plantation for wetlands and structures	12
4.5.2 Provision of Mobility and Machinery	14
4.6 Project Management.....	14
5 Economic Justification	15
5.1 Economic Analysis	15
5.2 Project Benefits.....	15
5.3 Non Quantifiable Benefits.....	15



5.4	<i>Social benefits</i>	15
6	Monitoring and Evaluation Mechanism	16
6.1	<i>Monitoring Framework</i>	16
6.2	<i>Indicators for monitoring</i>	16
6.3	<i>Mangrove Forest area mapping</i>	16
6.4	<i>Mangrove Forest species matrix</i>	16
6.4.1	Mangrove Forest condition trend analysis	16
6.4.2	Mangrove Forest survival rate.....	17
6.5	<i>Types of Indicators</i>	17
7	Participatory Approach Framework	17
7.1	<i>Participatory Monitoring Mechanism</i>	18
8	Safeguards	18
8.1	<i>Environmental</i>	18
8.2	<i>Resettlement issues</i>	18



List of Tables

Table 1: Summary of Nursery Practices	11
Table 2: Summary of Plantation Practices	13
Table 3: Species wise schedule of site selection, planting and planting period	14
Table 4: IERR and Sensitivity Analysis.....	15
Table 5: Mangrove Plantation targets and investment plan	19
Table 6: Economic Analysis of Mangroves Project.....	22



List of Figures

Figure 1: A typical Mangrove Container Plant Nursery	5
Figure 2: A Blank Potential Mudflat for Mangrove Planting	6
Figure 3: Potential Area for Raising Salt Tolerant Species in Supra Tidal Zone	7
Figure 4: Mangrove Planting along Tidal Link and Wetlands in Coastal Area.....	7
Figure 5: General work procedures of nursery work chart	10
Figure 6: General work Procedures for Plantation Establishment – Flow Chart.....	12



Acronyms

C	Celsius
CBD	Convention of Biological Diversity
CDA	Coastal Development Authority
CDM	Clean Development Mechanism
Ha	Hectare
IERR	Internal Economic Rate of Return
IUCN	International Union for Conservation of nature
Km	Kilometer
LBOD	Left Bank Outfall Drain
M & E	Monitoring and Evaluation
MFF	Forest Forum
mm	Milimeter
NGO	Non Governmental Organization
NPV	Net Present Value
REDD	Reducing Emissions from degradation and deforestation
Rs.	Pak Rupees
SF	Shaheed Fazil Rahu
SFD	Sindh Forest Department
UN	United Nations
UNFCC	United Nations Framework on Climate Change
WSSD	World Summit on Sustainable Development
WWF	World Wide Fund



Executive Summary

Background and Rationale

This feasibility has taken its cue from the issues and problems and respective interventions identified, proposed, and prioritized by the stakeholders in consultative workshops held during phase I of the study at community, district, regional, and national levels and pre-feasibilities prepared and discussed with the stakeholders during phase II.

Thatta and Badin are the two major hazard-prone districts of Sindh. Cyclones, heavy rainfall, droughts and floods follow each other often in quick succession. The intervening respite is normally short. Major disasters in the recent years include the cyclones in 1964/65, heavy rainfall in 1973, floods during in 1988, torrential rainfall in 1994, the cyclone in 1999, an earthquake in 2001, severe floods in 2003 and recent floods in 2010 and heavy rainfall in 2011.

Above events have resulted in several multidimensional issues and the problems in the delta and coastal area. It has been established that the resources of coastal areas such as mangroves, fisheries, and agriculture on which the people of the area are dependent for their livelihood have been adversely affected and become scarce. This has resulted in variety of social and economic problems in the area and its population. Mangroves are no longer there as they were vanished during 1999 cyclone, freshwater fisheries have declined due to sea intrusion in the existing dhands thereby converting freshwater areas to brackish water areas and, agricultural area have been adversely affected by water logging and salinity due to poor drainage and sea intrusion.

Project Objectives

The proposed project/intervention titled, “**Protective Plantation of Mangroves in the Coastal Areas of Left Bank**” is non-structural. The main objective of the project is to provide protection to the coastline and the delta ecosystems ensuring sustainable livelihoods to the local communities. The project has been so designed that it would create a biological screen, protect the lower reaches of the drainage system, engineering structures, farmlands, wetlands/water bodies and arrest coastline erosion and sea water intrusion. In addition, the proposed intervention will support fish production, provide fuel wood and fodder to local communities, and improve their livelihoods. The establishment of mangrove plantation is also in line with the CDM initiatives, and will act as carbon sink.

Project Location

The project will be located in coastal area of district Badin and Thatta district (left bank of Indus), comprising of coastal Talukas (sub-districts) namely Badin and S.F Rahu of Badin district and Jati and Shah Bander Talukas of Thatta district where potential areas/mudflats will be identified.

Issues and Problems

The main issues are:

- i) Unchecked sea intrusion
- ii) Degradation of dhands.
- iii) Inadequate public sector support for mitigating natural disasters
- iv) Increasing coastal erosion
- v) Deforestation of mangroves.
- vi) Decline in fish resource



- vii) Inadequate livelihood opportunities.

Project Outputs

The main outputs/targets of the proposed intervention are:

- Establishment of container plant nurseries (**11.0 million mangrove plants**)
- Mangrove plantation on blank mudflats in the frontage of sea and backwater (**28,000 ha**)
- Plantation of mangrove belts along the wetlands and tidal link and salt tolerant species in supra tidal zone and around the perimeters of wetlands and bunds (**5000 ha**)

Avicennia marina, *Rhizophora mucronata* and other species of mangroves will be planted.

Mangroves habitat and environment functions are critically important to the delta ecosystem. Mangroves play a key role in combating natural and man-induced hazards in coastal areas. They act as first defense line against the waves in tsunami and cyclones. Mangroves help impede the unwanted flow of saltwater and with their extensive root systems also supports in reducing the disaster risk of sea intrusion in the coastal belt. Absorb excessive amounts of nutrients and contaminants. Under such circumstances the mangroves are capable of mitigating potential impacts of coastal hazards such as storms surges, tsunami and other types of flooding.

This feasibility offers a proposal to revitalize the mangrove plantation along the coast which is one of the most critical and complex coastal ecosystem severely threatened due to over exploitation, constrained fresh water flows, and disposal of industrial pollutants and drainage effluent.

Project impacts

The main impact of the proposed project will be:

- i) Reduction in the coastal erosion and seawater intrusion and backwash, and further degradation of fertile land
- ii) Enhanced fish production in the wetlands and dhands
- iii) reduction in damages from cyclones/tsunami
- iv) Reclamation of productive lands in the coastal area
- v) Secured livelihood for the local communities
- vi) Improved environment through carbon development mechanism.

Project Cost

The total estimated cost of the project is Rs.749.085 million. The estimates of costs are based on existing rates being used in the development projects on mangroves plantation in coastal areas of Sindh. The implementation period for the proposed project is five years.

Implementation Arrangements

The proposed project will be implemented through participatory approach by involving all stakeholders from project preparation, execution, and benefit sharing. Due to participatory approach the local communities will be involved from initial stages of project development, survey, selection of sites, planting, maintenance, protection, and distribution of benefits.

Efforts will be made to solicit bilateral and multilateral funding support from the development partners. Mangrove development initiatives are Clean Development Mechanism (CDM) projects which are usually funded from allocations made to member countries of international protocols such as Kyoto Protocol, MFF, CBD, WSSD, UNFCCC, REDD etc. Pakistan is signatory on all above listed UN Protocols. The Government and International Donors and NGO and



development organizations will also join to fund and execute this project. Mangroves are the carbon sinks and improve adverse environmental impacts due to climate change.

Economic Evaluation

The estimated IERR has been computed at 19.1 %, hence the project is economically viable. The NPV at 12% is Rs.452.3 million. The sensitivity analysis presented in the above table shows that with 10% decrease in the benefits the IERR is 18.1 % while with 10% increase in the cost the IERR is about 18.2%. Both of these are above 12%. The simultaneous 10% decrease in benefits and increase in cost suggests the IERR is still above 12%, hence is robust.

The switching value indicate that if the benefits decrease by 54.7 %, and costs increase by 121.9%, while even if both may change by 37.9% the project will still be viable.

Environmental Benefits

Mangrove Forests provide environmental services through many ways. Protect shoreline from storm surges, cyclones and other extreme weather events, trap pollutants and reduce the effects of flooding, check sea intrusion and reduce its adverse impacts, protect structures (tidal link, bunds etc.), improve fish habitat in wetlands and mangrove areas, prevent soil erosion, serve as carbon sinks and store of biodiversity, improve landscape beauty and, provide several ecosystem services. The project being developed under CDM will generate carbon credits which will be owned by the Government and will be used for other CDM projects. Hence, the project has several environmental benefits and is environment friendly project.

Social Benefits

The proposed project will have positive impacts on the social aspects of the society such as poverty, income distribution, employment generation, livelihood opportunities and gender mainstreaming. With the development of this project and its execution through integrated and participatory approaches the coastal people will be mobilized, organized and act as executing team will get direct and indirect employment and sources of livelihood which will ultimately alleviate poverty and distribute benefits equitably. Furthermore, the communities will own the project. Women will also be involved in all the processes of the project.

Resettlement Issues

No resettlement will take place as the project will be implemented on the government forest land.



1 Introduction

In pursuance of the scope of work for the phase II of the preparation of the regional plan for the left bank of Indus, delta, and the coastal area study, a series of prefeasibility studies have been prepared. These pre feasibilities represent indicative interventions to mitigate the issues and problems related to the safe disposal of drainage effluent, flood and storm water, arresting sea water erosion, and restoration of degraded land and water bodies. These pre feasibilities take their cue from the issues and problems and respective interventions identified, proposed, and prioritized by the stakeholders in consultative workshops held during phase 1 of the study at community, district, regional, and national levels.

The proposed intervention which would create a biological screen will protect the lower reaches of the drainage system, particularly farmland, water bodies, arrest coastline erosion and sea water intrusion. In addition to this the proposed intervention will support fish production, provide fuel wood and fodder to local communities, and improve their livelihoods. The establishment of mangrove plantation is in line with the CDM initiatives, and will act as carbon sink.

During Phase II of the study a pre-feasibility was proposed and discussed with the stakeholders in district and provincial level consultative workshops for review and approval. This pre-feasibility was designated as priority intervention due to its importance in the coastal area development, sea intrusion check and livelihood options by the stakeholders, panel of experts and the client. Following its approval, detailed feasibility is prepared in the phase III of the study.

1.1 Background

Sindh coastline is approximately 350 km long, mainly comprised of Indus River Delta. The coastline may be divided into three sections. The eastern half of the coast line is part of the Badin district, while the middle section is part of the Thatta district, while Karachi district lies along the western end. Historically, the main economic activity in the coastal areas bordering Badin and Thatta districts was fishing, both marine and inland, livestock tending, and agriculture in the tail reaches of the Kotri barrage. Mangroves plantation along the coastline was home for fish breeding, fauna and flora, and migratory birds, and protected the coastline from sea erosion. After the construction of series of barrages on the river Indus, the coastline ecosystem started degrading and rendering the coastal areas of Badin and Thatta districts severely waned out of its natural resource base with adverse impact on the livelihoods and causing human miseries.

Thatta and Badin are the two major hazard-prone districts of Sindh. Cyclones, heavy rainfall, droughts and floods follow each other often in quick succession. The intervening respite is normally short. Major disasters in the recent years include the cyclones in 1964/65, heavy rainfall in 1973, floods during in 1988, torrential rainfall in 1994, the cyclone in 1999, an earthquake in 2001, severe floods in 2003 and recent floods in 2010 and heavy rainfall in 2011. The number of people affected in the latest floods exceeded 360,000 in Badin. In terms of damage to property, more than 22,500 houses were destroyed, about 160 villages were inundated making 200 thousand people homeless, and around 81 thousand ha of standing crops was obliterated. The simultaneous heavy precipitations of 350 or 450 mm coupled with breaches of the LBOD further aggravated the situation in Badin and Golarchi / Shaheed Fazil Rahu talukas. The situation has further exacerbated by problems emanating from the disposal of drainage effluent in to the coastal areas.



Mangroves habitat and environment functions are critically important to the delta ecosystem. Mangroves play a key role in combating natural and man-induced hazards in coastal areas. They act as first defense line against the waves in tsunami and cyclones. Mangroves help impede the unwanted flow of saltwater and with their extensive root systems also supports in reducing the disaster risk of sea intrusion in the coastal belt. Absorb excessive amounts of nutrients and contaminants. Under such circumstances the mangroves are capable of mitigating potential impacts of coastal hazards such as storms surges, tsunami and other types of flooding.

It has been established that the resource bases of coastal areas such as mangroves, fisheries, and agriculture on which the people of the area are dependent for their livelihood are scarce. This has resulted in variety of social and economic problems in the area and its population. Mangroves are no longer there as they were vanished during 1999 cyclone, freshwater fisheries have declined due to sea intrusion in the existing dhandhs thereby converting freshwater areas to brackish water areas and, agricultural area have been adversely affected by water logging and salinity due to poor drainage and sea intrusion. Following paragraphs will determine the factors responsible for the degradation of area.

Socio-economic survey (2008) reports that human population and households are increasing in the coastal area at a faster growth than other parts of the province. This was also confirmed by the communities during consultative workshop. The growth rate of population is extraordinarily higher than the provincial and national growth rates. This trend has put tremendous pressure on the mangrove, fish and other resources both directly and indirectly for meeting their livelihood needs.

With the decrease in fresh water flow and silt load and sea level rise due to climate change the sea intrusion has taken place along the coastal belt. The areas along the coastline in Coastal Talukas of Badin and Thatta districts have come under sea water. This has resulted in loss of biodiversity, extensive areas under water logging and salinity, poor underground water quality, soil quality deterioration and conversion of agricultural fields to barren wastelands and degradation of wetlands. Overall environment and coastal ecosystems have been depleted causing several imbalances in ecology and economy of the area.

1.1.1 Issues and Problems of project area

The issues and the problems in the delta and coastal area are multidimensional, however, this feasibility offers a proposal to revitalize the mangrove plantation along the coast which is one of the most critical and complex coastal ecosystem severely threatened due to over exploitation, constrained fresh water flows, and disposal of industrial pollutants and drainage effluent. The main issues are: i) unchecked sea intrusion; ii) degradation of dhandhs; iii) inadequate public sector support for mitigating natural disasters; iv) increasing coastal erosion; v) deforestation of mangroves; vi) decline in fish resource; v) inadequate livelihood opportunities;

Women constitute about half of the total human population of coastal area. The access to education, health and other civic facilities is less as compared to men. Most of them are directly and indirectly involved in fishing activity with their men. Facilities for education, health, child care, hygiene and marketing of handicrafts for alternate sources of livelihood are negligible and inadequate. This large portion of coastal population needs special attention through development of women-specific opportunities so that they may contribute significantly in the management of natural resources and livelihoods.



Despite the social, economic, and environment importance, there are several internal and external issues responsible for the degradation of coastal area and natural resources namely mangroves, fisheries and agriculture. These are: i) significantly reduced freshwater supplies below Kotri barrage; ii) reduced sedimentation and silt load iii) increased the industrial pollution, iv) sea water intrusion, overharvesting of mangroves by local communities and, enhanced coastal erosion. All these issues have resulted in progressive decrease of mangrove vegetation and exposed this complex ecosystem to severe environmental and social stresses in the form of loss of habitat and biodiversity, decline if fish productivity and social problems for coastal communities.

The proposed project intends to address most of the above described issues and problems of the coastal area and coastal population.

1.1.2 Rationale for Intervention

During the preparation of the phase I of the study, which followed an extensive stakeholder consultation, it was concluded that prior to the 1999 cyclone, there was significant area under mangroves along the Badin coast, which has almost eroded thereafter. The loss of the protective mangrove barrier led to sea water intrusion, converting agricultural lands to marshy lands, rendering the wetlands and water bodies brackish, limiting the livelihood of coastal population. This adversely compromised the socioeconomic and food security of local population, particularly fisher folks, sliding them into abject poverty.

Mangroves play vital role in protecting the coastline and structures as they act as barriers against the above mentioned disasters. The proposed project/intervention is nonstructural in nature and covers subsectors natural resources, environment improvement, and livelihoods improvement. It is proposed to establish a biological wall of mangroves along the coast by planting mangroves in blank mudflats in the frontage of sea, backwater areas, around wetlands, tidal link, and salt tolerant tree species in marshy and supra-tidal zone. Four species of mangroves namely *Rhizophora mucronata*, *Avicennia marina*, *Agicerus spp* and *Ceriops tagal* will be planted in the form of belts and clusters.

The regeneration of mangroves will perform both productive and protective functions. The productive functions include increased breeding of marine fish and production of fodder, supply of fuel wood, and shelter material. Notwithstanding the productive benefits, the protective functions significantly surpass the former as they serve as effective barriers to sea intrusion, coastal erosion, reduce intensity of cyclones, deterioration of productive land and wetlands. Considering both the productive and protective functions of mangroves it is proposed to initiate investment in protecting the coast line through green walling the coastline.

1.1.4 Project Area

The project will be located in coastal area of district Badin and Thatta district (left bank of Indus), comprising of coastal Talukas (sub-districts) namely Badin and S.F Rahu of Badin district and Jati and Shah Bander Talukas of Thatta district. The proposed project area is bounded by the Indus river on the west, Arabian sea in the south, Runn of Kutch in the east and agricultural lands and marshy areas of Indus delta in the north.



2 Project Area Profile

2.1 Climate

Since the proposed project is located along the coastline of Sindh, the climate is predominantly impacted by the Arabian sea. The climate is characterized by mild temperatures, high velocity south-western winds, low rainfall and high humidity. The general climate of the project area is moderate and humid. However, the summer months-April, May and June- are very hot during the day. The mean minimum and maximum temperatures during this period are 25 and 45 degrees C, respectively- December and January are the coldest months with maximum and minimum temperatures of 30 and 10 degrees C, respectively. The temperatures fall abruptly at night. The climate is tempered by the sea breeze, which blows for about 6-7 months from April to October, making the hot weather tolerable. The autumn starts in September and lasts for about two months. The maximum recorded humidity at Badin is 76 percent. Rainfall is highly erratic with an average of about 170 mm. the monsoon dominates from July to September. Rainfall is highly unpredictable and years without rainfall are quite common.

2.2 Physiography and Topography

The project area is part of the lower Indus plain formed by the alluvial deposits of the Indus River through the ancient Hakra, Nullah and Gungra water courses. Being a vast alluvial plain, its land is highly uniform in character. The southern part of the project area is close to the delta of the river Indus and the land surface is therefore relatively low in comparison with the northern part of Badin and Thatta districts. The general elevation of the project area ranges between 6-9 meters above sea level. The degree of slope is negligible; the drainage system is grossly inadequate and poorly maintained. Consequently, the system does not have the capacity to carry even a nominal increase in precipitation. Flooding is generated by canal and salt water from the irrigation and drainage systems flowing into the area.

The Indus Delta is low and bears the most onslaught of the southwest monsoon. The major part of coast is spread over Badin and Thatta districts. The delta, since ancient times, has shifted from northwest to the southeast, towards the sea, thereby creating new and fertile lands. The Indus Delta was reported to have 23 active creeks. At present the Indus Delta is comprised of 17 major creeks and several smaller creeks. The Delta adjoins the Badin and Golarchi (Shaheed Fazil Rahu) talukas of Badin District in which it has two main creeks namely the Shah Samando and the Sir creeks.

The soils of the project area belong to Zone C agro-ecological zone of Sindh province. This zone consists of lower Sindh and is fed by Kotri barrage and includes entire Indus delta. The soils are more saline than other parts of the province. Water logging and salinity are more severe and drainage is difficult due to absence of gradient.

2.3 Socio-economic Profile

The proposed project area is located in the coastal area of Badin and S.F. Rahu Talukas (sub-districts) of Badin district and Jati and Shah Bander Talukas of Thatta district.

The population of coastal zone comprises of six talukas of Thatta and two Talukas of Badin is about 1.2 million of which approximately 150,000 people (15%) reside in the proposed project area. It is estimated that about 80 percent of the population is below the poverty, of which about 55% live in extreme poverty. Majority of people mainly depend on fisheries

followed by agriculture and agriculture for their livelihood. As alternative opportunities for income generating options are limited. The literacy rate for men is about 29% and for women close to 9%. As the access to social infrastructure is poor, most the children do not attend school, incidence of diseases is common, and availability of fresh drinking water supply is limited with pathetic sanitation and hygiene.

3 Impact and Outputs

3.1 Project Impact and Outcome

The main purpose of the project is to provide protection to the coastline and the delta ecosystems ensuring sustainable livelihoods to the local communities. The main impact of the intervention will be: i) reduction in the coastal erosion and seawater intrusion and backwash, and further degradation of fertile land; ii) enhanced fish production in the wetlands and dhands; iii) reduction in damages from cyclones/tsunami; iv) reclamation of productive lands in the coastal area; v) secured livelihood for the local communities; and vi) improved environment through carbon development mechanism.

3.2 Outputs

The main outputs of the proposed intervention are: i) container plant nurseries established; ii) plantation on blank mudflats in the frontage of sea and backwater, iii) plantation of mangrove belts along the wetlands and tidal link and iv) plantation of salt tolerant species in supra tidal zone and around the perimeters of wetlands and *dhands*.

3.2.1 Output 1: Raising of mangroves and salt tolerant container plant nurseries

As a first activity, nurseries will be established in the inter-tidal and supra-tidal zones. The quantity of nursery plants will depend upon the area to be planted, spacing between rows and plants, type of planting and restocking. Prior to their establishment sites will be visited and finalized by the experts keeping in view the technical requirements. Although the exact target will be established during feasibility stage but the tentative target will be 11.0 million seedlings. Figure.1 shows a typical mangrove container plant nursery.



Figure 1: A typical Mangrove Container Plant Nursery

3.2.2 Output 2: Raising of protective mangrove plantations on the blank mudflats in the frontage of sea

After identification of potential blank mudflats in the frontage of sea the plantation of mangrove species will be carried out as per planting pattern and area to be planted (Figure.2).

The physical target of mangrove plantation in this activity Rs. 20,000 ha.

Error! Reference source not found. Figure 2: A Blank Potential Mudflat for Mangrove Planting

3.2.3 Output 3: Block and linear plantation of salt tolerant species in the supra-tidal zone

After identification of areas in supra-tidal zone the plantation of salt tolerant tree species will be carried out as per planting pattern such as woodlots or linear plantations (Figure 3). The target of plantation is proposed as 5,000 ha.



Figure 3: Potential Area for Raising Salt Tolerant Species in Supra Tidal Zone

3.2.4 Output 4: Protective mangrove plantation along the tidal link and wetlands

In order to protect the tidal link and wetlands from sea intrusion and its negative impacts mangrove plantation will be raised in linear plantation pattern over an area of 8,000 ha (Figure 4).

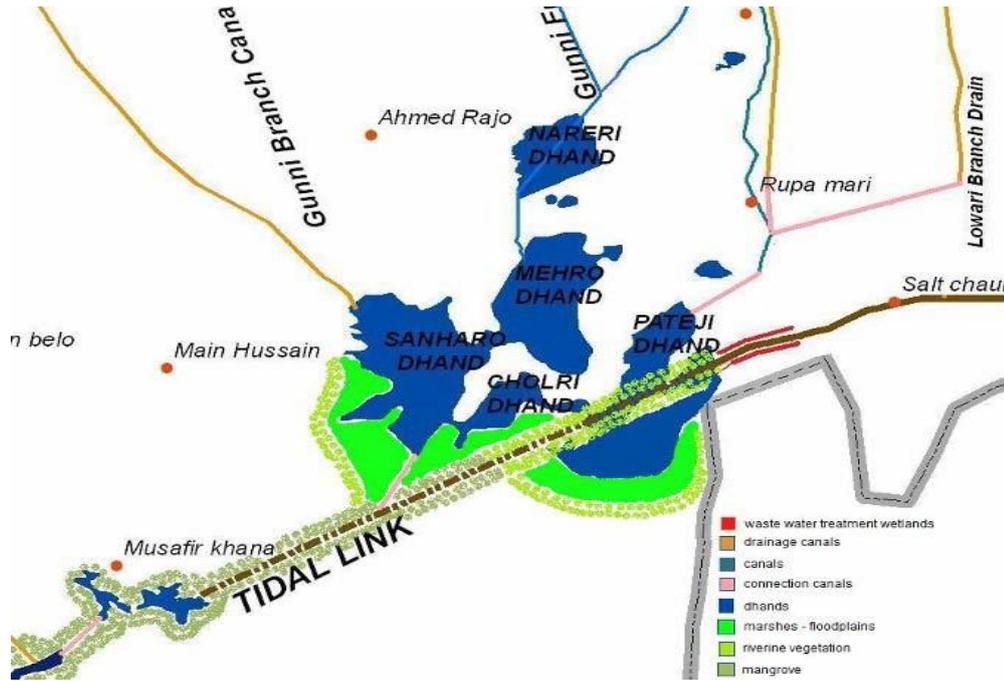


Figure 4: Mangrove Planting along Tidal Link and Wetlands in Coastal Area

3.3 Investment and Financing Plans

The total estimated cost of the project is Rs.671.2 million (Table.5). The estimates of costs are based on existing rates being used in the development projects on mangroves plantation in coastal areas of Sindh.

Efforts will be made to solicit bilateral and multilateral funding support from the development partners. Mangrove development initiatives are Clean Development Mechanism (CDM) projects which are usually funded from allocations made to member countries of international protocols such as Kyoto Protocol, MFF, CBD, WSSD, UNFCCC, REDD etc. Pakistan is signatory on all above listed UN Protocols. The Government and International Donors and NGO and development organizations will also join to fund this project. Mangroves are the carbon sinks and improve adverse environmental impacts due to climate change.

3.3.1 Implementation Arrangements

3.3.1.1 Time Frame

The implementation period for the proposed intervention is five years. Phasing of physical works along with financial is shown in Table 2, 3 and 4.

3.3.1.2 Executing and Implementing Agencies

The executing agency will be Sindh Coastal Development Authority (CDA); with the Sindh Forest Department (SFD) will be responsible for implementation. The interventions will be implemented through community based participatory approach. On state lands SFD will be responsible for all operational and management aspects, while on communal lands and around the wetland a public-private-partnership arrangements will be established. Similarly, nurseries will be established and maintained by the SFD. NGOs and civil society organizations will be engaged for community mobilization.

The experience so far gained reveals that due to ecological, environmental, social and economic importance of mangroves, the foresters, fishermen, marine scientists,

environmentalists, economists and ecologists are the stakeholders to be involved in implementation of the project. The implementation of the project is proposed to be participatory including government department, NGOs and local communities. In case the property of project area is private the owner of the land will also be included as a main stakeholder. Since Forest Department and international NGOs (IUCN and WWF) have technical knowledge will play an important role as they have experience of mangrove planting in the coastal areas of Sindh.

4 Due Diligence & Technical Preparatory activities

The main activities will be: i) preparation of inventory of existing area under mangroves; ii) identification of potential sites; iii) establishment of mangrove and salt tolerant plant nurseries; and iv) plantation of mangrove and salt tolerant saplings as per phased program.

4.1 Site identification and selection

Site selection is an important step for mangrove planting. The exact areas to be planted under mangroves and salt-tolerant tree species will be identified during the execution of the project, field surveys, through detailed field visits, consultations with stakeholders and by observing technical justifications. These activities will be undertaken in the first year of the project. It is estimated that 28,000 ha will be brought under mangroves and 5,000 ha will be planted with salt tolerant tree species in the coastal areas of Badin and Thatta districts.

4.2 Collection of seed

Seed collection is a critical operation of mangrove plantation program. *Avicennia marina* is propagated through seed called propagules which germinate while on the tree; when ripe, they fall into the mud and can root immediately. This species is also grown through transplanting of wildings collected from the mangrove area. Other species *Rhizophora mucronata*, *Ceriops tagal*, *Agicerus spp* grow through nursery grown seedlings. Seeds are collected from mature trees of these species from the field and are grown in nurseries for 6-9 months. Timely collection of seed is essential to ensure their viability and consequent success.

4.3 Raising of nurseries

Procedures for nursery establishment

Two types of mangrove nursery will be establishment i) *Avicennia marina* nursery and ii) *Rhizophora mucronata* nursery. The procedures for each type of nurseries are as under:

- i) ***Avicennia marina* nursery:** This nursery will be established in an inter tidal area and the container plants will be irrigated by natural seawater.
- ii) ***Rhizophora mucronata* nursery.** This nursery will be established at an elevated site and well above the high tide level (the terrestrial or supra tidal area) and the container plants will be irrigated by providing seawater into nursery beds.

After site selection for establishment of nursery following operations/activities will be carried out for nursery establishment:

- Site selection
- Nursery bed preparation
- Selection of plant containers



- Potting media
- Filling the plant containers
- Collection of seeds or propagules
- Seed/propagules selection
- Storage of seeds or propagules
- Sowing of seeds or propagules
- Nursery shedding
- Watering
- Disease and pest control
- Protection from outside influences
- Labor and protection staff

After above essentials are carried out the polythene bags of size 8 x 15 inches are filled with soil, and seed of mangrove species are placed in it under close supervision of technical staff. The nursery is regularly watered with saline water and or flushed by the tides.

4.4 General Work Procedures of Nursery Flow Chart

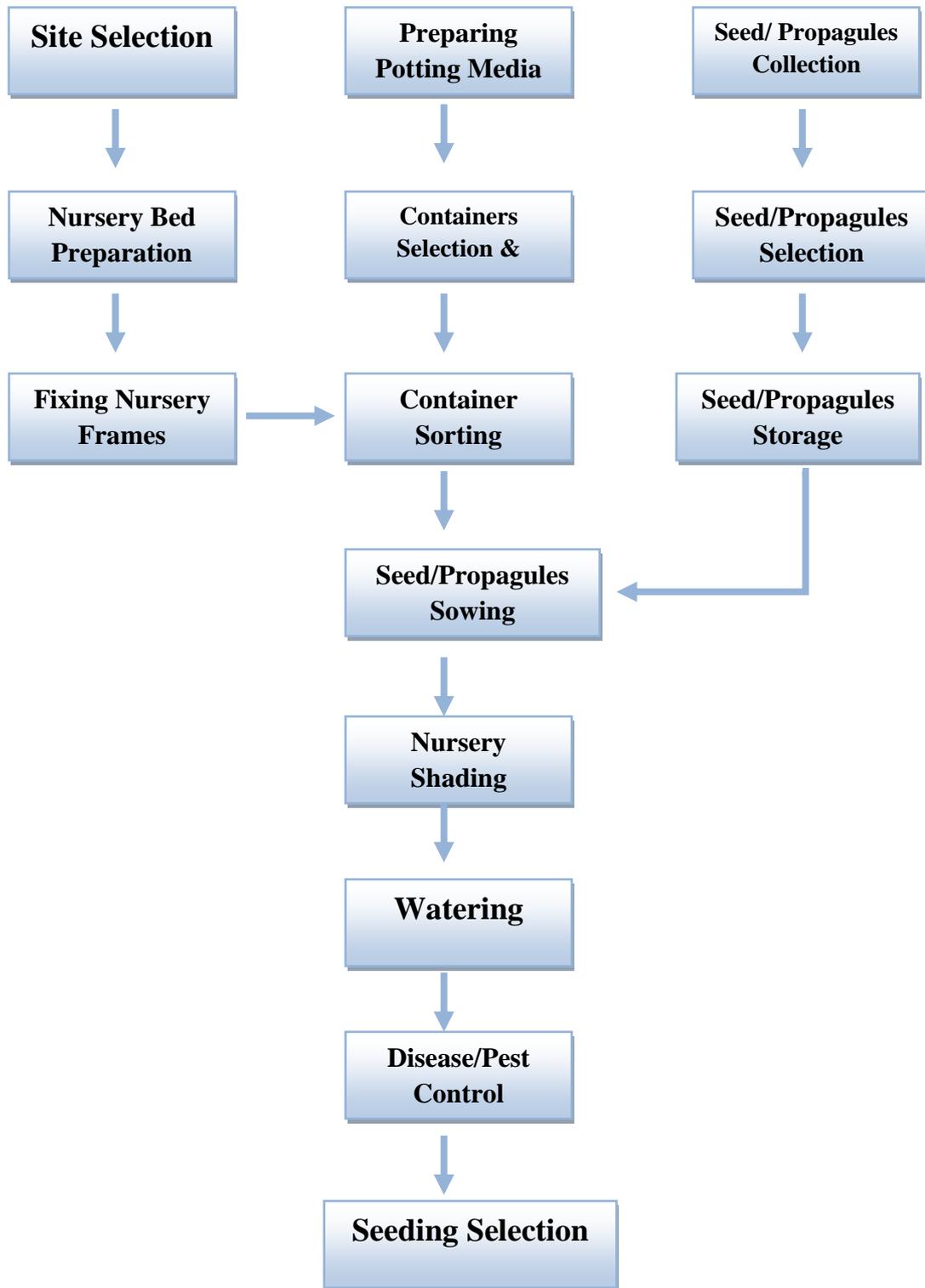


Figure 5: General work procedures of nursery work chart

Table 1: Summary of Nursery Practices

Species	Seed Type	Seed Season	Seed Selection	Seed Storage	Container Type	Potting Media	Seed Sowing	Shading	Watering
Avicennia Marina	Crypto-viviparous	August September	Seed weight at least 5 g	10 days	Polythene bags or plastic pots	Sandy loam & cow dung mix (3x1)	Pushing down redicle part of seed	30% direct sunlight	Twice a day two weeks. Afterwards one watering
Rhizophora mucronata	Viviparous	May - July	Lenth of propagule at least 35 cm	30 days	Polythene bags or plastic pots	Sandy loam & cow dung mix (3x1)	Inserting 5-6 cm radical part of propagule in the soil	30% direct Sunlight	Twice a day two weeks. Afterwards one watering

3.6 Seedling Selection Criteria

The specifications to select seedlings for field plantation are as under:

S. No.	Mangrove species	Height (cmc)	Pairs of leaves	Nursing period
1	<i>Avicennia marina</i>	At least 30	3 pairs	5-6 months
2	<i>Rhizophora mucronata</i>	At least 45	At least 4	7-8 months

4.4.1.1 Transportation of labor and planting stock from nurseries to planting sites

The mudflats and inter-tidal areas will be located far from nurseries and since the planting is to be done after the tides recedes, the labor engaged for planting operation has to be transported daily from the nearest villages through boats. The nursery stock and/or seed have also to be transported and placed at safer sites. For this activity conventional motor boats have to be engaged in advance along with their petrol/diesel arrangements.

4.4.1.2 Planting season

Best planting season for mangrove vegetation is spring season but they could be planted in other seasons also.

4.4.1.3 Planting techniques

Generally the planting will be mixed species clusters in close spacing and belts of 100 meter width. The planting techniques and specifications for each area are described as under:

4.4.1.4 Frontage and backwater

In frontage and backwater of the sea an area of 20,000 ha mangrove plantations will be established parallel to the shoreline. Nursery grown saplings of *Rhizophora mucronata* will be planted at close spacing (1 x 1 meter) from fringes of creeks towards backwater. In addition, 6 months old saplings and viable propagules and seeds of Timer (*Avicennia marina*) will be planted in blocks on the blank mudflats with a plant to plant and row to row spacing of 3 x 3 meter, and for linear plantation of Rhizophota and 5 X 5 meter for block plantation of Timer, respectively.

4.4.1.5 Inland block and linear plantation

In Supra-tidal zone beyond the mangrove zone, inland block and linear plantations of salt tolerant tree species such as *Cassuarina equisetifolia*, *Conocorpus*, *Acacia nilotica* and

Mesquite (Prosopis glandulosa) etc. will be planted for establishing the second line of defense against natural disasters. These areas used to be cultivated in the past but due to impact of sea intrusion the areas have become marshy, waterlogged and saline. The best use of such lands is to grow salt resistant tree species to reclaim such lands and made productive for agriculture. One year old nursery saplings will be planted in linear and block plantations at plant to plant and row to row distance of 5 x 7 meters.

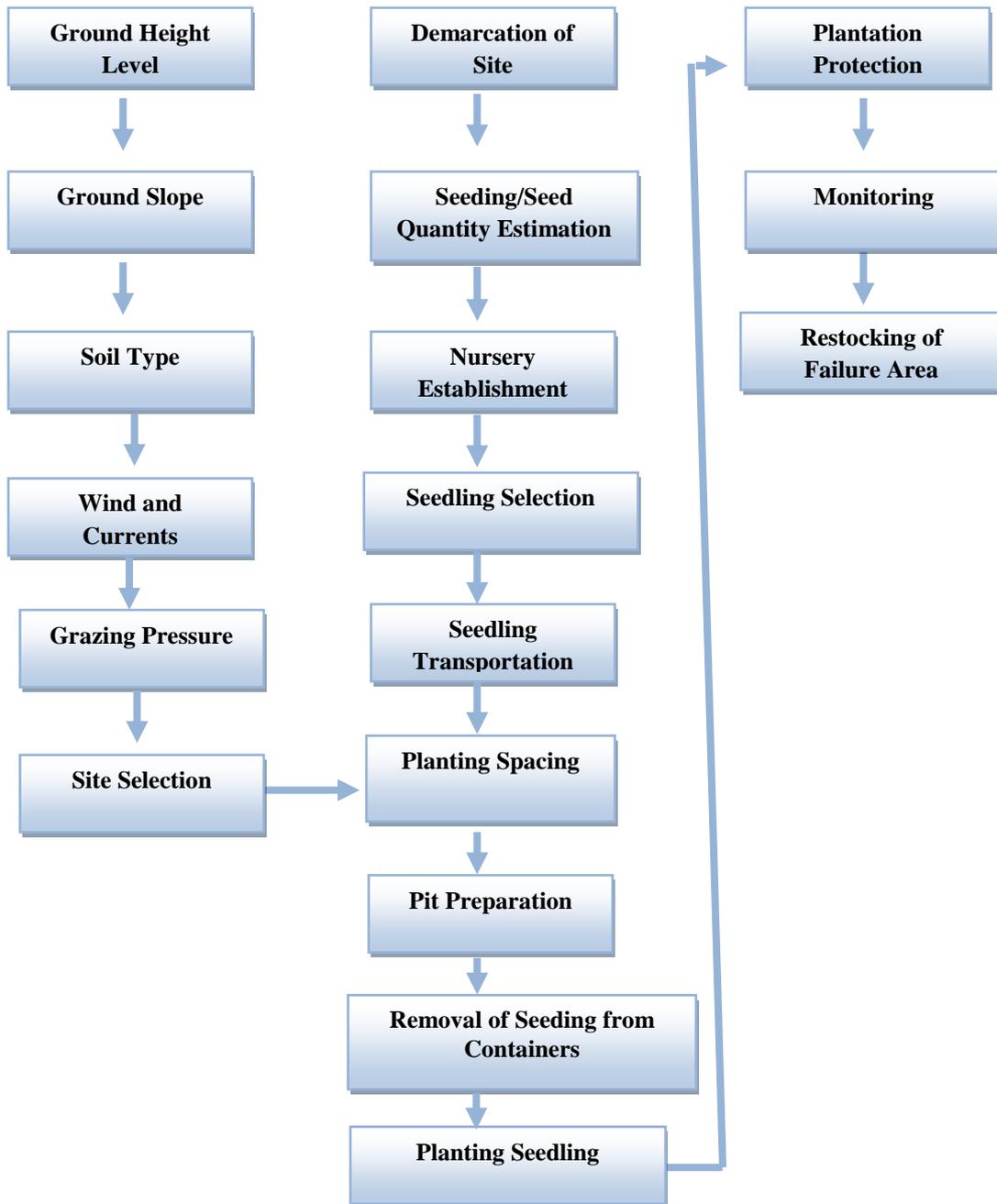


Figure 6: General work Procedures for Plantation Establishment – Flow Chart

4.5 Protective mangrove plantation for wetlands and structures

In order to contain the adverse impacts of sea intrusion on the quality of wetlands and damages to the structures, mangrove plantations will play a significant role. Hence, it is

proposed to grow protective plantations of mangroves in clusters and belts in potential areas/sites over an area of 8,000 ha to provide protection to structures from erosion and reduce/halt the sea water entry into wetlands. In this way the quality of wetlands will improve, flora and fauna will restore, and water quality of these dhandhs which are the main source of livelihood of coastal communities will improve. Above all the fish resource will enhance due to plantation component, ecosystem improvement, and provision of food resources in the wetlands.

Table 2: Summary of Plantation Practices

Species	Site	Soil	Planting	Time	Nursery Raising	Seeding Selection	Spacing	Planting
Avicennia marina	Seaward 50-100 cm lower than the high tide. Sheltered	Sandy-loam silt-loam & Sandy-clay loam	January to April	Low tide period	August to September	30 cm and above, at least 3 pairs of leaves	3x3 m on good sites, 2x2 m on poor sites	Removal of seedlings from containers Root collar rest at the ground level
Rhizophora mucronata	Middle ward. 50-75 cm lower than the high tide. Sheltered	Clay loam, Sandy-clay loam & Silt clay-loam	November to April	Low tide period	May to July	45 cm and above, at-least 4 pairs of leaves	3x3 m on good sites, 2x2 m on poor sites	Removal of seedlings from containers Root collar rest at the ground level

4.5.1.1 Post plantation activities

After the planting work is completed the essential activity is its post plantation care to ensure success. Following operations are to be taken in this context:

4.5.1.2 Revisiting of the area

Frequent of the technical staff be arranged to identify the gaps in the planted area where the plants have not survived and also note the causes of failure.

4.5.1.3 Restocking in gaps

The re-planting operation is to be organized for the large failure areas and staff should arrange planting stock and carry out re-planting operation either with seed or seedlings.

Table 3: Species wise schedule of site selection, planting and planting period

Species	Item	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Avicennia-marina	Selection of Plantation Sites					■	■	■					
	Raising of Container plants in the nursery								■	■			
	Planting Period		■	■	■					■	■	■	
Rhizophora-Mucronata	Selection of Plantation Sites		■	■	■	■							
	Raising of Container plants in the Nursery					■	■	■					
	Planting Period	■	■	■	■								

4.5.1.4 Protection from livestock

Within and around the planted areas there is problem of grazing and browsing and trampling by the livestock (Buffaloes and Camel). Camels graze the newly grown leaves of the mangroves so they hamper the growth of mangrove plants. The area has to be protected from grazing by engaging local people who move around the area and ensure that no grazing takes place. The most effective way to ensure protection of planted areas is to formulate protection committees of local people who should take the responsibility of protection.

4.5.2 Provision of Mobility and Machinery

Since the areas will be located in tidal zone and marshy areas, it is proposed that there should be a fool proof arrangement for boats and vehicles. Other machinery include fast moving fiber glass boats without board engine and four wheel driven pickups to facilitate the technical and supervising staff for frequent visits and carrying out their duties. The type of vehicles, boats and their cost estimates are given in Table 8.

In addition to above transportation facilities the equipment required for field work, office and consumable articles and utilities will be provided. Table 9 gives the physical and financial details of stores, tools and plants.

4.6 Project Management

The implementation arrangements of the project have been discussed in the previous paras of this project. The project will provide managerial and support staff during execution of the project including field staff, office staff, and support staff. The physical and financial details are shown in Table 10 of the project.

5 Economic Justification

5.1 Economic Analysis

- Number of household benefiting, increase in typical household income from farming, fish catch, and sale of fuel wood and forage.
- Income/expenditure statement of the SFD.

5.2 Project Benefits

The intervention will generate significant quantifiable and non quantifiable benefits. A preliminary assessment of the anticipated benefits is presented in with and without intervention analytical framework (Table 4). The results of financial and economic assessment are as follows:

Table 4: IERR and Sensitivity Analysis

No.	Scenario	NPV @12%	IERR	Switching Value
1	Base Case	452.3	19.1%	
2	Decrease in Benefits (10%)		18.1%	54.7%
3	Increase in Costs (10%)		18.2%	121.9%
4	Simultaneous Change by 10%		17.2%	37.9%

The estimated IERR has been computed at 19.1 %, hence the project is economically viable. The NPV at 12% is Rs.452.3 million. The sensitivity analysis presented in the above table shows that with 10% decrease in the benefits the IERR is 18.1 % while with 10% increase in the cost the IERR is about 18.2%. Both of these are above 12%. The simultaneous 10% decrease in benefits and increase in cost suggests the IERR is still above 12%, hence is robust.

The switching value indicate that if the benefits decrease by 54.7 %, and costs increase by 121.9%, while even if both may change by 37.9% the project will still be viable.

5.3 Non Quantifiable Benefits

Mangrove Forests provide environmental services through many ways as under: Protect shoreline from storm surges, cyclones and other extreme weather events, trap pollutants and reduce the effects of flooding, check sea intrusion and reduce its adverse impacts, protect structures (tidal link, bunds etc.), improve fish habitat in wetlands and mangrove areas, prevent soil erosion, serve as carbon sinks and store of biodiversity, improve landscape beauty and, provide several ecosystem services. The project being developed under CDM will generate carbon credits which will be owned by the Government and will be used for other CDM projects. Hence, the project has several environmental benefits and is environment friendly project.

5.4 Social benefits

The project will generate 30 direct employment opportunities (equivalent to 1800 man months) and 4,800 man months (80 x 60) of indirect employment to the communities of which about 15-20% will be women and about 3,000 man months (50 X 60) of skilled and semi-skilled employment.



The proposed project will have positive impacts on the social aspects of the society such as poverty, income distribution, employment generation, livelihood opportunities and gender mainstreaming. With the development of this project and its execution through integrated and participatory approaches the coastal people will be mobilized, organized and act as executing team will get direct and indirect employment and sources of livelihood which will ultimately alleviate poverty and distribute benefits equitably. Due to participatory approach the local communities will be involved from initial stages of project development, survey, selection of sites, planting, maintenance, protection and distribution of benefits. Furthermore, the communities will own the project. Women will also be involved in all the processes of the project.

6 Monitoring and Evaluation Mechanism

The purpose of Monitoring and Review will be to provide timely feedback and analysis to the program partners for making management decisions. This information will be used to facilitate problem-solving at the local level; identify trends requiring corrective actions, evaluate program performance, undertake impact assessment, and to document successful approaches and lessons learned and support strategic planning efforts.

6.1 Monitoring Framework

6.2 Indicators for monitoring

Participatory mangrove forest investigation exercises are to be conducted during investigation and execution stages of Mangrove program. Participatory field exercises attain two main objectives i) it demonstrates the considerable knowledge that communities have and ii) the communities and forest managers begin to know each other leading to trust building.

Following tools are used to compare the condition of natural resources after implementation of Mangrove plantation program:

6.3 Mangrove Forest area mapping

Information gathered during the investigation step of program and mapping done at that time shall be compared with periodical mapping after its execution. All the relevant information of natural resources shall be collected by the communities and mapped on the forest maps. The difference between the two mappings will indicate the impact of Program.

6.4 Mangrove Forest species matrix

Like area mapping the pre and post scenarios shall be compared periodically by preparing species matrixes showing their type, density, growth, health, uses and related information. This information will later be used by the forest managers and communities to plant and protect particular species.

6.4.1 Mangrove Forest condition trend analysis

This tool is used to focus on changes over time through historical trend analysis. Under this tool assessment of natural resource condition or products is carried out initially and later on periodically to know the resource's condition over time. The abundance and short supplies of resources products and services will be determined through this tool.



6.4.2 Mangrove Forest survival rate

This important tool is used as an indicator for analyzing the success of the project. Periodical visits of technical staff and stakeholders will conduct this exercise to estimate the success of the program.

6.5 Types of Indicators

Indicators for Monitoring and review revolve around immediate visible results (**outputs**) of natural resource, actions taken to achieve the desired results (**processes**), medium term results of plan execution (**outcomes**) and long term results of outputs and outcomes (**impact**).

Output - Immediate visible result.

Process – Actions taken by beneficiaries to achieve desired outcome.

Outcome – Medium-term result.

Impact – Long-term result that comes from achieving outputs and outcomes.

Participating actors could establish detailed indicators depending upon the type natural resource.

7.3 Monitoring roles and responsibilities

It is essential to define the roles and responsibilities of monitoring and review of Participatory M & E. Since the process of project identification and preparation has been participatory in which all the stakeholders have been involved, the monitoring shall also have to be participatory. The tools described above for participatory monitoring also describes the roles and responsibilities for monitoring and review of the plan. In addition, committees of stakeholders should be formulated for monitoring of the project.

7.4 Review process of Participatory Approach

Like monitoring, the review process shall have to be participatory involving representatives of all stakeholders. The success of Project will be judged from the achievements of indicators set during investigation exercises of project. Communities taking the responsibilities of participatory management in collaboration and participation of other stakeholders shall also set review process. Review process shall be continuous, critical and result oriented. Initially the project area shall be reviewed frequently and the corrective measures taken accordingly but the period of review could be increased as the participating actors gain experience and expertise of participatory management.

7 Participatory Approach Framework

Participation is the general term used to describe the involvement of groups and individuals in the decision-making process. There are several levels of participation such as informing, consulting, deciding together, acting together and supporting independent community interests. **Informing** is the lowest level of participation in which groups and individuals are informed about the proposed actions without having opportunities to change. In this level of participation the communication is one way and represents a ‘top down’ approach to decision making in conservation. **Consulting** is one step up from informing where local communities and key stakeholders and organizations are consulted for their views. Their views are taken account of but not necessarily acted upon in the planning process. **Deciding together** is another forward step where the groups, individuals, stakeholders are invited to learn, discuss



and become part of the final decision-making process. **Acting together** is the level of participation in which the people are involved in the process to the extent of shared decision-making and responsibility for implementing decisions. **Supporting independent community interests** is the highest level of participation where communities are responsible for planning, decision-making and implementation of the decisions they take. This is a complete ‘bottom up’ approach to conservation. The role of experts is to support the communities with information, expertise, and resources.

Till recent past none of the above described participation levels are practiced in coastal areas. Local people and communities who are the stakeholders in mangrove/forestry are not involved in the planning process and decision-making. The results of this approach have emerged in degradation of resources to a significant level.

Concerned government departments have been working on the strategies to develop and manage the natural resources by adopting top down approach without considering the role of the other stakeholders, particularly local communities. In order to formulate a set of strategies and participatory management it is essential to include and encourage the local communities in the planning process, execution and benefit sharing.

7.1 Participatory Monitoring Mechanism

Monitoring & Evaluation (M & E) Plan should jointly be prepared by all the stakeholders. This plan shall provide a brief overview of the purpose of M & E, roles and responsibilities, data collection and reporting mechanisms and selected NRM Plan and targets.

Three types of M & E are proposed as under:

- Implementation monitoring of project focuses on measuring progress against work plans (outputs) and the quality of facilitation and community participation (processes).
- Post-implementation monitoring focuses on the quality of completed targets and sustainability.
- Impact assessment of interventions vis-à-vis relevance, efficiency, cost effectiveness, and performance of the stakeholders and the implementing arrangements

8 Safeguards

8.1 Environmental

The project will not create any environmental issues during its execution but will address / improve the overall degraded environment of the area.

8.2 Resettlement issues

The project will not create any resettlement issues.



TABLES

Table 5: Mangrove Plantation targets and investment plan

	Unit	Quantities						Total
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	
I. Investment Costs								
A. Machinery, Equipment, Vehicles, and Office furniture & Fixtures								
Double Cab Pickup	#	1	1	-	-	-	-	2
Single Cab Pickup	#	-	1	-	-	-	-	1
Motorcycle	#	3	1	-	-	-	-	4
Boats	#	1	1	-	-	-	-	2
Implements	ls							
GPS	#	2	-	-	-	-	-	2
Computer Sets /a	#	2	-	-	-	-	-	2
Office Furniture & Fixtures	#	1	-	-	-	-	-	1
Subtotal								
B. Survey & Investigations								
Survey and Mapping	ls							
C. Civil Works								
	0							
D. Land Acquisition and Resettlement								
	0							
E. Plantation Cost								
1. Sapling Cost	saplins	3,000,000	3,000,000	3,000,000	2,000,000	-	-	11,000,000
2. Mangroves Planting Cost	saplins	-	7,000	7,000	7,000	7,000	-	28,000
3. Soil Tolerant Tree Planting	trees	-	1,500	1,500	1,500	500	-	5,000
Subtotal								
F. Capacity Building								
Farmer Training Cost	ls							
G. Consultancies, Studies, and Services								
1. Monitoring & Evaluation Consultants	ls							
H. Operations Cost								
1. Project Staff Cost								
Project Manager	pm	12	12	12	12	12	-	60
Project Officer	pm	12	12	12	12	12	-	60
Range Officers	2 pm	12	12	12	12	12	-	60
Forester	4 pm	12	12	12	12	12	-	60
Forest Guards	8 pm	12	12	12	12	12	-	60
Office Assistant	pm	12	12	12	12	12	-	60
Junior Clerk	2 pm	12	12	12	12	12	-	60
Computer Operator	pm	12	12	12	12	12	-	60
Office Attendants	2 pm	12	12	12	12	12	-	60
Security Guards	2 pm	12	12	12	12	12	-	60
Vehicle Drivers	2 pm	12	12	12	12	12	-	60
Boat Drivers	2 pm	12	12	12	12	12	-	60
Boat Crew	2 pm	12	12	12	12	12	-	60
Subtotal								
2. Travel Cost (TA/DA)								
	ls							
3. Vehicle Operating Cost								
	per year	1	3	3	3	3	-	13
4. Boat Operating Cost								
	per year	1	2	2	2	2	-	9
5. Expendables & Utilities								
	ls							
6. Post Planting Care								
	ls							
Subtotal								
Total Investment Costs								
II. Recurrent Costs								



	Unit Cost (PRs)	Base Cost (PRs Million)						Total
		Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	
I. Investment Costs								
A. Machinery, Equipment, Vehicles, and Office furniture & Fixtures								
Double Cab Pickup	2,700,000	2.7	2.7	-	-	-	-	5.4
Single Cab Pickup	2,000,000	-	2.0	-	-	-	-	2.0
Motorcycle	75,000	0.2	0.1	-	-	-	-	0.3
Boats	2,000,000	2.0	2.0	-	-	-	-	4.0
Implements		0.2	0.2	-	-	-	-	0.4
GPS	50,000	0.1	-	-	-	-	-	0.1
Computer Sets /a	150,000	0.3	-	-	-	-	-	0.3
Office Furniture & Fixtures	450,000	0.5	-	-	-	-	-	0.5
Subtotal		6.0	7.0	-	-	-	-	13.0
B. Survey & Investigations								
Survey and Mapping		2.0	2.0	1.0	-	-	-	5.0
C. Civil Works								
D. Land Acquisition and Resettlement								
E. Plantation Cost								
1. Sapling Cost	6	18.0	18.0	18.0	12.0	-	-	66.0
2. Mangroves Planting Cost	15,000	-	105.0	105.0	105.0	105.0	-	420.0
3. Soil Tolerant Tree Planting	14,000	-	21.0	21.0	21.0	7.0	-	70.0
Subtotal		18.0	144.0	144.0	138.0	112.0	-	556.0
F. Capacity Building								
Farmer Training Cost		1.0	3.5	4.0	3.0	2.0	-	13.5
G. Consultancies, Studies, and Services								
1. Monitoring & Evaluation Consultants		1.1	1.1	1.1	1.1	1.1	-	5.5
H. Operations Cost								
1. Project Staff Cost								
Project Manager	150,000	1.8	1.8	1.8	1.8	1.8	-	9.0
Project Officer	75,000	0.9	0.9	0.9	0.9	0.9	-	4.5
Range Officers	50,000/pm	1.2	1.2	1.2	1.2	1.2	-	6.0
Forester	35,000/pm	1.7	1.7	1.7	1.7	1.7	-	8.4
Forest Guards	20,000/pm	1.9	1.9	1.9	1.9	1.9	-	9.6
Office Assistant	25,000	0.3	0.3	0.3	0.3	0.3	-	1.5
Junior Clerk	20,000/pm	0.5	0.5	0.5	0.5	0.5	-	2.4
Computer Operator	20,000	0.2	0.2	0.2	0.2	0.2	-	1.2
Office Attendants	15,000/pm	0.4	0.4	0.4	0.4	0.4	-	1.8
Security Guards	15,000/pm	0.4	0.4	0.4	0.4	0.4	-	1.8
Vehicle Drivers	20,000/pm	0.5	0.5	0.5	0.5	0.5	-	2.4
Boat Drivers	20,000/pm	0.5	0.5	0.5	0.5	0.5	-	2.4
Boat Crew	15,000/pm	0.4	0.4	0.4	0.4	0.4	-	1.8
Subtotal		10.6	10.6	10.6	10.6	10.6	-	52.8
2. Travel Cost (TA/DA)		0.1	0.1	0.1	0.1	0.1	-	0.5
3. Vehicle Operating Cost	240,000	0.2	0.7	0.7	0.7	0.7	-	3.1
4. Boat Operating Cost	100,000	0.1	0.2	0.2	0.2	0.2	-	0.9
5. Expendables & Utilities		0.2	0.2	0.2	0.2	0.2	-	1.0
6. Post Planting Care		-	5.0	5.0	5.0	5.0	-	20.0
Subtotal		11.2	16.8	16.8	16.8	16.8	-	78.3
Total Investment Costs		39.3	174.3	166.9	158.9	131.9	-	671.2
II. Recurrent Costs								
		39.3	174.3	166.9	158.9	131.9	-	671.2



**Totals Including Contingencies
(PRs Million)**

	Year 1	Year 2	Year 3	Year 4	Year 5	Year 6	Total
I. Investment Costs							
A. Machinery, Equipment, Vehicles, and Office furniture & Fixtures							
Double Cab Pickup	2.9	3.0	-	-	-	-	5.9
Single Cab Pickup	-	2.2	-	-	-	-	2.2
Motorcycle	0.2	0.1	-	-	-	-	0.3
Boats	2.1	2.2	-	-	-	-	4.4
Implements	0.2	0.2	-	-	-	-	0.5
GPS	0.1	-	-	-	-	-	0.1
Computer Sets /a	0.3	-	-	-	-	-	0.3
Office Furniture & Fixtures	0.5	-	-	-	-	-	0.5
Subtotal	6.5	7.8	-	-	-	-	14.2
B. Survey & Investigations							
Survey and Mapping	2.3	2.5	1.3	-	-	-	6.1
C. Civil Works	-	-	-	-	-	-	-
D. Land Acquisition and Resettlement	-	-	-	-	-	-	-
E. Plantation Cost							
1. Sapling Cost	21.1	22.1	23.2	16.2	-	-	82.6
2. Mangroves Planting Cost	-	129.0	135.4	142.2	149.3	-	555.8
3. Soil Tolerant Tree Planting	-	25.8	27.1	28.4	10.0	-	91.3
Subtotal	21.1	176.8	185.7	186.8	159.2	-	729.7
F. Capacity Building							
Farmer Training Cost	1.2	4.3	5.2	4.1	2.8	-	17.5
G. Consultancies, Studies, and Services							
1. Monitoring & Evaluation Consultants	1.3	1.3	1.4	1.5	1.6	-	7.1
H. Operations Cost							
1. Project Staff Cost							
Project Manager	1.9	2.0	2.1	2.1	2.2	-	10.3
Project Officer	1.0	1.0	1.0	1.1	1.1	-	5.1
Range Officers	1.3	1.3	1.4	1.4	1.5	-	6.9
Forester	1.8	1.9	1.9	2.0	2.0	-	9.6
Forest Guards	2.1	2.1	2.2	2.3	2.3	-	11.0
Office Assistant	0.3	0.3	0.3	0.4	0.4	-	1.7
Junior Clerk	0.5	0.5	0.5	0.6	0.6	-	2.7
Computer Operator	0.3	0.3	0.3	0.3	0.3	-	1.4
Office Attendants	0.4	0.4	0.4	0.4	0.4	-	2.1
Security Guards	0.4	0.4	0.4	0.4	0.4	-	2.1
Vehicle Drivers	0.5	0.5	0.5	0.6	0.6	-	2.7
Boat Drivers	0.5	0.5	0.5	0.6	0.6	-	2.7
Boat Crew	0.4	0.4	0.4	0.4	0.4	-	2.1
Subtotal	11.4	11.7	12.1	12.4	12.8	-	60.4
2. Travel Cost (TA/DA)	0.1	0.1	0.1	0.1	0.1	-	0.6
3. Vehicle Operating Cost	0.3	0.8	0.9	0.9	0.9	-	3.7
4. Boat Operating Cost	0.1	0.2	0.2	0.2	0.3	-	1.1
5. Expendables & Utilities	0.2	0.2	0.2	0.2	0.3	-	1.2
6. Post Planting Care	-	6.1	6.4	6.8	7.1	-	26.5
Subtotal	12.1	19.3	20.0	20.7	21.5	-	93.5
Total Investment Costs	44.4	212.0	213.5	213.1	185.1	-	868.0
II. Recurrent Costs	44.4	212.0	213.5	213.1	185.1	-	868.0



Table 6: Economic Analysis of Mangroves Project

Years	1	2	3	4	5	6	7	8	9	10	15	20	30
A Without Project Scenario													
1 Value of Agriculture Production (Rs. M)	450.0	441.0	432.2	423.5	415.1	406.8	398.6	390.7	382.8	375.2	339.1	306.6	250.5
2 Value of Livestock Production (Rs. M)	90.0	88.2	86.4	84.7	83.0	81.4	79.7	78.1	76.6	75.0	67.8	61.3	50.1
3 Value of Fish catch (Rs. M)	9.0	8.8	8.6	8.5	8.3	8.1	8.0	7.8	7.7	7.5	6.8	6.1	5.0
Subtotal (Rs. M)	549.0	538.0	527.3	516.7	506.4	496.3	486.3	476.6	467.1	457.7	413.7	374.0	305.6
B With Project Scenario													
1 Value of Agriculture Production (Rs. M)	450.0	441.0	432.2	423.5	415.1	423.4	431.8	440.5	449.3	458.3	506.0	558.6	681.0
2 Value of Livestock Production (Rs. M)	90	88.2	86.4	84.7	83.0	84.7	86.4	88.1	89.9	91.7	101.2	111.7	136.2
3 Value of Fish catch (Rs. M)	9	8.8	8.6	8.5	8.3	8.6	8.8	9.1	9.3	9.6	11.2	12.9	17.4
4 Value of Mangrove Fuelwood & Small Wood (Rs. M)	0	0.0	0.0	0.0	0.0	0.0	0.8	1.8	3.1	4.5	7.3	11.8	30.5
5 Value of Tree Fuelwood & Small Wood (Rs. M)	0	0.0	0.0	0.0	0.0	0.0	4.8	9.6	14.4	16.0	16.0	16.0	16.0
6 Carbon Credit (Rs. M)	0	0.0	0.0	0.0	0.0	0.0	5.9	6.1	6.3	6.4	7.1	7.9	9.8
Subtotal (Rs. M)	549.0	538.0	527.3	516.7	506.4	516.6	538.5	555.2	572.3	586.6	648.8	719.0	890.9
C With Project Costs													
1 Investment Cost	31.8	137.2	131.4	125.2	104.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2 O&M Cost	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Cost	31.8	137.2	131.4	125.2	104.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
C Incremental Benefits (Rs. M)	0.0	0.0	0.0	0.0	0.0	20.3	52.2	78.6	105.2	128.8	235.0	345.0	585.3
D Incremental Costs (Rs. M)	31.8	137.2	131.4	125.2	104.3	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
E Incremental Cash Flow (Rs. M)	-31.8	-137.2	-131.4	-125.2	-104.3	20.3	52.2	78.6	105.2	128.8	235.0	345.0	585.3

NPV @ 12% (Rs. M)

452.3

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19.1%