Title of Sub-project:
Strategies for sustainable management of degraded coastal land and water for enhancing livelihood security of farming communities

Central Soil Salinity Research Institute
Regional Research Station
Canning Town, South 24 Parganas
West Bengal-743 329 (INDIA)
2013-14
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**Executive Summary**

NAIP sub-project on ‘Strategies for sustainable management of degraded coastal land and water for enhancing livelihood security of farming communities’ is being implemented since September 2009 under consortium mode with the specific objectives of (i) sustainable enhancement of the productivity of degraded land and water resources of the coastal region through integrated approaches; (ii) enhancement of livelihood security and employment generation for the poor farming communities of the coastal region; and (iii) empowerment through capacity building and skill development of stakeholders including men and women farmers. Central Soil Salinity Research Institute, Regional Research Station (CSRI, RRS), Canning Town is the lead center of the consortium and the partners are Ramkrishna Ashram Krishi Vigyan Kendra (RAVKK), Nimpith, Central Institute of Brackishwater Aquaculture, Kakdwip Research Centre (CIBA, KRC), Kakdwip, Bidhan Chandra Krishi Viswavidyalaya (BCKV), Mohanpur and Central Agricultural Research Institute (CARI), Port Blair. The project sites are located in disadvantaged areas in Sundarbans region of Ganges delta (West Bengal) and Tsunami affected Andaman & Nicobar Islands covering 32 villages in 12 Clusters in 4 districts (2 in West Bengal and 2 in Andaman & Nicobar Islands). The project was implemented in 8 Clusters representing 7 Blocks viz. Canning I, Basanti, Patharpatima, Mathurapur II, Kultali, Namkhana and Kakdwip in South 24 Parganas District and 1 Block viz. Sandeshkhali II in North 24 Parganas District in Sundarbans and in 4 Clusters viz. Chouldari in Port Blair and Shoal Bay in Ferrargunj in South Andaman District, and Dashrathpur in Rangat and Deshbandhugram in Diglipur in North & Middle Andaman District in Andaman & Nicobar Islands.

Major critical gaps identified in the project sites are (i) degraded land and water with high salinity, and water logging & drainage congestion; (ii) high scarcity of good quality of irrigation water during dry season with poor cropping intensity (mono-cropped) and low productivity of land & water; and (iii) poor soil health and unscientific soil fertility management. Various technological interventions suiting the prevailing land and water resources were implemented to bridge these gaps for higher land and water productivity in sustainable manner.

The major technological interventions/ innovations implemented in the study areas were land shaping for improving drainage facility, rainwater harvesting and enhancing productivity of low lying degraded land including affected land; cultivation of multiple and diversified crops including horticultural crops and their improved varieties for degraded saline and affected lands, promotion of composting including vermi-composting, green manuring, INM, etc. for enhancing productivity of agriculture and aquaculture and improvement of soil health; skill and capacity building of farmers and other stakeholders, and establishment of Rural Technology Centers (RTCs) in villages at the project sites.

About 349.58 ha of land in disadvantaged areas in Sundarbans and Andaman & Nicobar Islands has been converted from mono-cropped to multi-cropped with integrated crop and fish cultivation through implementation of different land shaping techniques like farm pond, deep furrow & high ridge, paddy-cum-fish, broad bed & furrow, three tire system, paired bed system and drainage improvement network. About 12,06,073 m³ rain water has been harvested under
various land shaping techniques adopted in 342.39 ha area which has been brought under multiple cultivation of crops and fishes with harvested rainwater. The cropping intensity has been increased up to 240% from a base level value of 100% due to implementing the land shaping techniques in the study area, as an additional benefit it contributed to harvesting of atmospheric CO$_2$. Compared to base line value the income of the farmers has increased by manifolds. Raising of land and creating water harvesting facilities reduced the problem of drainage congestion and salinity build up in soil during dry months thus, improved soil environment. Reduction of salinity and drainage congestion and increase in availability of fresh water for irrigation helped the farmers to grow multiple and diversified crops round the year instead of mono-cropping with rice in monsoon season (Kharif). About 3,66,000 man-days have been created per year from the farming activities after 3 years of implementation of land shaping techniques in the study area. As the farmers get employment in their own farm land throughout the year, this has checked the seasonal migration rate of the farm family. About 20.72 ha area has been brought under brackishwater aquaculture through shaping of land into shallow depth pond in the coastal areas particularly near the brackishwater rivers or sea coast which remain highly saline throughout the year and not suitable for crop cultivation.

New crops and improved varieties of crops have been introduced in 387.7 ha area in mono-cropped areas of degraded land in dis-advantaged region of Sundarbans and Andaman & Nicobar Islands for sustaining food security and economic growth. Introduction of improved varieties and diversified new crops has increased productivity of degraded land, enhanced employment, reduced risk for crop failure, provided better food and nutritional security, improved soil health, crop nutritional imbalances and increased farm income. The experiences/knowledge gained by the farmers will be helpful for future climate change adaptation in coastal areas.

Technological interventions like green manuring with *Sesbania*, fertilizer application on soil test basis and vermi-compost making were introduced to enhance the health and fertility status of the degraded soils. About 121.2 ha of degraded land have been brought under improved nutrient management and 133 numbers of vermi-composting units have been established in the study areas.

On-campus and off-campus training programmes and exposure visits of farmers were organized by all the partner institutions on various aspects for skill and capacity building of the farming communities of the study area. More than 6000 farmers participated in 133 nos. of trainings/exposure visits. Four numbers of Rural Technology Centres were established in Canning I, Patharpratima, Kakdwip and Kultali Clusters of Sundarbans region for dissemination of improved technologies in rural areas during the project period and post project period.

About 6400 farmers are using different technological interventions in the study area under this project. For the post project sustainability funds have been created and an amount of Rs. 99.45 lakhs as sustainability fund has been generated up to Feb. 2014 to ensure continued technological upgrading and hand holding of the beneficiary farmers.
Part-I: General Information of sub-project

1. **Title of the Sub-project:** Strategies for Sustainable Management of Degraded Coastal Land and Water for Enhancing Livelihood Security of Farming Communities

2. **Sub-project Code:** 2104

3. **Component:** 3

4. **Date of sanction of sub-project:** September 03, 2009

5. **Date of completion:** March 31, 2014

6. **Extension if granted:** September 01, 2013 to March 31, 2014

7. **Total sanctioned amount for the sub-project:** Rs. 1868.9398 lakhs (From Sep. 2009-Mar 2014)

8. **Total Expenditure of the sub-project:** Rs. 1743.009 lakhs

9. **Consortium Facilitator:**
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   Central Soil Salinity Research Institute, Karnal - 132 001, Haryana, India
   Telephone : +91-184-2290501 Fax : +91-184-2290480, 2292489
   E-mail : director@cssri.ernet.in
   Website : www.cssri.org

10. **List of Consortium Partners:**

<table>
<thead>
<tr>
<th>Name of CPI/ CCPI with designation</th>
<th>Name of organization and Address, Phone &amp; Fax, Email</th>
<th>Duration (From-To)</th>
<th>Budget (Rs. Lakhs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>CPI Dr. D. Burman, Principal Scientist</td>
<td>Central Soil Salinity Research Institute, Regional Research Station (CSSRI, RRS), Canning Town, West Bengal-743329 Tel: 03218-255241/255085 Fax: 03218-255084 Email: <a href="mailto:burman.d@gmail.com">burman.d@gmail.com</a></td>
<td>Mar.01, 2013 to Jun.30, 2014</td>
<td>377.548</td>
</tr>
<tr>
<td>CPI Dr. B. K. Bandyopadhyay, Principal Scientist &amp; OIC</td>
<td>Central Soil Salinity Research Institute, Regional Research Station (CSSRI, RRS), Canning Town, West Bengal-743329 Tel: 03218-255241/255085 Fax: 03218-255084 Email: <a href="mailto:bimalbkb@gmail.com">bimalbkb@gmail.com</a></td>
<td>Sep. 03, 2009 to Feb. 28, 2013</td>
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<td>Name of CPI/ CCPI with designation</td>
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<td>Duration (From-To)</td>
<td>Budget (Rs. Lakhs)</td>
</tr>
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</tr>
<tr>
<td>CCPI Dr. Subhasis Mandal, Senior Scientist</td>
<td>Central Soil Salinity Research Institute, Regional Research Station (CSSRI, RRS), Canning Town, West Bengal-743329 Tel: 03218-255241/255085 Fax: 03218-255084 Email: <a href="mailto:burman.d@gmail.com">burman.d@gmail.com</a></td>
<td>Mar.01, 2013 to Jun.30, 2014</td>
<td>692.9985</td>
</tr>
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<td>CCPI Dr. D. Burman, Principal Scientist</td>
<td>Central Soil Salinity Research Institute, Regional Research Station (CSSRI, RRS), Canning Town, West Bengal-743329 Tel: 03218-255241/255085 Fax: 03218-255084 Email: <a href="mailto:burman.d@gmail.com">burman.d@gmail.com</a></td>
<td>Sep. 03, 2009 to Feb. 28, 2013</td>
<td>381.7574</td>
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<tr>
<td>CCPI Dr. N.J. Maitra, Programme Coordinator</td>
<td>Ramkrishna Ashram Krishi Vigyan Kendra (RAVKK), Nimpith Ashram, South 24-Pgs, West Bengal-743338 Phone: 03218-226002 Fax: 03218-226636 E-mail: <a href="mailto:njmaitra@rediffmail.com">njmaitra@rediffmail.com</a></td>
<td>Sep. 03, 2009 to Jun. 30, 2014</td>
<td>135.8646</td>
</tr>
<tr>
<td>CCPI Dr. T.K. Ghosal, Senior Scientist &amp; Head</td>
<td>Central Institute of Brackishwater Aquaculture, Kakdwip Research Centre (CIBA, KRC), Kakdwip, West Bengal-743347 Tel: 03210-255072 Fax:03210-255012 E-mail: <a href="mailto:ghoshalciba@gmail.com">ghoshalciba@gmail.com</a></td>
<td>Sep. 03, 2009 to Jun. 30, 2014</td>
<td>280.7695</td>
</tr>
<tr>
<td>CCPI Dr. Biswapati Mandal, Professor &amp; Pro-VC</td>
<td>Bidhan Chandra Krishi Viswavidyalaya (BCKV), Mohanpur, Nadia, West Bengal-741 252 Tel. : 033-25879772, 03473-222666 Fax No. 03473-222275 e-mail: <a href="mailto:mandalbiswpati@rediffmail.com">mandalbiswpati@rediffmail.com</a></td>
<td>Sep. 03, 2009 to Jun. 30, 2014</td>
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<tr>
<td>CCPI Dr. S. K. Ambust, Principal Scientist &amp; Head (NRM Div.)</td>
<td>Central Agricultural Research Institute (CARI), Port Blair, Andaman &amp; Nicobar Islands-744101 Tel: 03192-250436 Fax: 03192-251068 E-mail: <a href="mailto:skambast@cari.res.in">skambast@cari.res.in</a>, <a href="mailto:skambast@gmail.com">skambast@gmail.com</a></td>
<td>Sep. 03, 2009 to Apr. 2012</td>
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</tr>
<tr>
<td>Name of CPI/ CCPI with designation</td>
<td>Name of organization and Address, Phone &amp; Fax, Email</td>
<td>Duration (From-To)</td>
<td>Budget (Rs. Lakhs)</td>
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<tr>
<td>CCPI Dr. A. Velmurugan, Senior Scientist &amp; I/C Head (NRM Div.)</td>
<td>Central Agricultural Research Institute (CARI), Port Blair, Andaman &amp; Nicobar Islands-744101 Tel: 03192-250436 Fax: 03192-251068 E-mail: <a href="mailto:vels_21@yahoo.com">vels_21@yahoo.com</a></td>
<td>Apr. 2012 to June 2014</td>
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CPI-Consortia Principal Investigator; CCPI-Consortia Co-Principal Investigator

11. Statement of budget released and utilization partner-wise (Rs in Lakh):

<table>
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<th>CPI/ CCPI (Name, designation &amp; address)</th>
<th>Total Budget Sanctioned</th>
<th>Fund Released (up to Closing Date)</th>
<th>Fund Utilized (up to March 15)</th>
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<tr>
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<td>377.548</td>
<td>377.5480</td>
<td>364.2701</td>
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<td>CCPI1 Dr. Subhasis Mandal, Senior Scientist, CSSRI,RRS, Canning Town, West Bengal-743329</td>
<td>692.9985</td>
<td>687.1433</td>
<td>692.4345</td>
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<td>104.5326</td>
<td>104.3828</td>
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<tr>
<td>CCPI4 Prof. Biswapati Mandal, Professor &amp; Pro-VC, BCKV, Mohanpur, Nadia, West Bengal–741 252</td>
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<td>CCPI5 Dr. A. Velmurugan Head in Charge, Senior Scientist, CARI, Port Blair, Andaman &amp; Nicobar Islands-744101</td>
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<td>1759.451</td>
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CPI-Consortia Principal Investigator; CCPI-Consortia Co-Principal Investigator
Part-II: Technical Details

1. Introduction

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 (Sundarbans region of the Ganges delta) are dominated by marginal farmers of the backward classes of people who are some of the poorest people in the world. Low agricultural productivity and high unemployment among the rural people is the characteristic feature of the area.

The low agricultural productivity of the coastal region is because of one or more of the following reasons viz. degradation of soil and water quality, cyclones/storm, lack of irrigation water, drainage congestion, weather adversities, etc. The degradation of the soil and water of coastal areas is caused due to phenomena like saline water flooding following breach or overflow of embankments due to very high tides, storms or Tsunami waves (as in Andamans) and presence of shallow brackish ground water table near the soil surface. The situation is common in delta region of major rivers like Ganges (Sundarbans), Mahanadi, Godavari, etc. The degraded soil and water of the coastal region is further likely to be endangered due to sea level rise following global warming. One or more of the natural adversities like, cyclones, Tsunami, gales, heavy rains, floods, etc. which cause colossal loss to the crops and properties are almost annual features of the coastal region, particularly in the east coast of the country including the Andaman & Nicobar Islands.

Agriculture in the coastal region is entirely dependent on rains which mostly occur only in a few monsoon months. The regions receive high rainfalls, which are concentrated only over a few monsoon months (June-September). Due to this heavy concentrated rainfall in a short span, flat topography, low infiltration rate, presence of ground water at the surface and lack of proper drainage facility most of the cultivated fields are deeply waterlogged in *Kharif* (wet) season. Thus, limiting the cultivation of HYVs of rice and leaving no choice for alternate crops other than tall *indica* rice varieties in *Kharif*. During *Rabi* (dry) season, acute shortage of irrigation water along with increase in soil and water salinity due to presence of brackish water table at a shallow depth compelled the farmers to keep their land fallow leading to high poverty and unemployment among the rural people. In spite of the vast resource potentials in the coastal region, the enhancement of the agricultural productivity could be achieved through scientific planning and management of the vast natural resources of the region.
of coastal lands has been neglected. The coastal areas are much lagging behind many inland areas in terms of agricultural productivity and livelihood security of the farmers.

It has been well tested that a potential source of good quality irrigation water for dry months can be created if the rainwater that goes waste into the sea can be harvested. This will increase the crop production in the area and will also minimize the effect of land and water degradation. An ample supply of brackish water resource is available in the region, which may be utilized judicially, either alone or in conjunction with harvested rain water for increasing productivity of the land and water. With proper scientific planning and management of the vast natural resources of the coastal region it is possible that the agricultural productivity of the degraded soil and water can be considerably increased. Increase in productivity of land will enhance the livelihood security of farming community and will generate employment opportunities which is extremely poor in the region. In view of the urgent necessity of increasing food production to feed the increasing population in this country, it is of utmost importance to enhance the agricultural productivity of the low producing marginal lands like, coastal lands as most of the productive lands are already under high pressure.

2. Overall Sub-project Objectives:

The problems of degraded land (salinity and drainage congestion) and water quality (salinity) of the coastal region can be considerably minimized and the livelihood security can be subsequently improved if efforts are made to utilize the vast natural resources of coastal region. The overall objectives of this project is to curb the ill-effects of degraded land and water of the disadvantaged coastal regions of Sundarbans and Andaman islands for improving productivity, livelihood security and employment opportunities of rural men and women, and their capacity building. The conservation of environmental qualities and ecology is given due importance in the project for sustainability. The specific objectives, in brief, are:

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

**Project sites:**

The project was implemented as Cluster approach basis. Each Cluster is representing 2-3 villages from adjoining areas. The Clusters of contiguous villages were selected in the degraded (salt affected) coastal region in West Bengal (Sundarbans region of Ganges delta) and Tsunami affected region in Andaman & Nicobar Islands covering 32 villages in 12 Clusters in 4 districts (Fig.1, Table 1). A total of 13212 no. of farm households with a total population of 79045 persons are dwelling in these villages. The Clusters were selected through participatory survey by the scientific teams of the respective consortium partners in collaboration with local farmers, farmers’ gosthis/ associations, NGOs and State Departments. In the Sundarbans region of both main land and islands were taken up. In selecting the villages priorities were given to the conditions of poor livelihood of the rural communities and low productivity of land due to soil and water degradation. The priorities were also given while selecting the beneficiaries to mostly small and marginal farmers having small land holding and having problems of degraded soil and water quality in their farm lands. Each partnering institutes were working in one or two Cluster(s) with primary focus on agriculture based livelihood interventions. This project was implemented by CSSRI, RRS in Canning I & Basati Clusters, by RAKVK in Patharpratima, Mathurapur II & Kultali Clusters, by CIBA, KRC in Kakdwip & Namkhana Clusters, by BCKV in Sadeshkhali II Cluster in the Sundarbans region and by CARI in Shoal Bay, Chouldari, Dashrathpur & Deshbandhunagar Clusters in Andaman & Nicobar Islands. The Clusters in Andaman & Nicobar Islands represents distinct island agro-ecoregion which is strikingly different from other Clusters in Sundarbans in Ganges delta. All the villages in each Cluster are affected by the typical problems of coastal region viz. soil & water salinity, drainage congestion, climatic adversities etc.
Fig. 1 Location of study area in Sundarbans and Andaman & Nicobar Islands
Table 1. Profile of project Clusters in the project sites

<table>
<thead>
<tr>
<th>District</th>
<th>Clusters</th>
<th>Villages</th>
<th>Total no of Households</th>
<th>Total population</th>
</tr>
</thead>
<tbody>
<tr>
<td>South 24 Parganas</td>
<td>Canning I</td>
<td>Chandkhali, Andharaia and Bahirsona</td>
<td>1118</td>
<td>5717</td>
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<tr>
<td>(West Bengal)</td>
<td>Basanti</td>
<td>Joygopalpur, Dakshin Moakamberia and Motgora</td>
<td>1583</td>
<td>10744</td>
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<td>Patharpratima</td>
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<td>2076</td>
<td>15730</td>
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<td>Mathurapur II</td>
<td>Damkal</td>
<td>1012</td>
<td>6551</td>
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<td></td>
<td>Kultali</td>
<td>Shyamnagar, Dakshin Durgapur and Madhabpur</td>
<td>2679</td>
<td>15075</td>
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<td></td>
<td>Namkhana</td>
<td>Dariknagar, Ganeshnagar and Uttar Chandanpuri</td>
<td>1254</td>
<td>5823</td>
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<td>Kakdwip</td>
<td>Gangadharpur, Jumainaskar and Akshyanagar</td>
<td>1379</td>
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<td></td>
<td>Sandeshkhali II</td>
<td>Korakathi, Dhunsnikhali and Tushkhi</td>
<td>388</td>
<td>1994</td>
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<td>North 24 Parganas</td>
<td>Shoal Bay in Ferrargunj</td>
<td>Shoal Bay</td>
<td>60</td>
<td>460</td>
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<tr>
<td>(West Bengal)</td>
<td>Chouldari in Port Blair</td>
<td>Craikabad, Port Mount and Badmash pahad</td>
<td>464</td>
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<td>(Andaman &amp; Nicobar Islands)</td>
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<td>1033</td>
<td>2876</td>
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<td>Deshbandhugram in Diglipur</td>
<td>Deshbandhugram, Rabindrapally and Madhupur</td>
<td>166</td>
<td>2839</td>
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<tr>
<td>4 Districts</td>
<td>12 Clusters</td>
<td>32 Villages</td>
<td>13212</td>
<td>79045</td>
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</tbody>
</table>

**Climate:** Sundarbans region lies between 21°32’ and 22° 40’ N latitude and between 88° 05’ and 89° 0’ E longitude and is recognized as one of the most disadvantaged areas in the World dominated by the poor farming communities. The UNESCO has also declared it as one of the heritage sites for biosphere diversity. The is classified as hot humid with three distinct seasons, viz. winter, summer and monsoon. Winter starts in the later part of November and lasts up to the middle of February, when heavy dew at night can be marked. January is the coldest month of the year. Summer starts from middle of March and continues up to June with occasional pre-monsoon rains in the later part of the season. Monsoon continues from July to September and gradually ceases from middle of October. The average minimum and maximum temperature in
the region during winter, summer and monsoon seasons are 13.6 and 31.6, 18.6 and 38.3 and 23.5 and 34.1°C, respectively. Relative humidity is high throughout the year, highest being in the monsoon, reaching almost 100%. The rainfall is received mostly from South-West monsoon which contributes about 80 percent of total annual rainfall and July to mid–September are the most wetted months. The average annual precipitation in this area is 1768 mm. In the summer season extended from April to middle of June, the temperature rises to around 40°C with humidity sometimes almost 100%.

Andaman & Nicobar Islands comprises of about 556 small and big islands with a coastline of 1,962 km between 92°-94° E longitude and 6°-14° N latitude in the Bay of Bengal. Crop growing season in Andaman and Nicobar Islands can be grouped in to wet and dry season. The climate of Andaman & Nicobar Islands is hot and humid with wet season (Kharif) is between May to November and dry season (Rabi) is from December to April. The Islands receives South-West monsoon from May to September and North-East monsoon during October to November. On an average, the Islands receive 3074 mm 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. From December to April, the rainfall is scanty or almost absent. The usual range of wind speed is 5 to 15 kmph in different months.

**Technological interventions/ innovations implemented:**

Following technological interventions/ innovations were implemented in the project sites in Sunderbans and Andaman & Nicobar Islands.
1. Land shaping for improving drainage facility, rainwater harvesting and enhancing productivity of low-lying degraded land including Tsunami affected land
2. Cultivation of multiple and diversified crops including horticultural crops and their improved varieties for degraded saline and Tsunami affected lands
3. Integrated cultivation of crops and fishes (freshwater and brackishwater fishes)
4. Promotion of composting including vermi-composting, green manuring, INM, etc. for enhancing productivity of agriculture and aquaculture and improvement of soil health
5. Improved irrigation system for efficient water utilization in horticultural and plantation crops
6. Introduction of low cost farm machineries for drudgery reduction and economic farm operations
7. Nursery raising for horticultural crops and fish seeds
8. Introduction and improvement in livestock/ poultry including nutrition and disease management
9. Introduction of mushroom cultivation and bee-keeping
10. Introduction of protected cultivation for high value crops
11. Establishment of Rural Technology Centers in villages at the project sites
12. Skill and capacity building of farmers and other stakeholders

Out of these technological interventions/innovations mentioned above the minor interventions like introduction of low cost farm machineries for drudgery reduction and economic farm operations, improved irrigation systems, nursery raising for horticultural crops and fish seeds, introduction and improvement in livestock/poultry including nutrition and disease management, introduction of mushroom cultivation and bee-keeping were discontinued from 2011-12 with the instruction from PIU, NAIP and World Bank review team with the contention that the project should give more emphasis on sustainable land management for which these interventions are not important.

4. Baseline Analysis

Detail baseline survey was conducted through pre-structured survey schedule; Focused Group Discussion (FGD) and Participatory Rural Appraisal (PRA) the study villages. The survey was conducted through a pre tested survey schedule, which contains all relevant information regarding socio-economics, agriculture and environment etc. Sampling of soil and water were randomly done from each project site. Various secondary data relevant to project area was also collected from different sources. These survey data was analyzed through relevant statistical and econometric tools. Collected soil and water sample were tested in laboratory. New Cluster of villages under Basanti and Mathurapur II were undertaken later on, detail information on these villages were collected, analysed and included in the report. Some of the major findings in baseline analysis are furnished below.

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 2. It was observed that average family size was 5 to 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 Andaman & Nicobar Islands 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 Andaman & Nicobar Island, the OBC population was the most dominating community (Fig. 2). 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 Andaman & Nicobar Islands Clusters (10-33%). In general it was observed that the illiteracy was quite prevalent in the Clusters under study.
### Table 2. Demographic features of population in selected Clusters in Sundarbans

<table>
<thead>
<tr>
<th>Sl no.</th>
<th>Clusters</th>
<th>Avg. family size (no)</th>
<th>F : M (no of female per 1000 male)</th>
<th>% SC</th>
<th>% ST</th>
<th>% General</th>
<th>% Illiteracy</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Canning</td>
<td>5.13</td>
<td>980</td>
<td>83.83</td>
<td>0.09</td>
<td>15.06</td>
<td>26.00</td>
</tr>
<tr>
<td>2.</td>
<td>Bsanti</td>
<td>6.25</td>
<td>978</td>
<td>83.25</td>
<td>1.75</td>
<td>15.00</td>
<td>35.00</td>
</tr>
<tr>
<td>3.</td>
<td>Patharpratima</td>
<td>7.18</td>
<td>945</td>
<td>29.24</td>
<td>2.58</td>
<td>68.16</td>
<td>45.40</td>
</tr>
<tr>
<td>4.</td>
<td>Mathurapur II</td>
<td>6.47</td>
<td>942</td>
<td>9.29</td>
<td>6.52</td>
<td>84.19</td>
<td></td>
</tr>
<tr>
<td>5.</td>
<td>Kultali</td>
<td>5.72</td>
<td>925</td>
<td>33.96</td>
<td>17.96</td>
<td>48.05</td>
<td>49.54</td>
</tr>
<tr>
<td>6.</td>
<td>Kakdwip</td>
<td>5.20</td>
<td>980</td>
<td>17.98</td>
<td>0.21</td>
<td>80.56</td>
<td>29.29</td>
</tr>
<tr>
<td>7.</td>
<td>Namkhana</td>
<td>4.72</td>
<td>951</td>
<td>23.84</td>
<td>0.00</td>
<td>71.13</td>
<td>11.77</td>
</tr>
<tr>
<td>8.</td>
<td>Sandeshkhali</td>
<td>5.00</td>
<td>956</td>
<td>75.26</td>
<td>8.51</td>
<td>9.54</td>
<td>16.00</td>
</tr>
<tr>
<td>9.</td>
<td>Chouldari</td>
<td>4.00</td>
<td>993</td>
<td>0.00</td>
<td>0.00</td>
<td>73.30</td>
<td>10.00</td>
</tr>
<tr>
<td>10.</td>
<td>Shoal Bay</td>
<td>7.00</td>
<td>993</td>
<td>0.00</td>
<td>0.00</td>
<td>100</td>
<td>33.30</td>
</tr>
<tr>
<td>11.</td>
<td>Dashrathpur</td>
<td>9.00</td>
<td>984</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00*</td>
<td>17.00</td>
</tr>
<tr>
<td>12.</td>
<td>Deshbandhugram</td>
<td>9.00</td>
<td>977</td>
<td>0.00</td>
<td>0.00</td>
<td>0.00*</td>
<td>24.00</td>
</tr>
</tbody>
</table>

Note: 1. Clusters 1-8 are in Sundarbans region and 9-12 are in Andaman & Nicobar Islands
2. In Shoal Bay 26.6 % of HH belongs to OBCs, * in Dashrathpur and Deshbandhugram Cluster 100% HH belongs to general and OBC categories, respectively.

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**Fig. 2 Demographic features of sample households under study**
Operational holdings pattern and land situations

The operational holding pattern given in tables and figures below (Table 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 Sunderbans 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 Andaman & Nicobar Islands and the average holding size was 1.80 2.80 ha across the Clusters under study. Around 90 % of the farmers in Sunderbans 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 Andaman & Nicobar Islands, 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 (Fig.3). 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 Sunderbans. 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 3. Operational holdings pattern and land situations

<table>
<thead>
<tr>
<th>Sl no</th>
<th>Cluster</th>
<th>Avg. farm size (ha)</th>
<th>Categories of farmers</th>
<th>Land situations#</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Marginal (%)</td>
<td>Small (%)</td>
<td>Landless/others (%)</td>
</tr>
<tr>
<td>1</td>
<td>Canning</td>
<td>0.19 (1.9)</td>
<td>95</td>
<td>1</td>
</tr>
<tr>
<td>2</td>
<td>Basanti</td>
<td>0.36 (1.25)</td>
<td>85</td>
<td>5</td>
</tr>
<tr>
<td>3</td>
<td>Patharpratima</td>
<td>0.56 (4)</td>
<td>91</td>
<td>7</td>
</tr>
<tr>
<td>4</td>
<td>Mathurapur II</td>
<td>0.51 (4)</td>
<td>92</td>
<td>6</td>
</tr>
<tr>
<td>5</td>
<td>Kultali</td>
<td>0.50 (4)</td>
<td>93</td>
<td>3</td>
</tr>
<tr>
<td>6</td>
<td>Kakdwip</td>
<td>0.36 (3.24)</td>
<td>89</td>
<td>6</td>
</tr>
<tr>
<td>7</td>
<td>Namkhana</td>
<td>0.29</td>
<td>91</td>
<td>4</td>
</tr>
<tr>
<td>Sl no</td>
<td>Cluster</td>
<td>Avg. farm size (ha)</td>
<td>Categories of farmers</td>
<td>Land situations#</td>
</tr>
<tr>
<td>-------</td>
<td>---------------</td>
<td>---------------------</td>
<td>-----------------------</td>
<td>-----------------</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Avg. margi. (%)</td>
<td>Small (%)</td>
</tr>
<tr>
<td>8</td>
<td>Sandeshkhali</td>
<td>0.36 (2.35)</td>
<td>88</td>
<td>8</td>
</tr>
<tr>
<td>9</td>
<td>Chouldari</td>
<td>1.8</td>
<td>30</td>
<td>50</td>
</tr>
<tr>
<td>10</td>
<td>Shoal Bay</td>
<td>2.6</td>
<td>27</td>
<td>18</td>
</tr>
<tr>
<td>11</td>
<td>Dashrathpur</td>
<td>2.8</td>
<td>10</td>
<td>26</td>
</tr>
<tr>
<td>12</td>
<td>Deshbandhugram</td>
<td>2.4</td>
<td>39</td>
<td>40</td>
</tr>
</tbody>
</table>

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.
3. In Sandeshkhali 9% farmers belonged to others category such as medium, semi-medium or large.
4.* Indicates other category of farmers such as semi-medium, medium or large.
5.** In Shoal Bay Cluster 57% land situation is hilly.
6.*** In Deshbandhunagar 43% land situation is hilly.
7. 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. 3 Land holding patterns and land situations under study area.

**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. 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 4, Fig. 4). 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.

Table 4. Occupation pattern of households in selected Clusters in Sundarbans and in Andaman & Nicobar Islands

<table>
<thead>
<tr>
<th>Sl no</th>
<th>Clusters</th>
<th>% of households’ primary occupation depends on</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Agriculture</td>
</tr>
<tr>
<td>1</td>
<td>Canning</td>
<td>45</td>
</tr>
<tr>
<td>2</td>
<td>Basanti</td>
<td>48</td>
</tr>
<tr>
<td>3</td>
<td>Patharpratima</td>
<td>45</td>
</tr>
<tr>
<td>4</td>
<td>Mathurapur II</td>
<td>62</td>
</tr>
<tr>
<td>5</td>
<td>Kultali</td>
<td>56</td>
</tr>
<tr>
<td>6</td>
<td>Kakdwip</td>
<td>46</td>
</tr>
<tr>
<td>7</td>
<td>Namkhana</td>
<td>45</td>
</tr>
<tr>
<td>8</td>
<td>Sandeshkhali</td>
<td>39</td>
</tr>
<tr>
<td>9</td>
<td>Chouldari</td>
<td>5</td>
</tr>
<tr>
<td>10</td>
<td>Shoal Bay</td>
<td>15</td>
</tr>
<tr>
<td>11</td>
<td>Dashrathpur</td>
<td>10</td>
</tr>
<tr>
<td>12</td>
<td>Deshbandhugram</td>
<td>25</td>
</tr>
</tbody>
</table>
In Andaman & Nicobar 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 households' 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 Deshbandhugram Cluster, respectively (Table 5). 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.

**Table 5. Income pattern of households in selected Clusters in Sundarbans (West Bengal) and in Andaman & Nicobar Islands**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Clusters</th>
<th>Average family income (Rs/family/year)</th>
<th>Average income from various sources (Rs/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Agri.</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

![Fig. 4 Occupational pattern of the sample households under study](image-url)
<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Clusters</th>
<th>Average family income (Rs/family/year)</th>
<th>Average income from various sources (Rs/year)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Agri.</td>
</tr>
<tr>
<td>1</td>
<td>Canning-I</td>
<td>22291</td>
<td>14023</td>
</tr>
<tr>
<td>2</td>
<td>Basanti</td>
<td>21445</td>
<td>15109</td>
</tr>
<tr>
<td>3</td>
<td>Patharpratima</td>
<td>18608</td>
<td>10492*</td>
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<tr>
<td>4</td>
<td>Mathurapur II</td>
<td>13330</td>
<td>9757*</td>
</tr>
<tr>
<td>5</td>
<td>Kultali</td>
<td>23958</td>
<td>12811*</td>
</tr>
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<td>6</td>
<td>Kakdwip</td>
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<td>12540</td>
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<td>Namkhana</td>
<td>23589</td>
<td>13210</td>
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<td>Sandeshkhali</td>
<td>22528</td>
<td>11240</td>
</tr>
<tr>
<td>9</td>
<td>Chouldari</td>
<td>180948</td>
<td>9397</td>
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<tr>
<td>10</td>
<td>Shoal Bay</td>
<td>199337</td>
<td>27002</td>
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<td>11</td>
<td>Dashrathpur</td>
<td>150666</td>
<td>10638</td>
</tr>
<tr>
<td>12</td>
<td>Deshbandhugram</td>
<td>306875</td>
<td>119995</td>
</tr>
</tbody>
</table>

Note: * Includes income from agriculture + horticulture

**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) at Cluster level, 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 6). 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 building 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 - Σ(Xi / Σ Xi), 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 6. Cropping pattern in selected Clusters in Sundarbans and in Andaman & Nicobar Islands

<table>
<thead>
<tr>
<th>Sl no</th>
<th>Clusters</th>
<th>Area (ha) under cultivation (Kharif + Rabi)</th>
<th>% to GCA under cultivation</th>
<th>NCA (ha)</th>
<th>GCA (ha)</th>
<th>Cropping Intensity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Rice Vegetable Others</td>
<td>Rice Vegetable Others</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Canning</td>
<td>233</td>
<td>99.7</td>
<td>193</td>
<td>234</td>
<td>121</td>
</tr>
<tr>
<td>2</td>
<td>Basanti</td>
<td>211</td>
<td>96.4</td>
<td>223</td>
<td>253</td>
<td>111</td>
</tr>
<tr>
<td>3</td>
<td>Patharpratima</td>
<td>1832</td>
<td>80.7</td>
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<td>2270</td>
<td>127</td>
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<tr>
<td>4</td>
<td>Mathurapur II</td>
<td>523</td>
<td>100</td>
<td>523</td>
<td>523</td>
<td>124.85</td>
</tr>
<tr>
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<td>Kultali</td>
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<td>81</td>
<td>1363</td>
<td>1719</td>
<td>126</td>
</tr>
<tr>
<td>6</td>
<td>Kakdwip</td>
<td>462</td>
<td>100</td>
<td>379</td>
<td>462</td>
<td>122</td>
</tr>
<tr>
<td>7</td>
<td>Namkhana</td>
<td>323</td>
<td>100</td>
<td>263</td>
<td>323</td>
<td>123</td>
</tr>
<tr>
<td>8</td>
<td>Sandeshkhali</td>
<td>126</td>
<td>87.5</td>
<td>126</td>
<td>144</td>
<td>114</td>
</tr>
<tr>
<td>9</td>
<td>Chouldari</td>
<td>32</td>
<td>57.3</td>
<td>40.6</td>
<td>55.8</td>
<td>137</td>
</tr>
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<td>10</td>
<td>Shoal Bay</td>
<td>16.2</td>
<td>25.4</td>
<td>63.8</td>
<td>119.8</td>
<td>188</td>
</tr>
<tr>
<td>11</td>
<td>Dashrathpur</td>
<td>30</td>
<td>54.5</td>
<td>37.8</td>
<td>55</td>
<td>146</td>
</tr>
<tr>
<td>12</td>
<td>Deshbandhuagram</td>
<td>80</td>
<td>63.5</td>
<td>67</td>
<td>126</td>
<td>188</td>
</tr>
</tbody>
</table>
Key socio-economic features of the farm households in the study area

- Detailed baseline survey was conducted by using pre-structured and tested survey schedule through personal interview with the respondents method. Also several Focussed Group Discussion (FGD) and Participatory Rural Appraisal (PRA) were conducted at Cluster villages to collect primary information on socio-economic conditions of farmers in the study area in Sundarbans as well as in Andaman & Nicobar Islands.

- In Sundarbans, majority of the people were belonging to backward communities like SC (84%). Whereas in Andaman & Nicobar Island dominating population was belongng to Other Backward Classes (OBC). Illiteracy was varying from 10-49% in Cluster of villages of Sundarbans and the same was 10-33% in Andaman & Nicobar Islands.

- Average operational land holdings was very low (0.19 – 0.56 ha) in Sundarbans region and that too were fragmented over several plots (2-4 nos). The holding size in Andaman & Nicobar Islands was relatively higher (1.80 – 2.80 ha) across the Cluster of villages in the study area. Over 90% of the households were possessiing less than one (1) hectare of land in Sundarbans region and about 2-9% households were having no operational land holdings i.e., landless.

- The land topography in the study area was dominated by low land (80%) in Sundarban region and the same was 10-23% in case of vilages in Andaman & Nicobar Islands. In Andaman & Nicobar Island substantial area was under hilly and undulated topography and not suitable for agricultural crop cultivation.

- Due to low-lying nature of the land, waterlogging coupled with severe drainage congestion was prevalent in the study area during monsoon months. In contrast during non monsoon months due to non-availability of good quality water, salinity builds up gradually and make the crop cultivation challenging.

- In Sundarbans, agriculture is the primary occupation of the majority of the households (39-56%) followed by daily labourers, migration to distance places for alternative livelihoods, fisheries and others.

- Average family income was calculated to be Rs. 22000-25000/-family per year during 2011-12. Though agriculture is the primary occupation of the people in the region but contributing low income and therefore large scale migration is prevailing for search of alternative livelihood are becoming more and more important. However these sources of alternative income very often fails to provide decent and secured livelihood for the people of the region.

- In Andaman & Nicobar Islands, income from services was the major occupation and agriculture as primary occupation was practiced by very few households (<5%).

- Overall the cropping intensity in the study region was low (114-127%) in the Sundarbans region with low level of crop diversification. The cropping intensities in Andaman & Nicobar Islands were relatively higher (137-188%) primarily due to presence of perennial crops.

- The soil in the study area was affected by high level of soil salinity (ECe2-18 dS/m) and water salinity (ECe 0.40 – 22 dS/m) that limits the choice and options of growing crops and therefore adoption of water management is most important.
5. Research Achievements

I. Targets & achievements:

The targets and achievements for the activities completed by the Consortium partners in the different Clusters in Sundarbans and Andaman & Nicobar Islands are presented in Table 7. The project has complemented most of the activities exceeding the planned target. However, achievement of some activities is less than the target as those activates were discontinued from 2011-12 with the advice of PIU, NAIP and World Bank review team.

Table 7. Targets and achievements for the different project activities

<table>
<thead>
<tr>
<th>Objective</th>
<th>Activities</th>
<th>Targets</th>
<th>Achievements up to March 2014</th>
<th>% Achievements</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sustainable enhancement of the productivity of degraded land and water resources of the coastal region through integrated approaches</td>
<td>Land shaping for water harvesting, drainage, crop &amp; fish cultivation (Excavation/ re-excavation of pond, rising of land, inputs, etc.)</td>
<td>260.16 ha</td>
<td>276.88 ha</td>
<td>106.4</td>
</tr>
<tr>
<td></td>
<td>Land shaping for Paddy-cum-fish cultivation / integrated farming</td>
<td>58.74 ha</td>
<td>73.35 ha</td>
<td>123.8</td>
</tr>
<tr>
<td></td>
<td>Land shaping for brackish water aquaculture</td>
<td>17.60 ha</td>
<td>20.72 ha</td>
<td>117.7</td>
</tr>
<tr>
<td></td>
<td>Diversification of crops (farm operations, inputs, etc.)</td>
<td>255.00 ha</td>
<td>387.68 ha</td>
<td>152.0</td>
</tr>
<tr>
<td></td>
<td>Water management</td>
<td>14 ha</td>
<td>4.5 ha</td>
<td>32.1</td>
</tr>
<tr>
<td></td>
<td>Crop nutrient management (Farm inputs, etc.) (ha)</td>
<td>53 ha</td>
<td>121.2 ha</td>
<td>228.7</td>
</tr>
<tr>
<td></td>
<td>Promotion of composting including vermi-composting</td>
<td>130 farmers</td>
<td>133 farmers</td>
<td>102.3</td>
</tr>
<tr>
<td></td>
<td>Drudgery reduction through farm mechanizations</td>
<td>332 farmers</td>
<td>180 farmers</td>
<td>54.2</td>
</tr>
<tr>
<td>Objective</td>
<td>Activities</td>
<td>Targets</td>
<td>Achievements up to March 2014</td>
<td>% Achievements</td>
</tr>
<tr>
<td>--------------------------------------------------------------------------</td>
<td>------------------------------------------------</td>
<td>---------</td>
<td>-------------------------------</td>
<td>----------------</td>
</tr>
<tr>
<td>Nursery raining for crops and fish</td>
<td>58 farmers</td>
<td>86 farmers</td>
<td></td>
<td>148.3</td>
</tr>
<tr>
<td><strong>Enhancement of livelihood security and employment generation for the poor farming communities of the coastal region</strong></td>
<td>Introduction of bee keeping</td>
<td>80 farmers</td>
<td>39 farmers</td>
<td>48.8</td>
</tr>
<tr>
<td></td>
<td>Introduction of mushroom cultivation</td>
<td>110 farmers</td>
<td>115 farmers</td>
<td>104.5</td>
</tr>
<tr>
<td></td>
<td>Livestock heath management</td>
<td>325 farmers</td>
<td>2705 farmers</td>
<td>832.3</td>
</tr>
<tr>
<td></td>
<td>Introduction of goat/sheep</td>
<td>72 farmers</td>
<td>32 farmers</td>
<td>44.4</td>
</tr>
<tr>
<td><strong>Empowerment through capacity building and skill development of stakeholders including men and women farmers.</strong></td>
<td>Establishment of Rural Technology centres</td>
<td>4 Nos.</td>
<td>4 Nos.</td>
<td>100.0</td>
</tr>
<tr>
<td></td>
<td>Number of trainings to farmers</td>
<td>116</td>
<td>133</td>
<td>114.7</td>
</tr>
<tr>
<td></td>
<td>Number of farmers to be trained</td>
<td>3700</td>
<td>6000</td>
<td>162.2</td>
</tr>
</tbody>
</table>

II. Technological interventions/innovations:

A. Major technological interventions/innovations:

a) Land shaping for improving drainage facility, rain water harvesting, salinity reduction and cultivation of crops and fishes (freshwater and brackishwater fishes) for livelihood and environmental security:

Different kinds of land shaping techniques for improving drainage facility, rain water harvesting, salinity reduction and cultivation of crops and fishes (freshwater and brackishwater fishes) for livelihood and environmental security have been developed to suit different land situations, farm size and farmers’ requirements. The details of the land shaping techniques which were implemented in different parts of degraded areas of Sundarbans and Tsunami affected Andaman & Nicobar Islands and their impacts are given below.

1. Land shaping for improving drainage facility, on-farm rain water harvesting, salinity reduction and integrated cultivation of agriculture – aquaculture

   (i) Farm pond (FP): In Sundarnabs region about 20% of the farm area was converted into on-farm pond of about 3m depth to harvest excess rainwater. The dug-out soil was used to raise the
land to form high and medium land situations besides the original low land situation in the farm for growing multiple and diversified crops throughout the year instead of mono-cropping with rice in *Kharif* season (Fig. 5). While reshaping the land with dug out soil care was taken to keep the surface soil (most fertile soil) aside which later uniformly distributed on raised land. At many places in coastal region the sub-surface soil at various depths may have highly acidic soils with acid sulfate soil properties. If the problem is acute such soil should not be dug out for farm pond. Other land shaping techniques with less depth of soil digging should be selected. It is therefore, important that before selecting a land shaping technique the subsoil properties should be assessed. In this land shaping technique high land was used for growing vegetables and fruit crops round the year. During *Kharif* season HVY of rice is grown in medium land and low land was used for paddy + fish cultivation. The low water requiring crops like sunflower, groundnut, and cotton was grown on the medium land and rice was grown on lowland during *Rabi/Summer* season. The pond was used for rainwater harvesting of about 5000 m$^3$ ha$^{-1}$ for irrigation and poly culture of fish. Mainly Indian major carps like ruhu, catla, mrigel and fresh water prawn were grown in the pond.

![Schematic diagram of farm pond technique](image1)

Excavation of farm pond at farmers’ field

Crop cultivation under pond technique at farmers’ field

*Fig. 5 Farm pond technique in Sundarbans Clusters*
In Tsunami affected Andaman & Nicobar Islands, farm pond with broader dikes was excavated in relatively low-lying areas in the farm land with flat topography or in the undulating landscape to harvest rainwater during monsoon season (Fig.6). The dug out soil was used to make broader dykes of 5 m width and 1.5 m height around pond. The pond was used to harvest rain water (about 8000 m$^3$ ha$^{-1}$) which was used for composite fish culture and providing irrigation to crops on dikes during dry season. The broader dikes in the farm pond was used for vegetable cultivation round the year.

![Schematic diagram of farm pond with broader technique](image)

**Fig. 6 Farm pond technique in Andaman & Nicobar Islands**

(ii) **Deep furrow & high ridge (DF):** About 50% of degraded farm land in Sundarbans was shaped into alternate high ridges (1.5 m top width x 1.0 m height x 3m bottom width) and deep furrows (3m top width x 1.5 m bottom width x 1.0 m depth) (Fig. 7). The rainwater is harvested in the deep furrows and the harvested rainwater of about 1875 m$^3$ ha$^{-1}$ was used for initial
irrigation during *Rabi*. The water stored in furrows was also used for fish cultivation and supplementary irrigation in *Kharif*, if required. Due to higher elevation and presence of fresh rainwater in furrows these ridges remain free of waterlogging during *Kharif* with less soil salinity build up in dry seasons. The ridges were used for cultivation of vegetables and other horticultural crops/ multi-purpose tree species (MPTs) round the year instead of mono-cropping with rice in *Kharif*. Remaining portion of the farmland including the furrows was used for growing more profitable paddy + fish cultivation in *Kharif*. During *Rabi* Summer season farm land (non-furrow and non-ridge area) was used for low water requiring crops.

**Fig. 7 Deep furrow & high ridge technique in Sundarbans**

(iii) **Paddy-cum-fish (PCF):** In this technique, trenches (3m top width x 1.5 m bottom width x 1.0 m depth) were dug around the periphery of the farm land in Sundarbans leaving about 3.5m wide outer from boundary and the dugout soil was used for making dikes (about 1.5 m top width x 1.0 m height x 3m bottom width) (Fig. 8). A small ditch was dug out at one corner of the field for sheltering of fish when water will drain out in trenches. Dikes protected free flow of water
from the field and trenches were used for harvesting rain water. About 1400 m³ of rain water was harvested in 1 ha of farm land under this land shaping technique. The dikes were used for growing vegetables and / or green manuring crops/fruit crops/multi-purpose tree species (MPTS) round the year. Remaining portion of the farm land including the trenches was used for more profitable paddy + fish cultivation in Kharif. The farm land (non-trench and non-dike area) was used for low water requiring crops during dry (Rabi/Summer) season with the rain water harvested in trenches. Deep trenches in the field provided better drainage condition in the field during the non-monsoon months. In some areas of Sundarbanas paddy-cum-fish with ‘Ail’ cultivation technique was implemented. Under this technique ‘Ail’ or land embankment around the farm land was made with 4′ (1.2m) top width x 4′ (1.2 m) m height x 6′ (1.83m) bottom width.

![Schematic diagram of paddy-cum-fish technique](image)

**Excavation of paddy-cum-fish technique at farmers’ field**  
**Crop cultivation under paddy-cum-fish technique at farmers’ field**

**Fig. 8 paddy-cum-fish technique in Sundarbans**

In Andaman & Nicobar Islands integrated rice, fish and vegetables were grown under paddy-cum-fish with border bed technique. This involves digging of trenches of about 5.0 m width and
1.5 m depth around the field and forming beds of 4 m width around the field (Fig. 9). The centre of the land left undisturbed was used for paddy cultivation during rainy season and vegetables/field crops during dry season and, fruit crops were planted on the outer slopes of the border beds. The rainwater harvested in the trenches (3564 m$^3$ ha$^{-1}$) was used for fish culture and for irrigation for vegetables grown on border beds around the field.

Fig. 9 paddy-cum-fish technique in Andaman & Nicobar Islands

(iv) Broad bed & furrow (BBF): This involves shaping of land for broad beds and furrows alternatively in low-lying lands. This technique was implemented in Tsunami affected areas in Andaman & Nicobar Islands. In broad bed & furrow system, beds of 4 - 5m width and 1 m height, and furrow of 5 - 6m width and 1m deep with a provision of (2 m x 4 m x 1 m) fish shelter at the end of the furrow has been made (Fig. 10). Raised beds are used for cultivation of vegetables round the year and fish was cultivated in the furrows. This system provided the scope
for *in-situ* rainwater harvesting of about 3800 m$^3$ ha$^{-1}$ and which was used to cultivate second crop during dry seasons.

![Schematic diagram of broad bed & furrow technique](image)

**Excavation of broad bed & furrow technique at farmers’ field**

**Crop cultivation under broad bed & furrow technique at farmers’ field**

**Fig. 10 Broad bed & furrow technique**

**(v) Three tier**: In this technique of land shaping degraded low-lying land in Andaman Islands is shaped into three equal portions as raised land, mid or original land and pond with a depth of 2.5-3m and dikes of 5m wide and 1.5 m height (Fig. 11). Pond was in the lower part of the land which was used for harvesting of rain water of about 4500 m$^3$ ha$^{-1}$ and polyculture of fish. Paddy in mid (original) land along with vegetables on raised land and dikes were cultivated.
(vi) **Paired bed:** In paired bed technique degraded low lying land in Andaman Islands was shaped into broad furrow of 9 m width x 2 m depth and two beds of 6 m width (Fig. 12). In this 5 m x 9 m size nursery pond was also created at one end of the furrow for fish culture. Two dykes were created of 2 – 3 m width at both ends. Broad furrow was used for harvesting of rain water of about 3750 m3 ha-1. The fish nursery of 90 m3 at one end of the furrow was used for raising fingerlings and broad furrow was used for brooders. Vegetables were grown round the year in the raised beds and dikes. In this technique the inner rows of raised beds were remain in aerated condition even if the furrow was filled with rain water.
(vii) Drainage improvement network: In Andaman Islands agriculture is practiced in land patches and generally in undulating terrain. Due to heavy rainfall and inundation during high tide some of these areas are either permanently or part of a season under waterlogged condition. Otherwise these areas are fertile and suffer only from waterlogging. Under this NAIP sub-project for drainage improvement surface drainage network (2-3 m width x 1.5-2 m depth) was developed after completing hydrographic survey and proving bunding at the seaward side of the slope with or without one-way sluice gate (Fig. 13). The area now brought under rice-vegetable or rice-pulse cultivation. In some areas contour trench was made at the foot hill and the water was directly taken upto the lowest point avoiding overland flow of water in the valley areas.
Schematic diagram of drainage improvement network

Water logging before implementation of drainage improvement network at farmers’ fields

Improvement of water logging situation after implementation of drainage improvement network at farmers’ fields

**Fig. 13 Drainage improvement network**

**Impact of land shaping techniques:**

**Economic impact:**

Out of the total target area of 318.90 ha for the Consortium partners for implantation of land shaping techniques in different Clusters in Sundarbans region and Andaman & Nicobar Islands, 342.39 ha of the study area has been brought under various land shaping technologies like farm pond, deep furrow & high ridge, paddy-cum-fish cultivation, broad bed & furrow, 3 tire system, paired bed system and drainage improvement network (Table 8). About 1841 water storage structures were created under different land shaping techniques and 12,06,073 m³ rainwater has been harvested annually in these structures in the study area and with harvested rain water about 242.29 ha additional area has been brought under dry season.

**About 1841 water harvesting structures were developed with water storage capacity of 12,06,073 m³ to irrigate 242.3 ha during dry season.**
irrigation for cultivation of different field crops and vegetables during Rabi season (Table 9). These areas were earlier remaining fallow during dry season after the harvest of the tradition varieties of rice in Kharif due to acute shortage of freshwater water for irrigation. Different types of land situations were created under different land shaping techniques. These land situations provided the scope for growing multiple and diversified crops and integrated cultivation of crops & fishes round the year. The cropping pattern has been changed from almost mono-cropped with rice to multiple and diversified crops in the study Clusters (Table 10). The cropping intensity has been increased upto 240% from a base level value of 100% due to implementing the land shaping techniques.

Table 8. Implementation of land shaping techniques by the different Consortium partners

<table>
<thead>
<tr>
<th>Consortium Partners</th>
<th>Target area (ha)</th>
<th>Achievement area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sundarbans Clusters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CSSRI, RRS</td>
<td>43.95</td>
<td>51.64</td>
</tr>
<tr>
<td>RAKVK</td>
<td>125.81</td>
<td>141.24</td>
</tr>
<tr>
<td>CIBA, KRC</td>
<td>43.24</td>
<td>51.79</td>
</tr>
<tr>
<td>BCKV</td>
<td>15.00</td>
<td>14.40</td>
</tr>
<tr>
<td>Total</td>
<td>227.99</td>
<td>259.07</td>
</tr>
<tr>
<td>Andaman &amp; Nicobar Islands Clusters</td>
<td></td>
<td></td>
</tr>
<tr>
<td>CARI</td>
<td>90.91</td>
<td>90.51</td>
</tr>
<tr>
<td>Grand total</td>
<td>318.90</td>
<td>349.58</td>
</tr>
</tbody>
</table>

Table 9. Area covered, on-farm rainwater harvested and additional area irrigated under different land shaping techniques

<table>
<thead>
<tr>
<th>Land shaping techniques</th>
<th>Area covered (ha)</th>
<th>Rain Water harvested (m3)</th>
<th>Additional area irrigated with harvested water (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sundarbans Clusters</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm pond</td>
<td>184.36</td>
<td>921800</td>
<td>147.49</td>
</tr>
<tr>
<td>Paddy-cum-fish</td>
<td>60.66</td>
<td>84014</td>
<td>53.40</td>
</tr>
<tr>
<td>Deep furrow &amp; high ridge</td>
<td>14.05</td>
<td>26343</td>
<td>10.53</td>
</tr>
<tr>
<td><strong>Andaman &amp; Nicobar Islands Clusters</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm pond</td>
<td>9.55</td>
<td>76400</td>
<td>8.60</td>
</tr>
<tr>
<td>Paddy-cum-fish</td>
<td>12.69</td>
<td>45227</td>
<td>10.79</td>
</tr>
<tr>
<td>Broad bed &amp; furrow</td>
<td>9.19</td>
<td>35032</td>
<td>7.35</td>
</tr>
<tr>
<td>Three tier</td>
<td>1.38</td>
<td>6222</td>
<td>1.24</td>
</tr>
<tr>
<td>Pair bed</td>
<td>2.70</td>
<td>10125</td>
<td>2.29</td>
</tr>
<tr>
<td>Drainage improvement</td>
<td>55.00</td>
<td>--</td>
<td>--</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td><strong>349.58</strong></td>
<td><strong>12,06,073</strong></td>
<td><strong>242.29</strong></td>
</tr>
</tbody>
</table>

Table 10. Changes in cropping pattern due to implementation of land shaping techniques
<table>
<thead>
<tr>
<th>Land situation</th>
<th>Before interventions</th>
<th>After interventions</th>
<th>Kharif season</th>
<th>Rabi/summer season</th>
<th>Cropping intensity</th>
<th>Land shaping models</th>
<th>Kharif season</th>
<th>Rabi/summer season</th>
<th>Cropping intensity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mostly low-lying with deep waterlogging in <em>Kharif</em> season</td>
<td>Traditional rice</td>
<td>Mostly fallow</td>
<td>114 %</td>
<td>Farm Pond</td>
<td>Fish</td>
<td>Vegetables</td>
<td>Fish</td>
<td>Vegetables</td>
<td>193%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&amp; fruit crops/ multi-purpose tree species (MPTs)</td>
<td>Fish</td>
<td>Vegetables</td>
<td>(Sundarbans Clusters) - 200% (A&amp;N Islands Clusters)</td>
</tr>
<tr>
<td>High land</td>
<td>Vegetables</td>
<td>Vegetables</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Medium land</td>
<td>HYV Rice</td>
<td>Vegetables</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>Vegetables, low water requiring field crops</td>
<td></td>
</tr>
<tr>
<td>Original low land</td>
<td>Rice + fish</td>
<td>Low water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>requiring field crops/vegetables, short duration rice</td>
<td></td>
</tr>
<tr>
<td>Mostly low-lying with deep waterlogging in <em>Kharif</em> season</td>
<td>Traditional rice</td>
<td>Mostly fallow</td>
<td>114 %</td>
<td>Deep furrow &amp; high ridge</td>
<td>Fish</td>
<td>Vegetables</td>
<td>Fish</td>
<td>Vegetables</td>
<td>186%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&amp; fruit crops/ MPTs</td>
<td>Fish</td>
<td>vegetables</td>
<td></td>
</tr>
<tr>
<td>Original low land</td>
<td>Rice</td>
<td>Low water</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>requiring field crops/vegetables</td>
<td></td>
</tr>
<tr>
<td>Mostly low-lying with deep waterlogging in <em>Kharif</em> season</td>
<td>Traditional rice</td>
<td>Mostly fallow</td>
<td>114 %</td>
<td>Paddy-cum-fish</td>
<td>Fish</td>
<td>Vegetables</td>
<td>Fish</td>
<td>Vegetables</td>
<td>166%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>&amp; fruit crops/ MPTs</td>
<td>Fish</td>
<td>vegetables</td>
<td>(Sundarbans Clusters) - 200% (A&amp;N Islands Clusters)</td>
</tr>
<tr>
<td>Land situation</td>
<td>Before interventions</td>
<td>After interventions</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Crops</td>
<td>Cropping-intensity</td>
<td>Land shaping models</td>
<td>Kharif season</td>
<td>Crops</td>
<td>Rabi/summer season</td>
<td>Cropping intensity</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mostly low-lying with deep waterlogging in Kharif season</td>
<td>Traditional rice</td>
<td>Fallow</td>
<td>100%</td>
<td>Broad bed and furrow</td>
<td>Bed</td>
<td>Vegetables &amp;/ fruit crops</td>
<td>Vegetables, pulses &amp;/ fruit crops</td>
<td>240%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Furrow</td>
<td>Fish/rice+fish</td>
<td>Fish</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mostly low-lying with deep waterlogging in Kharif season</td>
<td>Traditional rice</td>
<td>Fallow</td>
<td>100%</td>
<td>Three tire system</td>
<td>Raised land &amp; dikes</td>
<td>Vegetables &amp;/ fruit crops</td>
<td>Vegetables, pulses &amp;/ fruit crops</td>
<td>220%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Mid (original) land</td>
<td>Rice</td>
<td>Rice</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mostly low-lying with deep waterlogging in Kharif season</td>
<td>Traditional rice</td>
<td>Fallow</td>
<td>100%</td>
<td>Paired bed system</td>
<td>Bed</td>
<td>Vegetables &amp;/ fruit crops</td>
<td>Vegetables, pulses &amp;/ fruit crops</td>
<td>240%</td>
<td></td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>Furrow</td>
<td>Fish</td>
<td>Fish</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Mostly low-lying with deep waterlogging in Kharif season</td>
<td>Traditional rice</td>
<td>Fallow</td>
<td>100%</td>
<td>Drainage improvement network</td>
<td>Original land</td>
<td>Rice</td>
<td>Low water requiring field crops/vegetables</td>
<td>200%</td>
<td></td>
</tr>
</tbody>
</table>

These land shaping techniques are very popular among the farmers of both Sundarbans and Andaman & Nicobar Islands Clusters as these technologies have increased the income by manifolds compared to base line value (Table 11). Average net income per ha of farm land has been increased from Rs.22000 to Rs. 1,22,734 in Sundarbans Clusters due to adoption of land shaping techniques. In Andaman & Nicobar Islands, land shaping techniques except drainage improvement net work has increased average net income to Rs. 1,89,085 from base line value of Rs.22400 per ha of degraded land. Average income of the households has been by 6 times in Sundarbans and 9 times in Andaman & Nicobar Islands. Due to implementation of drainage improvement net work net income of the farmers has been increased by double.

*Crop intensity has been enhanced from 100 to 240%. Average income of farm family in the degraded coastal land has increased by 6-9%*
<table>
<thead>
<tr>
<th>Land shaping techniques</th>
<th>Household involved (no.)</th>
<th>Employment generated (man days hh⁻¹ yr⁻¹)</th>
<th>Net Income (Rs. hh⁻¹/ha⁻¹ yr⁻¹)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Before intervention</td>
<td>After intervention</td>
<td>Before intervention</td>
</tr>
<tr>
<td>Sundarbans Clusters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm pond</td>
<td>1215</td>
<td>87</td>
<td>227</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paddy-cum-fish</td>
<td>306</td>
<td>87</td>
<td>223</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Deep furrow &amp; high ridge</td>
<td>65</td>
<td>87</td>
<td>218</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Andaman &amp; Nicobar Islands Clusters</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Farm pond</td>
<td>88</td>
<td>8</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Paddy-cum-fish</td>
<td>42</td>
<td>8</td>
<td>35</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Broad bed &amp; furrow</td>
<td>51</td>
<td>9</td>
<td>48</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Three tier</td>
<td>8</td>
<td>10</td>
<td>42</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Pair bed</td>
<td>16</td>
<td>9</td>
<td>54</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Drainage improvement</td>
<td>50</td>
<td>6</td>
<td>15</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total</td>
<td>1841</td>
<td>--</td>
<td>--</td>
</tr>
</tbody>
</table>

Note: Costs & returns at current price of 2012-13. *hh⁻¹*: per household (av. holding was 0.35 ha in Sundarbans Clusters, av. holding of implementation was 0.20 ha in Andaman & Nicobar Islands Clusters)

**Social impact:**

Farming activities under land shaping techniques have enhanced the employment opportunities for the farm families in the Clusters (Table 11). About 3,66,000 man-days have been created per year from the farming activities after 3 years of implementation of land shaping techniques in the study area. As the farmers get employment in their own farm land throughout the year, this has checked the seasonal migration rate of the farm family in search of their livelihood. Social security is also established through this technology by ensuring income security.

**Environmental impact:**

With land shaping techniques, different land situations like, high land, medium land and low (original) apart from farm pond/ furrows/ trenches etc. were created in low-lying and degraded farmers’ fields. Raising of land and creating water harvesting facilities reduced the problem of drainage congestion (Table 12). The high land/ridges/ dikes were free from water logging during *Kharif* season which provided the scope for growing high value crops during this season and it also facilitated early sowing of *Rabi* crops so that the farmers could get good return. Though the
most of the rainfall (about 80%) occurs during monsoon, however, medium to heavy rains occasionally occurs in dry season (Rabi/summer) following climatic depression in the coastal area. The upland crops on heavy textured coastal saline soils suffer a considerable loss due to drainage congestion following a heavy rain and at times, it leads to almost total crop failure in dry season. This is one of the hindrances to raise a successful second crop in the area which is primarily a mono-cropped with Kharif rice. In the land shaping situation, water harvesting structures like pond/furrows/trenches create better drainage of the field through harvesting/ draining of excess rainwater in pond/furrows/trenches and thereby prevent damage to the standing upland crops.

Table 12. Average depth of standing water (cm) on the different land situation created under land shaping techniques during Kharif season

<table>
<thead>
<tr>
<th>Months</th>
<th>Farm pond</th>
<th>Deep furrow &amp; high ridge</th>
<th>Paddy-cum-fish</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Without land shaping</td>
<td>Low land</td>
<td>Medium land</td>
</tr>
<tr>
<td>July</td>
<td>20-30</td>
<td>05-15</td>
<td>0</td>
</tr>
<tr>
<td>August</td>
<td>30-40</td>
<td>05-15</td>
<td>5-15</td>
</tr>
<tr>
<td>September</td>
<td>40-50</td>
<td>15-20</td>
<td>0</td>
</tr>
<tr>
<td>October</td>
<td>30-40</td>
<td>30-40</td>
<td>5-15</td>
</tr>
<tr>
<td>November</td>
<td>25-30</td>
<td>25-30</td>
<td>0-5</td>
</tr>
<tr>
<td>December</td>
<td>05-15</td>
<td>0</td>
<td>0</td>
</tr>
</tbody>
</table>

The salinity of the harvested rain water in the different land shaping techniques was monitored periodically. The variation in salinity of water showed a seasonal fluctuation which has been depicted in Fig. 14. The highest salinity was observed during dry months and it goes down to lowest value during monsoon months. Salinity of water indicated that it was suitable for irrigation as well as for the fish cultivation.

Fig. 14 Seasonal variation in the salinity of the harvested rainwater in land shaping techniques
The salinity (ECe), pH (1:2), nutrients and microbial parameters of the root zone soil were monitored periodically under different land situations created under different land shaping techniques. The salinity build up in soil under different land situations showed seasonal variability (Fig. 12 - 14). The soil salinity was lowest in Kharif (September). On drying up of standing water on field at the end of Kharif season the soil salinity gradually increased to its highest value in the summer (May). This is mainly due to upward capillary flow of saline ground water present at shallow depth (<1 m during dry season) following evaporation from the soil surface, which resulted in gradual accumulation of salts in the surface soil. It was observed that the salinity build up in the soil of different land situations especially medium land and highland/ridges/ dikes in land shaped area was relatively less compared to original salt affected coastal low land (control) (Fig. 13-15). Lesser soil salinity in the raised soil might be due to : i) increased distance between the saline groundwater table and the surface soil resulting in decreased accumulation of salt through upward capillary flow and/or ii) due to the presence of fresh water (harvested rain water) in the furrows/ trenches, the soil at the bottom region of ridges/ dikes, remains almost saturated with fresh water in the initial months after the Kharif season (or as long as there was a stock of fresh water in the furrows) thereby decreasing the soil water potential at the bottom region of ridges, which resulted in less upward capillary movement of saline groundwater.

Quality of the degraded land has been improved by reducing build up of soil salinity, increasing soil organic carbon content, nutrient status and soil microbiological activities.

Fig. 13 Seasonal variation in soil salinity under different land situation under farm pond technique
It was observed that under board bed & furrow (BBF) system surface soil pH of the beds was higher (slightly acidic, 6.36) whereas it was significantly lower (acidic, 5.8) in the surrounding soils (Table 13). Moreover, the salinity level in the beds of BBF system made in water logged soil was much lower (1.5 dS m\(^{-1}\)) than under saline soils (>2.0 dS m\(^{-1}\)). The salt concentration in saline soils remained higher throughout the dry season and after May the salt level has decreased.

Fig. 14 Seasonal variation in soil salinity under different land situation under deep furrow & high ridge technique

Fig. 15 Seasonal variation in soil salinity under different land situation under paddy-cum-fish technique
Significantly lower Na$^{+}$, Ca$^{2+}$ and SAR values were observed in the beds of BBF than both the initial value and the surrounding areas where no intervention was carried out.

Table 13. Effect of board bed & furrow (BBF) system on physico-chemical properties of degraded soil in Andman & Nicobar Islands

<table>
<thead>
<tr>
<th>Parameters</th>
<th>BBF system</th>
<th>With BBF system</th>
</tr>
</thead>
<tbody>
<tr>
<td>pHs</td>
<td>6.36 (0.06)</td>
<td>5.88 (0.10)</td>
</tr>
<tr>
<td>ECe (dSm$^{-1}$)</td>
<td>1.18 (0.06)</td>
<td>1.90 (0.08)</td>
</tr>
<tr>
<td>Na$^{+}$ (me l$^{-1}$)</td>
<td>33.20 (0.91)</td>
<td>55.40 (1.93)</td>
</tr>
<tr>
<td>Ca$^{2+}$+Mg$^{2+}$ (me l$^{-1}$)</td>
<td>16.20 (0.74)</td>
<td>20.45 (0.62)</td>
</tr>
<tr>
<td>SAR</td>
<td>11.75 (0.43)</td>
<td>17.43 (0.74)</td>
</tr>
<tr>
<td>HCO$_3^-$ (me l$^{-1}$)</td>
<td>0.36 (0.04)</td>
<td>0.50 (0.05)</td>
</tr>
<tr>
<td>Cl$^-$ (me l$^{-1}$)</td>
<td>30.80 (0.88)</td>
<td>47.00 (0.92)</td>
</tr>
<tr>
<td>SO$_4^{2-}$ (me l$^{-1}$)</td>
<td>17.46 (0.85)</td>
<td>33.60 (0.73)</td>
</tr>
</tbody>
</table>

Mean values, n=10; SE in parentheses; different letters within one row indicate a significant difference at p<0.05.

The organic C, nutrient status and microbiological properties of root zone soil were motored in with or without land shaped fields. Due to creation of different land situations and following cultivation of crops round the year org. C, av. N, P & K and biological activities (microbial biomass C, Basal Respiration, Dehydrogenase activity, Fluorescein diacetate activity and β-Glucosidase activity) in surface soil have been increased under land shaping techniques like farm pond, deep furrow & high ridge and paddy-cum-fish compared to control (Table 14).

Table 14. Nutrient and microbiological status in the root soil under different land shaping techniques

<table>
<thead>
<tr>
<th>Land shaping techniques</th>
<th>Land situations</th>
<th>Organic Carbon (%)</th>
<th>Available Nitrogen (kg ha$^{-1}$)</th>
<th>Available Phosphorus (kg ha$^{-1}$)</th>
<th>Available Potassium (g g$^{-1}$ dry soil)</th>
<th>Microbial Biomass Carbon (µg g$^{-1}$ dry soil)</th>
<th>Basal Respiration (µg g CO$_2$ C g$^{-1}$ oven dry soil h$^{-1}$ at 22°C)</th>
<th>Dehydrogenase activity (µg TPF g$^{-1}$ oven dry soil h$^{-1}$ at 37°C)</th>
<th>Fluorescein diacetate activity (µg fluorescein g$^{-1}$ oven dry soil h$^{-1}$ at 24°C)</th>
<th>β-Glucosidase activity (µg g pnp released oven dry soil h$^{-1}$ at 37°C)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Without land shaping (Control)</td>
<td>Original low land</td>
<td>0.61</td>
<td>195.81</td>
<td>15.42</td>
<td>673.82</td>
<td>187.63</td>
<td>0.614</td>
<td>11.63</td>
<td>148.72</td>
<td>97.38</td>
</tr>
<tr>
<td>Farm pond</td>
<td>Original low land</td>
<td>0.87</td>
<td>236.48</td>
<td>17.06</td>
<td>628.43</td>
<td>243.8</td>
<td>0.688</td>
<td>13.87</td>
<td>145.24</td>
<td>95.35</td>
</tr>
<tr>
<td></td>
<td>Medium Land</td>
<td>1.06</td>
<td>238.2</td>
<td>18.94</td>
<td>486.36</td>
<td>279.1</td>
<td>0.748</td>
<td>12.95</td>
<td>128.88</td>
<td>92.05</td>
</tr>
<tr>
<td></td>
<td>Up land/ raised land</td>
<td>1.1</td>
<td>256.4</td>
<td>22.36</td>
<td>431.52</td>
<td>275.24</td>
<td>0.968</td>
<td>12.27</td>
<td>121.37</td>
<td>86.19</td>
</tr>
<tr>
<td>Deep furrow &amp; high ridge</td>
<td>Original low land</td>
<td>0.68</td>
<td>238.62</td>
<td>16.43</td>
<td>563.24</td>
<td>341.04</td>
<td>1.578</td>
<td>13.93</td>
<td>145.3</td>
<td>95.41</td>
</tr>
<tr>
<td></td>
<td>Ridge</td>
<td>1.16</td>
<td>253.4</td>
<td>23.48</td>
<td>396.25</td>
<td>376.34</td>
<td>1.638</td>
<td>13.32</td>
<td>138.25</td>
<td>101.74</td>
</tr>
<tr>
<td>Paddy-cum-fish</td>
<td>Original low land</td>
<td>0.81</td>
<td>225.72</td>
<td>17.48</td>
<td>526.3</td>
<td>225.63</td>
<td>1.278</td>
<td>13.81</td>
<td>145.18</td>
<td>95.29</td>
</tr>
<tr>
<td></td>
<td>Dikes</td>
<td>0.9</td>
<td>243.6</td>
<td>21.36</td>
<td>428.26</td>
<td>260.93</td>
<td>1.338</td>
<td>11.52</td>
<td>123.82</td>
<td>90.17</td>
</tr>
</tbody>
</table>
Horizontal spread of land shaping technology:

Within the span of 4 years, most of the farmers of NAIP villages realized the benefits of this technology and adopted it by their own, learning the technicalities from Consortium partner institutes. Observing the potential performance, the Deptt. of Agril. Govt. of West Bengal has been extrapolating this technology in all the blocks of Sundarbans even in neighboring district i.e. North 24 Parganas through BGREI, ATMA, MGNREGA, IWMP, NWDPRA, etc. A total fund of Rs. 1678 lakhs has been allocated for spreading of land shaping techniques in North & South 24 Pargans of Sundarbans region through those schemes. The State Agriculture Department has included this technology as a component of Natural Resource Management under NWDPRA (National Watershed Development Programme for Rainfed Area) programme implemented in the North and South 24 Parganas districts. In 11th 5 year plan, Sundarban Development Board, Govt. of West Bengal allotted more than crores of rupees for the extension of this technology in different blocks of Sundarbans through PRI and NGOs.

Aadoption of land shaping technologies:

Having analysing the economics and financial feasibility of land shaping techniques, it is important to know the different factors that influence the farmers’ behaviour towards adoption of these technologies. Farmers have to operate under host of socio-economic conditions that determines the decision to adopt new or modify their existing technologies. To analyse this behaviour, Logistic Regression Model has been employed and various parameters were included in the analysis to predict the probability of adoption of these techniques. It was noticed that as the farm size, % of lowland area, aggregate family income, family size and educational level increases the probability of adoption of these techniques also increases (Table 15). Whereas as the no of parcels in farm holdings, distance of farm land from residential area, % of off-farm income and availability of irrigation water from sources (e.g. canals, creeks, bils etc) increases the probability of adoption of these techniques decreases. While extending the techniques to the farmers’ field these socio-economic factors needs to be taken under consideration. However, rental value of land was not a significant factor to influence adoption behaviour of these techniques.

In coastal area the land shaping technique is a unique technology for addressing the key challenges like land degradation (salinity), drainage congestion and scarcity of fresh water for
irrigation and in turn have the potential to enhancing production, productivity, income and employment. These techniques particularly farm pond and paddy-cum-fish are financially viable and attractive proposition for the coastal region. However, for larger adoption of these techniques need to address some key issues like socio-economic constraints, some of which can be addressed by research level (e.g., land configuration, soil quality) some other at policy level (e.g., financial incentives). Community based rainwater harvesting as well as common pool wasteland may be encouraged in this direction.

Tale 15. Factors affecting adoption of land shaping models in coastal region of West Bengal

<table>
<thead>
<tr>
<th>Factors Name</th>
<th>Co-efficient</th>
<th>SE</th>
</tr>
</thead>
<tbody>
<tr>
<td>Constant</td>
<td>1.3471***</td>
<td>0.0214</td>
</tr>
<tr>
<td>X1 Farm Size (in ha)</td>
<td>0.435***</td>
<td>0.0473</td>
</tr>
<tr>
<td>X2 No of parcels in farm holdings (no)</td>
<td>-0.0187***</td>
<td>0.0045</td>
</tr>
<tr>
<td>X3 % of Lowland area</td>
<td>0.0952***</td>
<td>0.0388</td>
</tr>
<tr>
<td>X4 Distance of land from residential area (binary var. 1=within 1km, 0 otherwise)</td>
<td>-0.2110*</td>
<td>0.012</td>
</tr>
<tr>
<td>X5 Aggregate family income (Rs/year)</td>
<td>0.0871***</td>
<td>0.0126</td>
</tr>
<tr>
<td>X6 % of off-farm income (Rs/year)</td>
<td>-1.1543***</td>
<td>0.4422</td>
</tr>
<tr>
<td>X7 Family size (no)</td>
<td>0.0675***</td>
<td>0.0548</td>
</tr>
<tr>
<td>X8 Availability of irrigation water (binary var. 1= available for at least 4 months, 0 otherwise)</td>
<td>-0.4871***</td>
<td>0.1789</td>
</tr>
<tr>
<td>X9 Education level (no of years of education of key respondents)</td>
<td>0.1510***</td>
<td>0.0984</td>
</tr>
<tr>
<td>X10 Rental value of land (Rs/year/ha)</td>
<td>0.0511</td>
<td>0.0432</td>
</tr>
<tr>
<td>-2 Log Likelihood</td>
<td>149.52</td>
<td></td>
</tr>
<tr>
<td>Correct Prediction (%)</td>
<td>68.93</td>
<td></td>
</tr>
<tr>
<td>No of observation</td>
<td>180</td>
<td></td>
</tr>
</tbody>
</table>

2. Land shaping for brackishwater aquaculture

Brackishwater aquaculture pond: There are many areas in the coastal areas particularly near the brackishwater river or sea coast remain highly saline throughout the year and not suitable for crop cultivation. These lands are shaped into shallow depth brackishwater pond. Brackishwater aquaculture intervention has been implemented in Akshaynagar, Gangadharpur and Jamainaskar villages of Kakdwip Cluster and Ganeshnagar, Dwarknagar and Uttarchandanpuri villages of Namkhana Cluster of South 24 Parganas District of Sundarbans region. Out of total target area of 17.6 ha, about 20.72 ha area has been brought under this intervention with excavation of 113 nos. of ponds (Fig.16). The pond size varied from 0.13 ha to 0.4 ha with a depth of 1.0 -1.5 m. The height of the embankment of the pond is determined by the tidal height occurring in the area, generally about 30 cm above the maximum flood level. Under this project about 4 ft high and 5 ft wide embankment was made on the periphery of the pond. The slope of the pond bottom was
so adjusted that it drains readily towards the outlet and sluice gates were constructed in the deepest portion of the farm. In case of large ponds, channels were dug to facilitate the draining.

Schematic diagram of brackishwater aquaculture pond

Poly culture system of brackishwater fish farming with tiger shrimp (*Penaeus monodon*) along with brackishwater fish like golbhangon/bhangon (*Liza tade*) and aansbhangon (*Mugil cephalus*) was practiced in the pond with brackishwater from the nearest river. Inputs like seed of tiger shrimp and fish, feed, lime, fertilizers like urea and SSP were supplied to the farmers (Fig. 17).
Impacts of brackishwater aquaculture:

Production of tiger shrimp (*Penaeus monodon*) was 452.28± 20.58 kg ha⁻¹, *Mugil cephalus* 182.80 ± 8.58 kg ha⁻¹ and *Liza tade* 446.61± 15.55 kg ha⁻¹ following polyculture system (Fig. 18). Before implementation of this project, the land was fallow and not being utilized for any agricultural activity on account of high soil salinity. Farmers are getting benefitted from this brackishwater aquaculture with a net income of about Rs. 1,45,745 ha⁻¹ of pond area. Selling of fish throughout the year allowed farmers to earn sufficient hard cash which was utilized for creating some asset for the family. Consumption of fish from won farm land has improved their nutritional security. The employment generation has been increased from 75 to 240 man-days hh⁻¹ yr⁻¹ and migration rate of farm family for employment has been reduced.

In order to assess the environmental impact of brackishwater aquaculture, soil and water quality were regularly monitored over the time period in pond, nearby land and creeks. The creeks are the major rource of water for brackishwater aquaculture in study area.

Monthly salinity variation study in major brackishwater creeks source in NAIP selected villages also indicated a highly seasonal flotation in salinity through the study period with maximum salinity (34.53±0.89 ppt) in the month of May and lowest salinity (6.48 ± 0.92 ppt) in the month of November. This coincides with peak of summer and post-monsoon periods respectively. Monthly variations of water salinity of Saptamukhi and Chunkuri creeks in the year 2013 are presented in Fig. 19.
The average water salinity of brackishwater ponds in the selected Clusters was 10.10±0.43 ppt with a maximum 26.80 ppt during Summer month (May) and minimum 1.25 ppt during monsoon month (October). Seasonal variation of water salinity measured during 2013 in a brackishwater aquaculture pond at village Gangadharpur in Kakdwip Cluster is presented in the Fig 20.

The salinity of soil in the pond also showed seasonal variation. The average electrical conductivity in the soil of brackishwater ponds was 23.42±3.67 dS m$^{-1}$ with a lowest value 8.63 dS m$^{-1}$ in monsoon and maximum value 36.09 dS m$^{-1}$ in summer.

The total and differential microbial counts in brackishwater aquaculture intervention were conducted in water and soil samples over a time period. The total and differential microbial counts in water are presented in Table 16. The higher total microbial count in water was observed in brackishwater (120.83±18.95 ×10$^2$ CFU/mL) than in creek (80.62±21.22×10$^2$)
CFU/mL). Among the different microbial groups, the level of *Bacillus* count was higher compared to *Vibrio* and *Aeromonas* in both ponds and river. However, compared to other bacterial groups, the higher level of *E. coli* was recorded in creek water (107.50±42.50 ×10^1 CFU/mL). The level of *E. coli* signifies the level of pollution. Thus, it indicates the creeks supplying the water source in these villages are polluted with microbial load and sewage discharges.

**Table 16. Total and differential microbial count in water under brackishwater aquaculture and riverine source (Mean±SE)**

<table>
<thead>
<tr>
<th>Bacterial count</th>
<th>Brackishwater aquaculture pond</th>
<th>Creek</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total count (×10^2 CFU/mL)</td>
<td>120.83±18.95</td>
<td>80.62±21.22</td>
</tr>
<tr>
<td><em>Bacillus</em> (×10^1 CFU/mL)</td>
<td>205.00±50.86</td>
<td>165.00±55.31</td>
</tr>
<tr>
<td><em>Vibrio</em> (×10^1 CFU/mL)</td>
<td>76.25±13.75</td>
<td>63.13±19.95</td>
</tr>
<tr>
<td><em>Aeromonas</em> (×10^1 CFU/mL)</td>
<td>85.00±16.56</td>
<td>66.88±13.49</td>
</tr>
<tr>
<td><em>E. coli</em> (×10^1 CFU/mL)</td>
<td>65.00±20.21</td>
<td>107.50±42.50</td>
</tr>
</tbody>
</table>

The total and differential microbial count in soil of brackishwater aquaculture pond, paddy field and creek are presented in Table 17. The total microbial count in soil of brackishwater pond was highest (285.42±16.62×10^4 CFU/mL) and lowest in paddy field (225.42±17.23×10^4 CFU/mL). Among the different microbial groups, the highest level was recorded for the *Bacillus* which ranged between 418.13±85.37×10^2 CFU/mL (creek) to 543.75±52.39×10^2 CFU/mL (Brackishwater aquaculture Pond). *Vibrio* sp. is invariably associated with many disease problems in brackishwater fishes were found to be present in all brackishwater aquaculture pond (106.67±15.71×10^2 CFU/mL).

**Table 17. Total and differential microbial count in soil collected from pond of brackishwater aquaculture, paddy field and creek (Mean±SE)**

<table>
<thead>
<tr>
<th>Microbial counts</th>
<th>Brackishwater aquaculture pond</th>
<th>Paddy field (Control)</th>
<th>Creek</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total count (×10^4 CFU/mL)</td>
<td>285.42±16.62 (217.5-420)</td>
<td>225.42±17.23 (107.5-307.5)</td>
<td>242.19±55.88 (90-610)</td>
</tr>
<tr>
<td><em>Bacillus</em> (×10^2 CFU/mL)</td>
<td>543.75±52.39 (275-780)</td>
<td>508.33±63.38 (130-895)</td>
<td>418.13±85.37 (75-745)</td>
</tr>
<tr>
<td><em>Vibrio</em> (×10^2 CFU/mL)</td>
<td>106.67±15.71 (25-190)</td>
<td>79.17±14.17 (15-145)</td>
<td>119.38±41.65 (55-405)</td>
</tr>
<tr>
<td><em>Aeromonas</em> (×10^2 CFU/mL)</td>
<td>120.83±23.87 (5-335)</td>
<td>100.83±17.67 (15-190)</td>
<td>75.00±19.82 (15-190)</td>
</tr>
</tbody>
</table>
3. Community based water harvesting:

Different land shaping techniques for rainwater harvesting and drainage improvement which are mentioned above in section 1 & 2 were implemented in the individual’s farm land. In Sundarbans region many water harvesting structures and drainage canals were developed long back in the low-lying community/ Govt. land for harvesting of rainwater for use of local farming communities and for drainage of excess water from adjoining farmers fields. On due course of time, these canals have been silted and presently not in its optimum use. Due to drainage congestion as well as due to acute shortage of irrigation water farmers in theses areas are growing low-yielding traditional varieties of rice in Kharif and keeping their land fallow during Rabi. Thus, the productivity of their lands is very low. In order to improve the productivity of these lands, two such canals were re-excavated by RAKVK, Nimpith in two Clusters in Sundarbans region during 2014 (Fig.21). The details of the re-excavation work is given in Table 18.

![Re-excavation of canals in Sundarbans region](image-url)
**Impact of re-excavation of canals:**

Due to the re-excavation of canals about 1,34,800 m³ rainwater can be harvested and that can be utilised by 550 no. of farmers to irrigate 27 ha of degraded land for growing second crop like vegetables, pulse and oil seed crops in the area. Harvesting of rainwater will provide the scope of drainage improvement in the area during *Kharif* season and due to these large nos. of farmers can grow HYVs of rice instead of growing traditional varieties of rice.

**Table 18. Details of the re-excavation of canal and expected outcome**

<table>
<thead>
<tr>
<th>Region</th>
<th>Cluster</th>
<th>Name of canal &amp; village</th>
<th>Re-excavation area</th>
<th>Water to be harvested</th>
<th>Area to be irrigated</th>
<th>No. of direct beneficiaries</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sundarbans</td>
<td>Patharpratima</td>
<td>Natun Jhil at Achintyanagar</td>
<td>500’ x 300’ x 5’</td>
<td>25,800 m³</td>
<td>5 ha</td>
<td>100</td>
</tr>
<tr>
<td></td>
<td>Kultali</td>
<td>Sakir Khal at Dakshin Durgapur village</td>
<td>4620’ x 1000’ x 5’</td>
<td>1,09,000 m³</td>
<td>22 ha</td>
<td>450</td>
</tr>
</tbody>
</table>

**b) Sustaining food security and economic growth through diversified and multiple crops and their improved varieties:**

Crop diversification and cultivation of multiple crops and their improved varieties are essentially required for sustaining food security and economic growth in mono-cropped, degraded and dis-advantaged area like Sundarbans and Andaman & Nicobar Islands. New crops and improved varieties of crops have been introduced (Fig.21, 22) by the different Consortium partners in 387.7 ha area against the target area of 255 ha in Sundarbans and Andaman & Nicobar Islands (Table 19). A list of crops and some of their improved varieties which were introduced in the study area is given in Table 20. Introduction of improved varieties and new crops has increased productivity of degraded land (Table 21). Farmers in the area were growing both *Kharif* and *Rabi* vegetables in a limited area due to waterlogging in *Kharif*, scarcity of irrigation water in *Rabi*, non-availability of the salt tolerant and improved varieties. Due to raising of land and on-farm harvesting of rainwater farmers in the study areas are now growing *Kharif* and *Rabi* vegetables. The partner institutes have provided improved varieties of vegetable which resulted in enhance productivity of their farm land. The cropping pattern of the study areas has also changed from rice-fallow to rice-vegetable/ vegetable- vegetable. Replacement of farmers’ crop varieties with improved varieties has increased the productivity of crops ranging from 6.5 % to 26 % (Table ). The enhancement of productivity varied with crops which were introduced in the different Clusters.
**Fig. 21 Improved variety of rice introduced in Sundarbans and Andaman & Nicobar Islands**

**Fig. 22 Vegetables and oil seed crops grown in Sundarbans**

**Table 19: Implementation of crop diversification intervention by the Consortium partners in the study area**

<table>
<thead>
<tr>
<th>Consortium Partner</th>
<th>Target area (ha)</th>
<th>Achieved area (ha)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Sunderbans Clusters</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CSSRI, RRS</td>
<td>45.00</td>
<td>85.32</td>
</tr>
<tr>
<td>RAKVK</td>
<td>112.00</td>
<td>111.98</td>
</tr>
<tr>
<td>CIBA, KRC</td>
<td>44.00</td>
<td>101.98</td>
</tr>
<tr>
<td>BCKV</td>
<td>34.00</td>
<td>35.50</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td>235.00</td>
<td>334.78</td>
</tr>
<tr>
<td><strong>Andaman &amp; Nicobar Clusters</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CARI</td>
<td>20.00</td>
<td>52.90</td>
</tr>
<tr>
<td><strong>Grand Total</strong></td>
<td><strong>255.00</strong></td>
<td><strong>387.68</strong></td>
</tr>
</tbody>
</table>
Table 20. Crop and their varieties introduced

| Vegetables | Kharif vegetables: | Okra (007, Avantika), Bittergourd (Meghna, Bolder), Bottle gourd (Botlong, Ganga jomuna, Jorabota), Ridge gourd (12 pata), Cucumber (7 star, Sonali, Chotachetan), Sponge gourd (12 pata), Basella (Bombai), Pumpkin (IR-8, Kalia), Colocasia (Kali, Dholi), Amaranthus (Jabakusum), Brinjal (Benipurguli, Makra), Been (Deepsikha), Cow pea (Laffa mauri). | Rabi vegetables : | Carrot (Earlynantis), Tomato (Rocky, Dev, Avinash 2, Avinash 3, Heemsona, US-04, S&G-1458), Knolkhol (Winner, Samrat), Snake gourd (Baruipur), Beet (Crimson, Globe, Red ball), Cauliflower (White flash, Hemamalini), Cabbage (Golden acre, Pride of India), Raddish (Minong white), Spinach (Haldibari). Chilli (Tejaswini, JK-178, Bullet), Bitter Gourd (US-6214, JK-Vinod) |

| Rice | Kharif rice (Sabita, Gitanjali, SR-26B, Amalmana, CSR 36, CSR 23, CARI Dhan - 5), Rabi rice (Annada, Sadaminikit (IET 7486), Lalminikit (WGL 20471), Lalat, Canning 7) |

| Oilseeds | Groundnut (Tag-24), Sunflower (Sunbright, J.K- Chitra, PAC-36, KBSH-44, DRSF-108) |

| Other crops | Cotton (Surobhi), Moong (Samrat), Black pepper, Cinnamon, Clove, Areacanut (Mangala), Coconut (Green and yellow King coconut), Pine apple (Queen), Sapota (Cricket ball), Guava (Baruipur khaja) |

Table 21. Average productivity of crops in the study area

<table>
<thead>
<tr>
<th>Crops</th>
<th>Area cultivated (ha)</th>
<th>Productivity before Project intervention (Baseline) (q ha$^{-1}$)</th>
<th>Productivity after Project intervention (q ha$^{-1}$)</th>
<th>Increment over baseline value (q ha$^{-1}$)</th>
<th>Increase in productivity (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sunderbans Clusters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kharif Rice</td>
<td>73.03</td>
<td>31.11</td>
<td>39.20</td>
<td>8.09</td>
<td>26.00</td>
</tr>
<tr>
<td>Rabi Rice</td>
<td>24.00</td>
<td>43.00</td>
<td>45.80</td>
<td>2.80</td>
<td>6.51</td>
</tr>
<tr>
<td>Kharif vegetables</td>
<td>56.86</td>
<td>0.00</td>
<td>113.35</td>
<td>113.4</td>
<td>-</td>
</tr>
<tr>
<td>Rabi vegetables</td>
<td>42.20</td>
<td>0.00</td>
<td>187.5</td>
<td>187.5</td>
<td>-</td>
</tr>
<tr>
<td>Oil seed</td>
<td>77.19</td>
<td>1.20</td>
<td>1.34</td>
<td>0.14</td>
<td>11.67</td>
</tr>
<tr>
<td>Cotton</td>
<td>31.08</td>
<td>0.00</td>
<td>8.95</td>
<td>8.95</td>
<td>-</td>
</tr>
<tr>
<td>Pulses</td>
<td>28.92</td>
<td>6.50</td>
<td>7.54</td>
<td>1.04</td>
<td>16.00</td>
</tr>
<tr>
<td>Fruit</td>
<td>3.50</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Andaman &amp; Nicobar Clusters</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Kharif Rice</td>
<td>50</td>
<td>21.0</td>
<td>38.00</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Fruit &amp; Spices</td>
<td>2.40</td>
<td>-</td>
<td>-</td>
<td>-</td>
<td>-</td>
</tr>
</tbody>
</table>
Cotton is a less water requiring and salt tolerant crop and it can be grown as a second crop after the harvest of Kharif rice by utilizing residual moisture during Rabi season in the salt affected degraded coastal land. RAKVK has introduced cotton crop in the rice based cropping system in Kultali, Pathapratima and Mathurapur II Clusters in Sundarbans region (Fig. 23).

![Cotton cultivation in Sundarbans region](image)

Cotton cultivation in rice based cropping system provided good monitory return (Table 22). Introduction of cotton under rice-fallow system income has increased net return from Rs.15400 (Rice-fallow) to Rs.42,400 ha$^{-1}$ (rice-cotton).

<table>
<thead>
<tr>
<th>Cropping Sequence</th>
<th>Cultivation methods</th>
<th>Productivity (kg/ha)</th>
<th>Expenditure (Rs. ha$^{-1}$)</th>
<th>Gross income (Rs. ha$^{-1}$)</th>
<th>Net income (Rs. ha$^{-1}$)</th>
<th>B:C ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td>Paddy - Cotton</td>
<td>Direct sowing</td>
<td>825.00</td>
<td>11890.00</td>
<td>21690.00</td>
<td>9800.00</td>
<td>1.82</td>
</tr>
<tr>
<td>Paddy - Cotton</td>
<td>Transplanted</td>
<td>965.00</td>
<td>12650.00</td>
<td>24910.00</td>
<td>12260.00</td>
<td>1.97</td>
</tr>
</tbody>
</table>

It is observed that continuous cultivation of cotton crop for 5-6 years in the salt affected soil reduced the soil salinity from 3.5-5.0 dS m$^{-1}$ to 0.75 -1.20 dS m$^{-1}$ and increased organic C content of soil by 0.02 – 0.03 % due to addition of organic matter from decomposition of litter fall and roots of the crop. Further, it has also been observed that the degraded land thus reclaimed by cotton cultivation has, over the time, developed the potentiality of vegetable cultivation if provision for irrigation is made. For marketing of cotton, RAKVK has already developed the door step marketing channel in collaboration with Cotton Corporation of India (CCI) in a Public-Private-Partnership mode through which the farmers are enjoying the actual rate of cotton without any intervention of middle man.
C) Crop nutrient management

Poor soil health and unscientific soil fertility management are key constraints for higher agricultural productivity in the coastal areas. Technological interventions like green manuring with *Sesbania*, fertilizer application on soil test value, micro-nutrient application and vermi-composting were introduced by the Consortium partners to enhance the health and fertility status of the degraded soils of the study area (Table 23). Out of the total target of 130 nos. of vermi-compost unit, 133 nos. of units were demonstrated in the different Clusters of Sundarbans (Fig.24).

**Table 23: Area covered under crop nutrient management intervention by Consortium partners**

<table>
<thead>
<tr>
<th>Consortium Partner</th>
<th>Vermi-compost unit (No's)</th>
<th>Nutrient management</th>
<th>Fertilizer and micro-nutrients</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Target</td>
<td>Achievement</td>
<td>Target</td>
</tr>
<tr>
<td>Sunderbans</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>CSSRI, RRS</td>
<td>37.0</td>
<td>36.0</td>
<td>11.0</td>
</tr>
<tr>
<td>RAKVK</td>
<td>47.0</td>
<td>50.0</td>
<td>20.0</td>
</tr>
<tr>
<td>CIBA, KRC</td>
<td>31.0</td>
<td>31.0</td>
<td>-</td>
</tr>
<tr>
<td>BCKV</td>
<td>15.0</td>
<td>16.0</td>
<td>6</td>
</tr>
<tr>
<td>Total</td>
<td>130.0</td>
<td>133.0</td>
<td>37</td>
</tr>
</tbody>
</table>

Vermi-composting is a highly profitable venture for farmers. The major raw materials used for vermi-compost were cow dung, water hyacinath, kitchen waste, goat dung etc. In making of vermi-compost, three species of epigeic earth worms (*Perionyx excavatus*, *Eisenia fetida* and *Eudrilus eugeniae*) were used. The average vermi-compost production per cycle (3 month) from vermi-compost unit (12 feet × 5 feet × 0.25 feet) was 600-700kg. Generally farmers completed 4
vermi-composting cycles per year with an average annual production of 2.0 - 2.5 q per unit per year. Vermi-compost is being used by the farmers for vegetable production and for production of beetle vine–The approximate cost and benefit ratio of vermi-compost units was 2.7. The average organic carbon content in the vermi-compost was 9-12% and nitrogen content was 0.5-1.5% and phosphorous was 0.2 to 1 %. Hence, substantial amount of organic carbon, nitrogen and phosphorus are being added annually in degraded saline soil in Sundarbans from 300 q vermi-compost produced in the study area.

About 77 ha of degraded land have been brought under improved nutrient management through cultivation and incorporation green manuring crop, Sesbania in the crop fields. Farmers were not only growing Sesbania as a green manure but also for seed production (Fig. 25) and selling the seeds to the local market was highly remunerative. Practicing green manuring and vermi-composting increased land productivity by 20-30% and soil health through increasing soil organic C (0.02 to 0.04% ) and microbial activities. It also reduced farm input cost by reducing application of chemical fertilizer, increasing efficiency of chemical fertilizers and improved soil micro-environment.

![Sesbania crop on raised land for seed production](image)

**Fig. 25 Sesbania for crop nutrient management**

Under crop nutrient management, chemical fertilizer like urea, DAP and SSP on soil test value was demonstrated in 10 ha of farm land in Sundarbans Clusters. Micro-nutrient like zinc and boron was also demonstrated on 34.2 ha of degraded land covering 243 nos. beneficiaries. This has resulted in enhancement of yield of Kharif rice from 2.25 t ha$^{-1}$ to 2.70 t ha$^{-1}$.

**B. Minor technological interventions:**

Following technological interventions were discontinued from 2011-12 with the instruction from PIU, NAIP and World Bank review team as the project has given more emphasis on sustainable management of degraded land for which these interventions are less important.
a) Drip irrigation system

Though Andaman Island received high amount of rainfall still water becomes scare during the dry season. Under NAIP drip irrigation system was implemented in 4.5 ha land covering all the four Clusters in Andaman & Nicobar Islands for fruits, plantation and vegetable crops (Fig. 26). The land was leveled and proper slope was provided to facilitate gravity flow as well. The water was taken either from well or pond, filtered and fed into the laterals and supplied by emitters. This improved the productivity of crops and enhanced the water use efficiency during dry season (January – April). In addition, the salinity level in the coastal saline area was kept below permissible level in the root zone of crops. The effect of drip irrigation is presented in Table 24.

![Fig. 26 Implementation of drip irrigation system in Andaman & Nicobar Islands Clusters](image)

### Table 24. Effect of drip irrigation system in Andaman & Nicobar Clusters

<table>
<thead>
<tr>
<th>Name of the Cluster</th>
<th>Crops grown</th>
<th>No of beneficiary</th>
<th>Productivity of crops (t ha⁻¹)</th>
<th>Soil salinity (dS m⁻¹)</th>
<th>Employment generation (man-days)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td></td>
<td>Before</td>
<td>After</td>
<td>Before</td>
</tr>
<tr>
<td>Chouldhari</td>
<td>Coconut, Arecanut, Banana, Vegetable</td>
<td>4</td>
<td>3.1</td>
<td>5.0</td>
<td>1.4</td>
</tr>
<tr>
<td>Shoal Bay</td>
<td></td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>1.5</td>
</tr>
<tr>
<td>Rangat</td>
<td></td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>1.7</td>
</tr>
<tr>
<td>Diglipur</td>
<td></td>
<td>4</td>
<td>-</td>
<td>-</td>
<td>1.3</td>
</tr>
</tbody>
</table>

b) Nursery raising for horticultural crops and fishes for livelihood security:

Availability of good quality of crop saplings and fish seeds for Indian major carps (Rohu, Catla and Mrigal) in the remote places of Sundarbans and Andaman & Nicobar Islands is one of the major hindrances for higher crop and fish productivity. So nursery raising not only provides good quality planting materials and fish seeds in remote places but also provide employment
opportunity among rural farming communities in coastal areas. Out of the total target of 58 nursery units for crops and fishes, 86 units were demonstrated in the different Clusters of Sundarbans by CSRI, RAKVK & CIBA, KRC. For nursery raising farmers of the different Clusters of study area provided training, portable crop nursery raising structures, good quality seeds for horticultural crops like vegetables, coconuts, arecanut, good quality fish fry of Rohu, Catla and Mrigal, etc. (Fig. 27). Nursery raising both for crops and fish were highly profitable for the farmers and can be practiced by the farmers even with marginal holdings. Farmer got net profit of Rs. 11,000 from his 0.33ha land by raising coconut plant (cv. East-Coast). Nursery rearing of fish (carps) was successfully conducted in 53 farmer’s ponds covering 3.08 ha area in Sundarbans Clusters with production of 1,40,000 nos. of fingerlings ha$^{-1}$. Farmers could able to earn a profit of Rs. 1,50,000 -1,87,500 per ha of pond.

Portable crop nursery raising structures     Distribution of carp fry for nursery raising

In Andaman & Nicobar Islands 4 satellite nurseries have been formed in order to promote production of fishlings of Indian Major Carps (IMC) to meet the local demand and timely availability for fish seeds. Farmers were provided with necessary facilities to take up fish culture as a micro business and training has been imparted (Fig.28). There were four farmers group and each farmer has earned Rs.12,000 each with in 40 days by only pooling their resources during the fish breeding season. In addition the farmers group benefited by getting fish supply at the cost of Rs.1.0 and at proper time.
b) Mushroom cultivation for livelihood security of women and landless farmers:

Mushroom cultivation has been introduced among the individual landless farmers, women farmers and self help groups (SHGs) in the different Clusters of Sundarbans region to improve the livelihood of poor farmers especially women and landless farmers and their nutritional security. Before introducing the mushroom cultivation technique off-campus training programs were organized where farmers were trained to grow mushroom with locally available materials (Fig. 29). Out of total target of 110 units, low-cost mushroom cultivation technique was introduced to 115 nos. farmers in Sundarbans Clusters by CSSRI, RRS, RAKVK & CIBA, KRC. It was adopted mostly (90%) by the women farmers. Spawn of *Pleurotussajorcaju* popularly called as “oyster mushroom” was supplied on regular basis to the farmers. Mushroom was grown in a plastic bag filled with paddy straw. Average Rs.600 was earned from each unit per year. This technology not only enhanced the income of the farm families but also improve the nutritional security due to inclusion of mushroom in their diet.
d) Drudgery reduction through farm mechanizations:

Under this intervention, different farm implements like wheel hoe (50 nos.), Knapsack sprayer (18 nos.), cono-weeder (12 nos.), paddy weeder (2 nos.), drum seeder (12 nos.), thresher (10 nos.), coconut tree climber, copra dryer, and coconut dehusker were distributed among the farmers in different Clusters by CSSRI, RRS, RAKVK, CIBA, KRC and CARI for drudgery reduction and economization of farm operations (Fig. 30). Thresher, paddy weeder, cono-weeder, Knapsack sprayer and drum seeder have been distributed for implementation by the beneficiaries in a co-operative manner usage.

![Fig.30 Farmes were provided with farm implements for dudgery reductions](image)

- **Fig.30 Farmes were provided with farm implements for dudgery reductions**

e) Bee keeping:

Thirty nine numbers of landless men and women farmers in the study area of Sundarbans were supported by RAKVK and CIB, KRC with inputs like bee boxes for bee keeping to enhance their family income (Fig. 31). Training were imparted to the farmers for efficient beekeeping and its management. Beneficiaries started harvesting of 250-750 g of honey per box per collection at 15 days interval and selling in the local market @ Rs. 160 kg⁻¹.
f) Introduction of improved livestock:

RAKVK and CIBA, KRC provided improved breeds of goat to 32 nos. of farmers and improved breed of pig to 1 no. woman farmer for better livestock production and enhancing farm income. Trainings were also imparted to the farmers for improved livestock management. Black Bengal goat was supplied to farmers as improved breeds of goat. As this breed is a prized goat of West Bengal with its tasty meat and multiple births, farmers are practicing breeding for its propagation and better livelihood.

In Andaman & Nicobar Islands Clusters, CARI has introduced animal sheds along with improved breeds of livestock animals and poultry birds to encourage integrated farming system for enhancing income and availability of improved nutrition particularly those of women farmers (Fig. 30). The integration of agriculture, livestock, poultry, fishery, horticultural crops, agro forestry in addition to effective recycling of wastes to ensure better environmental quality was achieved through Integrated farming System. Poultry bird (Vanaraja) has given a net income of 2,000 per farmer with in 40-50 days per cycle.
Women farmers were supported with improved breed of goat in Sundarbans. Poultry bird rearing under integrated farming system in Andman & Nicobar Islands

Fig. 32 Introduction of improved livestock in the study area

g) Livestock health management:

Intervention on improvement in livestock management through better health care measures like nutrition and disease management was implemented by BCKV, RAKVK and CIBA,KRC in the different Clusters of Sundarbans. Health camps were organized time to time in the villages for nutritional and disease management (Fig. 33). During the camp, vaccination against Foot and Mouth Disease, hemorrhagic septicemia and black quarter for cattle, goat pox for goats and Ranikhet disease for poultry were carried out. In addition, deworming, verification and infertility treatment for the livestock were also carried out in the health camp. RAKVK, Nimpith has developed parasitological map for helminthic attack in a specific season in a particular area for effective and complete parasitological control.

Trainings were imparted to the farmers for improved health management of livestock for better health and productivity. Sudan grass was introduced as fodder crop to increase the milk production and to improve the health of milch cow.
h) Skill & capacity building:

Off-campus and on-campus training programmes/exposure visits (Fig. 34) were organized by the partners institutions on various aspects for skill and capacity building of the farming communities of the study area. The details of programmes are presented in section 14. More than 6000 farmers participated in 133 nos. of training/exposure visits.

(a) On-station training programmes
(b) On-farm training programmes

(c) Exposure visit of framers

**Fig. 34 Training programmes and exposure visit of farmers**

i) Establishment of Rural Technology Centres (RTCs):

Four numbers of Rural Technology Centres (RTCs) were established in Canning I, Mathurapur II, Kakdwip and Kultali Clusters of Sundarbans region (Fig. 35). The RTCs are equipped with
kiosk machine where very useful and user friendly information on crop production, aquaculture, bee keeping, mushroom cultivation, etc. in both English and Bengali language are kept for easy accessibility to the farmers.

RTC in Kakdwip Cluster

Inaugurated by Dr. S. Ayyappan, Secretary, DARE & DG, ICAR

RTC in Canning I Cluster

Inaugurated by Sh. Shyamal Mandal, Honble. Mister, Sundarban Affairs & Irrigation and Waterways, Govt. of West Bengal
Innovations for Tsunami affected degraded lands:

The following innovation were introduced / observed in the course of the implementation of the project in Andaman & Nicobar Islands Clusters (Fig. 36).

- **Utilization of degraded land by spot cultivation and erecting pandals**

  The land is limited in supply and investing on reclamation of entire degraded land is not remunerative. Therefore, the farmers cultivate only 4 ft² areas by digging a pit, draining out salts by applying limited quantity of water before filing the pit with organic manures. In the selected sport tolerant crops like cucurbits and cow pea are grown. Further, the climbers are supported by erecting pegs in the degraded land to make pandals (Fig. 36). By this way, resources are utilized...
effectively and degraded land is put into productive use without much investment. The yield of the crop is as good as in normal land (4-5 t ha$^{-1}$).

*Fig. 36* spot cultivation and erection of pandals

- **Providing shade to fishes and use of furrow**
  In BBF and Paired bed system rainwater is harvested in the furrow and fish culture is practiced. However, during dry season the water level goes down and the water gets heated up to 35 C. Therefore, providing some kind of shade is essential. At the same time the area available for cultivation of vegetable is limited (land to water ratio is 4:6). Therefore, the farmers grow the climber vegetables (cucurbits) at the edge of the beds, make pandal over the furrows by using bamboo and pegs, allow the climber to grow over there (*Fig. 37*). This method not only ensures shade to the fishes but also effectively utilize the aerial space over water body for growing of crops.

*Fig. 37* Providing shade to fishes and use of furrow by pandals
• **Satellite fish nurseries**

In Andaman timely availability of fish seed is a problem at the same huge potential exist for the sale of fishlings. Under NAIP, a group of farmers are brought together, trained in fish culture and provided with all necessary support to start a fish nursery in any one farmers field by pooling the resources (Fig. 38). A group of 6-8 farmers are joined together to start a fish nursery. In collaboration with fisheries department who arranged for market network and sale of fishlings, CARI has provided technology and NAIP provided material support to initiate the satellite nurseries. The farmers have grown the fishlings upto 40 days and sold to the needy farmers and they went for two cycles with in a season and shared the benefits. There were four farmers group and each farmer has earned Rs.12,000 each with in 40 days by only pooling their resources during the fish breeding season. In addition the farmers group benefited by getting fish supply at the cost of Rs.1.0 and at proper time.

![Fig. 38 Satellite fish nurseries](image)

• **Multiple cropping**

In the tsunami affected coastal low-lying areas availability of cultivable land is limited. In addition farmers can not afford to waste any of their resources including season. Therefore, some of the farmers have adopted multiple cropping systems in their land after land shaping to get maximum benefit from it (Fig. 39). In both during kharif and rabi season rice is grown in the furrows along with fish culture. In the beds, banana is cultivated with 1 m spacing intercropped with bhendi at initial stages. When the Banana grows, cowpea and greens are grown in the interspaces. Thereby the space and time is effectively utilized and cropping intensity and water productivity is increased while the surrounding areas are still under waterlogging and suffering from salinity.
• Use of noni fruits (*Morinda citrifilia*) as pig feed for prophylactic effect

Noni (*Morinda citrifilia*) is a shrub and grows very well in salinity and even in slightly waterlogged conditions. The native of this plant is Andaman and Nicobar Islands. The fruit has medicinal properties. Farmers of the NAIP interventions areas where livestock are distributed faces the problem of quality feed material for pig, poultry and goat. The fruits are commercially sold at the rate of Rs. 10 kg$^{-1}$ and the plant seedling are easily available at CARI. Some of the farmers have used the fruits as nutritional supplement for pig (Fig. 40) and poultry. In addition, it was observed that feeding of fruits has also induced disease resistance among the animals. The farmers themselves recommend noni fruits to their friends and relatives to get the benefit out of it. CARI, Port Blair has been actively engaged in research on the commercial exploitation of noni.
Innovations for Sundarbans region:

- Parasitological mapping– an innovative tool for parasite control of animals

Domesticated creatures often suffer from helminth infestation. The type of helminths may vary from region to region while in different seasons they may vary in their intensity, type and nature of effects. The modern anthelminthic drugs that are used are mostly broad spectrum in nature and can kill and/or control many types of worms. Thus, the extent of treatment is enhanced. But, at the same time, farmers often do not give the proper required dose of the dewormer for effective control of the parasites. Thus, there is every possibility of growing resistance of the parasites against the same drug. The drug being the latest one, if not administered with proper dosage, may create a situation where the parasites are not fully controlled leading to great economic loss both for the particular animal as well as the whole population. Besides, unnecessary and repeated use of dewormer not only costs more but also reduces the performance of the productive animals. Thus, there was a need to develop an outlay for proper and optimum use of a particular dewormer for a particular region so that indiscriminate and unjustified use of anthelminthic drugs can be minimized.

**The technology:** During the animal health camp at NAIP villages in different seasons, the RAKVK experts felt that in spite of regular and normal de-worming schedule; the worm infestation was observed through stool examination. Thus the strategic plan to develop parasitological mapping was carried out for effective and complete parasitological control. RAKVK, Nimpith has conducted several field visits in a number of villages of Sundarbans in different seasons and collected stool samples from the non-descriptive indigenous dairy animals. The samples were analyzed both by the sedimentation and floatation method to identify the worm burden in that region in relation to specific season. The camp in those regions continued with selective and effective dewormer over a period of two years and for each successive camp, stool samples were again analyzed and plotted to develop a map of the parasitological infestation (Fig. 41). The map was developed to have a prediction of helminthic attack in a specific season in that particular area. In the follow-up period, the same principle was followed and deworming was done without examining the stool samples. The technology proves to be very effective for controlling the parasites in a region and season specific manner.
Effects of technology on production and economic gain: The previous pattern of deworming in these NAIP villages was not as per scientific standard and recommendations. The farmers used to deworm their animals, at the most, twice a year whereas it should be followed at every three months interval including a dose each, before and after monsoon. So the ideal deworming is five times a year. The non descript cattle of these villages were generally producing 1.2 kg of milk per day with average lactation period of 170 days (Table 25). The effect of ineffective deworming poses the situation for shortened lactation period caused by malnutrition. After the intervention and with appropriate and effective dose of deworming in specific time the same cattle yielded more with increased lactation period. Besides, effective deworming also reduced the disease incidence and thus reduced the treatment cost.

Table 25. Effect of parasitological mapping on production and economic gain

<table>
<thead>
<tr>
<th>Category</th>
<th>Cost of deworming (Rs/year)</th>
<th>Other cost (Rs/year)</th>
<th>Average milk production (Kg/day)</th>
<th>Lactation period (days)</th>
<th>Gross income (Rs/year)</th>
<th>Net income (Rs/month)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Before intervention</td>
<td>44.00</td>
<td>2,800.00</td>
<td>1.2</td>
<td>170</td>
<td>4,080.00</td>
<td>103.00</td>
</tr>
<tr>
<td>After intervention</td>
<td>120.00</td>
<td>1,900.00</td>
<td>2.1</td>
<td>190</td>
<td>7980.00</td>
<td>496.00</td>
</tr>
<tr>
<td>Average Body weight of newly born calf (Kg)</td>
<td>22.5</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td>28.5</td>
</tr>
</tbody>
</table>
Ornamental fish catching device - an innovative low cost tool:

At the very initial phase of the project, to augment the fish productivity, ornamental fishes were advocated to rear in the nylon net/hapa fixed on the pond water along with the normal practices of IMC cultivation. It was observed the color intensity and growth of the ornamental fishes in the pond were better than that of the fishes reared in the aquarium. The scientific methodology including its feeding and rearing management were included to the farmers through training. Farm women were very much interested to rear ornamental fishes in their ponds as they directly enjoyed the additional income obtained from ornamental fishes. To catch the ornamental fishes from the net enclosures/hapa which is generally fixed almost middle of the pond to avoid theft, one low cost device was developed by the farmers as soon. In this device, four no. of milk/plastic crates /trays are fixed together to make it a small boat shaped structure and floated on the water. The balance is made rightly taking the help of rope. Through this innovative device, the farmers can easily rich to the “hapa” without much stress and can collect and store the fishes in the plastic crates in good condition for better market price (Fig. 42). At present this practices is going on in the NAIP adopted villages an also in neighboring villages where ornamental fish is reared.

Ornamental fish culture in hapa

Use of fish catching device

Fig. 42 Ornamental fish catching device

7. Process/ Product/Technology Developed

<table>
<thead>
<tr>
<th>S. No</th>
<th>(Process/Product/Technology Developed)</th>
<th>Adoption/ Validation/ Commercialization, etc.</th>
<th>Responsible Consortium</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Biomass fired copra dryer has been upgraded and standardised for use in Andaman Islands (Fig. 43). The copra dryer is available for drying 250 to 500 coconuts. It takes about 16-</td>
<td>Validated and transferred the technology</td>
<td>CARI, Port Blair</td>
</tr>
</tbody>
</table>
20 hrs in biomass fired dryer in comparison to 40 hours in open sun drying. The shells of coconut can be used as fuel materials. The approximate cost is 40,000 to 60,000 based on the size and quality of materials used.

Fig. 43 A view of biomass fired copra dryer and drying process of coconut

8. Patents (Filed/Granted) N.A.

9. Linkages and Collaborations

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Linkages developed</th>
<th>Activity</th>
<th>Units (Rs./no./ha)</th>
<th>Period From-To</th>
<th>Responsible Partner</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>ATMA, South 24 Parganas</td>
<td>Investment for adoption of land shaping techniques</td>
<td>08.00 lakhs</td>
<td>2010-2012</td>
<td>RAKVK</td>
</tr>
<tr>
<td>2</td>
<td>Mahatma Gandhi NREGA</td>
<td>Investment for adoption of land shaping techniques</td>
<td>10.00 lakhs</td>
<td>2011-2012</td>
<td>RAKVK</td>
</tr>
<tr>
<td>3</td>
<td>BGREI, Deptt. of Agriculture, GOWB</td>
<td>Investment for adoption of land shaping techniques</td>
<td>980.00 lakhs</td>
<td>2012-2014</td>
<td>RAKVK</td>
</tr>
<tr>
<td>4</td>
<td>NWDPRA, Deptt. of Agriculture, GOWB</td>
<td>Investment for adoption of land shaping techniques</td>
<td>30.00 lakhs</td>
<td>2012-2014</td>
<td>RAKVK</td>
</tr>
<tr>
<td>5</td>
<td>Sundarban Development Board, GOWB</td>
<td>Investment for adoption of land shaping techniques</td>
<td>200.00 lakhs</td>
<td>2012-2014</td>
<td>RAKVK</td>
</tr>
<tr>
<td>6</td>
<td>IWMP, Deptt. of Agriculture, GOWB</td>
<td>Investment for adoption of land shaping techniques</td>
<td>450.00 lakhs</td>
<td>2013-2017</td>
<td>RAKVK</td>
</tr>
<tr>
<td>7</td>
<td>NHM, Deptt. of FPI &amp; H, GOWB</td>
<td>Investment for adoption of High – tech Beetle vine cultivation</td>
<td>385 lakhs</td>
<td>2012-2015</td>
<td>RAKVK</td>
</tr>
<tr>
<td>S. No.</td>
<td>Linkages developed</td>
<td>Activity</td>
<td>Units (Rs./no./ha)</td>
<td>Period From-To</td>
<td>Responsible Partner</td>
</tr>
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</tr>
<tr>
<td>8</td>
<td>Deptt. of Agriculture, Soil Conservation, Animal Husbandy, Govt. of WB</td>
<td>Experience sharing and technical support</td>
<td>-</td>
<td>2010-2014</td>
<td>CSSRI, RRS, RAKVK, CIBA, KRC, BCKV</td>
</tr>
<tr>
<td>9</td>
<td>Jilla Parisad, Panchayat Samities, Gram Panchayat</td>
<td>Implementation and selection of beneficiaries</td>
<td>-</td>
<td>2010-2014</td>
<td>CSSRI, RRS, RAKVK, CIBA, KRC, BCKV</td>
</tr>
<tr>
<td>10</td>
<td>NGOs- Jaigopalpur Gramin Vikash Kendra, Janakalyan Seva Sangha, Youth Club</td>
<td>Extension support, selection of beneficiaries, motivation and experience sharing</td>
<td>-</td>
<td>2010-2014</td>
<td>CSSRI, RRS, BCKV</td>
</tr>
<tr>
<td>11</td>
<td>National Banks (SBI, UBI etc.)/Bangiya Gramin Bikash Bank/NABARD</td>
<td>Financial support to farmers</td>
<td></td>
<td>2010-2014</td>
<td>CSSRI, RRS, RAKVK, CIBA, KRC, BCKV</td>
</tr>
<tr>
<td>12</td>
<td>Dept. of Fisheries, A&amp;N Administration</td>
<td>Implementation of satellite nurseries at farmers field.</td>
<td>4</td>
<td>2011-2013</td>
<td>CARI, Port Blair</td>
</tr>
<tr>
<td>14</td>
<td>Zilla Parishad</td>
<td>Implementation of community ponds at selected villages</td>
<td>3</td>
<td>2011-2013</td>
<td>CARI, Port Blair</td>
</tr>
<tr>
<td>15</td>
<td>NGO – Pasumai Sigaram Nature farmers Trust</td>
<td>Training to farmers on organic cultivation</td>
<td>-</td>
<td>2011-2013</td>
<td>CARI, Port Blair</td>
</tr>
</tbody>
</table>

### 10. Status on Environmental and Social Safeguard Framework

As committed in the project, efforts were made to address environmental and social safeguards through various initiatives. As part of social safeguard measures, soil and water quality under different technological interventions were monitored periodically in the study area. Under different land shaping techniques about 12,06,073 m³ good quality water has been harvested per year which is being utilized to irrigate 242.29 ha degraded land. Due to land reshaping and harvesting of rain water, the soil salinity (ECe) of the degraded land has been reduced from initial value of 14-16 dS m⁻¹ to 5-4 dS m⁻¹. The acidity of degraded soil in Tsunami affected lands in Andaman & Nicobar Islands is gradually recovering from 4.99 to 5.49 after intervention. Electrical Conductivity (EC) in the area also is in the acceptable levels i.e. 1.2 dSm⁻¹ from the initial level of 3.2 dSm⁻¹. Increase in nutrient status (av. N, P, K), Org. C and micro-biological properties indicated improvement of degraded land in the study area due to implementation of technological interventions like land shaping techniques and crop nutrient management. Due to improvement of soil quality and availability of good quality irrigation water, the cropping
intensity of the area has been increased up to 300% from baseline value of 100%. In the study areas in Sundarbans region the underutilized brackish water which is available in plenty in the area are being used for productive brackish water aquaculture systems. This technology also providing the scope for utilizing highly degraded (saline) land near brackishwater rivers/ creeks which was earlier remain unutilized due to high salinity. Care has been taken for less infestation of animal diseases in the study area. Activities like training and animal health caps were organized in the Clusters village for health and disease management of the livestock.

As part of social safeguard measures, for selecting the villages in the Clusters priorities were given to the conditions of poor livelihood of the rural communities and low productivity of land due to soil and water degradation. The priorities were also given while selecting the beneficiaries to mostly small and marginal farmers having small land holding and having problems of degraded soil and water quality in their farm lands. Different technological interventions enhanced the net income of the farming communities by manifolds. Due to generation of employment the migration of the family members has been reduced. The production of multiple and diversified crops has enhanced nutritional security of the poor farming communities in the coastal region. Attempts have been made for drudgery reduction of women farmers through introduction of low-cost farm machineries. Off-campus and on-campus training programmes/ exposure visits were organized time to time by the partners institutions on various aspects for skill and capacity building of the farming communities of the study area.

11. Constraints, if any and Remedial Measures Taken

<table>
<thead>
<tr>
<th>Constraints</th>
<th>Remedial Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Degraded land and water with high salinity and water logging &amp; drainage congestion</td>
<td>Eco-friendly Land shaping techniques implemented to reduced soil salinity build up and to improve drainage congestions</td>
</tr>
<tr>
<td>High scarcity of good quality of irrigation water during dry season, mono cropped area, low productivity of land and water</td>
<td>Increased the availability of irrigation water in dry season through rain water harvesting. Low water requiring/ short duration/ salt tolerant/ HYV of crops was introduced for enhancing productivity.</td>
</tr>
<tr>
<td>Poor soil health and unscientific soil fertility management</td>
<td>Technology like Green manuring, vermicomposting and balance fertilizer application based on soil testing was demonstrated for improving soil health.</td>
</tr>
<tr>
<td>Lack of proper knowledge regarding soil health and crop management</td>
<td>Numbers of off and on campus training programme are organized with adaption rate.</td>
</tr>
<tr>
<td>Bottleneck in communication</td>
<td>Established door step marketing opportunity in PPP mode</td>
</tr>
</tbody>
</table>
12. **Publications** (As per cited in Indian Journal of Agricultural Sciences)

A. Research papers in peer reviewed journals

<table>
<thead>
<tr>
<th>S. No</th>
<th>Authors, Title of the paper, Name of Journal, Year, Vol. &amp; Page No.</th>
<th>NAAS Ratings</th>
<th>Responsible Consortium</th>
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<tr>
<td>2</td>
<td>Land shaping for crop diversification and enhancing agricultural productivity in degraded lands of A&amp;N Islands, J. of soil salinity and water quality, 2011, 3(2):83-87.</td>
<td>3.0</td>
<td>CARI &amp; CSSRI</td>
</tr>
<tr>
<td>3</td>
<td>Assessment of post tsunami land degradation and vulnerability of a tropical island, 2014, Land degradation &amp; Development (accepted for publication)</td>
<td>7.5</td>
<td>CARI &amp; CSSRI</td>
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</table>

B. **Books/ Book chapters/ Abstracts/ Popular articles, Brochures, etc.**

<table>
<thead>
<tr>
<th>S. No</th>
<th>Authors, Title of the papers, Name of Book/ Seminar/ Proceedings/Journal, Publisher, Year, Page No.</th>
<th>Responsible Partner</th>
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<tbody>
<tr>
<td><strong>Books :</strong></td>
<td></td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>Jana,A.k, , Rahaman,S. And Maity.U. 2013. NAIP Beacons Road to the future. Ramkrishna Ashram Krishi Vigyan Kendra, Nimpith, west Bengal</td>
<td>RAKVK</td>
</tr>
<tr>
<td><strong>Book Chapter:</strong></td>
<td></td>
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<td><strong>Newspaper Article:</strong></td>
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**Abstract:**
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<tr>
<th>S. No.</th>
<th>Authors, Title of the papers, Name of Book/ Seminar/ Proceedings/Journal, Publisher, Year, Page No.</th>
<th>Responsible Partner</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Bandyopadhyay, B. K., Burman, D., Mandal, S., Sarangi, S. K., Mahanta, K. K. 2011. Adaptation strategies for agriculture practices in coastal region of India to mitigate the adverse impacts of climate change. Presented in the International conference on “DELTA 2011 on delta under climate change” held in Hanoi, Vietnam from 2-4 March, 2011.</td>
<td>CSSRI, RRS, Canning</td>
</tr>
<tr>
<td>3</td>
<td>Bandyopadhyay, B.K., Burman, D., Patra, P., De, S., and Patra, S. 2012. Land shaping to arrest salinity buildup and increase productivity in salt affected coastal soil of sunderbans. Paper present in Golden Jubilee seminar on Advances in Agricultural Research Towards Food Security and Environmental Subsistence on 1-3 Sep. 2012 at Santiknatan, West Bengal, India, pp. TL P048</td>
<td>CSSRI, RRS, Canning</td>
</tr>
<tr>
<td>4</td>
<td>Kumaran, M., Panigrahi, A.K., Ghoshal, T.K., Biswas, G., De, Debasis, Sundaray, J.K. and Ananda Raja 2012. Improving brackishwater aquafarming systems in the Sunderbans of West Bengal for the livelihood, food and nutritional security- an exploratory study. Paper present in Global Symposium on Aquatic Resources for Eradicating Hunger and Malnutrition- Opportunities and Challenges, held on 3-6 December 2012 at Mangalore, Karnataka, India, pp.77, IM 6.</td>
<td>CIBA, Kakwdip</td>
</tr>
<tr>
<td>7</td>
<td>Burman D., Bandyopadhyay B.K., Mandal U.K., Mandal, S., Sarangi, S.K., Mahanta, K.K., Maji, B., Sharma, D.K., Maitr,N.J., Ghoshal,T.K., Mandal, B., Patra, P., Patra, S. and De, S. 2013. Productivity enhancement of degraded coastal land through land shaping techniques. Paper presented in the Agricultural Section of 100th Session of Indian Science Congress held in Kolkata from Jan 3-7, 2013.</td>
<td>CSSRI, RRS, Canning</td>
</tr>
<tr>
<td>8</td>
<td>Tarik Mitran, Pabitra Kumar Mani, Biswapati Mandal and Debasis Mazumdar. Effect of organics application on soil biological indices</td>
<td>BCKV, Mohanpur, West Bengal</td>
</tr>
<tr>
<td>S. No.</td>
<td>Authors, Title of the papers, Name of Book/ Seminar/ Proceedings/Journal, Publisher, Year, Page No.</td>
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<td></td>
<td>and rice yield under different rice-based cropping system in coastal Sunderbans. (2012) Proceedings of 77th Annual Convention of Indian Society of Soil Science, held at PAU, Ludhiana during 03 to 06 Dec, 2012</td>
<td>BCKV, Mohanpur, West Bengal</td>
</tr>
<tr>
<td>9</td>
<td>Tarik Mitran, Pabitra Kumar Mani, Durgesh Kumar Singh and Biswapati Mandal. Soil Fertility Constraint Assessment using GPS based Nutrient Map at different Villages of Coastal Sunderbans. (2013) Proceedings of 78th annual convention of Indian Society of Soil Science, held at CAZRI, Jodhpur during 23 to 26 Oct, 2013</td>
<td>BCKV, Mohanpur, West Bengal</td>
</tr>
<tr>
<td>10</td>
<td>Durgesh Kumar Singh, Pabitra Kumar Mani, Tarik Mitran and Biswapati Mandal. Assessment of Soil and Water Status in Coastal Saline Belts of West Bengal. (2013) Proceedings of 78th annual convention of Indian Society of Soil Science held at CAZRI, Jodhpur during 23 to 26 Oct, 2013</td>
<td>BCKV, Mohanpur, West Bengal</td>
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</tbody>
</table>

**Popular article**


**Booklet:**

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<td>Velmurugan, A., Swarnam, T.P, Swain, S. Subramani, T. and Dam Roy,S. 2013. Enhancing the productivity and profitability of rice based cropping system in coastal low land</td>
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<td>Patra, P., De, S., Patra, P., Bandyopadhyay, B. K., Burman, D., Mandal, S., Sarangi, S. K., Mahanta, K.K. 2011. Vermicompost (in local language, Bengali). Central Soil Salinity Research Institute, Regional Research Station, Canning Town, West Bengal. 4 p.</td>
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<td>De, S., Patra, P., Patra, P., Bandyopadhyay, B. K., Burman, D., Mandal, S., Sarangi, S. K., Mahanta, K.K. 2011. Paddy-cum-fish cultivation (in local language, Bengali). Central Soil Salinity Research Institute, Regional Research Station, Canning Town, West Bengal. 4 p.</td>
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<td>Step To Reach (An Initiative To Landless Families Through Ornamental Bird, Sheep And Goat Rearing) in local language, Bengali). Ramkrishna Ashram Krishi Vigyan Kendra, Nmpith, West Bengal, 8 p.</td>
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### 13. Media Products Developed/Disseminated

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14. Meetings/Seminars/Trainings/Kisan Mela, etc. organized

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**On campus training:**

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**Off campus Training:**

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**Off campus training**

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**Off campus training**

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15. Participation in Conference/Meetings/Trainings/Radio talks, etc.

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<td>Dr. B. Maji</td>
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<td>Doordarshan Kendra, Port Blair : Subji ka kethi</td>
<td>04/03/2012</td>
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<td>76th Annual Convention of Indian Society of Soil Science, held at UAS, Dharwar, Karnataka</td>
<td>16-19th November, 2011</td>
<td>Rs. 4731.00</td>
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<td>Annual Review meeting for NAIP (Comp-III) held at New Delhi.</td>
<td>2nd December 2011</td>
<td>Rs. 15214.00</td>
<td>Prof. Biswapati Mandal CCPI, NAIP (Comp-III) BCKV, Mohanpur, Nadia</td>
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<td>Exposure visit on Assessment of environmental impact on land and water at University of California, Davis, USA</td>
<td>15th to 28th February, 2012</td>
<td>Rs. 194347.00</td>
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<td>77th Annual Convention of Indian Society of Soil Science, held at PAU, Ludhiana</td>
<td>03rd to 06th December 2012</td>
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<td>Durgesh Kumar Singh SRF, NAIP (Comp-III) BCKV Mohanpur, Nadia</td>
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16. Foreign Trainings/Visits:

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<tbody>
<tr>
<td>1</td>
<td>Dr. B. K. Bandyopadhyay, CSSRI, RRS</td>
<td>Exposure visit in the Area of Farming Activities for Higher Productivity and their Environmental Impact at University of California, Davis, USA (February 15-28, 2012)</td>
<td>07/03/2012</td>
<td>Monitoring the relevant issues of environmental studies and developing collaborative research programme involving international institutes.</td>
<td>1,90,492</td>
</tr>
<tr>
<td>2</td>
<td>Dr. D. Burman, CSSRI, RRS</td>
<td>Training on <code>Decision Support System for Coastal Agro-Eco-System Management using GIS based by Rologed Models</code> in the Lab. of Dr. Phillip R. Owens, Associate Prof., Department of Agronomy, College of Agriculture, Purdue University, West Lafayette, USA Purdue University, West Lafayette, IN, USA (March 1-31, 2012)</td>
<td>15/04/2012</td>
<td>Conducting studies on management of degraded coastal land and water in on-going research programmes as well as developing future research programs in collaboration with Research Institutes in USA and other countries</td>
<td>3,61,537</td>
</tr>
<tr>
<td>3</td>
<td>Dr. Biswapati Mandal, BCKV</td>
<td>Exposure visit on Assessment of environmental impact on land and water at University of California, Davis, USA (February 15-28, 2012)</td>
<td>-</td>
<td>Environmental studies and developing further research with the help of International funding</td>
<td>1,94,347.00</td>
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<td>4</td>
<td>Dr. N.J. Maitra, Programme Coordinator &amp; CCPI, NAIP, R.K. Ashram KVK, Nimpith, South 24 Parganas</td>
<td>Training- i). Lancaster University Management School, Lancaster Management School, Lancaster ii). Bangor University, Gwynedd, Wales, UK</td>
<td>27/08/2012</td>
<td>Implementation of MOET in instructional dairy farm, development of horti-pasture and grass lands for rearing of ruminents, transfer of technology of semen sexing, successful entrepreneurship development</td>
<td>5,60640</td>
</tr>
<tr>
<td>5</td>
<td>Dr. Tapas</td>
<td>Aquaculture development</td>
<td>06/08/2012</td>
<td>Address the various issues of poor survival of brackishwater</td>
<td>3.82178</td>
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17. Performance Indicators

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<tr>
<th>Sl. No.</th>
<th>Indicator</th>
<th>Total No.</th>
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<tr>
<td>1</td>
<td>Number of new technologies developed and introduced in the project area</td>
<td></td>
</tr>
<tr>
<td>2</td>
<td>Number of improved technologies introduced in project areas</td>
<td>12</td>
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<tr>
<td>3</td>
<td>Number of improved technologies adopted in these areas</td>
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<tr>
<td>4</td>
<td>Number of farmers involved in consortia activities</td>
<td>6400</td>
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<td>5</td>
<td>Increase in agriculture services and processing enterprises in project area</td>
<td>Baseline</td>
</tr>
<tr>
<td>6</td>
<td>Increase in income of participating household (Rs/Annum)</td>
<td>Baseline</td>
</tr>
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<td>7</td>
<td>Number of farmer groups involved in consortia activities/NGOs</td>
<td>25</td>
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<tr>
<td>8</td>
<td>Incremental employment generated (person days/year/HH)</td>
<td>Baseline</td>
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<tr>
<td>9</td>
<td>No. of farmers/area in addition to project beneficiary farmers adopting introduced technologies</td>
<td>Farmers (Nos)</td>
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<td>11</td>
<td>Number of patent/intellectual property protection applications filed based on NAIP research</td>
<td>NiL</td>
</tr>
<tr>
<td>12</td>
<td>Number of patents/intellectual property protections granted/published based on NAIP research</td>
<td>NiL</td>
</tr>
<tr>
<td>13</td>
<td>Number of scientists trained overseas in consortium-based subject areas</td>
<td>5</td>
</tr>
<tr>
<td>14</td>
<td>Success stories</td>
<td></td>
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<tr>
<td>15</td>
<td>Amount of sustainability fund corpus created (Rs. Lakh)</td>
<td>99.4445</td>
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<td>16</td>
<td>Publications</td>
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<td></td>
<td>NAAS rated journals</td>
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<td>Other journals</td>
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<td></td>
<td>Book</td>
<td>3</td>
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<td></td>
<td>Book Chapter</td>
<td>2</td>
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18. Employment Generation (man-days/year)

19. Assets Generated
(Details to be given on equipments and works undertaken in the sub-project)

(i) Equipment

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name of the equipment with manufacturers name, model and Sr.No.</th>
<th>Year of purchase</th>
<th>Quantity (Nos.)</th>
<th>Total cost (Rs.)</th>
<th>Responsible consortium</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>LCD Projector ; Manufacturers Name – Sony Model No. VPL-EX-7, Sl. No. 7331443</td>
<td>2010-11</td>
<td>1</td>
<td>0.569</td>
<td>CSSRI, RRS, Canning Town</td>
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<tr>
<td>2</td>
<td>Photo copier; Manufacturers Name – Xerox Model No. 5020DN, Sl. No. 00340026188</td>
<td>2010-11</td>
<td>1</td>
<td>0.94848</td>
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</tr>
<tr>
<td>3</td>
<td>Laptop; Manufacturers Name – Sony Model No. VPC EA-36 Sl. No. 700084</td>
<td>2010-11</td>
<td>1</td>
<td>0.57794</td>
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</tr>
<tr>
<td>4</td>
<td>Computer with all accessories Desktop Computer Manufacturers Name – HP</td>
<td>2010-11</td>
<td>2</td>
<td>1.39256</td>
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<tr>
<td>5</td>
<td>Digital Camera; Manufacturers Name – Sony, Model No. DSC-HX1</td>
<td>2010-11</td>
<td>1</td>
<td>0.247</td>
<td></td>
</tr>
<tr>
<td>6</td>
<td>i. Electronic/ Digital Weighing Balance; Manufacturers Name – Adhair Dutta &amp; Company (India) Pvt. Ltd.</td>
<td>2010-11</td>
<td>1</td>
<td>1.0288</td>
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<td></td>
<td>ii. Electronic Balance for large range weighing Model No. AD 3000B, Sl.No. 17548 + Box</td>
<td>2010-11</td>
<td>1</td>
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<td>iii. Electronic Balance for medium range weighing Model No. AD 300B, Sl.No. 23843+ Box</td>
<td>2010-11</td>
<td>1</td>
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<td>iv. Digital Weighing Balance; Model No. ADGR 200, Sl.No. 14221925</td>
<td>2010-11</td>
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<td>7</td>
<td>AC Machine (Split); Manufacturers Name – Carrier, Model No. Darakooop Plus</td>
<td>2010-11</td>
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<td>0.58013</td>
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<td>8</td>
<td>Water Bath Shaker; Manufacturers Name – Remi, Model – RSB 12</td>
<td>2010-11</td>
<td>1</td>
<td>0.43189</td>
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<td>9</td>
<td>Deep Freezer (Vertical); Manufacturers Name – Remi, Model - RQFV-65(D)</td>
<td>2010-11</td>
<td>1</td>
<td>1.32926</td>
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<td>10</td>
<td>Auto Clave (Vertical); Manufacturers Name – Amalgameted</td>
<td>2010-11</td>
<td>1</td>
<td>0.4975</td>
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<td>11</td>
<td>Laminar Air Flow (Horizontal); Manufacturers Name: Amalgameted</td>
<td>2010-11</td>
<td>1</td>
<td>0.79300</td>
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<tr>
<td>S. No.</td>
<td>Name of the equipment with manufacturers name, model and Sr.No.</td>
<td>Year of purchase</td>
<td>Quantity (Nos.)</td>
<td>Total cost (Rs.)</td>
<td>Responsible consortium</td>
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<tr>
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<td>12</td>
<td>Ekman Dradge; Manufacturers Name: Modern Instruments</td>
<td>2010-11</td>
<td>1</td>
<td>0.155</td>
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<td>13</td>
<td>BOD Incubator; Manufacturers Name: Amalgameted (Lunar)</td>
<td>2010-11</td>
<td>1</td>
<td>0.4938</td>
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<td>14</td>
<td>Oven (Digital); Manufacturers Name: Amalgameted</td>
<td>2010-11</td>
<td>1</td>
<td>0.445</td>
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<td>15</td>
<td>Vacuum System; Manufacturers Name: Tursun, Model- Rocker 600</td>
<td>2010-11</td>
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<td>0.49810</td>
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<td>16</td>
<td>Ultra pure water system; Manufacturers Name – Borosil, Model No. NM72MX2KK11</td>
<td>2010-11</td>
<td>1</td>
<td>0.75137</td>
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<td>17</td>
<td>Piezo Meter; Manufacturers Name: Mondal Tubewell and Hardware</td>
<td>2010-11</td>
<td>25</td>
<td>0.35000</td>
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<td>18</td>
<td>pH Meter; Manufacturers Name: Systronics, Model No.- 361</td>
<td>25.03.2011</td>
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<td>0.18194</td>
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<td>19</td>
<td>Conductivity Meter; Manufacturers Name- Systronics Impex, Model No.- 306</td>
<td>25.03.2011</td>
<td>1</td>
<td>0.24842</td>
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<td>20</td>
<td>Water testing Kit (Analyzer); Manufacturers Name: Systronics, Impex, Model No.- 371</td>
<td>25.03.2011</td>
<td>1</td>
<td>0.67563</td>
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<td>21</td>
<td>Micro Scope; Manufacturers Name: CARL ZEISS Model . Primo Star</td>
<td>25.03.2011</td>
<td>1</td>
<td>1.19743</td>
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<td>22</td>
<td>Nitrogen Digestion &amp; Distillation set; Manufacturers Name: Pelican Equipments, Model No. KFS</td>
<td>26.03.2011</td>
<td>1</td>
<td>5.84177</td>
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<td>23</td>
<td>Soil Augers; Manufacturers Name- AIC</td>
<td>2010-11</td>
<td>8</td>
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<td>24</td>
<td>Touch Screen; Manufacturers Name: M/S Digitron Systems (Kiosk)</td>
<td>2010-11</td>
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<td>1.479</td>
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<td>25</td>
<td>Soil Testing Kit; Manufacturers Name: Modern Instruments</td>
<td>2010-11</td>
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<td>26</td>
<td>Gas Chromatgraphy; Manufacturers Name: Agilent, Model No. 7890A</td>
<td>2011-12</td>
<td>1</td>
<td>14.9001</td>
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<td>27</td>
<td>Audio Visual Equipments; Conference System: Chairman Unit, Manufactures Name: Ahuja, Model No.CMC 4100</td>
<td>2012-13</td>
<td>1</td>
<td>3.99313</td>
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<td>28</td>
<td>Computer with Accessories; Desktop Computer Manufacturers Name – HP</td>
<td>2013-14</td>
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<td>1.29413</td>
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<td>29</td>
<td>Accessories for existing Gas Chromatgraphy equipment; Manufactures Name: Agilent, Model No. 7890A</td>
<td>2013-14</td>
<td>1</td>
<td>7.58136</td>
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<td>30</td>
<td>Electromagnetic Induction Meter for In-Situ Soil Salinity Measurement ; Manufactures Name: Eijkelkamp Agrisearch Equipment, Model No.14.01</td>
<td>2013-14</td>
<td>1</td>
<td>3.8745</td>
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<td>31</td>
<td>Conductivity, Temperature and Depth Measuring Device for Water Body; Manufacturers Name-YSI, Model No. YSI Cast Away CTD</td>
<td>2013-14</td>
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<td>32</td>
<td>Pan Evaporimeter; Manufacturers Name- M/S Steel Fabricators</td>
<td>2013-14</td>
<td>1</td>
<td>1.47</td>
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<tr>
<td>S. No.</td>
<td>Name of the equipment with manufacturers name, model and Sr.No.</td>
<td>Year of purchase</td>
<td>Quantity (Nos.)</td>
<td>Total cost (Rs.)</td>
<td>Responsible consortium</td>
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<td>33</td>
<td>Differential GPS ; Manufacturers Name-TRIMBLE, Model No. GEOXT 3000 Series</td>
<td>2013-14</td>
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<td>5.5125</td>
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<td>34</td>
<td>Automated Solar Powered Drip Irrigation System Manufacturers Name-PROXICHEM, Model No. SQF 2.5-2</td>
<td>2013-14</td>
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<td>2.48065</td>
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<tr>
<td>35</td>
<td>Piezo Meter; Manufacturers Name- Mondal Tubewell and Hardware</td>
<td>2013-14</td>
<td>25</td>
<td>0.57000</td>
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<tr>
<td>36</td>
<td>i. Portable Digital Balance; Manufacturers Name-SATWIK, Model No. VIK20MJ ii. Digital Spring Balance; Manufacturers Name-Unique, Model No. US200Kal</td>
<td>2013-14</td>
<td>1 set</td>
<td>0.2688</td>
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<td>37</td>
<td>On-line UPS Manufacturers Name-Microtek, Model No. Cat. No. 3364,3366,3367</td>
<td>2013-14</td>
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<td>0.9573</td>
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<td>38</td>
<td>Stage Micrometer/Ocular Micrometer ; Manufacturers Name- ERMA</td>
<td>2013-14</td>
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<td>39</td>
<td>Vacuum Pump; Manufacturers Name – Precivac, Model No. DC 101</td>
<td>2013-14</td>
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<td>0.59903</td>
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<td>40</td>
<td>Centrifuge Machine ; Manufacturers Name – Remi, Model No. R-8CBL</td>
<td>2013-14</td>
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<td>41</td>
<td>Quebec Colony Counter; Manufacturers Name – Chemiline, Model No. CL-920</td>
<td>2013-14</td>
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<td>0.03927</td>
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<td>42</td>
<td>Portable Conductivity (EC) and pH Meter for In-situ Measurement i. pH Meter Manufactures Name-EUTECH Model No. ECPHW61042K, Sl. No. 2059475 ii. Conductivity Meter; Manufactures Name-EUTECH, Model No. ECCONWP61043K, Sl. No. 2026542</td>
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<td>Hot Air Drier; Manufacturers Name – YOMA, Model No. OMS-2436 (D)</td>
<td>2013-14</td>
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<td>0.49464</td>
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<td>Flame Photometer; Manufactures Name-Systronics, Model No. 128</td>
<td>2013-14</td>
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<td>1.13303</td>
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<td>46</td>
<td>Mechanical Shaker (Rotary Type); Manufacturers Name – Simeco</td>
<td>2013-14</td>
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<td>0.56105</td>
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<td>Mechanical Shaker (Horizontal); Manufacturers Name- Modern Instrument, Model No. MRS-101</td>
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<td>0.25148</td>
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<td>ODR Meter with accessories; Manufacturers Name Eijkelkamp, Model No.-14.36</td>
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<td>7.60493</td>
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<td>Surface and Profile Soil Moisture probe ; Manufacturers Name- Delta-T Devices, Model No. ML2x Theta Probe, PR2 Profile Probe, HH2 Moisture Meter</td>
<td>2013-14</td>
<td>1</td>
<td>9.13805</td>
<td>(8003.96 GBP)</td>
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<td>Refrigerator; Manufactures Name- Samsung, Model No. RT42FEJQASP</td>
<td>2013-14</td>
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<td>S. No.</td>
<td>Name of the equipment with manufacturers name, model and Sr.No.</td>
<td>Year of purchase</td>
<td>Quantity (Nos.)</td>
<td>Total cost (Rs.)</td>
<td>Responsible consortium</td>
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<td>1</td>
<td>Atomic Absorption Spectrophotometer Manufacturers Name – PerkinElmer, Model No. A Analyst 400, (Including all accessories)</td>
<td>2013-14</td>
<td>1</td>
<td>USD 32,539.00 INR 21,91000</td>
<td>RAKVK</td>
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<td>Digital Camera, Nikon</td>
<td>2010-11</td>
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<td>0.25</td>
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<td>3</td>
<td>Software-</td>
<td>2010-11</td>
<td>2</td>
<td>0.5</td>
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<td>4</td>
<td>LCD Projector- Epson</td>
<td>2010-11</td>
<td>1</td>
<td>1.45</td>
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<td>5</td>
<td>pH Meter-</td>
<td>2010-11</td>
<td>1</td>
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<td>6</td>
<td>Soil Auger</td>
<td>2010-11</td>
<td>8</td>
<td>0.18</td>
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<td>7</td>
<td>Conductivity meter</td>
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<td>8</td>
<td>Refrigerator- Worlpool</td>
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<tr>
<td>9</td>
<td>Mobile Soil Testing Kit</td>
<td>2010-11</td>
<td>12</td>
<td>0.486</td>
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<td>10</td>
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<td>2010-11</td>
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<td>11</td>
<td>Pizometer</td>
<td>2010-11</td>
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<td>0.7635</td>
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<td>12</td>
<td>Distribution Amplifier</td>
<td>2012-13</td>
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<td>0.184</td>
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<td>13</td>
<td>46 inch LED BLU-Samsung</td>
<td>2012-13</td>
<td>1</td>
<td>0.8</td>
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<td>14</td>
<td>Logitec Cordless Key Board- LOGITECH</td>
<td>2012-13</td>
<td>1</td>
<td>0.0135</td>
<td></td>
</tr>
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<td>15</td>
<td>Logitec Pointer- LOGITECH</td>
<td>2012-13</td>
<td>1</td>
<td>0.0325</td>
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<td>16</td>
<td>HP Pro Book-4540s - HP</td>
<td>2012-13</td>
<td>1</td>
<td>0.484</td>
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<td>17</td>
<td>Mixer Unit-Australian Monoitor (Microphone, Spekar)-HCL</td>
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<td>Mini Tractor ( with cultivator, Rotavator, Hydrolic trolly &amp; Other accessories)-Mahindra</td>
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<td>Quantity (Nos.)</td>
<td>Total cost (Rs.)</td>
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## (ii) Works

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<th>Quantity (Nos.)</th>
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<td>2013-14</td>
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<td>1.95523</td>
<td></td>
</tr>
</tbody>
</table>

CSSRI, RRS Canning Town
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Particulars of the work, name and address of agency awarded the work</th>
<th>Year of work done</th>
<th>Quantity (Nos.)</th>
<th>Total cost (Rs.)</th>
<th>Responsible consortium</th>
</tr>
</thead>
</table>
| 1      | Name - Construction of Rural technology Centre  
Name and address of agency - Nonigopal Midya  
Vill. + P.O.: Ganeshnagar (Battala), P.S.:  
Kakdwip, Dist.: South 24 Parganas, West Bengal  
– 743 357 | 2012-13 | 1 | 4,67375 | KRC, CIBA |
| 2      | Name - Model integrated farm phase II  
Name and address of agency - S.S. Enterprise Prop.  
Barnali Halder vill. Gandhinagar P.O.+P.S-  
Kakdwip.  
Dist-24 South Parganas  
Site of Construction - Sector C Kakdwip Research Centre, CIBA  
Name - Pipeline  
Name and address of agency - M/s Maa Laxmi  
Construction (Prop. Sahadeb Bera) Vill. -  
Uttar Chandanpuri, P.O. Chandanpuri.  
P.S. Namkhana Dist. South 24 Paragana. West Bengal-743357  
Site of Construction - Sector C Kakdwip Research Centre, CIBA  
Name - Construction of pond inlet sluice - 10 Nos.  
Name and address of agency - M/s Maa Laxmi  
Construction (Prop. Sahadeb Bera) Vill. -  
Uttar Chandanpuri, P.O. Chandanpuri.  
P.S. Namkhana Dist. South 24 Paragana. West Bengal-743357  
Site of Construction - Sector C Kakdwip Research Centre, CIBA  
Name - Construction of poultry shed in sector-C  
Name and address of agency - M/s Maa Laxmi  
Construction (Prop. Sahadeb Bera) Vill. -  
Uttar Chandanpuri, P.O. Chandanpuri.  
P.S. Namkhana Dist. South 24 Paragana. West Bengal-743357  
Site of Construction - Sector C Kakdwip Research Centre, CIBA | 2012-13 | 1 | 22,58446 | |
| 3i.    | Name - Construction of Semi-Permanent Shed  
for housing the feed machineries  
Name and address of agency - Nonigopal Midya  
Vill. + P.O.: Ganeshnagar (Battala), P.S.:  
Kakdwip, Dist.: South 24 Parganas, West Bengal | 2013-14 | 1 | 19,66880 | |
<table>
<thead>
<tr>
<th>S. No.</th>
<th>Particulars of the work, name and address of agency awarded the work</th>
<th>Year of work done</th>
<th>Quantity (Nos.)</th>
<th>Total cost (Rs.)</th>
<th>Responsible consortium</th>
</tr>
</thead>
<tbody>
<tr>
<td>iv.</td>
<td>Electrical Items for Semi-Permanent Shed</td>
<td>2013-14</td>
<td>1</td>
<td>4.90260</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Civil Materials and Workman required for</td>
<td>2013-14</td>
<td>1</td>
<td>1.96510</td>
<td></td>
</tr>
<tr>
<td></td>
<td>electrification of Semi-Permanent Shed</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Site of Construction- Sector C Kakdwip Research Centre, CIBA</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>Construction of Rural Technology Centre,</td>
<td>2010-11</td>
<td>2</td>
<td>507518.00</td>
<td>RAKVK</td>
</tr>
<tr>
<td></td>
<td>Anuradha Construction,</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Vill+PO: Damkal Raidighi, South 24 Parganas.</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

(iii) Revenue Generated: Nil

(iv) Livestock

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Details of livestock (Breed, etc.)</th>
<th>Year of procurement/production</th>
<th>Nos. of livestock</th>
<th>Total cost (Rs.)</th>
<th>Responsible consortium</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Male goats Black 6 months old</td>
<td>2011-12</td>
<td>12</td>
<td>26400</td>
<td>KRC,CIBA</td>
</tr>
<tr>
<td>2</td>
<td>Female goats Black 6 months old</td>
<td>2011-12</td>
<td>24</td>
<td>40800</td>
<td>KRC,CIBA</td>
</tr>
<tr>
<td></td>
<td>Poultry Bird (Hitkary&amp; Upkary)</td>
<td>2010-11</td>
<td>240</td>
<td></td>
<td>RAKVK</td>
</tr>
<tr>
<td></td>
<td>Goat (Black Bengal)</td>
<td>2010-11</td>
<td>72</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Pigs (Ghungru)</td>
<td>2011-12</td>
<td>25</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Sheep (Garole)</td>
<td>2011-12</td>
<td>16</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Ornamental Bird (Budgeriger)</td>
<td>2011-12</td>
<td>760</td>
<td></td>
<td></td>
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</table>
20. Awards and Recognitions

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Name, Designation, Address of the person</th>
<th>Award/ Recognition (with date)</th>
<th>Institution/ Society facilitating (Name &amp; Address)</th>
<th>Responsible consortium</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Dr. P.K. Mani</td>
<td>Best poster presentation award in 77th Annual Convention of ISSS, held at PAU, Ludhiana during 03 to 06 Dec, 2012</td>
<td>Indian Society of Soil Science</td>
<td>BCKV, Mohanpur, West Bengal</td>
</tr>
</tbody>
</table>

21. Steps Undertaken for Post NAIP Sustainability

- **Sustainable fund:** More than 99.4445 lakhs fund generated to further financial support for extension of technology during post project period

  **Sustainable fun generation:**

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Consortium partner</th>
<th>Sustainable fund (Rs. In Lakhs)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>CSSRI, RRS,</td>
<td>9.67846</td>
</tr>
<tr>
<td>2</td>
<td>RAKVK</td>
<td>74.36882</td>
</tr>
<tr>
<td>3</td>
<td>KRC, CIBA</td>
<td>11.41222</td>
</tr>
<tr>
<td>4</td>
<td>BCKV</td>
<td>0.50</td>
</tr>
<tr>
<td>5</td>
<td>CARI</td>
<td>3.485</td>
</tr>
<tr>
<td><strong>Total</strong></td>
<td></td>
<td><strong>99.4445</strong></td>
</tr>
</tbody>
</table>

- **Village and Cluster committees:** Village committees and Cluster committees in different villages and Clusters have been organized to monitoring farmers’ fields and further extension of technology.

- **NGOs:** Different local NGOs are linked to the project to aware them about the technology.

- **Line departments:** Govt. line department such as SDB, Soil and water conservation, Dept. of Agriculture etc. have been communicate for continuing the technological interventions through development work

- **RTCs:** RTCs which were established in the 4 Clusters in Sundarbans region will help as technology disseminating centres in the area.
22. Possible Future Line of Work

- Assessment of degraded soil and water quality in the coastal region
- Augmenting productivity of degraded land and water resources in the coastal region
- Improvement of livelihood security, gender equity and environmental quality
- Long term impact of the land shaping interventions in the coastal region with particular focus on extent, magnitude and sustainability of soil and water qualities
- Private vs public economic gain, extent of exploitation of natural resources and environmental sustainability and trade-off decisions
- Long-term environmental impact assessment and sustainability of agricultural intensification under fragile coastal ecosystem
- Adaptability to the changing climates scenario and extent of carbon sequestration under these alternative farming system in coastal region
- Utilization of community resources for augmenting agricultural production in large scale - Issues, options and strategies.

23. Personnel

(Staff of Lead Centre & Partner-wise, their Name, Designation, Discipline and Duration)

<table>
<thead>
<tr>
<th>Research Management (CL)</th>
<th>From – To (DD/MM/YYYY)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Gurbachan Singh, Director, CSSRI, Karnal, Consortium Facilitator</td>
<td>2019-2010</td>
</tr>
<tr>
<td>Dr. Dr. D. K. Sharma, Director, CSSRI, Karnal, Consortium Facilitator</td>
<td>2010-2014</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Scientific (CPI, CCPI, others)</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>CSSRI, RRS</td>
<td></td>
</tr>
<tr>
<td>Dr. B.K. Bandyopadhyay, Pr. Scientist (Soil Chem.), CPI</td>
<td>2009-2013</td>
</tr>
<tr>
<td>Dr. D. Burman, Pr. Scientist (Soil Phy. &amp; Water Con.), CPI (CCPI up to Feb. 2013)</td>
<td>2013-2014</td>
</tr>
<tr>
<td>Dr. S. Mandal, Sr. Scientist (Agril. Economics), CCPI</td>
<td>2013-2014</td>
</tr>
<tr>
<td>Dr. S. K. Sarangi, Sr. Scientist (Agronomy)</td>
<td>2009-2014</td>
</tr>
<tr>
<td>Dr. K.K. Mahanta, Scientist (Sr. Scale) (Agril. Eng.)</td>
<td>2009-2014</td>
</tr>
<tr>
<td>Dr. B. Maji, Head, CSSRI, RRS, Canning Town</td>
<td>2012-2014</td>
</tr>
<tr>
<td>Dr. U.K. Mandal, Sr. Scientist (Soil Phy. &amp; Water Con.)</td>
<td>2012-2014</td>
</tr>
<tr>
<td>Dr. Sekhar De, Res. Associate</td>
<td>01.04.2010 to continuing</td>
</tr>
<tr>
<td>Dr. Sabyasachi Patra, Res. Associate</td>
<td>28.04.211 to continuing</td>
</tr>
<tr>
<td>Sh. Paritosh Patra, Sr. Res. Fellow</td>
<td>01.04.2010 to continuing</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>RAKVK</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. N.J. Maitra, Prog. Coordinator, CCPI</td>
<td>2009-2014</td>
</tr>
<tr>
<td>Sh. S.K. Samui, SMS (Agron.)</td>
<td>2009-2014</td>
</tr>
<tr>
<td>Dr. D. K. Roy, Prog. Asst. (Agron.)</td>
<td>2009-2014</td>
</tr>
<tr>
<td>Research Management (CL)</td>
<td>From – To (DD/MM/YYYY)</td>
</tr>
<tr>
<td>--------------------------</td>
<td>------------------------</td>
</tr>
<tr>
<td>Sh. P. Chatterjee, SMS (Fishery)</td>
<td>2009-2014</td>
</tr>
<tr>
<td>Shri C. K. Mondal, SMS (Hort.)</td>
<td>2009-2014</td>
</tr>
<tr>
<td>Dr. Subhasis Roy, SMS (Animal Sci.)</td>
<td>2011-2014</td>
</tr>
<tr>
<td>Utapal Maity</td>
<td>01.02.2010 to 31.03.2014</td>
</tr>
<tr>
<td>Bhaskar Mukherjee</td>
<td>01.12.2012 to 31.03.2014</td>
</tr>
<tr>
<td>Sahanur Rahaman</td>
<td>01.06.2010 to 31.03.2014</td>
</tr>
<tr>
<td>Arun Kumar Jana</td>
<td>02.09.2010 to 31.01.2014</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>KRC, CIBA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. T.K. Ghoshal, Sr. Scientist (Animal/ Fish Nutrition), CCPI</td>
</tr>
<tr>
<td>Dr. Debasis Dey, Sr. Scientist (Animal/ Fish Nutrition)</td>
</tr>
<tr>
<td>Dr. J.K. Sundaray, Pr. Scientist(Aquaculture)</td>
</tr>
<tr>
<td>Dr. Ashotosh D. Deo, Sr. Scientist(Aquaculture)</td>
</tr>
<tr>
<td>Dr. G. Biswas, Scientist (Aquaculture)</td>
</tr>
<tr>
<td>Dr. Ananda Raja, Scientist (Vet. Pathology)</td>
</tr>
<tr>
<td>Dr. Sujeet Kumar, Scientist (Vet. Microbiology)</td>
</tr>
<tr>
<td>Mrs. Shyamalendu P.S. Scientist (Aquaculture)</td>
</tr>
<tr>
<td>Dr. M. Kumaran, Sr. Scientist (Agril. Extension)</td>
</tr>
<tr>
<td>Dr. A. Panigrahi, Sr. Scientist(Aquaculture)</td>
</tr>
<tr>
<td>Mr. Jayanta Kumar Pradhan RA</td>
</tr>
<tr>
<td>Miss. Bandana Das RA</td>
</tr>
<tr>
<td>Mr. Samsut Tabayaj Khan Sr. Res. Fellow</td>
</tr>
<tr>
<td>Mr. Anindya Nayak Sr. Res. Fellow</td>
</tr>
<tr>
<td>Mr. Uttam Kumar Sarkar Sr. Res. Fellow</td>
</tr>
<tr>
<td>Mr. Joy Chakraborty Sr. Res. Fellow</td>
</tr>
<tr>
<td>Mr. Shubhra Das Sr. Res. Fellow</td>
</tr>
<tr>
<td>Mr. Abdul Motin Gazi Sr. Res. Fellow</td>
</tr>
<tr>
<td>Miss. Kabita Biswas Sr. Res. Fellow</td>
</tr>
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</table>

<table>
<thead>
<tr>
<th>BCKV</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Biswapati Mandal, Prof. (Soil Sci.) CCPI</td>
</tr>
<tr>
<td>Dr.P.K. Mani, Reader (Soil Sci.)</td>
</tr>
<tr>
<td>Dr. Susanta Kr. Sarkar, Prof. (Fruit &amp; Orchard Management)</td>
</tr>
<tr>
<td>Dr. Mahadev Pramanick, Prof. (Agron.)</td>
</tr>
<tr>
<td>Dr. A. Mitra, Prof. (Agril Economics)</td>
</tr>
<tr>
<td>Dr. Srikanta Das, Prof. (Plant Pathology)</td>
</tr>
<tr>
<td>Dr. G.C. Hazra, Prof. (Soil Chem.)</td>
</tr>
<tr>
<td>Dr. Biswanath Bandyopadhyay, Reader (Agril. Entomology)</td>
</tr>
<tr>
<td>Dr. Nilotpal Ghosh, Reader (Animal Sci.)</td>
</tr>
<tr>
<td>Dr. Sagar Mondal, Reader (Agril. Extension)</td>
</tr>
<tr>
<td>Dr. P.B. Chakraborty, Reader (Soil &amp; Water Conservation)</td>
</tr>
<tr>
<td>Dr. N. Saha, Reader (Soil Microbiology)</td>
</tr>
<tr>
<td>Dr. Arup Chattopadhyay, Reader (Veg. crops)</td>
</tr>
<tr>
<td>Dr. Soumitra Chatterjee, Lecturer (Agril. Economics)</td>
</tr>
<tr>
<td>Tarik Mitran Sr. Res. Fellow</td>
</tr>
<tr>
<td>Research Management (CL)</td>
</tr>
<tr>
<td>--------------------------------------------------------</td>
</tr>
<tr>
<td>A. Roychoudhury Sr. Res. Fellow</td>
</tr>
<tr>
<td>A. Tamang Sr. Res. Fellow</td>
</tr>
<tr>
<td>Durgesh Kumar Singh Sr. Res. Fellow</td>
</tr>
<tr>
<td>CARI</td>
</tr>
<tr>
<td>Dr. N. Ravisankar</td>
</tr>
<tr>
<td>Dr. A. Velmurugan, CCPI* (from 24-04-12)</td>
</tr>
<tr>
<td>Dr. T. P. Swarnam</td>
</tr>
<tr>
<td>Dr. T. Subramani</td>
</tr>
<tr>
<td>Dr. Sachidananda Swain</td>
</tr>
<tr>
<td>Dr. M. Sankaran</td>
</tr>
<tr>
<td>Dr. M. S. Kundu</td>
</tr>
<tr>
<td>Dr. Nagesh Ram</td>
</tr>
<tr>
<td>Dr. Subhash Chand</td>
</tr>
<tr>
<td>Mr. S. K. Pandey, Research Associate</td>
</tr>
<tr>
<td>Ms. Rajani Sahadevan, Sr. Res. Fellow</td>
</tr>
<tr>
<td>Mr. K. Prabakaran, Research Associate</td>
</tr>
<tr>
<td>Mr. Tapan Kumar Biswas, Sr. Res. Fellow</td>
</tr>
<tr>
<td>Mr. Suresh Mistry, Sr. Res. Fellow</td>
</tr>
<tr>
<td>Mr. A. Anantharaj, Sr. Res. Fellow</td>
</tr>
</tbody>
</table>
## Governance, Management, Implementation and Coordination

### A. Composition of the various committees (CIC, CAC, CMU, etc.)

<table>
<thead>
<tr>
<th>S. No.</th>
<th>Committee Name</th>
<th>Chairman (From-To)</th>
<th>Members (From-To)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>CIC</td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>Dr. Gurbachan Singh</td>
<td>Director, CSSRI, Karnal</td>
<td>2009-2010</td>
</tr>
<tr>
<td></td>
<td>Dr. D.K. Sharma</td>
<td>Director, CSSRI, Karnal</td>
<td>2010-2014</td>
</tr>
<tr>
<td></td>
<td>Dr. B.K. Bandyopadhyay, CPI</td>
<td></td>
<td>2009-2013</td>
</tr>
<tr>
<td></td>
<td>Dr. D. Burman</td>
<td>CPI, CSSRI, RRS, Canning Town</td>
<td>2013-2014</td>
</tr>
<tr>
<td></td>
<td>Dr. D. Burman</td>
<td>CCPI, CSSRI, RRS, Canning Town</td>
<td>2009-2013</td>
</tr>
<tr>
<td></td>
<td>Dr. S. Mandal</td>
<td>CCPI, CSSRI, RRS, Canning Town</td>
<td>2012-2014</td>
</tr>
<tr>
<td></td>
<td>Dr. N.J. Maitra</td>
<td>CCPI, RAKVK, Nimpith</td>
<td>2009-2014</td>
</tr>
<tr>
<td></td>
<td>Dr. T.K. Ghosal</td>
<td>CCPI, CIBA, KRC, Kakdwip</td>
<td>2009-2014</td>
</tr>
<tr>
<td></td>
<td>Dr. A. Velmurugan</td>
<td>CCPI, CARI, Port Blair</td>
<td>2012-2014</td>
</tr>
<tr>
<td></td>
<td>Dr. B.K. Bandyopadhyay, CPI</td>
<td>CSSRI, RRS, Canning Town</td>
<td>2013-2014</td>
</tr>
<tr>
<td></td>
<td>Prof. G.P. Sen</td>
<td>Former prof. of Veterinary Public Health &amp; Emeritus Scientist IVRI</td>
<td>2009-2012</td>
</tr>
<tr>
<td></td>
<td>Dr. S. K. Khan</td>
<td>Palli Skshi Vhaban, Santiniketan</td>
<td>2009-2012</td>
</tr>
<tr>
<td></td>
<td>Dr. Gurbachan Singh</td>
<td>Director, CSSRI, Karnal</td>
<td>2009-2010</td>
</tr>
</tbody>
</table>

2. CAC

<p>|        | Dr. A. K. Bandyopadhyay | Ex-Director, CARI, Port Blair, Andaman &amp; Nicobar Islands | 2009-2014  |
|        | Dr. A.P. Srivastava, NC, NAIP | 2009-2012  |
|        | Dr. R.P. Misra, GEF Coordinator, NAIP | 2012-2014  |
|        | Dr. D. Burman | CPI, CSSRI, RRS, Canning Town | 2013-2014  |
|        | Prof. G. P. Sen, Former prof. of Veterinary Public Health &amp; Emeritus Scientist IVRI | 2009-2012  |
|        | Dr. S. K. Khan, Palli Skshi Vhaban, Santiniketan | 2009-2012  |
|        | Dr. Gurbachan Singh | Director, CSSRI, Karnal | 2009-2010  |</p>
<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. D.K. Sharma</td>
<td>Director, CSSRI, Karnal</td>
<td>2010-2014</td>
</tr>
<tr>
<td>Dr. K.K Satapati</td>
<td>Ex-Director, NIRJAF, Kolkata</td>
<td>2013-2014</td>
</tr>
<tr>
<td>Dr. B.K. Bandyopadhyay</td>
<td>Emeritus Scientist, CSSRI, RRS, Canning Town</td>
<td>2013-2014</td>
</tr>
<tr>
<td>Sh. S. Chakder</td>
<td>General Manager, Bangiya Gramin Vikash Bank, West Bengal</td>
<td>2009-2014</td>
</tr>
<tr>
<td>Dr. Kartik Chandra Naskar</td>
<td>Doctor –cum-Farmer, Nikarighata, Canning, South 24 Parganas</td>
<td>2009-2014</td>
</tr>
</tbody>
</table>

3. CMU

<table>
<thead>
<tr>
<th>Name</th>
<th>Position</th>
<th>Period</th>
</tr>
</thead>
<tbody>
<tr>
<td>Dr. Gurbachan Singh</td>
<td>Director, CSSRI, Karnal</td>
<td>2009-2010</td>
</tr>
<tr>
<td>Dr. D.K. Sharma</td>
<td>Director, CSSRI, Karnal</td>
<td>2010-2014</td>
</tr>
<tr>
<td>Dr. B.K. Bandyopadhyay</td>
<td>CPI, CSSRI, RRS, Canning Town</td>
<td>2009-2013</td>
</tr>
<tr>
<td>Dr. D. Burman</td>
<td>CPI, CSSRI, RRS, Canning Town</td>
<td>2013-2014</td>
</tr>
<tr>
<td>Dr. D. Burman</td>
<td>CCPI, CSSRI, RRS, Canning Town</td>
<td>2009-2013</td>
</tr>
<tr>
<td>Dr. S. Mandal</td>
<td>CCPI, CSSRI, RRS, Canning Town</td>
<td>2013-2014</td>
</tr>
<tr>
<td>Dr. N. J. Maiti</td>
<td>CCPI, RAKVK, Nimpith</td>
<td>2009-2014</td>
</tr>
<tr>
<td>Dr. T. K. Ghosal</td>
<td>CCPI, CIBA, KRC, Kakdwip</td>
<td>2010-2014</td>
</tr>
<tr>
<td>Dr. A. Velurugan</td>
<td>CCPI, CARI, Port Blair</td>
<td>2012-2014</td>
</tr>
<tr>
<td>Dr. Biswapati Mandal</td>
<td>CCPI, BCKV, Mohanpur</td>
<td>2009-2014</td>
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<tr>
<td>Dr. Soumitra Chatterjee</td>
<td>Agril. Economist, BCKV, Mohanpur</td>
<td>2009-2014</td>
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</tbody>
</table>
Part-III: Budget and its Utilization

STATEMENT OF EXPENDITURE

(Period from ______________ to ______________)

Sanction Letter No. _________________
Total Sub-project Cost Rs. _________________
Sanctioned/Revised Sub-project cost (if applicable) Rs. _________________
Date of Commencement of Sub-project _________________
Duration: From _________________ to _______________ (DD/MM/YYYY)
Funds Received in each year
I Year Rs.___________________
II Year Rs.__________________
III Year Rs. _________________
Bank Interest received on fund (if any) Rs. _________________
Total amount received Rs. _________________
Total expenditure Rs. _________________

Expenditure Head-wise:

<table>
<thead>
<tr>
<th>Sanctioned Heads</th>
<th>Funds Allocated (*)</th>
<th>Funds Released</th>
<th>Expenditure Incurred</th>
<th>Total Expenditure</th>
<th>Balance as on date</th>
<th>Requirement of additional funds</th>
<th>Remarks</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>1&lt;sup&gt;st&lt;/sup&gt; Year</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; Year</td>
<td>3&lt;sup&gt;rd&lt;/sup&gt; Year</td>
<td>1&lt;sup&gt;st&lt;/sup&gt; Year</td>
<td>2&lt;sup&gt;nd&lt;/sup&gt; Year</td>
<td>3&lt;sup&gt;rd&lt;/sup&gt; Year</td>
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<tr>
<td>A. Recurring Contingencies</td>
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<td>(1) TA</td>
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<td>(2) Workshops</td>
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<td>(3) Contractual Services/RA/SRF</td>
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<td>Sub-Total of A (1-4)</td>
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<td>B. HRD Component</td>
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<td>(5) Training</td>
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<td>(6) Consultancy</td>
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<td>Sub-Total of B (5-6)</td>
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<td>C. Non-Recurring</td>
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<td>(7) Equipment</td>
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<td>(8) Furniture</td>
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<td>(9) Works (new renovation)</td>
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<td>(10) Others (Animals, Books, etc.)</td>
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<td>Sub-Total of C (7-10)</td>
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<tr>
<td>D. Institutional Charges*</td>
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<td>Grand Total (A+B+C+D)</td>
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</tbody>
</table>

* Institutional charges will be 10% of the recurring contingencies for the Lead Consortium and 5% for Consortia Partners.

Name & Signature of CPI: ____________________________
Name & Signature of Competent Financial authority: ____________________________

Date: ____________  Date: ____________
PART-IV: DECLARATION

This is to certify that the final report of the Sub-project has been submitted in full consultation with the consortium partners as per the approved objectives and technical programme and the relevant records, note books; materials are available for the same.

Place:_________  
Date:_________  
Signature of Consortium Principal Investigator

Signature & Date  
Consortium Co-Principal Investigator

Signature & Date  
Consortium Co-Principal Investigator

Signature & Date  
Consortium Co-Principal Investigator

Signature & Date  
Consortium Co-Principal Investigator

Signature & Comments of Consortium Leader  
Date: