Baseline report

NAIP Project on

Strategies for Sustainable Management of Degraded Coastal Land and Water for Enhancing Livelihood Security of Farming Communities

(Component 3: Research on Sustainable Rural Livelihood Security (SRLS), GEF Funded)

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Strategies for Sustainable Management of Degraded Coastal Land and Water for Enhancing Livelihood Security of Farming Communities

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ABBREVIATION USED

Abbreviation	Expansion
NAIP	National Agricultural Innovation Project
WB	West Bengal
CSSRI	Central Soil Salinity Research Institute
BCKVV	Bidhan Chandra Krishi Viswavidyalaya
RAKVK	Ramkrishna Ashram Krishi Vigyan Kendra
CIBA, KRC	Central Institute of Brackishwater Aquaculture, Kakdwip Research Centre
CARI	Central Agricultural Research Institute
RRS	Regional Research Station
SC	Scheduled Caste
ST	Scheduled Tribe
OBC	Other Backward Class
HH	Househlod
A & N	Andaman and Nicobar
STW	Shallow Tube Well
DTW	Deep Tube Well

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EXECUTIVE SUMMARY

- The present NAIP project is being implemented under consortium mode with the specific objectives of (1) Sustainable enhancement of the productivity of degraded land and water resources of the coastal region through integrated approaches; (2) Enhancement of livelihood security and employment generation for the poor farming communities of the coastal region and (3) Empowerment through capacity building and skill development of stakeholders including men and women farmers. Central Soil Salinity Research Institute (CSRI), Regional Research Station (RRS), Canning Town West Bengal is the lead center of the consortium and the partners are RAKVK Nimpith, CIBA Kakdwip, BCKV Mohanpur & CARI Andaman & Nicober . The operational area of the project are the coastal region of ''Sundarbans' (in the Ganges delta) in the district of South 24 Parganas and North 24 Parganas in West Bengal and South Andaman and North & Middle Andaman districts of Andaman & Nicobor Islands. The project sites are comprised of 10 clusters spread over 29 villages and covering more than 11000 farm households.
- The major problems adverse to successful crop cultivation in the coastal region are (1) High soil salinity, (2) Shallow water table enriched with salts contributing to salinity build-up in soil during dry months (winter and summer seasons), (3) Heavy textured soil, (4) Influence of tidal waves and periodical inundation by tidal water, (5) Low-lying situation of the land, (6) Poor surface and sub-surface drainage conditions, (7) Lack of good quality irrigation water during summer and winter seasons, (8) Short winter and prolonged monsoon, (9) Heavy and intensive rains during monsoon resulting in deep waterlogging of cultivated fields, (10) Frequent meteorological depressions, cyclonic storms and similar other climatic adversity along with heavy intense rains causing damage both to rice and upland crops, (11) These problems turn almost the entire region as monocropped area growing mostly traditional rice with low productivity during *Kharif* season and (12) Very prolong drought period after monsoon (*Kharif*) season. More than 80% of rainfall occurs in few monsoon months only.
- The average family size was 5 – 7 persons per family in Sundarbans area and the same relatively higher in A & N Island (7 - 9 person per family). In Sundarbans study clusters, the mostly the people were belonging the backward communities, particularly, SC with the share up to 84%. In contrast, in A & N Island, the OBC population was the most dominating. The illiteracy was quite prevalent in the study clusters under study.

- Average land holding is very low and fragmented in Sunderbans region with dominance of marginal farmers whose average land holding ranged between 0.19-0.56 ha across the clusters in Sundarbans area. These holdings are also further fragmented to nearly 2-4 no of parcels making the operational size of agricultural land further smaller. The land holding size was higher in case of clusters under A & N Island and the average holding size was 1.80 – 2.80 ha across the study clusters. Around 90 % of the farmers in Sundarbans area was holding operational area below one ha (marginal) followed by small (3-8%) and rest were landless people (2-9%) in various clusters under study. In clusters under A & N Island, 10-39 % farmers were belonging to marginal categories, 18-50% were small farmers and most importantly 21-64 % of the households were belonging to others categories of farmers (i.e., semi-medium, medium or large). Land situations in Sundarbans cluster were dominated by the low land condition (around 80%) followed by medium (9-14 %) and upland (7-11%). Hilly areas among different land situations were quite important in A & N Island. Medium land (13-40%) and low land (10-23%) was also common features of the land situation in clusters of A & N Island.
- One of the key objectives of the present project is to address these issues and to promote best management practices suited to the prevailing land and water resources for higher land and water productivity in sustainable manner.
- In Sundarbans region agriculture is the primary occupation of the majority of the households (39-56%) across the study clusters followed by daily labourers for non-agricultural activities (5-14%), migration (2-11%) to other places for alternative livelihood, fisheries (4-11%), business (2-9%), others including handicrafts (3-10%) and service (3-7%). Average family income of the households in Sundarbans Cluster is Rs 22000-25000 per/family/year.
- In A & N Islands, average family income is because some member of most of the families is in Govt. service which is the major occupation of most of the families.
- There is high scarcity of irrigation water in the region. However, around 20-25 % of operational area has the facilities for life saving irrigation to crops through harvested rainwater stored in ponds, tanks and Shallow Tube Well (STW) and cultivation of *Rabi* crops. entirely depends on the availability of irrigation water Around 92 % of the cropped area in *Rabi* season is being irrigated from STW water and rest area (8 %) is irrigated by water from ponds or tanks. Harvested rain water in ponds/tanks were the major source of irrigation in all clusters in A & N Islands during the dry months (December to April).
- The existing cropping pattern in Sundarbans area is rice based mono-cropping and rice accounts for almost 99 % of cultivable area. Major crop

rotation was rice-rice with very negligible share of vegetables cultivation. The Cropping intensities in the clusters of quite low, 114-127% only. Cropping pattern in various clusters of A&N Islands are strikingly different from the cropping pattern in 'Sunderland's area. For example, the plantation crops in some clusters occupied a significant area (38- 57 %) and the overall cropping intensity is about 137 %.

- In Sundarbans cluster, both male and female migration was dominant. On an average employment received by the male-migrant was calculated to be 105-269 days/ year and the same was 105-201 days/year for female-migrants. Male and female migration was also a common phenomenon in clusters of A&N Islands also. On an average employment received by the male-migrant was calculated to be 130-240 days/ year and the same was 90-120 days/year for female-migrants.
- Major critical gaps identified are high soil and water salinity, high acidity of soil (acid-sulphate soil), non-scientific nutrient management, scarcity of good quality irrigation water during *Rabi*/summer season, low crop diversification, low land & water which is unable to sustain livelihood, lack of alternative livelihood option for landless/marginal men and woman farmer, very low level of farm mechanization and high drudgery, low productivity of freshwater fish culture and un-utilization of available Brackishwater.

1. BACKGROUND

The coastal region of India is traditionally disadvantaged and backward with low livelihood security of the farmers. The ecology of the coastal region is also highly fragile and vulnerable to further degradation due to anthropogenic activities. The farming communities of the coastal region of Sundarbans (the Ganges delta region of the South 24 Parganas and North 24 Parganas of West Bengal) are dominated by backward classes of people who are some of the poorest of the poors in the world. Agriculture and allied activities are the predominant livelihood for majority of the habitants but the productivity of land is very poor. Sustainable management of degraded (salt affected) soils and water in the region is very important to enhance the productivity of land and livelihood security of the people.. Low agricultural productivity high unemployment among the rural people is the characteristic feature of the area. The entire ecology of the coastal region (natural vegetation/mangrove forest, water bodies, land, biodiversity, etc.) is highly threatened due to over-use & ill-use by the poverty stricken people who are highly dependent on the natural resources of the region for their survival. The natural resources of coastal region are also highly vulnerable to the adverse affects of global warming vis-à-vis climate change. Climate change is likely to have profound impact on agricultural productivity of land due to alteration of rainfall & rainfall distribution pattern, temperature regimes, producing more extreme weather events like cyclones, sea surges, etc., increasing salinity and drainage congestion of coastal lands, and changing the type and frequency of pest infestations. Agriculture in developing countries is more vulnerable to these changes. The climate change will, therefore, greatly affect the food security and livelihood of low-income rural people of the coastal areas, whose primary occupation is agriculture. . The most important impacts of global climate change on agriculture in the coastal areas may be the change in the cropping patterns as there will be more and more

waterlogging/drainage congestion, increased salinity of soil & water land and sea water submergence of agricultural lands. . The degraded soil and water quality, together with climatic adversities contribute to the low agricultural productivity poor livelihood and food security of the rural people. .

Overall objective of this National Agricultural Innovation Project (NAIP) is to enhance the rural livelihoods in a sustainable manner particularly in the economically backward region and for the most disadvantaged groups of people. The concept of rural livelihoods is very wide and it comprises of people, their capabilities and their means of living including food income and assets. A livelihood is environmentally sustainable when it maintains or enhances the local and global assets on which livelihood depend, and has net beneficial effects on others' livelihood. A livelihood is socially sustainable which can cope with and recover from stress and shocks and provide for future generations.

In the present project the constraints of agricultural productivity due to degraded soil and water of the coastal areas will be addressed with primary concern for the landless, marginal and small farmers in ten selected locations (Blocks/clusters) with twenty nine villages representing two of the most disadvantaged coastal areas of the country viz. the 'Sundarbans', the coastal delta region of the river Ganges in the state of West Bengal and North-mid & South of Andaman islands. The environmental issues of relevant parameters of soil, water and air will be monitored and audited for sustainability of the interventions/technologies. The findings of this project may be important road map for application in similar other coastal agro-ecosystems of the country and elsewhere.

1. 1 Theme of the project

The problems of degraded land (salinity and drainage congestion) and water (salinity) of the coastal region can be considerably minimised and the livelihood security of the farmers can be subsequently improved with appropriate use of the vast natural water and soil resources of coastal region. Majority of the coastal areas have great potentiality for rainwater harvesting during monsoon which may be used for irrigation in dry periods. The huge resources of natural surface and underground brackishwater may be used in conjunction with harvested rainwater for crop and fish cultivation, alone or in integration. Analysis of the rainfall data shows that on an average about 70% or more of the rainwater in the high rainfall coastal areas, as in Sundarbans region, are lost in monsoon (*Kharif*) season, mostly as surface runoff to the seas. As a result, there is an awful reduction in the per capita availability of fresh water. The huge run off losses of rain water also enhances the soil erosion, which is accelerated due to deforestation, overgrazing and improper agricultural activities, resulting in siltation of drainage channels and water bodies.

It is possible to make simple land shaping for cultivation of different crops on degraded land having the problems of soil and groundwater salinity, drainage congestion, lack of irrigation water, etc. The furrows/ farm ponds excavated for shaping the land may be used for various purposes like, harvesting of excess rainwater for irrigation in dry months, cultivation of fishes, improving drainage in farm , integrated crop-fish cultivation (like, rice-cum-fish cultivation) *Kharif* and increasing productivity of land & water for higher income of farmers. A portion of the low lying farm land may be converted into high and medium lands with the excavated soils from dug out furrows/ farm ponds. High lands will have no waterlogging problem in *Kharif* season and may be used for the cultivation of vegetables and other crops, than only rice, through out the year. The medium land may be used for cultivation of HYVs of rice rice in *Kharif* and vegetables/low water requiring crops in *Rabi*. The farm land with

land shaping will have lesser problems of soil and water salinity build up in dry months due to stored fresh (rain) water in furrow/pond, improved drainage of field and higher elevation of a portion of farm land. The presence of furrow/ pond in field will minimize damages of crops due to drainage congestion following rains in dry months. Suitable crops having characteristics like, requiring less water, tolerant to salinity/ drainage congestion; shorter durations, etc. may be selected for dry seasons depending upon the specific land situations and amount of rain water harvested. Crop diversification with inclusion of crops like, pulses, oilseeds, vegetables, spices, flowers, fruits, etc. is needed for enhancing income and livelihood & food security of the farmers and reducing their risk of single-crop failure under mon-ocrop cultivation.

Diversification of the traditional farming through land shaping has a tremendous scope in the coastal areas. The present system of mono-cropping with rice results in extremely sub-optimal resource utilization and poor return. Instead of mono-cropping with rice in *Kharif* season, rice-cum-fish cultivation may be introduced in many areas for higher profitability, food security, employment generation and for reducing the risk factor under mono-crop cultivation. The integration of agriculture, livestock, poultry, fishery, apiculture, horticulture, agro-forestry, etc. through farming system approach will have tremendous scope in the coastal areas for enhancing employment opportunities, productivity, supplementary income to marginal/ women farmers, livelihood security and food & nutritional security on a sustainable basis. The integrated farming will help in maintaining proper soil health through system management and will ensure better environmental quality. Many of land shaping technologies developed at CSSRI, RRS, Canning Town have been successfully demonstrated under farmers' field conditions.

Where no crop is possible after *Kharif* cultivation of brackish water fishes with utilization of vast resources of surface and under ground brackish water in the coastal areas has the potentiality to provide a sizeable income to the coastal farmers. The land after the cultivation of brackishwater fishes in dry/ fallow periods may safely be used for cultivation of rice during *Kharif* season after draining out of brackish water and subsequent washing out salt from surface soil with the use of pre-monsoon rains. This technology has, many a times, been successfully demonstrated under on-farm and off-farm conditions by CSSRI, RRS, Canning; CIFRI, Barrackpore and CIBA, Kakdwip, both individually and collaboratively.

For sustainability of the proposed interventions for enhancing the livelihood security of the rural people the environmental issues of the coastal region will be given due importance. The coastal ecology is fragile and vulnerable to degradation due to non-judicious anthropogenic activities. Monitoring of appropriate parameters of different components of environment viz., soil, water and air following implementation of the technologies will provide the sustainability of the proposed technologies under the coastal ecosystems. Identifying appropriate technologies based on such environmental auditing will prove to be robust in ensuring the livelihood security of the populace of the coastal regions.

1.2. Goal

The primary goal of the project is alleviation of the ill-effects of degraded land and water of the disadvantaged coastal regions for enhancing productivity, livelihood security, employment opportunities of rural men & women and their capacity building along with conservation of environment and improving the quality of natural resources

1.3. Specific Objectives

1. Sustainable enhancement of the productivity of degraded land and water resources of the coastal region through integrated approaches
2. Enhancement of livelihood security and employment generation for the poor farming communities of the coastal region
3. Empowerment through capacity building and skill development of stakeholders including men and women farmers.

The project is being implementing under consortium mode. The Central Soil Salinity Research Institute (CSSRI), Regional Research Station (RRS), Canning Town West Bengal is the lead center of the consortium and the partners are Ramkrishna Ashram Krishi Vigyan Kendra (RAKVK), Nimpith; Central Institute of Brackishwater Aquaculture (CIBA), Kakdwip Research Centre (KRC), Kakdwip, Bidhan Chandra Krishi Viswavidyalaya (BCKVV), Mohanpur & Central Agricultural Research Institute (CARI), Andaman & Nicober.

1.4. Project sites:

The operational area of the project are the coastal region of ''Sundarbans' (in the Ganges delta) in the district of South 24 Parganas and North 24 Parganas in West Bengal and South Andaman and North & Middle Andaman districts of Andaman & Nicobor Islands. The project sites are comprised of 10 clusters spread over 29 villages and covering 11629 farm households.

2. DATA AND METHODOLGY

2.1 Selection of project sites

The project is being implemented as cluster approach basis. Each cluster is representing 2-3 villages from adjoining areas. Each partnering institutes were working in one or two cluster(s) with primary focus on agriculture based livelihood intervention. The cluster in A & N Islands represents a distinct agro-ecoregion i.e, island ecosystem which is strikingly different from other clusters in Sundarbans. All the villages in each cluster are typically affected by soil & water salinity, drainage congestion, climatic adversities etc of the coastal region. The project site is distributed in West Bengal and Andaman & Nicobar Islands covering 29 villages in 4 districts. A total of 11629 no of farm households with a total population of 62584 persons are dwelling in these villages (**Table 1**).

2.1.1. Selected Clusters in Sundarbans

The 'Sundarbans' in the coastal region of the Ganges delta in West Bengal is a typical coastal salt affected region of India on the eastern coast. The coastal region of 'Sundarbans' is comprised of 19 blocks in two coastal districts, namely, South 24 Parganas (13 blocks) and North 24 Parganas (6 blocks). Under current project, 6 clusters representing 6 blocks viz. Canning I, Patharpratima, Kultali, Namkhana, Kakdwip and Sandeshkhali II of Sundarbans were selected. Details of villages under the project have been reported in **Table 1 & Fig. 1**.

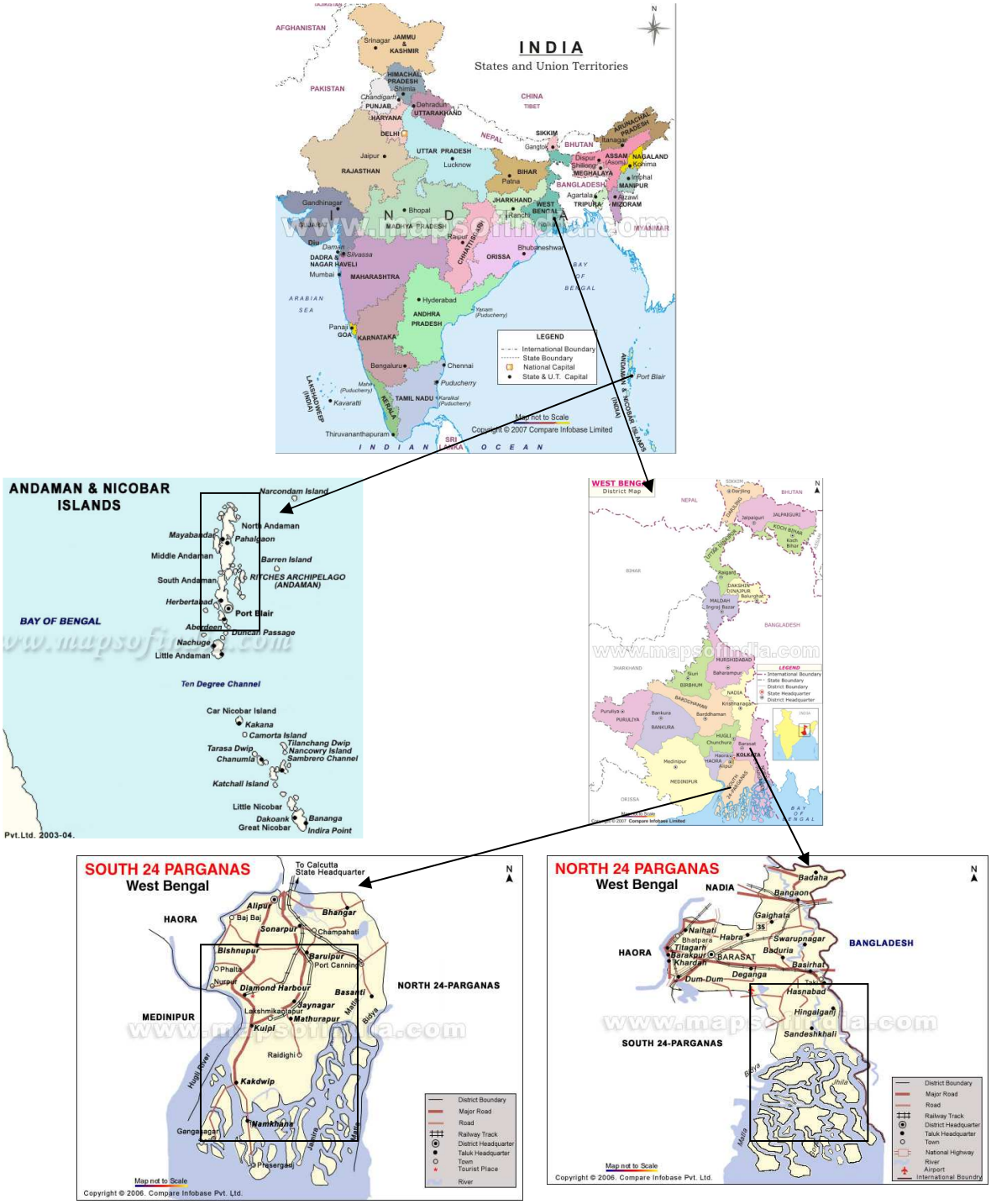

Fig. 1. Location of study area in Sundarbans and Andaman & N Islands

2..1.2. Selected Clusters in A & N Islands

In Andaman Nicobar Islands the study area comprised of two districts namely South Andaman and North & Middle Andaman. Four clusters viz. Chouldari in Port Blair, Shoal Bay in Ferrargunj, Dashrathpur in Rangat and Deshbandhugram in Diglipur blocks of A&N Islands have been identified for implementation of the project. These clusters contain both low-lying waterlogged rice lands and hilly plantation lands. The land and water quality in Dashrathpur and Deshbandhugram were reported poor since long mainly due to their proximity to coast. The land and water quality in Chouldari and Shoal Bay degraded severely after Tsunami in December 2004. Rice is the major field crop in all the selected clusters. Low-yielding long duration traditional rice varieties are grown in low-lands whereas high yielding rice varieties like *Jaya* is grown in uplands during *Kharif*. Most of the land remains fallow after rice in *Kharif*. In hilly parts of the clusters, coconut, arecanut and spices are the common plantation crops.

Table 1. Location, number of households and population of project implementing villages

Sl no	District	Block/Cluster / Panchyat	Villages	Total no of Households	Total population*
1	South 24 Parganas	Canning-I	Chandkhali, Andharaia and Bahirsona	1118	5717
2	South 24 Parganas	Patharpratima	Kuemuri, Damkal and Achintanagar	3088	22281
	South 24 Parganas	Kultali	Shyamnagar, Dakshin Durgapur and Madhabpur	2679	15075
3	South 24 Parganas	Namkhana	Dariknagar, Ganeshnagar, Uttar Chandanpiri	1254	5823

	South 24 Parganas	Kakdwip	Gangadharpur, Jumainaskar and Akshyanagar	1379	7182
4	North 24 Parganas	Sandeshkhali II	Korakathi, Dhunsnikhali and Tushkhali	388	1994
5	South Andaman	Shoal Bay in Ferrargunj	Shoal Bay	60	460
	South Andaman	Chouldari in Port Blair	Craikabad, port Mount and Badmash pahad	464	4054
	North & Middle Andaman	Dashrathpur in Rangat	Dashrathpur, Janakpur, Mithila and Sitapur	1033	2876
	North & Middle Andaman	Deshbandhugram in Diglipur	Deshbandhugram, *Rabi*ndrapally and Madhupur	166	2839
6	4 Districts	10 Clusters	29 Villages	11629	62584

Note: * The total population in the villages as per the primary survey may not exactly tally with the population in the original project document because initially the information was collected from the panchayat office (secondary source) and finally the number of households and population has been obtained based on the primary survey.

2.2. Data and its sources

The baseline report has been prepared based on the information collected from all the villages where the project is being implementing by various partners of the consortium. Relevant primary information has been collected through household survey method by using pre-structured and tested survey schedule during 2010. The primary focus of the survey schedule was to capture the detail information on the present livelihoods pattern of the farmers. In some cases, relevant secondary information has been used from various sources like, *Statistical Abstract 2008*, Bureau of Applied Economics and Statistics, Govt. of

West Bengal; *District Statistical Handbook 2007* of South 24 Parganas, North 24 Pargans of West Bengal, Govt. of West Bengal, Various Annual Report of Central Soil Salinity Research Institute, Canning Town and report of Andaman & Nicobar Administration, 2005.

2.3. Data analysis

Mostly the data has been analysed by using simple statistics such as average, percentage, coefficient of variation, standard deviation etc. Economics of various crops as cultivated by the farmers in the project sites has been calculated based on standard farm budgeting technique.

3. EXTENT AND MAGNITUDE OF COASTAL SALT AFFECTED SOILS AND LAND DEGRADATION

India has 8,129 km long coastline covering 10.78 millions of land under coastal agro-climate. Coastal lands are subjected to various types of degradation problems of which salinity, alkalinity acidity, drainage congestions, droughts/ physiological droughts are the major ones. The food, fodder and fiber production in the coastal zone is much below the national average and the intensity of present land use is barely 127 % due to a variety of constraints, which warrants special attention. The productivity of coastal soils can be increased to a considerable extent if appropriate improved technologies are adopted. Knowledge of characteristics of coastal soils is thus, extremely important for optimizing the land use/ alternate land uses.

3.1 Problems of the coastal region

The major problems adverse to successful crop cultivation in the coastal region may be outlined as below.

- High soil salinity
- Shallow water table enriched with salts contributing to salinity build-up in soil during dry months (winter and summer seasons)
- Heavy textured soil
- Influence of tidal waves and periodical inundation by tidal water
- Low-lying situation of the land
- Poor surface and sub-surface drainage conditions
- Lack of good quality irrigation water during summer and winter seasons
- Short winter and prolonged monsoon
- Heavy and intensive rains during monsoon resulting in deep waterlogging of cultivated fields
- Frequent cyclonic storms and similar other climatic adversity along with heavy intense rains causing damage both to rice and upland crops

These problems turn almost the entire region as mono-cropped area growing

mostly traditional rice with low productivity during *Kharif* season

- Very prolong drought period after monsoon (*Kharif*) season. More than 80% of rainfall occur in few monsoon months only.

Fig. 2. Field condition during dry months in Sundarbans area

3.2 Coastal Soils of Sundarbans

The 'Sundarbans' region comprises of coastal region of the districts of North 24 Parganas and South 24 Parganas of West Bengal. The geographical area of 'Sundarbans' region in India is presently 0.9630 million ha out of which 0.4494 million ha is inhabited, 0.4264 million ha is under wet land mangrove forest and the rest about 0.09 million ha is occupied by the rivers. An intricate network of distributaries, furrows and tidal creeks dissect the area forming numerous plano-convex islands made up of silt and silty clay.

About 70 % of the coastal salt affected soils in the state of West Bengal are present in this region. Along with the main land the coastal soils are distributed over 102 deltaic islands in these two districts. Of these 102 islands 54 are under habitation and the rest 48 islands are under reserved forest. The inhabited areas are distributed over 19 blocks (13 in the South 24-Parganas & 6 in the North 24-Parganas) and are protected from ingress of saline water from rivers by earthen embankments, the total length of which is about 3600 km. The flat topography of land along with presence of ground water (brackish) water table at shallow depth resulting in very poor condition of land.

The soils of Sundarbans are generally poor in available N but variable in available P. There are soils with low, medium and high available P status. The soils are rich in available K, Ca, Mg and S. The soils are generally rich in micronutrients except Zn (**Table 2**). Some typical soil profiles and range of

common Physico-chemical characteristics of surface soil of the study region are given in **Tables …..**, which show that the soils are usually heavy textured with variable in salinity and pH. Chlorides and Sulphates of sodium, magnesium, calcium and potassium, in order of preference, are the dominant salts with traces of bicarbonate. The soils are non-sodic, saline and usually neutral in reaction but at places highly acidic acid sulphatic soils are present both in Sundarbans and Andaman island.

Table 2 : Morphological, physical and physico-chemical characteristics of soil profileof Patharpratima Block, (Village Shivnagar, South 24 Parganas, West Bengal)
(Soil classification: *Fine, mixed hyperthermic Typic Endoaquents)*

(a)

Horizo-n	**Depth (cm)**	**Colour (moist)**		**Tex-ture**	**Clay (%)**	**pH (1:2)**	**ECe (dSm^{-1})**	**SA R**	**ESP**	**Org. C (%)**
		Matrix	**Mottles**							
Ap	0-24	5Y 5/2	2.5Y 5/4,f2d	sic	40	6.7	7.9	11.8	12.4	1.15
Bwg1	24-49	5Y 4/2	2.5Y 5/6,c2d	sic	42	7.0	10.7	11.9	11.7	0.91
Bwg2	49-91	5Y 4/1	2.5Y 5/6,c2d	c	44	7.3	10.9	11.9	14.2	0.81
C1g	91-151	5Y 4/2	10YR 5/8,c2p	sicl	34	6.1	10.9	11.4	12.4	0.58
2Cg	151-170+	2.5Y 4/0	10YR 5/8,c2p	sil	27	7.2	14.9	12.2	13.1	0.42

(b)

Horizo-n	Ionic composition of saturation extract (m.e. l^{-1})							CEC (c mol (p^+) kg^{-1})	Base sat(%)
	Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	SO_4^{2-}	HCO_3^-		
Ap	49.9	3.1	5.9	29.9	54.2	31.9	1.5	24.1	78.1
Bwg1	54.4	3.9	8.7	33.0	69.2	28.5	1.7	24.7	81.8
Bwg2	58.8	4.2	10.1	38.5	72.7	36.9	1.9	24.6	84.0
C1g	56.7	4.2	10.2	38.8	71.3	36.8	1.3	23.3	76.3
2Cg	73.3	5.9	23.1	49.1	92.8	55.8	1.9	22.2	80.2

Table 3: Morphological, physical and physico-chemical characteristics of soils of Canning Block (Village: Barabari, South 24 Parganas, West Bengal)
Soil classification: *Fine, mixed hyperthermic Typic Endoaquents*

(a)

Horizon	Depth (cm)	Colour (moist) Matrix	Colour (moist) Mottles	Texture	Clay (%)	pH (1:2)	ECe (dSm^{-1})	SAR	ESP	Org. C (%)
Ap	0-25	5Y7/3	7.5YR6/8,c1d	sicl	32	5.6	3.8	6.7	10.4	1.17
Bwg1	25.69	2.5Y5/0	2.5YR3/6,m2d	sic	42	4.8	7.9	6.9	12.1	0.55
Bwg2	69-115	2.5Y4/0	7.5YR6/8,m2d	sic	42	4.7	7.8	8.3	13.3	0.89
Cg	115-175+	2.5Y5/0	5YR5/6,f1d	l	25	8.5	9.4	9.5	14.1	0.14

(b)

Horizon	Ionic composition of saturation extract (m.e. l^{-1}) Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	SO_4^{2-}	HCO_3^-	CEC (c mol (p^+) kg^{-1})	Base sat. (%)
Ap	37.9	1.08	8.7	17.3	12.6	24.6	0.5	16.27	67.8
Bwg1	66.8	1.20	13.7	31.0	32.4	44.9	0.8	13.09	64.5
Bwg2	66.8	1.12	10.8	28.7	40.0	36.9	0.8	12.72	65.0
Cg	69.1	1.12	25.0	29.6	43.2	48.8	1.8	12.90	64.9

Table 4: Morphological, physical and physico-chemical characteristics of soils of Sandeshkhali, (Village: Gayan para Kanmari, North 24 Parganas, West Bengal)
Soil classification: *Fine, mixed hyperthermic Vertic Endoaquents*

(a)

Horizon	Depth (cm)	Colour (moist) Matrix	Colour (moist) Mottles	Texture	Clay (%)	pH (1:2)	ECe (dSm^{-1})	SAR	ESP	Org. C (%)
Ap	0-20	2.5Y5/2	5YR5/6,m2p	cl	38	4.3	13.9	4.0	14.3	1.62
Bwg1	20-55	5YR5/1	5YR5/4,c2d	cl	38	4.1	9.2	4.7	14.0	1.17
Bwg2	55-110	5YR4/1	2.5YR3/4,m2p	sic	50	4.0	9.2	5.3	13.7	1.87
Bwg3	110-210+	5YR4/1	2.5Y8/4,f2f	sic	50	4.1	11.1	6.2	13.8	1.90

Special feature: cracks and silken-slides within a depth of 125 cm

(b)

Horizon	Ionic composition of saturation extract (m.e. l^{-1}) Na^+	K^+	Ca^{2+}	Mg^{2+}	Cl^-	SO_4^{2-}	HCO_3^-	CEC (c mol (p^+ kg^{-1})	Base sat. (%)
Ap	89.1	1.52	22.7	89.1	81.7	56.5	0.5	14.5	67.0
Bwg1	69.1	1,28	18.5	47.5	46.8	45.2	0.3	14.5	65.0
Bwg2	71.3	1.20	12.7	41.4	56.5	34.8	0.8	50.0	67.0
Bwg3	83.5	0.88	22.7	62.1	65.2	45.3	0.5	13.1	67.0

Table 5: Summery of common physico-chemical characteristic of surface soil in the project sites at Sundarbans and A & N island

Cluster	Soil and Water properties			
	Soil		Water	
	ECe (ds/m)	pH (1:2)	ECe (ds/m)	pH
Canning	2.8 - 15.7	5.5 – 7.9	0.50- 23.6	6.5 - 8.1
Sandeshkhali	3.1 - 18.7	3.8 - 7.9	0.40 - 21.4	4.9 - 8.4
Patharpratima	2.0 – 10.1	6.3 - 7.9	0.70 - 24.8	6.2 - 7.8
Kultali	1.8- 8.3	6.5 – 7.8	0.50 - 18.6	6.5 - 8.0
Kakdwip	2.1 – 10.1	5.8 - 8.0	0.60 - 22.2	6.3 – 7.9
Namkhana	1.7 - 12.3	6.4 – 7.8	0.40- 20.6	6.8 - 8.3
Chauldhari	3.8 - 9.2	3.5 - 5.7	0.50 - 7.4	5.0 - 7.2
Shoal Bay	2.1 - 5.4	7.0 - 8.2	0.60 - 8.8	6.4 - 7.6
Dashrathpur	5.4 - 12.6	5.4 - 6.3	0.40 - 8.5	5.8 - 7.4
Deshbandhugram	3.2 - 4.6	5.0 - 6.6	0.40 - 7.9	5.6 - 7.2

3.2.1. Soils of different salinity in Sunderbans

The salinity of soil is mostly attributed to the upward capillary movement of water from brackish groundwater table located at shallow depth. Following the evaporation of water the salts accumulate in the soil surface and the salinity of soil increases as the dry spell proceeds. Occasional ingression of saline tidal water from the sea or the rivers also contributes to the salt accumulation in soil in coastal ares. Impeded drainage also plays a major role in salinity build-up in the area. The salinity of soil is highly temporal and spatial in nature in the coastal areas of both Sundarbans and Andaman & Nicobar islands. There is a gradual increase in salinity of soil after rainy season till the onset of next monsoon season. A general trend of seasonal variation of soil salinity build up in common agricultural land in Sundarban region is presented in **Fig. 1**.

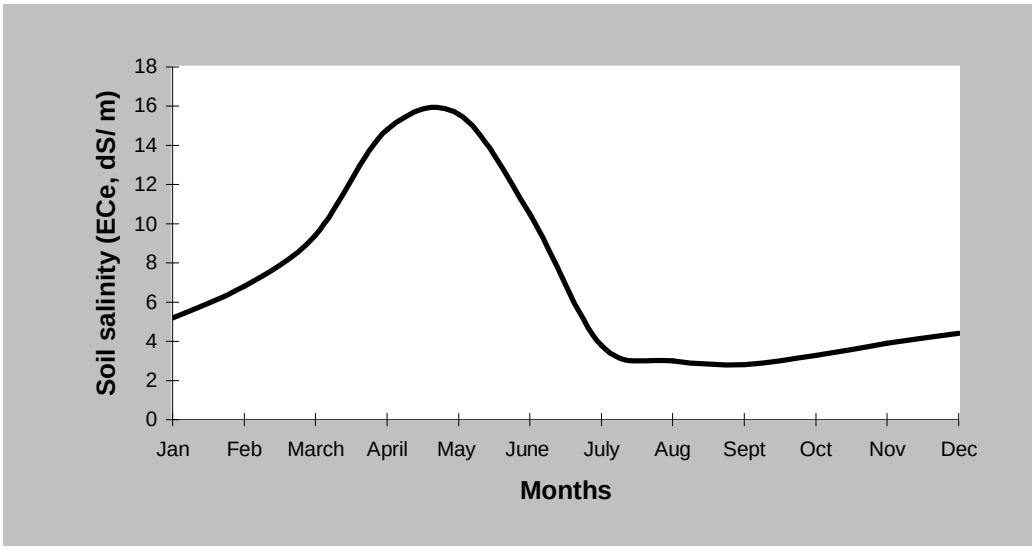

Fig. 3. Seasonal variability of soil salinity in coastal areas of Sundarbans

3.2.2. Hydrology

The coastal areas of Sundarbans , India is a part of the Gangetic delta region of the Bengal basin. Due to neo-tectonic movement during 16th to 18th century the Bengal basin had tilted easterly along a hinge zone starting from Sagar (Sundarbans) going north of Malda (north of West Bengal) and curving towards Dhaka (Bangladesh). As a result of this, flow of the Ganges river started coursing through the river Padma in Bangladesh leaving Hugli the erstwhile course as a more tidal channel. During 16th – 18th century innumerable tributaries were generated from Ganges, which formed huge network of creeks and furrows within Sundarbans delta of India, and most of them act as brackish water furrows and the water salinity of rivers / estuaries / creeks increased. The Central Ground Water Board of India, Eastern Region has studied the hydrology of the coastal areas of West Bengal and the report is available in

www.cgwber.nic.in/westbengal.htm. The ground water in the coastal region of Sundarbans occurs in porous alluvial formation both under water table and confined conditions. The yield of the aquifer is about 150 m^3 hr^{-1}. Fresh ground water bearing aquifer is occurring at varying depth ranges within 180 – 360 m/bgl with the drilled depth of 600 m/bgl. The fresh groups of aquifers are sandwiched between saline / brackish aquifers. The top saline / brackish aquifer lies within the depth span of 20 m – 180 m with max depth of 320 m/bgl in the extreme south. The shallow fresh water aquifers occur in dunes in Digha-Ramnagar area of East Medinipur down to depth of 9 m/bgl and in levee deposit within 50 mbgl in Baruipur - Sonarpur – Bhangar – Canning tract in Sough 24 Parganas district.

3.2.3 Climate in sunderbans region

Climate in Sundrabans region are presented in **Table 6** that includes the average climatic conditions of several parameters, temperature, RH, wind velocity, rainfall, no of rainy days and bright sunshine hours. In general the climate of Sundarbans region is characterized by high rainfall (but skewed to few rainy months only) and hot & humid summer.

Table 6: Mean monthly weather parameters at Canning Town [Latitude 22°15' N, Longitude 88°40' E, Altitude 3.0 m (a.m.s.l)

Average of previous 5 years (2005-2009)

Month	Temperature °C			Relative Humidity (%)		Wind Velocity (Km h^{-1})	Total Rainfall (mm)	Rainy Days	Bright Sunshine (h d^{-1})
	Max.	Min.	Mean	Max.	Min.				
Jan.	25.58	13.28	19.42	91.6	50	2.64	32.04	1.4	7.38
Feb.	28.9	17.08	23	91.4	49.6	3.42	17.92	1.2	8.44
March	32.66	21.56	27.12	90.6	46.6	5.1	31.58	1.2	8.12
April	34.84	25.06	29.96	89	52.6	8.96	38.44	3.2	9.0
May	35.04	25.64	30.34	85.4	58.6	8.84	147.78	7.6	6.866
June	33.98	26.6	30.32	87.4	69.8	9.12	192.68	11	5.34

July	31.32	25.96	28.64	91	79.2	8.4	488.66	19.4	3.36
Aug.	31.68	26.16	28.92	91.6	79.2	7.46	314.52	16.6	3.96
Sept.	31.54	25.94	28.74	91.8	78.2	6.68	437.9	13.4	4.9
Oct.	30.96	23.78	27.42	91.6	68.8	3.1	186.78	5.6	6.44
Nov.	28.98	19.14	24.08	91	55.2	2.12	14.92	0.8	7.72
Dec.	25.98	14.12	20.06	91	49.2	1.92	0	0	7.2
Overal l	31.0	22.0	26.5	90.3	61.4	5.6	1903.2	81.4	6.6

3.3. **Current Status of Agriculture**

The economy of coastal areas of is mainly dependent on agriculture (including crop culture, fisheries, forestry, etc.), which influences the livelihoods of millions of rural households in the region. Nearly 20% of the NSDP (Net State Domestic Product) is accounted by this primary sector, out of which crop culture contributed 16% of NSDP in East Medinipur, 12% in North 24 Parganas and 15% in South 24 Parganas (**Table 7**). Contribution of agriculture to districts NSDP showed a declining trend over the period 2002-03 to 2006-07. This indicated that the young generations are shifting towards other livelihood options than the agricultural, as those are more effective to pull the income. The low producing agriculture sector of the coastal region alone can no longer fulfill the requirements of their livelihood needs. Hence, it is necessary that the profitability in agricultural sector must be increased through adoption of modern technologies for sustainable enhancement of productivity and employment. However, agriculture sector still continues to be the most important sector because it supports the livelihood of large number of active workers.

Table 7: Estimates of Net State Domestic Product (NSDP %) in Sundarbans Coastal districts

(at 1999-00 constant prices)

Sl no	**Particulars**	**24 PARGANAS (N)**		**24 PARGANAS (S)**	
		2002-03	**2006-07**	**2002-03**	**2006-07**

1	Agriculture	15.3	11.5	17.7	14.6
2	Forestry	0.5	0.5	1.2	1.3
3	Fisheries	3.3	4.5	7.6	6.8
4	Per Capita Income (Rs)	18034	23108	16621	18892

Source: Govt. of West Bengal (2009)

The employment pattern in the rural areas (unskilled labours) of the coastal areas of West Bengal shows that the availability of labour force is less than demand during the peak planting (July-August) and harvesting (December- January) periods of *Kharif* rice which is the major crop of the region. In the remaining periods of the year there is huge surplus labour force that are to depend on non-agricultural livelihood options available mostly in nearby cities and towns. Thus, there is huge migration of labours to nearby cities and towns during the lean periods of agricultural activities. If the agricultural activities are intensified through adoption of modern technologies for soil, water and crop management, the agriculture dependent livelihoods and employments in the coastal areas can be improved substantially thus, reducing the migration of labour forces to the cities and towns to a great extent.

Agriculture in the coastal region, as a whole, is complex, diverse and risk prone. The cropping pattern is predominantly mono-cropped with low yielding traditional rice in almost 98% of the area in monsoon season (*Kharif*), as no other crop is possible due to submergence of agricultural fields during the period. The crop production in *Kharif* season suffers from various adversities like heavy and intensive rain resulting deep waterlogging, periodical brackish water inundation by high tides, poor surface and subsurface drainage, floods, frequent cyclonic storms, etc. Land utilization pattern in coastal districts indicated that in North 24 Parganas district nearly 67% of the land area is under cultivation (Net Sown

Area) but the same is only 39% in South 24 Parganas. The cultivable land in these two districts (South 24 Parganas and North 24 Parganas) are highly fragmented and more than 85% of operational holdings are categorised as marginal (<1 ha) and nearly 10% of the holdings are of small categories (1-2 ha). While implementing land and water management technologies the size of operational holdings should be kept into mind. Most of lands (about 70-90%) in the region remain fallow after the *Kharif* season, primarily because of high soil and water salinity, lack of good quality irrigation water, drainage congestion, etc. The overall productivity of rice in *Boro* (January- February to April- May) season (t ha^{-1}) is relatively higher than *Aman(June- July to November-December)* season((t ha^{-1}) and *Aus* (April-May to September- October) season (2.2-2.6 t ha^{-1}). Majority of the rice is grown as *Aman* rice (80% in South 24 Parganas and 62% in North 24 Parganas). The productivity of rice in salt affected areas is very low *Kharif* rice. The scope for rice cultivation in *Rabi, Boro* and *Aus* seasons is severely restricted due to scarcity of good quality of irrigation water and higher soil salinity. Though the coastal areas of West Bengal is mostly mono-cropped with rice in *Aman* season, but there lies plenty of opportunities of crop diversification towards high value fruits & vegetable crops by adopting suitable soil, water and crop management practices.

3.4. Andaman and Nicobar Islands – A Brief

The Andaman and Nicobar (A&N) archipelago comprises of about 556 small and big islands with a coastline of 1,962 km between 92-94 ^{0} E longitude and 6-14 ^{0} N latitude in the Bay of Bengal. The northern group of islands form the Andaman Islands, while the southern group of islands form the Nicobar Islands, which is separated by 10 ^{0} channel. The North Andaman, Middle Andaman and South Andaman islands occupy major land mass. The A&N group of islands fall under hot humid to par humid island eco-region uner Agro-ecological Region 21 in the

Agro-ecological map of India. The tropical ecosystem of the A&N Islands is very unique having diverse species with wide range of genetic diversity in varying density. High rainfall, extremely humid climate, undulating terrain and backwater creeks are very conducive for faunal and floral diversity. Evergreen and littoral forests, mangroves and coral reefs are important components of the existing ecosystems prevailing in the islands.

The total geographical area of A&N Islands is 8,249 sq km. The forests in A&N Islands occupy about 92.2 percent of the total geographical area in which about 87 percent area is under legally notified forest. Remaining area is available for agriculture and allied activities. The area of Andaman group of islands is 6,408 sq km whereas the Nicobar group of islands is 1,841 sq km. The total population in these islands is about 3,56,152 (Population Census, 2001) with a growth rate of about 26.9 percent in the last decade. Out of 556 islands, 38 are inhabited in which 25 are in Andaman group and 13 are in Nicobar group of islands. It is interesting to note that inhabited islands encompass about 94 percent of the geographical area of A&N Islands.

The land distribution system, in general, allowed each settler 4.4 ha of land consisting of 2 ha of low-lying rice land, 2 ha of hilly land generally planted with coconut, arecanut, banana, papaya and spices and 0.4 ha land for the homestead. However with time, the land holdings have been fragmented. Approximately 46,000 ha land is under agricultural crops that include about 30,000 ha land under fruits and plantation crops, about 10,000 ha land under field crops (about 8000 ha rice land after tsunami) and about 461 ha land as fallow land. The current annual production of rice in the A&N Islands is 16790 tonnes with an average productivity of only 2.2 t ha^{-1} . Further, due to intense and erratic rainfall, crop losses are very high in A&N Islands. The short-term weather

forecast based advisories help the farmers in minimizing crop damages, input losses and increase farm productivity and income.

3.4.1. Climate of Andaman and Nicobar Island

On an average, the islands receive 3074 mm (**Table 8**) of rainfall distributed over 8 months. From June to September, the rainfall is intense and may have even up to 30 rainy days per month in some years. From December to April, the rainfall is scanty or almost absent. The undulating terrain results in severe water crisis during the period which is aggravated by higher evapotranspiration. Presence of rich flora and fauna establishes that the climate is congenial to many cultivated crops, livestock and fisheries. At Port Blair, the rainfall exceeded 4300 mm in 1947 but it was as low as 1550 mm in 1979. The usual range of wind speed is 5 to 15 kmph in different months. The climatological normal of Islands are presented in **Table 9**, which states that the wettest year 1961 received as high as 4370 mm of rainfall and driest year 1979 received 1577 mm of rainfall. The heaviest rainfall recorded in 24 hours is 374 mm during 1976. Crop growing season in A & N islands can be grouped in to wet and dry season. Wet season is between May to November which receives almost 126 rainy days and the evaporation is much lesser than rainfall during the period. The dry season is from December to April which receives only 17 rainy days and evaporation is much higher than rainfall making crop production difficult. The Islands receives South-West monsoon from May to September and North-East monsoon during October to November. The topography of A&N Island is undulating with a stiff terrain exposed to soil erosion due to heavy rainfall.

Table 8. Weather parameters at Port Blair (A&N Islands)

Sl no	Particulars	Value
1	Average Rainfall (mean of 48 years)	3074.2 mm

2	Number of rainy days (mean of 26 years)	143
3	Mean minimum temp (mean of 48 years)	23.0^0 C
4	Mean maximum temp(mean of 48 years)	30.1^0 C
5	Mean relative humidity (mean of 31 years)	80 %
6	Mean wind speed (Mean of 22 years)	9.7 KMPH
7	Evapotranspiration	1588.2 mm
8	Mean daily sunshine hours (mean of 1 year)	6.16 h

(Ganeshamurthy *et al.,* 2002)

Table 9. Climatological normal at Port Blair (A&N Islands)

Month	Max. RH (%)	Max Clouds (okta)	Rainfall					
			Total (mm)	No. of Rainy days	Total (mm) in wettest month with year	Total (mm) in driest month with year	Heaviest fall in 24 hours	Date & Year
Jan	77	4.7	052.2	2.8	583.7 1912	000.0	208.3	22 1922
Feb	74	3.8	020.3	1.3	180.1 1961	000.0	131.1	07 1902
Mar	73	3.8	009.9	0.9	206.3 1910	000.0	67.1	26 1881
Apr	75	4.9	072.8	3.7	446.8 1974	000.0	206.8	20 1922
May	83	6.6	428.0	16.2	1060.6 1961	062.0 1934	264.9	31 1891
June	86	7.1	495.6	19.5	1054.1 1888	124.7 1966	258.3	01 1908
Jul	87	7.1	465.4	19.8	929.9 1959	133.9 1929	166.0	20 1964
Aug	87	7.1	441.6	19.3	924.8 1934	72.9 1932	173.2	13 1934
Sep	88	6.6	469.4	18.4	1123.0 1954	126.2 1927	191.1	01 1970
Oct	87	6.0	321.1	16.1	579.9 1889	82.3 1930	153.2	11 1926
Nov	84	5.5	225.9	11.9	648.7 1907	24.1 1931	147.3	09 1901
Dec	79	5.1	186.6	5.9	709.7 1980	1.7 1979	374.3	31 1976

Mean	82	5.7	3168.8	135.8	4370.4 1961	1577.2 1979	374.3	

4. BASELINE INFORMATION AND DISCUSSIONS

The baseline information collected from the farm households from all the villages has been compiled at cluster level for each partnering institute of the consortium and has been presented in the subsequent section.

4.1. Demographic features

The demographic information includes information on population statistics, age, sex, caste, family size, educational statistics etc of the selected clusters. The demographic features of the cluster are given in **Table 10.** It was observed that average family size was 5 – 7 persons per family in Sundarbans area and the same higher in A & N Island (7 - 9 person per family). The female ratio was 925-980 per 1000 male in Sundarbans clusters, indicated that the population was little imbalanced and biased to male population. In A & N Island the male-female population was almost balanced (977-993 female /1000 male). Under Sundarbans clusters, the majority of the people belongs to the backward communities, particularly, SC with the share up to 84%. In contrast, in A & N Island, the OBC population was the most dominating community. Regarding educational status, the share of illiterate people was varying 12-50 % across the clusters in Sundarbans area and the same was relatively less in the A & N Islands clusters (10-33%). In general it was observed that the illiteracy was quite prevalent in the clusters under study.

Table 10. Demographic features of population in selected clusters in Sundarbans (W B) and in A&N Islands

Sl no	Cluster	Avg. family size (no)	F : M (no of female per 1000 male)	% SC	% ST	% General	% Illiteracy
1	Canning	5.13	980	83.83	0.09	15.06	26.00
2.	Patharpratima	7.18	945	29.24	2.58	68.16	45.40
3.	Kultali	5.72	925	33.96	17.96	48.05	49.54
4.	Kakdwip	5.20	980	17.98	0.21	80.56	29.29
5.	Namkhana	4.72	951	23.84	0.00	71.13	11.77
6.	Sandeshkhali	5.00	956	75.26	8.51	9.54	16.00
7.	Chouldari	4.00	993	0.00	0.00	73.30	10.00
8.	Shoal Bay	7.00	993	0.00	0.00	100	33.30
9.	Dashrathpur	9.00	984	0.00	0.00	0.00*	17.00
10	Deshbandhugram	9.00	977	0.00	0.00	0.00*	24.00

Note: 1. Clusters 1-6 are in Sundarban region and 7-10 are in A&N Islands
2.. In Shoal Bay 26.6 % of HH belongs to OBCs, * in Dashrthpur and Deshbandhugram cluster 100% HH belongs to general and OBC categories, respectively.

4.2. Operational holdings pattern and land situations

The operational holding pattern given in tables and figures below (**Table 11, Fig 2, Fig. 3).** It is observed that the average land holding is very low and fragmented in Sunderbans region with dominance of marginal farmers with average land holding ranged between 0.19-0.56 ha across the clusters in Sundarbans area. These holdings are also further fragmented to nearly 2-4 no of parcels making the operational size of agricultural land further smaller. The land holding size was higher in case of clusters under A & N Island and the average holding size was 1.80 – 2.80 ha across the clusters under study. Around 90 % of the farmers in Sundarbans area was holding operational area < 01 ha (marginal) followed by small (1-2ha) farmers' (3-8%) and rest were landless farmers(2-9%) in various clusters under study. In clusters under A & N Island, 10-39 % farmers were

belonging to marginal categories, 18-50% were small farmers and most importantly 21-64 % of the households were belonging to others categories of farmers (i.e., semi-medium, medium or large). Land situations in Sundarbans cluster were dominated by the low land (around 80%) followed by medium land (9-14 %) and upland (7-11%). Hilly areas among different land situations were quite important in A & N Island. Medium land (13-40%) and low land (10-23%) was also common features of the land situation in clusters of A & N Island. The cultivable lands of the farmers were further scattered into more than one plots/parcels. Cultivable non-hilly lands in these clusters are affected by salinity problem of various degrees particularly during dry *Rabi*. Waterlogging during *Kharif* (Monsoon) season coupled with drainage congestion and salinity building up in soil during non- monsoon months is the typical problems for agricultural operation in the coastal salt affected areas in Sundarbans. One of the key objectives of the present project is to address these issues and to promote best management practices suited to the prevailing land and water resources for higher land and water productivity in sustainable manner.

Table 11. Operational holdings pattern and land situations in selected clusters in Sundarbans (W B) and in A&N Islands

Sl no	Cluster	Avg. farm size (ha)	Categories of farmers			Land situations#		
			Marginal (%)	Small (%)	Landless (%) or others*	Low (%)	Medium (%)	Up (%)
1	Canning	0.19 (1.90)	95	1	4	76	15	9
2.	Patharpratima	0.56 (4.00)	91	7	2	78	14	8
3.	Kultali	0.50 (4.00)	93	3	4	81	12	7
4.	Kakdwip	0.36 (3.24)	89	6	5	80	11	9
5.	Namkhana	0.29 (2.43)	91	4	5	79	10	11
6.	Sandeshkhali	0.36 (2.35)	86	8	6	84	9	8
7.	Chouldari	1.80	30	50	20*	40	37	23
8.	Shoal Bay	2.60	27	18	55*	18**	13	12
9.	Dashrathpur	2.80	10	26	64*	50	40	10

10	Deshbandhugram	2.40	39	40	21	43***	38	10

Note:

1. *Clusters 1-6 are in Sundarbans and 7-10 are in A&N Islands*
2. *Figures in parentheses indicates average no of plots/parcels*
4. *In Sandeshkhali 9 % farmers belonged to others category such as medium, semi-medium or large.*
5. ** Indicates other category of farmers such as semi-medium, medium or large*
6. ***In Shoal Bay cluster 57 % land situation is hilly*
7. **** In Deshbandhunagar 43 % land situation is hilly*
8. # Land situation has been classified according to the waterlogging in *Kharif* season as low land (waterlogging >30cm), medium land (15-30 cm of waterlogging and upland (no waterlogging).

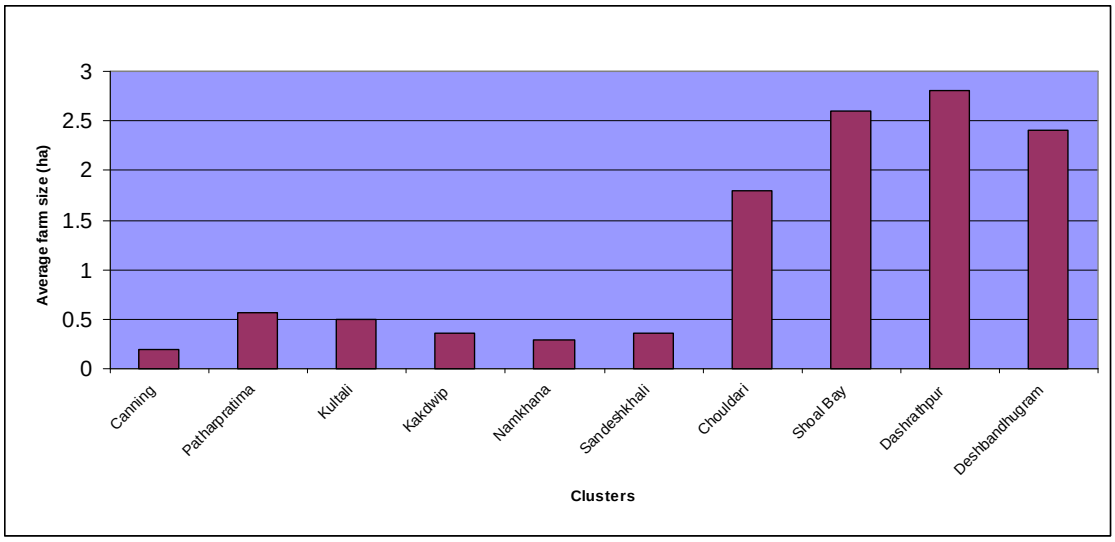

Fig. 2: Average farm size (ha) across the study clusters in Sundarbans and A & N Islands

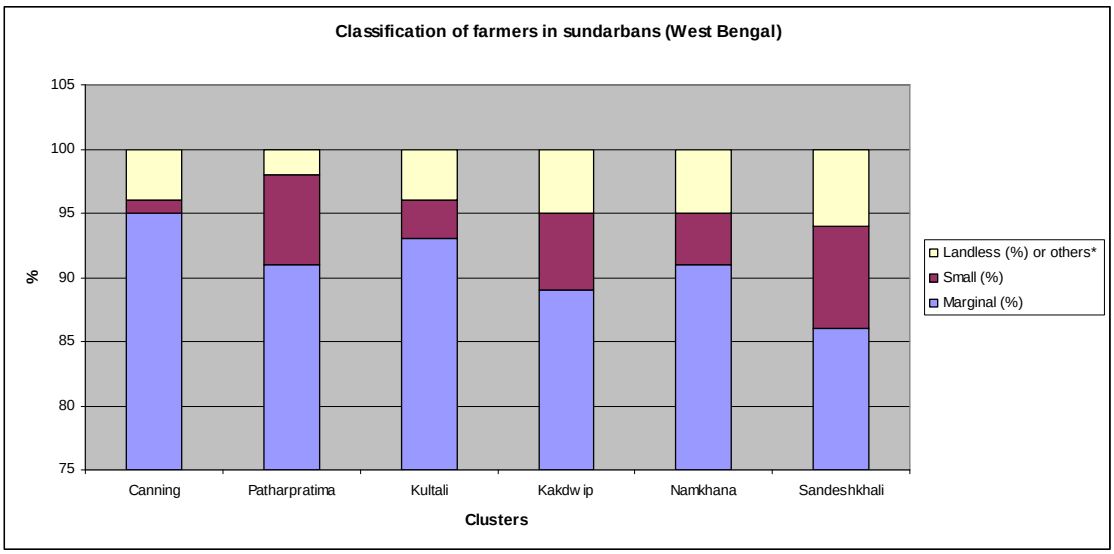

Fig. 3: Classification of farmers of sample farm households in Sundarbans (West Bengal)

4.3. Ownership pattern of cultivable area

It is a unique system in 'Sunderbans' that owners usually cultivated their land in *Kharif* season when rice is the main crop. Rice cultivation in the *Kharif* season are less risky due to abundance of water, less salinity and less labour intensive. While in *Rabi* seasons there is higher soil salinity, scarcity of irrigation water (irrigation water is to be purchased or drawn from underground) and more labour intensive. In *Rabi* season the farmer who are have less family labour or have secondary professions prefer to lease out their lands to those who have more family labour. Since, the cost of cultivation is increasing day by day, the farmers left with little or no positive net returns. Many farmers opt for leasing out their land for brackish water fish farm for lump sum remuneration which are usually higher than the remuneration receivable from crop cultivation. In Chouldari cluster of A & N Islands, more no of farmers were observed to be cultivating their own land during *Kharif* season rather in *Rabi* season. And the total area under cultivation was much higher during *Kharif* season as compared

to *Rabi* season. Similar trend was prevalent in all other clusters also such as Shoal Bay, Dashrathpur and Dshbandhunagar.

4.5. Occupational pattern of the households

In view of the importance of the baseline information on occupational pattern of any livelihood improvement project, detail information on several relevant income sources have been collected and compiled (**Table 12, Fig.4**). In Sundarbans area, agriculture was the primary occupation of the majority of the households (39-56%) across the study clusters followed by daily labourers for non-agricultural activities (5-14%), migration (2-11%) to other places for alternative livelihood, fisheries (4-11%), business (2-9%), others including handicrafts (3-10%) and service (3-7%). Average family income of the households in Sundarbans Clusters has been estimated to be around Rs 22000 - 25000 per/family/year (**Table 13, Fig. 5**). Though agriculture is the primary occupation of the majority of the people but in general the agriculture was contributing low income (less than half of the total income) in these clusters of Sundarbans. Under this situation, large scale migration was quite prevailing in this area and was fetching better income than from agriculture. But this large scale migration to other places very often fails to provide decent and sustainable livelihood options to the people and therefore can be termed as distress migration which will have detrimental effect on the rural society Agriculture and allied sector must be made more productive by utilizing the existing natural resource base of this region to secure better sustainable livelihood option for the people of this region and security to the rural society. Other income sources of the people in the study area were income from livestock, fisheries, service and business.

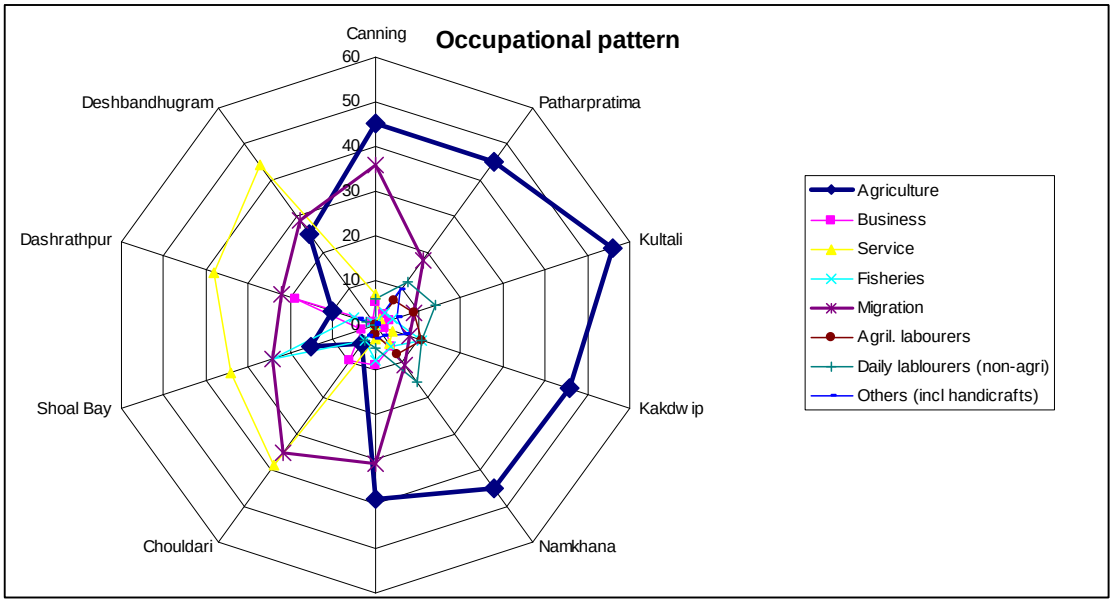

Fig. 4: Occupational pattern of the sample households under study

Table 12. Occupation pattern of households in selected clusters in Sundarbans (W B) and in A&N Islands

Sl no	Cluster	% of hoseholds' primary occupation on							
		Agriculture	Business	Service	Fisheries	Migration	Agril. labourers	Daily lablourers (non-agri)	Others (incl. handicrafts)
1	Canning	45	5	7	0.5	36	0	6	0.5
2.	Patharpratima	45	3	1.8	3.5	18	7	12	9.7
3.	Kultali	56	3	0	4	9	9	14	5
4.	Kakdwip	46	2	4	11	8	11	11	7
5.	Namkhana	45	6	5	6	11	8	16	3
6.	Sandeshkhali	39	9	3	8	31	2	5	3
7.	Chouldari	5	10	39	4	35	0	4	3
8.	Shoal Bay	15	3	34	24	24	0	0	0
9.	Dashrathpur	10	19	38	5	22	0	2	4
10	Deshbandhugram	25	1	44	1	29	0	0	0

Note: In Kakdwip, Namkhana and Sandeshkhali cluster farmers were depending on multiple livelihood option and therefore, no single primary occupation was identified

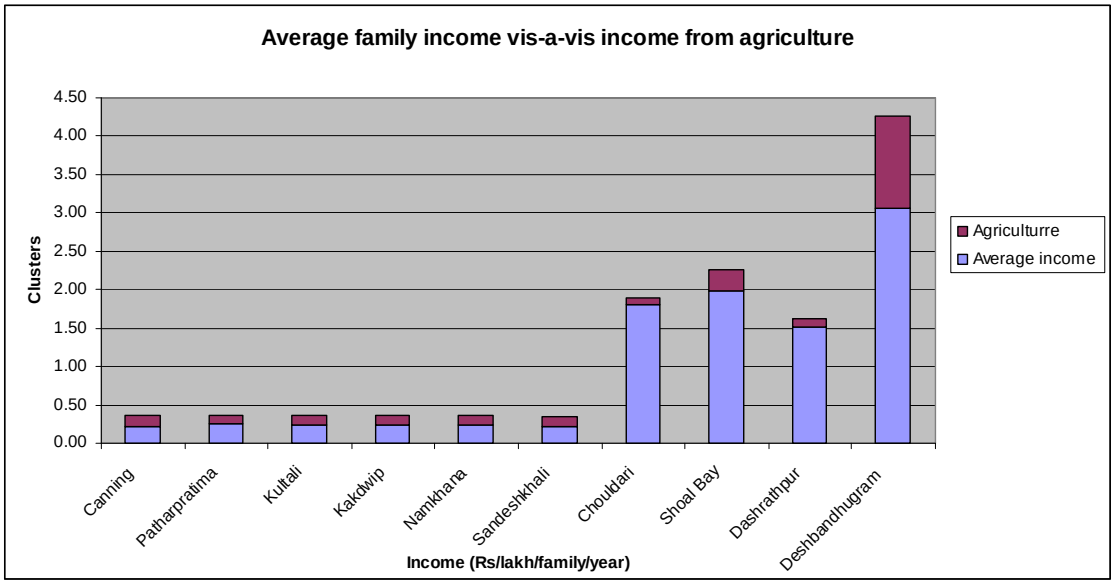

Fig. 5: Average family income (Rs/lakh/family/year) vis-à-vis income from agriculture

Table 13. Income pattern of households in selected clusters in Sundarbans (W B) and in A&N Islands

Sl no	Cluster	Average family income (Rs/family/year)	Average income from various sources (Rs/year)					
			Agri.	Livestock	Bus.	Serv.	Fish.	Migration
1	Canning	22291	14023	2896	42670	79295	9540	44123
2	Patharpratima	25444	10492*					
3	Kultali	23958	12811*					35824
4	Kakdwip	23441	12540					
5	Namkhana	23589	13210					
6	Sandeshkhali	22528	11240		20000			7500
7	Chouldari	180948	9397	13876	12782	118545	2069	24278
8	Shoal Bay	199337	27002	10592	8787	109454	16090	27412
9	Dashrathpur	150666	10638	21145	29709	59110	8548	21516
10	Deshbandhugram	306875	119995	10605	7589	127969	18340	22377

*Note: * Includes income from agriculture + horticulture*

In A & N Islands, average family income was calculated to be quite high for all the clusters as one or more members of most of the families were in Govt.

service. In terms of occupational pattern, 39 % of total households' primary occupation was services in Chouldari Cluster, followed by income from migration (35%), business (10%), livestock (7%), agriculture (5%) and fisheries (4%). In Shoal Bay cluster, service was the primary occupation of nearly 34 % of total households, followed by fisheries (24%), migration (24 %), agriculture (15%) and business (3%). Similar was the case under Dashrathpur cluster where 33 % of households' primary source of income was service, followed by migration (20 %), livestock (20 %), business (18 %), agriculture (5 %) and fisheries (5 %). Similar occupational pattern was observed in Deshbandhugram cluster where 44 % of total housholds' primary source on income was service and followed by migration (29 %), agriculture (25 %), fisheries (1 %) and business (1 %). The average income per family per year was Rs. 274959, 199337, 652162 and 146142 in Chouldari, Shoal Bay, Dashrathpur and Deshbandhugrgam cluster, respectively. Out of these total incomes around 70-80 % of the income was accounted for the service only. Agriculture was observed to be a subsidiary income source for most the households in all the clusters and which accounted for only 2%, 14%, 8 % and 12% in Chouldari, Shoal Bay, Dashrathpur and Deshbandhugram cluster, respectively.

4.6. Irrigation status

The coastal areas in Sundarbans normally receive high precipitation during monsoon season and the cultivation is entirely rainfed. For crop cultivation during *Rabi* season the irrigation is a must and there is high scarcity of irrigation water in the region. However, around 20-25 % of operational area has the facilities for life saving irrigation to crops through harvested rainwater stored in ponds, tanks and through capturing the water stored in perched aquifers at relatively shallow depths at isolated places by installing Shallow Tube Wells (STW). In Canning cluster nearly 20-25 % of the total operational lands are being

cultivated during *Rabi* season. The cultivation of *Rabi* crops purely depends on the availability of irrigation water either through STW or from ponds/tanks. Around 92 % of the cropped area in *Rabi* season is being irrigated from STW water and rest area (8 %) is irrigated by water from ponds or tanks. Similar to Sundarbans clusters, the ponds/tanks were also major source of irrigation in all clusters in A & N Islands. The area under irrigation by all sources in Chouldari cluster has been calculated to be 8.7 ha, the same was 8.6 ha in Shoal bay, 8.4 ha in Dashrathpur and 5.1 ha in Deshbandhunagar cluster. Duration of availability of irrigation water has been observed to be 4-5 months from December to April.

4.7. Cropping Pattern

The existing cropping pattern in Sundarbans region is primarily rice based mono-cropping. Rice is the most preferred crop irrespective of seasons and it accounts for almost 99 % of cultivable area. Major crop rotation was rice-rice with very negligible share of vegetables cultivation. The Net Cropped Area (NCA) has been calculated to be varying 126 ha in Sandeshkhali cluster to 1789 ha in Patharpratima cluster. The Gross Cropped Area (GCA) was estimated to be varying 126 ha (Sandeshkhali) to 2270 ha (Patharpratima) in Sundarbans cluster. The Cropping intensities in the clusters of Sundarbans have been observed to be quite low, 114-127% only (**Table 14**). Low cropping intensity in these clusters is due to non-availability of good quality irrigation water and also due to soil salinity building up in non-monsoon months. The soil salinity build in some clusters was aggravated due to flooding of land with saline water (from saline water rivers) following cyclone-aila in preceding year. The cultivable area in Sandeshkhali cluster was worst affected due to cyclone-'Aila' Extent of crop diversification in Sundarbans area has been estimated by employing Simpson Diversification Index (SID) as SID = $1 - \sum(Xi / \sum Xi)^2$, Where, Xi = area under

ith crop. The index value ranges in between 0 to 1, as the estimated value approaches from 0 to 1, the cropping pattern is more diversified. The value of SID based on the sample farm households in Sundarbans area has been estimated to be **0.39**, implying that currently the existing crop diversification is very low.

Table 14. Cropping pattern in selected clusters in Sundarbans and in A&N Islands

		Area (ha) under cultivation (*Kharif* + *Rabi*)			% to GCA under cultivation			NCA (ha)	GCA (ha)	Cropping Intensity (%)
Sl no	Cluster	Rice	Vegetables	Others	Rice	Vegetables	Others			
1	Canning	233	0.74		99.7	0.3	0.0	193	234	121
2.	Patharpratima	1832	324	114	80.7	14.3	5.0	1789	2270	127
3.	Kultali	1394	244	81	81.1	14.2	4.7	1363	1719	126
4.	Kakdwip	462			100.0	0.0	0.0	379	462	122
5.	Namkhana	323			100.0	0.0	0.0	263	323	123
6.	Sandeshkhali	126	18		87.5	12.5	0.0	126	144	114
7.	Chouldari	32	9.2	7.3	57.3	16.5	13.1	40.6	55.8	137
8.	Shoal Bay	16.2	8.4	47.5	25.4	13.2	74.5	63.8	119.8	188
9.	Dashrathpur	30	9.5	7.7	54.5	17.3	14.0	37.8	55	146
10	Deshbandhugram	80	7	21	63.5	5.6	16.7	67	126	188

*Note: * includes pulses (100 ha) and oilseeds (14 ha),*

1. *In A&N Clusters (Chouldari, Shoal Bay, Dashrathpur and deshbandhugram) area under other crops includes are of perennial crops.*
2. *High cropping intensity in Shoal Bay and Deshbandhugram A&N cluster is due to presence of large portion of area under perennial plantation crops.*

Cropping pattern in clusters of A&N Islands is strikingly different from the cropping pattern in Sunderbans region. In the clusters of A & N islands (Chouldari, Shoal bay, Dashrathpur and Deshbandhunagar), besides rice-rice, the plantation crops occupies significant area in the existing cropping pattern. In Chouldari clusters, GCA has been calculated to be 55.8 ha with rice-rice as the most dominating (57% of GCA) followed by plantation crops (38% of GCA) and vegetables (16% of GCA) and the cropping intensity is 137%. In Shoal Bay nearly 40% of the GCA (47.5 ha) was under plantation crops and followed by 14% (16.2 ha) area under rice and 7% (8.4 ha) area under vegetables. Small portion of the

area has been under cultivation of betel leaf in this cluster. The cropping intensity has been accounted to be quite high (188%) which includes the area under perennial plantation crops also. In Dashrathpur cluster, rice-rice was the dominating crop covering 55% of the GCA (55 ha). Vegetables accounted for 17% of GCA and plantation crops covered around 14%. The cropping intensity has been estimated to be 146%. Similarly, in Deshbandhugram the cropping pattern dominated by the rice crop which accounted for 63% of GCA (125.8 ha). Area under plantation crop was accounted for 15% of GCA and rest of the cropped area was covered by vegetables and other crops. The cropping intensity was calculated to be quite high (188%) due to the presence of perennial plantation crops in this cluster.

4.8. Production and marketable surplus of major communities

Analysis of cropping pattern has clearly indicated that in Sundarbans region rice is the dominating crop followed by small area under the cultivation of vegetables. Besides, rice and vegetables, fish, livestock and livestock products are other major commodities, which are generally produced by the farmers to fulfill their cash income and family needs. Rice is also primarily cultivated for home consumption purpose. A small surplus quantity of all these produces is traded through small-scale business in the local market.. However, fish and livestocks have potentially of bring good cash income to the farm families and many farmers, are in the occupation of small commercial tradings of these commodities. These products (fish and livestock) have very high demand in local, national as well as international market. The production capacities and extent of market surplus for these commodities are being reported in the following sections. Average production of rice per family has been calculated to be varying under various clusters in Sundarbans area (e.g., 5-6 quintal per family in Canning cluster and 8-10 quintal per family in Sandeshkahli cluster). Most of

the farm families produce rice to meet the home consumption need (83-86% of total production) and seed purposes (10-14% of total production). Very small quantity of rice is being traded through small scale trader or farmers to farmers exchange in the villages or local market. In case of fish, the marketable surplus is much higher (60-70% of total production) as compared to staple crops. Vegetables cultivation is becoming popular in the study area and major vegetables grown by farmers are brinjal, bhindi, cucurbits, tomato, etc. But the farmers are growing these vegetables a very small scale (0.08 – 0.30 ha) due to scarcity of good quality of irrigation water during dry months. Average production per family varies between 4.5- 8.5 q per year. Among fruit crops guava is the most suitable crop and most important cash crops (fruit crops) that are grown by farmers commercially.

In Chouldari clusters of A&N Islands, around 33% of the total rice produced by the farmers is sold in the market soon after harvest, and the same was 90% for vegetables. Almost entire production (90%) from plantation crop is sold through agro-processing. For other important fruit crops (mango, banana, tamarind, etc.) almost 80% are sold in the market soon after harvest. The average distance of nearest market from the study villages is in the range of 5 to 10 kilometers. In Shoal Bay cluster distance of nearest market from the study village is 15-30 km. Almost entire produce of betel leaf and other crops (mango, banana) are sold in the market soon after harvest. Nearly 80% of the produce from plantation crops are sold through agro-processing. More than 80% of rice produced by these cluster was consumed by them and rest were kept for seed purposes. Extent of marketable supply was higher for vegetables (81%), plantation crops (78%) and etelleaf (93%) in this cluster which are the major source of cash income to the farmers. Total production of various crops in Shoal Bay was calculated to be 32 t rice, 10 t of vegetables, 21 t of plantation crops and 1.4 t of betel leaf. In Dashrathpur cluster around 89% (65/t) of total rice production (73 t) was utilized

as home consumption and the same was 24% (26 t) for vegetables and 23% (290 kg) for plantation crops. Almost entire amount of banana produced by the farmers in this cluster are sold in the market. In this cluster around 71% of vegetables and 25% of other crops are sold in the market soon after harvesting. More than half (55%) of the plantation crops produced in this cluster goes to agro-processing center for processing. In Deshbandhugram total production of major crops has been calculated to be 105 t of rice, 13.6 t of pulses and 9.3 t of other crops (like banana, mango, etc.). Out of this total production 34% is sold in the local market and the same is 91% for vegetables, 80% for plantation crops, 90% for pulses and 94% for other crops. Average distance of nearest market from the villages of this cluster is 3-6 km. In case of rice, nearly 21% of the production is sold in market soon after harvest and the same is 90% for vegetables and 84% for other crops. Major portion of pulses (96%) and plantation crops (93%) are sold in market through agro-processing centers.

4.9. Livestock ownership pattern

Livestock is an important asset for the farming communities dwelling in coastal areas of India. It acts as the insurance against the unforeseen happening such as loss of crop due to natural calamites or disaster etc. In Sundarbans area around 29-55 % of the farmers were rearing cow in various clusters (**Table 15**). Poultry was reared by 12 -28% of the farmers and goat was reared by around 4-35 % of the sample farmers across the study clusters. Landless farmers were observed to be rearing more number of goats (average 2.50 per family) as compared to other categories of farmers. In contrast, marginal and small farmers were rearing more number of cows as compared to landless farmers in the farming system.

Table 15. Livestock ownership pattern in selected clusters in Sundarbans (W B) and in A&N Islands

Sl no	Cluster	% of farm families possess	No of animals possess per family

		Cow	Goat	Sheep	Poultry	Others	Cow	Goat	Sheep	Poultry
1	Canning	29	4	1	12		2-4	3-4	1-2	4-8
2.	Patharpratima	35	35	4						
3.	Kultali	38	25	8						
4.	Kakdwip	58	21		28	1.76	1-2	3-10		2-5
5.	Namkhana	47	24	1	26	2	2-3	1-2		5-9
6.	Sandeshkhali	55	5	1.5	19		1-3	2-5	1-3	6-12
7.	Chouldari	38	20		64	2	1-2	1-2		20-35
8.	Shoal Bay	64	52		79	30	1-2	1-3	1-2	20-40
9.	Dashrathpur	58	41		65	54	1-2	1-2		4-18
10	Deshbandhugram	63	35		94	15	1-2	1-2	20-30	1-2

Note: others include duck, pig, buffaloes etc

In clusters of A & N Islands poultry was most important livestock component and 64-94 % of the farm families were rearing quite a large no of poultry birds (as high as 40 bird per family). Around 38-64 % of the farmers reared cow with an average of 1-2 number per family across the clusters in A & N Island. And the same was 20-52 % for goat rearing with an average no. of 1-2 per family.

4.10. Migration, employment and income pattern

Migration of both male and female population was very common phenomena in all the clusters in Sundarbans area. People migrate for search of alternative livelihoods other than agriculture mainly to Kolkata or to other sub-urban areas. Since, agriculture could not provide sufficient livelihood to the villagers, a large section of people was gradually shifting out from agriculture and are mainly working as daily paid labourers in un-organised sector in the cities. But very often this un-organised sector fails to provide decent livelihood options to the large section of migrant people that can be called 'distress migration'. This kind of out-migration contributes negatively to the agricultural operation in the villages and the rural society. Therefore, unless and until the agriculture can be made more remunerative, this kind of out-migration will continue.

In Sundarbans clusters, both male and female migration was dominant. On an average employment received by the male-migrant was calculated to be 105-269 days/ year and the same was 105-201 days/year for female-migrants (**Table 16**). The income earned by male-migrants was observed to be much higher (Rs 25000 to 36270/year) as compared to female-migrant (Rs 8585-13000/year) primarily due to varying nature of work by male and female migrants. The average wage rate prevailing in these clusters were Rs 120/day for work in agricultural field and Rs 150/day for work in building construction. Average earning for work as head load carrying was observed to be Rs 200/day and the same was Rs 1200/month for the work as maid servant.

Male and female migration was also a common phenomenon in clusters of A&N Islands also. On an average employment received by the male-migrant was calculated to be 130-240 days/ year and the same was 90-120 days/year for female-migrants. The income earned by male-migrants was observed to be much higher (Rs 23000 to 48000/year) as compared to female-migrant (Rs 16000-21000/year) primarily due to varying nature of work by male and female migrants.

Table 16. Migration, employment availability and income pattern in selected clusters in Sundarbans (W B) and in A&N Islands

Sl no	Cluster	No of days of migration per year		Average income (Rs/year)		No of days of employment			
		Male	Female	Male	Female	Own farm	Other's farm	Within village	Outside village
1	Canning	269	201	36270	8585	65	45	135	165
2.	Patharpratima					143	43	139	142
3.	Kultali					140	42	124	57
4.	Kakdwip	210	105	25000	13000	55	75	110	200
5.	Namkhana	210	105	25000	13000	55	75	110	200
6.	Sandeshkhali					66			110
7.	Chouldari	203	90	36600	16200	153		63	133
8.	Shoal Bay	130	90	23400	16200	190			130
9.	Dashrathpur	240	120	48600	21600	103		87	63
10	Deshbandhugram	136	100	24600	18000	183		40	96

Note: others include duck, pig, buffaloes etc

5. ECONOMICS OF CROPS

Although the entire area of Sunderbans is almost mono cropped with rice there is very good scope for crop diversification for increasing income of farmers and reducing risk factor in agriculture, better soil health and nutritional security to the farm families. The following crops may be grown as diversification: vegetables (Tomato, brinjal, knolkhol, carrot, beet, lady's finger, spinach, cucurbits, amaranthus, ipomoea, etc.), fruit crops (guava, sapota, banana), flowers (marigold, tuberose etc), fields crops, fibre crops (cotton), root crops (sweet potato, yam, colocasia) and fodder crops (*coix*, paragrass, etc). In addition to these, fisheries (both freshwater and brackishwater) are important and remunerative options for farmers.

5.1. Economics of Rice

Economics of major crops grown by the farmers in various clusters of Sundarbans and A&N Islands are described in details in this section. Rice cultivation practices are strikingly different between *Kharif* and *Rabi* seasons; therefore, economics of rice cultivation has been calculated separately for these two seasons.

Rice is widely grown during *Kharif* season in Sundarbans region and wherever good quality water is available (through freshwater ponds/ canals or shallow tube well), *Rabi* rice is cultivated. In general the rice productivity is quite low in *Kharif* season (2.0 tha^{-1}) and the same is relatively higher during *Rabi* season (4.30 t/ha) (**Table 17**). In *Kharif* season mainly traditional long duration rice varieties are grown. In contrast, high yielding and short duration varieties are grown in *Rabi* season. In *Kharif* waterlogging is the common phenomena in Sundarbans

region, therefore tall varieties of rice (patnai, SR-26-B, sabita, Amalmana, Geetanjali, lalat, etc) are grown widely. In *Kharif Rabi* season mainly short duration HYV rice area grown such as Bidhan 2, Canning 7, lal minikit, Sada minikit etc. Economics of rice cultivation in both the seasons indicated that although cultivation of rice is not profitable but it is cultivated by the farmers for sustaining their food security or under compulsion as no other crops can be taken up during *Kharif* season due to waterlogging of fields. In both the seasons, labour cost was the most important component among cost items and accounted for more than half of the total cost. In *Rabi* season irrigation was the next important cost item (24% of total cost). The output-input ratio was just covering the operational cost of *Kharif* rice (1.12) and the same was relatively better in case of *Rabi* rice (1.23). Straw, a by-products of rice, has great value to the farming communities as it serves different functions such as thatching, fodder and also used as fuel. Similarly, in A & N Island also rice was mainly cultivated during *Kharif* season and the total cost, total return and net return was calculated to be Rs 16940, Rs 20500 and Rs 3560 per ha (**Table 18**).

Table 17. Economics of rice (*Kharif and Rabi*) in selected clusters in Sundarbans of West Bengal

(per ha)

Sl no	Item	*Kharif* rice		*Rabi* rice	
		Cost/return	% to share	Cost/return	% to share
A.	**Cost (Rs/ha)**				
1	Seed	1269	5.8	1968	4.6
2	Labour	14445	66.3	21660	50.8
3	Fertiliser	1533	7.0	2928	6.9
4	Irrigation	-	-	10383	24.3
5	Manure	3750	17.2	3408	8.0
6	Pesticides	788	3.6	2300	5.4
	Total Cost	21784	100	42647	100
B	**Return (Rs/ha)**				
1	Gross return	24463		52458	
	Net return	2679		9811	
C	**Yield**				

	Main product (kg/ha)	2053		4300	
	By-product	10		9	
D	**Output-input ratio**	1.12		1.23	

Note:

1. **production of by-product (straw) in Kahan (local unit), 1 kahan = 1280 bundle of straw,*
2. *Gross return includes value of by-product also.*
3. *** value of by-product in Rs*
4. *Total cost in Kultali and Patharpratima Cluster includes miscellaneous cost of Rs 1125*

Table 18: Economics of *Kharif* Rice grown by the farmers in Andaman & Nicobar Islands

(per ha)

Particulars	Qty (Kg or specify if others)	Rate (Rs)	Amount (Rs)
Cost of seed	50	9	450
Total labour (no)	68	180	14490
No of irrigation applied (no)	0	0	0
Cost of Fertlizer	0	0	0
Urea	120	450/50 kg	900
DAP	50	8/kg	400
SSP	0	0	0
MOP	50	250	250
Cost of pesticides (insecticides and fungicides)	1 lit	450	450
Total Cost (Rs/ha)			16940
Production			
Main product	2500	8	20000
By-product	1 truck	500	500
Total Return (Rs/ha)			20500
Net Return (Rs/ha)			3560

Major varieties cultivated are Jaya and C-14-8, Data pertains to Deshbandhugram cluster

6. ECONOMICS OF FISHERIES

The economics of fish cultivation (both freshwater & brackishwater) and paddy-cum-fish has been presented in **Table 19, 20 & 21**.

Table 19 : Economics of freshwater fish cultivation in study clusters

Sl no	Particulars	Sandeshkhali	Canning I	Kakdwip	A & N Islands
1.	Area surveyed (ha)	0.042	21.91	17.25	6

2.	Cost of pond preparation/ maintenance (Rs /ha)	6738	693	1000	130000
3.	Cost Fish seed (Rs/ha)	29595	1870	2000	48385
4.	Total production (kg/ha)	1976	184	600	735
5.	Average selling price of fish (Rs/kg)	85	70	60	100
6.	Total Return (Rs/ha)	168643	12879	36000	73483

Note:

1. Major fish species grown are Rohu, Katla, Mrigal, Grass Carp, Silver carp, Tangra, Prawn etc
2. Almost all the fish growers uses own land and very few takes on lease @ Rs 1000-1500/year
3. Fisheries are managed entirely by family labour and almost without any special care, therefore the cost of labour was very insignificant and has not been imputed

Table 20 : Economics of Brackishwater fish cultivation in study clusters

Sl no	Particulars	Canning I	Kakdwip	A & N Islands
1.	Area surveyed (ha)	4.20	22.65	0.5
2.	Cost of pond preparation or maintenance (Rs/ha)	2087	500	238000
3.	Cost Fish seed (Rs/ha)	5388	Free (Tidal entry)	22000
4.	Total production (kg/ha)	649	400	460
5.	Average selling price of fish (Rs/kg)	115	60	100
6.	Total Return (Rs/ha)	35843	24000	46000

Note:

1. Major fish species grown are Shrimp, Bhetki, Parse, Bhangon, Crabs etc
2. Fisheries are managed entirely by family labour ad almost without any special care, therefore the cost of labour was very insignificant and has not been imputed

Table 21 : Economics of fisheries under Paddy-cum-fish cultivation in study clusters

Sl no	Particulars	Canning I	Kakdwip	A & N Islands
1.	Area surveyed (ha)	2.31	2.5	3
2.	Cost Fish seed (Rs/ha)	9355	2000	7333
3.	Total production (kg/ha)	232	300	233
4.	Average selling price of fish (Rs/kg)	110	70	100

5.	Total Return (Rs/ha)	25548	21000	23333

Note: Major fish species grown area Rohu, Katla, Mrigal and prawn

7. CRITICAL GAP ANALYSIS

Sl. No.	Critical Gap	Baseline Information			Intervention	Benefit
1.	High soil and water salinity, high acidity of soil (acid-sulphate soils, etc.)	Resource Soil Water	ECe 1.8-18.7 0.40-24.8	PH 3.5-8.2 4.9-8.4	1. Land shaping 2.Drainage improvement 3. Rain water harvesting 4. Introduction of salt tolerant crop varieties 5.Liming of acid soil	1.Decline in salinity build up, increase cultivable land improve land productivity, 2.Mangement of salinity and acidity affected degraded land for better use
2.	Non-scientific nutrient management	Less or no application of organic manure, imbalanced fertilizer application			1. Introduction of composting, green manuring, vermi composting, INM, etc. 2.Traning on crop nutrient management	1. Increase in land productivity and soil health 2. Decrease in cost of production.
3.	Scarcity of good quality irrigation water during Rabi/summer	Mono-cropping (cropping pattern is skewed to *Kharif* season only), very low cropping			1. Rain water harvesting 2. Short duration/low	1.Increase in irrigated area 2. Increase in cropping intensity

	season.	intensity (120-127 %) Irrigation water available for live saving irrigation of crop on 20-25 % of land having irrigation facilities only.	water requiring crops. 3. Practicing multi-cropping system	3. Increase farm income 4.Decrease in soil salinity build up
4.	Low crop productivity	Traditional crop varieties, low rice yield:1.8-2.1 t/ha in *Kharif* and 3.5-4.2 t/ha in *Rabi* season, Limited scope of high value crops due to acute shortage of good quality irrigation water, soil salinity, drainage congestion	1. Introduction of HYV/improved crop varieties 2. Creating water recourses for irrigation 3.introduction of non-traditional high value crop on reshaped land	1. Option for multi crops. 2. Increase in crop productivity. 3. Employment generation and reduction in migration of labour
5.	Low crop diversification	Extent of crop diversification through Simpson Index Value (SID) estimated to be 0.39 only implying very low level of crop diversification. Salinity of soil and water, scarcity of irrigation water, low-land situation	1. Land shaping 2. Multi cropping system 3. Fruit crop cultivation	1. Increase in land productivity. 2. Increase in farm income. 3. Employment generation 4. Encourage agriculture based industry
6.	Low land & water productivity which is unable to sustain livelihood	Majority of people (35-56 %) depend on agriculture	Introduction of farming System with integration of crop and fish through improved practices	1.Increase in productivity of land and water 2. Increase in household income, employment generation and reduction in labour migration
7.	Lack of alternative livelihood option for landless/marginal men and woman farmer	Limited option for agriculture-allied activities due to poor backward linkages	Mushroom cultivation, Bee keeping, Goatery, Livestock management	1.Increase income from agriculture & allied activity 2. Improved nutrition of poor familiesy 3. Increase income

				of women farmer
8	Very low level of farm mechanization and high drudgery	Manual operation, labour intensive and less labour efficiency	Introduction of low cost farm mechanization	1. Reduction of drudgery 2. Decrease cost of cultivation 3. Increase in labour efficiency
9.	Less knowledge about improved agricultural technologies	Unaware about improved agricultural technologies	1. Establishment of Rural Technology Centres 2. Skill and capacity building of farmers	1. Increase application of improved agricultural technologies 2. Overall improvement of agricultural productivity 3. Higher livelihood security and income
10.	Low productivity of freshwater fish culture	Non-scientific fish cultivation and less availability of quality seed, low fish productivity (<1t/ha)	1. Introduction of improved practices of fresh water fish cultivation 2. Fish nursery raising	1. Increase fish production and income 2. Improve household nutrition and income
11.	Unutilization of available Brackishwate	Plenty of unutilized brackishwater in the area, use fish seed from tidal entry or collection from natural water bodies	1.Introduction of brackish water fish cultivation	1. Increase fish production 2. Improve household nutrition and income. 3. Better utilization of natural resources of land and water

REFERENCES

Collection of baseline information through PRA at Chandkhali village in Canning Cluster of Sundarbans

Collection of baseline information through PRA at Kakdwip cluster of Sundarbans

Collection of baseline information through personal interview (Kakdwip)

Collection of baseline information through personal interview (Kakdwip)

Collection of baseline information through personal interview in villages of Nimpith cluster

Collecting baseline information - Chandkhali village in canning Cluster

Typical view of houses in Canning cluster of Sundarbans

Typical view of houses in Canning cluster of Sundarbans

Colleting baseline information through PRA at Andharia village of Caning Cluster

Briefing farmers about the NAIP project

Collection of baseline information through personal interview at villages in Sandeshkhali cluster

Collection of baseline information through personal interview at villages in Sandeshkhali cluster

View of agriculture land in Andaman & Nicobar Island showing deposit of ferric salts on soil surface alongwith salts after Tsunami

Discussion and briefing about the NAIP project to the farmers of A & N Island