Disaster Preparedness for Effective Response

Agronomic Rehabilitation and Livelihood Restoration of Tsunami Affected Lands in Nagapattinam District of Tamil Nadu

P. Thamizoli
R. Rengalakshmi
K. Senthil Kumar
T. Selvaraju

M.S.Swaminathan Research Foundation
Chennai

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Project Team
Dr. P.Thamizoli
Dr. R. Rengalakshmi
Mr. K. Senthil Kumar
Mr. T. Selvaraju
Dr. A. Gopalakrishnan
Dr. Sudha Nair and
Dr. M.Velayutham

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Foreword

The titanic tsunami of December 26, 2004 served as a wake up call in relation to the problems which our coastal communities may face in the coming years as a result of sea level rise, more frequent coastal storms and tsunamis and sea water inundation, primarily arising from the impact of global warming and climate change. The tsunami affected both fisher and farming communities. The MSSRF strategy developed within two weeks after the tsunami, consisted of a two pronged strategy dealing with fisher communities on the one hand, and farmers on the other. The fisher communities suffered more both in the loss of lives and livelihoods and therefore received priority attention. Sea water inundation however also caused harm to good farm land. Therefore the need for agronomic rehabilitation became urgent.

MSSRF organized a Traveling Workshop in the affected areas which enabled the leading soil scientists and agronomists of our country to visit the sea water inundated farms and study the damage done to soil health and ground water quality. As a result of such an indepth study by experienced scientists, it was possible to develop an agronomic rehabilitation strategy. Considerable amount of unnecessary expenditure, like the indiscriminate application of gypsum was also saved. The impact of the rehabilitation package was studied carefully during the last two years. This report gives the data from these studies. The results show the way to meeting similar situations in the future and could form an important part of the disaster management strategy in coastal areas.

MSSRF has simultaneously promoted the establishment of bio-shields and coastal biovillages to strengthen both the ecological and livelihood security of coastal areas. In addition, Village Knowledge Centres have been established to provide an effective communication tool for spreading knowledge about avoidance and rehabilitation strategies. The Government of Tamil Nadu and the Government of India are developing a Vulnerability Map to identify the disaster prone "hot spots" along the coasts. Special efforts can be made to train the farm and fisher families living in the vulnerable areas on disaster mitigation and management. Tool Kits have already been prepared for establishing Village Knowledge Centres and coastal biovillages. It will be prudent to concentrate on disaster preparedness, avoidance, mitigation and rehabilitation. I therefore hope that this Publication will be widely read and used by all concerned in the sustainable and integrated management of coastal ecosystems.

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M. S. Swaminathan

PROF. M. S. SWAMINATHAN
Chairman, National Commission on Farmers, Govt. of India
President, Pugwash Conferences on Science and World Affairs
Chairman, M S Swaminathan Research Foundation
Third Cross Street, Taramani Institutional Area
Chennai - 600 113 (India)
Tel: +91 44 2254 2790 / 2254 1229; Fax: +91 44 2254 1319
Email: chairman@mssrf.res.in / msswami@vsnl.net

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Preamble

The sudden impact of any major natural disaster unleashes havoc and tragedy : huge loss of life, livelihood, shelter, and damage to the environment. Natural disasters are cyclic; hence there is urgent need to prepare the society to meet any such future calamities. The paradigm shift is gaining momentum - from 'disaster management' to 'disaster mitigation and preparedness'. Disasters hit differentially, the most vulnerable are the poor; women and children are the worst affected. Hence it is a clarion call to identify structural causes for poverty and vulnerability in the society, and execute disaster management strategies. The need of the hour is to improve the social, economic and institutional support of the most vulnerable groups in the communities, which could in turn reduce the risk, prevent and bring down the magnitude of any such future disaster. Fostering disaster risk reduction measures will enhance the opportunities for good development and total welfare.

The recent earthquake-triggered Tsunami waves in the Indian Ocean, caused unprecedented damage to humanity and environment in the coastal areas of several South Asian countries. Indian shores were devastated by the surging tidal waves . With regard to damage in terms of agriculture and livestock, Nagapattinam was the worst affected District in Tamil Nadu. The small and marginal farmers lost their primary livelihoods, land, water, standing crops, fodder, livestock etc. Unfortunately, reviving normalcy in the context of agronomic rehabilitation, is a slow process. Improving the soil, ground water aquifer and irrigation facilities would take some more time. The strategy requires medium and long term perspectives. The farmers need to cope with the situation with available strength and resources.

However, apart from loss and destruction, any disaster creates the opportunity to equip the community and environment with risk reduction measures to encounter future disasters in a better way. Post-disaster management, is best achieved with the combination of humanitarian support, social protection and the promotion of livelihoods of the victims. In this context, this Report is intended to share our experiences, and delineate the activities implemented in the field, related to agronomic rehabilitation and livelihood restoration of the Tsunami affected lands, with the farming communities and other partners in the field. This document is a record of experiences and insights gained in the field during last year, which could be used for any future reference.

I. Agriculture in the Tsunami affected Districts

On 26th December 2004, a major earthquake of magnitude 9 on the Richter Scale occurred in the Indian Ocean on the northern tip of Sumatra Island. This led to fast moving, giant Tsunami waves that lashed the coastal line the Tamil Nadu and Pondicherry, and caused severe damage. Similar Tsunami waves had occurred in the Tamil Nadu coasts during 1881 and 1941, but the details of damage were not available. However, in 2004, the Tsunami ravaged the coastal areas and the those living in the coastal districts in multiple ways. There was a colossal loss of life and assets, damage to soil and water in the agricultural lands, loss of cattle and cash crops. In the context of agriculture, the Tsunami caused extensive damage to standing crops, as well as agricultural fields, in Kancheepuram, Vilupuram, Cuddalore, Nagapattinam , Tirunelveli and Kanyakumari districts of Tamil Nadu. The type and extent of damage varied across these coastal districts. Coupled with the damage to crops and soil, the loss of livestock was very severe. Most of the households lost their animals which were the major or supplementary contributors to household income. The damage to the crop and soil led to the loss of fodder, and scarcity of open grazing areas.

Damage Caused by Tsunami in Agriculture and Livestock Sector, Tamil Nadu

S.No	District	Area (ha)	Livestock Cattle & Goat (nos)
1	Nagapattinam	9567.09	128121
2	Kanyakumari	12.00	131501
3	Cuddalore	1681.22	1068
4	Kancheepuram	750.00	4
5	Villupuram	155898	0
	Total	13569.29	

Source: Area - G.O. Ms, No. dated 23.3.005
Livestock , Cattle & Goat - Post Tsunami Sustainable Livelihoods Programme for the Coastal Communities of Tamil Nadu - Design Document

The above Table shows that Nagapattinam District was the worst affected, in relation to Agriculture and Livestock. M.S.Swaminathan Research Foundation (MSSRF) initiated the Agronomic Rehabilitation activities, focusing on the damaged agricultural areas and related

infrastructure, reclamation of salt affected soils, and farm based water bodies for resumption of crop production. In the process, it focused on developing the capacity of the local farmers through active participation in the activities - diagnosis, analysis and evaluating the results, developing local resource persons, and to promote farmer -led horizontal extensions, and facilitating grassroots Farmers Groups.

Profile of Nagapattinam District

Nagapattinam is a coastal district; covering a total area of 2,71,583 hectares. Out of the total area, around 1,26,149 hectares is classified as wetland, 61,880 hectares as dry land, and the remaining 83,548 hectares as *'poramboke'* or Government land. Around 74% of the cultivators have less than one hectare of land, and another 15% hold between one to two hectares. The remaining 11% of the households own above two hectares of land. Though the area receives an average of 1337 mm of rainfall annually, nearly 76% occurs during the Northeast Monsoon, followed by 17.3% during the Southwest Monsoon. The soil is predominantly sandy in texture, and clayey in certain pockets, with slight salinity/alkalinity. The soil in the region belongs to Valudalakudi series; dark brown to brown, deep, sandy and possessing characteristics, of mild to moderate alkalinity levels[1]. The area lying between Nagapattinam and Vedaranyam, dominated by sand dunes, and cultivated soils mostly sandy in texture. Regarding the water table, fresh water is overlying saline ground water. The cultivation depends primarily on rainfall, supplemented by underground water. The area lying between north of Nagapattinam, to the border of Cuddalore District is covered under the Delta Irrigation System.

Agriculture in this region is dominated by rain fed and canal irrigated cultivation, supplemented by tank irrigation for the main crop of rice, and small-scale irrigation using underground water for the secondary crop viz pulses, gingelly, groundnut etc. Paddy is the primary subsistence crop, being traditionally cultivated in different methods. More than two third of the farming community are small and marginal landholders, and paddy is the most suitable staple crop. Groundnut, coconut, cashew, mango, vegetables like brinjal, cluster bean, lady's finger etc are cultivated using small scale irrigation. Cotton, and Casuarina are the other commercially important crops. In some of the areas, pulses like green gram, black gram and cowpea are cultivated as secondary crops (relay crop) after first season paddy, or finger millet, gingelly, sun hemp etc, are grown.

1 Soil Survey Report of Tsunami affected area in the coastal belt of Nagapattinam District

Livestock played a major role in strengthening their livelihoods, particularly the small ruminants. Generally small ruminants are reared in stall-fed system, using tree fodder, supplemented during lean season by open grazing in the agricultural fields. Agricultural work is the major livelihood for the agricultural labourers, supplemented by major multiple livelihoods like seasonal fish catch in the rivers/backwaters, prawn farms, coconut leaf mat-making, copra preparation, etc.

Between 1891 and 2000, nearly 26% of cyclones that formed in the Bay of Bengal struck the coast of Tamil Nadu; of which 55 severe cyclones crossed the region, mostly during the months of October and November. In addition to frequent cyclones, mid-season drought, floods, and water logging due to the flat topography, and improper/disturbed drainage systems, make the region more vulnerable. Thus the soil resources in this region show fluctuating characteristics of soluble salt concentration and soil pH.

Tsunami: Damage to Agriculture

Focusing on damages to important natural resources like soil and water, there was major damage to drainage facilities, field bunds, sand dunes etc. The turbulent tidal waves eroded the top soil in the sloppy fields, damaged the field bunds, small canals/dikes on one hand, and on the other, it deposited clay and sand materials in the low lying fields. In both the cases, the field topography was affected, and the thickness of the sediments varied across the damaged area, depending upon the distance from the coast and the gradient. The soil as well as water sources were severely affected, and the type and intensity of the damaged soil varies across the affected area. It can be broadly classified as follows:

- Landscape de-surfacing
- Deposition of slushy grayish brown clay deposit /sand deposit
- Dislocation and deposition of coastal sand dunes (erosion)
- Seawater intrusion, which receded (within 3 hrs to one week from the field) leaving salts in the field.
- Contamination of farm ponds, community ponds and other irrigation sources by sea water
- Damage to standing crops like paddy, groundnut, casuarina, coconut, cashew

The following Table gives the details of different types and extent of damage in the District.

Damage to Soil and Water Bodies in Nagapattinam District

Total area affected	4675 ha
Total area affected due to soil salanization	4657 ha
Sand/ silt castings	1367 ha
Silting of farm ponds	3200 nos
Silting of community ponds	142 nos
Standing crop damage to Paddy	4021 ha
Standing crop damage to Groundnut	1186 ha

Source:
Report on Tsunami Damage to Agricultural Lands, Soil Test Report - Nagapattinam District by Assistant Soil Chemist, Mobile Soil Testing Lab, Thiruvarur (Jan 2005).

The Table below also indicates the changes in the soil quality in pre and post Tsunami situation.

Changes in the Soil quality in Pre and Post Tsunami

Parameters	Pre Tsunami	Post Tsunami (Jan 2005)*
Soil pH	6.1-8.5	< 8.5 and it seldom exceeds 9
EC (Dsm-1)	0.2 – 1.1	Up to 23.7 especially in the clay deposits
Organic Carbon(%)	0.02-0.6	0.6-1.2 in the silt/clay deposited areas and in the remaining areas it is low

Source:
Soil Survey Report of Tsunami affected area in the coastal belt of Nagapattinam District carried out by the Soil Survey and Land Use Organization, Department of Agriculture, Govt. of Tamil Nadu

The following table gives the details of the different types of livestock lost in Nagapattinam District

Livestock lost in Nagapattinam District

Milch animals	424
Draught animals	14
Calves	87
Goats	3019
Poultry	368

Sources: Records, Animal Husbandry Department, Nagapattinam

II. Multiple Players in the Field - Rehabilitation Strategies

Since the devastating Tsunami, several players like Department of Agriculture, Tamil Nadu, Indian Council of Agricultural Research, New Delhi, along with the concerned Research Institutes and Non Governmental Organizations (NGOs), voluntary organizations and others have visited the affected areas and the farming and agricultural labour communities. The initial focus was on ensuring the revival of the livelihoods of the fishing communities by Government and NGOs, and simultaneously assessment of the damage to agriculture and livestock sectors. Researchers from National and State institutions, local Agricultural Officers, consultants of NGOs, assessed the damage (published the scientific results) and identified/ contracted agricultural fields with the consent of farmers for rehabilitation.

Rehabilitation Strategies

I. Support from Government Sector: Department of Agriculture has issued a Government Order (D.O.Lr.No.IAP4/232285/2004 dated 3.2.2005) on the possible rehabilitation package of strategies - *soil testing, removal of salt, land surface leveling, gypsum application, sowing of seeds, ploughing and cultivation of crops* - to the affected farmers. Immediately, the Department of Agriculture mobilized the affected farmers into Self-Help Groups and linked them to banks. The Government allotted Rs 12,500/ ha of the affected fields as an input Subsidy, and deposited the amount into the joint accounts of farmer SHGs and Joint Director/ Assistant Director. A series of soil tests for pH levels and electrical conductivity were carried out in the affected farmers' fields. The input provided during the first year of rehabilitation was adjusted against the allotted amount to the farmers.

II. Support from NGOs: NGOs identified affected villages and number of farmers in each village, and decided on the area to be identified for rehabilitation. NGOs took the support of consultants in drafting the agronomic rehabilitation strategies. They also mobilized farmers and agricultural labourers into Self Help Groups in some of the areas. As part of the soil management practices, and also to provide employment for the agricultural laboureres, many of the NGOs had started removing deposits of clay and sand from the fields, heaped them in the field, and transported the same to the seashore under 'Work for Cash' programme. They also managed the de-silting of canals and removing of seawater and slushy deposits from the farm ponds.

In fact, during the initial phase of rehabilitation, only a very few NGOs were involved in agronomic rehabilitation. During that period of time, reviews and reports generally indicated that Tsunami agronomic rehabilitation has not received the required attention of donors and NGOs. In course of time, the NGOs took an active role in providing support for soil reclamation, crop cultivation and rebuilding the infrastructures like canals and ponds.

From the beginning, both the Government, as well as NGOs, evolved rehabilitation strategies in isolation, and started implementing in a selected number of villages, based on their capacity and financial strength. Though the type and degree of damage varied across the affected agricultural fields, the Government evolved common recommendations and allotted relief inputs to the farm families. However, the NGOs working in the specific region, evolved and followed site-specific strategies in the regions where they operated. In both the cases, the affected farming communities were not adequately consulted in evolving and implementing the strategies. As a result, each of the groups implemented their own strategies and this situation led to confusion among themselves, and among the farmers, in agronomic rehabilitation of the affected fields.

There were no concrete scientific recommendations based on proper survey and situation analyses, other than the GO issued by State Agricultural Department. Hence, there was a need to understand the ground situation, and to focus on the integrated rehabilitation measures in the large scale, on a medium to long-term strategy, to help the farmers revive and strengthen the production systems.

Diverse opinions were received from the farmers of Northern part of Nagapattinam on the seawater intrusion and soil deposits on fields, based on their past experiences. Traditional Knowledge plays a vital role in mitigating the localized problems. This knowledge has developed among the local communities over a period of time in the same location (Box 1).On the contrary in Vedaranyam, Pusphavanam, Vellapapallam, Periyakuthagai, Naluvedathapathy, Koilpathu, Vettaikaranirruppu, Vilunthamavadi and Tirupoondi (southern part of Nagapattinam) areas, the huge clay/silt dominated deposits was noticed for the first time and there was no such earlier experience. Thus farmers were not confident about the impact of the deposits in the field. In this situation, State Department of Agricultural Extension issued an order for rehabilitation strategies, in which removal of deposits was recommended as one of the reclamation strategies. NGOs started the same approach in the field, mostly to provide work for agricultural labour households under 'cash for work' programmes. The soil reclamation package developed by the individual NGOs recommended

the removal of deposits. In most of the fields theses deposits were scrapped and removed from the field mostly during May 2005 onwards. In this period the region received two good rains (April - 197.5 mm and May 41.97mm). At that stage it was difficult to scrap the deposit alone (mixed with top soil) and hence in most of the fields topsoil was also removed to some extent with the clay/ sand deposits. Though a portion of the salt might have been taken away along with the top soil, most part of it must have entered into the subsurface soil and into the ground water along with the sub-surface leaching.

In this situation, to gain better under standing of the problem, there was a need for proper situation analysis with the support of different experts. M.S. Swami nathan Research Foundation decided to organize an interdisciplinary traveling workshop, to understand the situation and evolve site specific strategies to address the different types of problems caused by the Tsunami across the affected regions. The Report of the workshop, with recommendations, is given as Annexure I. The workshop recommendations and discussions were prepared as Brochures, both in Tamil and English, and disseminated to farmers, civil society organizations, and District Coordination Committee and Government Officials. The outcomes were also immediately uploaded in MSSRF web site (www.mssrf.org) and disseminated through Village Knowledge Centres promoted by MSSRF, wherever it operated, and in village meetings with the farming communities.

Box: 1. ***Traditional knowledge on seawater intrusion and deposits in agricultural field***

Farmers in the Neithavasal, Keliyur, Poombukar villages recalled that seawater intrusion and deposition of sediments from the sea have occurred also in the past. They differentiated the incidents, based on seawater intrusion or seawater intrusion with sand or clay deposits. If it is seawater alone, they locally call it as '*kadal ponguthal*' (turbulent sea water entry). Entry of seawater with deposits of soil into the field is known as '*kadal puraluthal*' (rolling waves along with sea bed sediments). Seawater with clay deposit is locally called as '*porrukku*', which is very fertile and used to incorporate in the field while ploughing. In these circumstances, and also when there is an increased salinity, the following remedial measures are adopted by the farmers: in case of wetland, ploughing is carried out twice, followed by leaching with good water, and application of *Calotrophis* leaf and other green leaf manures. This is left for decomposition, and ploughed *in situ.* In case of dry lands, application of tank silt (porukkuman) and farmyard manure is the usual practice.

III. Major Interventions in the Field

The interventions focused on participatory demonstrations on agronomic rehabilitation measures, monitoring the soil quality in both the participatory fields and benchmark sites with the support of Agricultural College and Research Institute, Trichy, water management techniques, including farm ponds, organization of Farmers Associations, training and capacity building, introducing need based eco-enterprises for soil fertility management, and strengthening livestock components, since September 2005.

Approach

The interventions followed a community centered, multi-stakeholder approach, involving small and marginal farmers in the rehabilitation process. The process has been facilitated to develop a replicable model for the region. The cause for vulnerability has been viewed beyond the recent Tsunami damage, but with in the larger framework of structural inequalities. These local farmers were mobilized and formed into groups, which would facilitate horizontal linkages, share the experiences and disseminate the knowledge. To create an enabling environment, skill building in farmers was given importance, which in turn could pave the way for the long-term sustainability of the project results. Through partnership development and effective coordination, exchange of experiences, ideas and technical support among the different agencies like Government, non-Government and academic institutions were achieved. Participation of women farmers and farm labourers were ensured in discussions and decision-making.

1. Agronomic Rehabilitation

The major farming communities in the project villages are Tamil speaking Vanniyars, Sozhli Vezhalalar, Konars, Nadars, and Naidus. Agriculture has traditionally been the primary livelihood of these communities. Sections of these communities are also landless, and work as daily wage labourers. The other demographically dominant group in the region is the Parayar, the asset-less community which occupies the lowest rung in the social hierarchy. They earn their livelihood through working as agricultural labourers. Since the employment opportunities are seasonal and uncertain, they are forced to migrate to other places in Tamil Nadu, and to Kerela - the neighbouring State.

Participatory agronomic rehabilitation was carried out in five villages, each one representing unique problems identified during the traveling workshops. The demonstration and verification trials covered around 24 hectares in each of the five most affected areas, covering a range of damages, in close collaboration with the affected farming community. Small and marginal farmers were the participants in the programme. Interventions simultaneously focused on techniques/methods that sustain the practice of soil fertility management - like decentralized vermicompost preparation and *Abuscular Mycorhyzae* (AM) Biofertilizer production.

Participatory Field Demonstrations: Based on the issues identified during the traveling workshop on the basis of the intensity and type of the damage, five participatory field demonstrations were carried out: a) Vellapallam (Rice-rainfed) b) Vettaikaranirruppu (Groundnut and Casuarina) c) Anaikovil (Rice-rainfed) d) Neithavasal (Rice and Groundnut) e) TS Pettai (Groundnut). Total area covered under Agronomic Rehabilitation is around 59.93 acres (23.97 ha) and 67 farmers are involved in the activity.

Soil Reclamation Process: Field specific soil reclamation practices were carried out in each of the villages. In Vellapallam and Vettaikaranirruppu villages, slushy deposition of clay material was present, which was rich in organic matter. The heavy metal analysis of the deposited material indicated a concentration of Chromium, Lead, Zinc, Copper, Nickel, Cadmium and Mercury, which are within the permissible limits, and thus it can be incorporated into the field (detailed report is given as Annexure II). In Anaikovil, Neithavasal and TS Pettai villages, there were sandy deposits in groundnut fields, and seawater had intruded and stagnated in paddy fields. The following measures were taken in an integrated manner to tackle the issues:

- *Deep ploughing and land Leveling*: In all the selected fields deep ploughing was carried out twice, using rotavators or manual labour, before sowing, and field bunds were reformed/strengthened, land smoothening/leveling was carried out wherever necessary.
- *Spreading and incorporation of sand/clay deposit*: In some of the fields, farmers with the support of other NGOs, collected the top layer of deposits and heaped it in the field. With the consent of the farmer, this was spread evenly and incorporated in to the soil by deep ploughing.
- *Removal of cyperus and other weed species*: Especially in the clay deposited fields, the growth of cyperus weed was abundant, and these were uprooted and ploughed.

- *Providing proper drainage facilities*: In many of the fields the water drainage was blocked with debris and sediments. These were removed and clean drainage was were restored.
- *Sowing and in situ ploughing of green manure species* (*Sesbania aculeata*) - In almost all the paddy fields, irrespective of the paddy cultivation method, *Sesbania aculeata* was grown and incorporated in the field at the time of flowering. On an average, nearly 12.5 t/ha under irrigated conditions. and 4 t/ha under rain fed conditions. were incorporated into the soil before flowering.
- *Leaching:* It was carried out in the fields wherever seawater had intruded and stagnated, thereby causing an increase in the soluble salts concentration.
- *Application of Farm Yard Manure (FYM) and Biofertilizers*: On an average, 5 t of FYM was applied before the last ploughing. In addition, salt tolerant strains of Phosphobacteria, Azosprillum and Pseudomonas species were applied @ 2 kg per ha (Source: Microbiology Lab, MSSRF, Chennai).
- *Selection of salt- tolerant varieties*: Paddy varieties that can tolerate salt water instrusion, like TRY 2, CO 43, MDU 5, ADT 43, and traditional landraces like *kuzhivedichan,* were grown wherever possible; the transplanted method of cultivation was followed.
- *Gravity drip system was introduced to enhance water use efficiency* of the farm ponds.

The heavy rainfall during the months of November and December 2005, amounting to nearly 600 mm within the period of less than 20 days, coupled with water stagnation, hampered the crop growth. Thus, it is very difficult to differentiate the impact of reclamation, on both soil properties as well as crop performance, in the Tsunami affected soils. Except Casuarina, Rice and Groundnut were harvested and the rice yield in the Tsunami affected areas was further hampered by continuous rain and flood during its panicle initiation stage. The stagnation of water in the field affected the growth of yield components and reduced nearly 40-80 % crop fields across the demonstration sites. In Vellapallam and Vettaikaranrrupu, paddy was cultivated under rain fed situation, following direct sowing, whereas in Anaikovil and Neithavasal villages due to the water availability in the canal, transplanting was carried out under irrigated condition. In the case of Neithavasal village alone, rice was grown during the second season (Dec 2005 - March 2006), immediately after the monsoon, the crop recorded a good grain yield (2.5 t /ha, whereas the normal average yield was around 2 to 2.2 t/ha). Here also, the combination of reclamation practices was carried out. In case of Groundnut, pod yield was comparable with previous year yield in Neithavasal. During this year, the average yield was 1600 kg /ha and two varieties were tried, namely VRI 2 and POL 1. Whereas in

Vellapallam and Vetaikaranirruppu villages, though the crops were healthy with good biomass production, the kernel formation was affected; shelling percentage being about 58- 60% only. The general post harvest soil analysis shows both pH and EC were normal, with few exceptions.

Crop	Village	Variety	Yield (kg/acre)
Paddy	Neithavasal	CO 43 - Transplanted	400 - 1300
	Anaikovil	ADT 43 - Transplanted	350 - 700
		TRY 2 - Transplanted	320 - 860
		ADT 38 - Direct sowing	1200
	Vellapallam	Kulivedichan - Direct sowing	190 - 400
	Neithavasal	MDU 5	920
Groundnut	Vettaikaranirrupu and Neithavasal	VRI 2	800
	Vellapallan and TS Pettai	POL 1	620

It is clear that with the participation of local communities, in these vulnerable coastal system, adequate consideration has to be given to select paddy varieties that possess both the characters of salinity tolerance and flood resistance. The planting method also needs to be taken care, and direct sowing (instead of transplanting) reduces the crop duration and helps to overcome the flood hazards during the Northeast monsoon in this vulnerable ecosystems.

Regarding the soil quality, assessments were carried out thrice in the participated farmers fields i.e (i) before transplanting (Oct 2005), (ii) during panicle formation stage (after heavy rainfall during Dec 2005) and (iii) after harvest of paddy (April 2006). The table shows the gradual reduction in the soil salinity. During April 2006 both the pH and EC levels reduced to the levels normally observed in coastal soils and most of the lands were found suitable for crop cultivation without any constraints (annexure III).

But at that time still few farmers perceived that soil has salt or other contaminants which may affect the crop growth. In such farmer's fields, individual field specific spot soil assessment was carried out during April 2006. During that time farmers were explained about their field condition, salinity level. The water quality in their respective farm ponds were also tested to clarify their doubts. This analysis indicated the presence of salinity and thus the crop growth was stunted and very poor.

Water quality of few farm ponds*

Villages	July 2005		April 2006	
	pH	EC	pH	EC
Annaikovil	7.36 to 8.32	1.5 to 2.8	8.40	2.60
Vettaikaranirruppu	8.3 to 8.5	3.5 to 18.7	8.50 to 8.88	3.7 to 14.00
Vellapallam	8.05 to 8.7	3.3 to 26.5	8.01 to 8.63	2.29-6.93

The range indicates the minimum and maximum values in several farm ponds
**exclusively used to irrigate second crops/groundnut*

The water quality in the farm ponds indicates medium to high salinity levels that caused stunted growth, drying of crops etc led to total crop loss in the second season (March- May 2006) crops mostly vegetables like Bhendi, Clusterbean, Cowpea, Gingelly, Fingermillet, Groundnut etc. The tests in different farm ponds (depth ranges from 2-3 m) indicates the salinization of the fresh water aquifers. The results confirms with the aquifer study carried out in Sri Lankan Tsunami affected coasts where the shallow aquifers got salinized and the water is not suitable for either irrigation or potable[2]. Thus during the current season much efforts are needed to study the hydrological situations and need to focus on evolving integrated strategies.

Contingency Cropping

Owing to the heavy flooding during the north-east monsoon season, coupled with frequent cyclones, the farmers incurred heavy loss in their standing paddy crop of the season, amounting to nearly 40-70 %. As per the suggestion of Prof.M.S.Swaminathan, small scale planting of sweet potato was carried out as life-saving crop, with the support of Central Tuber Crop Research Institute, Trivandram. Sweet potato had been cultivated in the region a decade ago, and this intervention helped to revive the practice. Five thousand cuttings, consisting of three different varieties, viz. *Kanjangad, Sree Rathna* and *Sree Arun,* were introduced among 37 farmers in six villages. Sree Rathna and Sree Arun are 90 to 100 days duration spreading type, whereas *Kanjangad* is semi spreading, with duration of 120 days. The results indicated that the harvested quantity was, in the case of *Sree Rathna,* 12 ton per

Illangasekare, Tissa; Tyler, Scott W.; Clement, T. Prabhakar; Villholth, Karen G.; Perera, A. P. G. R. L.; Obeysekera, Jayantha; Gunatilaka, Ananda; Panabokke, C. R.; Hyndman, David W.; Cunningham, Kevin J.; Kaluarachchi, Jagath J.; Yeh, William W.G.; van Genuchten, Martinus T.; Jensen, Karsten., 2006. Impacts of the 2004 tsunami on groundwater resources in Sri Langa, Water Resour. Res, 42, W05201, doi: 10. 1029/2006WR004876.

ha, *Sree Arun,* 18 ton per ha and *Kanjangad,* 19 ton per ha. This proved that in future, it is essential to develop a contingency crop plan for each of the villages, and develop a linkage to get the seeds or planting materials for these very vulnerable spots.

Long Term Measures to Sustain Soil Fertility Management Practices

Adequate supply of organic matter for the soil helps to enhance the soil fertility and tilth, to improve the water holding capacity - especially in the sandy textured soils, and enhance the beneficial microbial activity. Due to the deposition of sand/clay, as well as topsoil removal, along with deposits, led to changes in the texture of topsoil layer. In order to improve the soil conditions by considering the low organic matter content even at pre Tsunami condition, it was planned to increase the addition of organic matter. Taking into the consideration the soil quality, cropping systems and available human resource, it was planned to introduce allied enterprises/activities, which would help to strengthen the local agro-ecosystem, generate employment and additional income to farm/labourers families. They are: (1).Decentralised Production of vermicomposts and (2) Production of VAM - biofertiliser (Details in Chapter IV)

Water Management Techniques - Including Farm Ponds

Farm ponds play a vital role in providing irrigation source to the second crop of vegetables after paddy, in the main season in the wet land, Groundnut in dry land and Coconut. The major activities carried out were the removal of salt water and de-silting of farm ponds. The bunds of these semi permanent farm ponds were strengthened by planting fodder crops like Cumbu Napier grass to provide stabilization.

The traditional farmers' practice of manual lifting of water using small earthern pots, a time consuming activity which involves drudgery, or using oil engines. In order to provide an alternative to water lifting, Pedal Pump technology, with a capacity to deliver 60- 80 liters of water per minute,was demonstrated in two villages with the support of 'Water for Third World'. In the present conventional system of irrigation using small pots, a middle aged man could lift 2 pots per minute; that has the capacity of 20 litres per minute or 1200 litres per hour. But the Pedal Pump has the capacity to lift at least 3600-4000 litres per hour, which is more efficient than the conventional practice. Farm pond is a very common feature in the lands of all farming households in the region; hence there is a good scope for the self replication of the technology. According to the farmers, the technology is affordable and replicable.

But here, due to the sandy soil texture, the use of Pedal Pump and direct irrigation need not help to increase the water use efficiency. Hence, considering the area, as well as the ponds' water holding capacity, it was decided to introduce Gravity Drip Irrigation, coupled with Pedal Pump lifting technology. Two units were installed in two villages (Vellapallam and Vettaikaranirruppu) covering an area of 400 and 200 M^2 for vegetables and coconut respectively.

Drainage Canal De-silting: Due to the heavy rainfall during the northeast monsoon season, to avoid the water stagnation in the fields and choked canals, in Vellapallam, Anaikovil and Vettaikaranirrupu villages, the drainage canals were cleaned with the participation of village communities to drain the excess flood water.

Strengthening Livestock Resources

To some extent, livestock such as goat and dairy play an important role in supplementing the major portion of income among the agricultural and agricultural labour households. Semi stall-fed system is in practice. During cropping season, the backyard of the house (under the trees) is normally used as s shed, and during that period, stall-fed system is the major feeding practice. Leaves of tree species such as *Poovarasu, Othiyan, Casuarina, Neem* etc, are commonly used as a feed, sometimes supplemented with open grazing in the evening hours. Whereas, during the lean season, a small hut is made to pen the goats in the field during the daytime, and at night they shift from one place to another within the field locally termed as *'kidai'*.

Immediately after the Tsunami, the grazing resources were affected due to the saline water. In order to strengthen the resources, an exposure visit was organized to the Livestock Research Station at Kattupakkam, Tamil Nadu Veterinary and Animal Sciences University in Chennai. The visit helped the farmers understand the importance of animal health care and nutritional management. Based on the farmers' requirements, green forage – Cumbu Napier grass slips, were supplied initially, and with plans to introduce protein rich green forage sources. In order to improve goat farming, improved breeds like 'boyar' and 'jamnapari' breeds will be introduced, and training will also be arranged on disease management.

IV. Traditional Cultivars and Local Knowledge

Immediately after the Tsunami, there has been widespread recognition for the traditional varieties which are vital to such vulnerable ecosystems. An exploratory survey was carried out on the diversity of rice germplasm available in the coastal ecosystems, the unique characteristics, geographical areas and status of current cultivation.

Different traditional landraces are the major genotypes that have been cultivated by the local farmers according to the soil type, method of cultivation and seasons. The choice also takes into account the gastronomic and nutritional values of the grain. Of late, due to the introduction of high yielding varieties of paddy, the area, as well as the number of genotypes under traditional landraces is gradually declining. In certain pockets, the communities tested the high yielding varieties, but reverted to the cultivation of traditional landraces. Around twenty seven flood and drought resistant landraces were recorded in different micro agro climatic zones all along the Nagapattinam District coast, cultivated by small and marginal holders. Out of this, several landraces are already out of cultivation. The major reason is the scarcity of the seed immediately after the flood/ drought year. It is not as readily available in the market as the high yielding varieties, and this limited access led to the

Kuzhivedichan -

a traditional widely cultivated variety: It is a traditional widely cultivated variety grown in lands with higher elevation, short duration (90 days), drought tolerant, comes even at low rainfall, low to medium flood resistant locally referred as *illavarai*, it tolerates *kattavellam*, not suitable for *peruvellam*, gives good yield, a farmer explained its yield potential as it makes the farmer rich as '*panakkaran akkum'*, but during maturity it will easily shatters and thus it need to be harvested immediately after attaining maturity. farmers says Kuzhivedichan and kallurundai are sisters to explain the characteristics of each one of them. Rice is black in colour called as *karuparisi soru*, the strained water after boiling can be used as a drink similar to coffee, some times the bran is also used as a snack mixed with jaggery, food is nutritious, tasty, grain is bold, best suitable for *palaiyasoru*, it has unique flavour, suitable for the preparation of products like idly, puttu, upuma.

disappearance of the particular landrace. In case of upland rice landraces, it was replaced by Groundnut and Casuarina. In most of the dry land areas, where paddy is predominantly cultivated, Groundnut has taken its place, in spite of the risk the farmer would encounter if there is any flood/drought or pest incidence.

The following Table gives the list of traditional varieties suited to this area, and other related details:

No	Traditional Varieties	Distinct Character	Flood Tolerance	Geographic Location	Duration	Status / Place of Cultivation
1	Kattukottalai	Bold grain	Vazhuvarai	Puspavanam, vettaikaran irruppu	4 ½ months	Presently not cultivated
2	Madumuzhingi	Deep water rice	Vazhuvarai	Thalaigayiru	6 months	Thalaigayiru area
3	Mappilai Samba	Bold grain	Vazhuvarai	Puspavanam	4 months	Pushphavan and Periya kothagai areas
4	Kudavazhlai	Tolerates flood, red rice, tasty, it grows up to the height of a person and yield is low, suited to lands with low drainage facility, and prone to water stagnation, slightly fine variety, the rice wont get spilt during processing	Vazhuvarai	Puspavanam, periya kuthagai and vettaikaran irrupu and	4 months	Pushpavanam area
5	Kumpaalai	Best suited for fodder	Vazhuvarai	Puspavanam	4 months	Pushpavan area
6	Sepukurikadu	longer duration, the glume is red	Vazhuvarai	Naaluveda pathi	4 months	Pushpavan areas

7	Vellaikurikadu	Not suited for fodder	llavarai	Naaluveda pathi	3 months	Pushpavan area
8	Thillainayagam also called as Thillaikatai,	Red rice, drought tolerant, bold grain, straw is useful for thatching grown up to six feet	Vazhuvarai	Sembanar kovil, Arupathi area	6 months	Presently not cultivated
9	Kothhamalli Samba	Fine grain quality, transplanted, grown up to the height of 5-51/2 feet, grain is round shaped with rind on the husk	Vazhuvarai	Neithavasal, Vanagiri, Sirkazhi block	5 months	Presently not cultivated
10	Seeragasamba	Tolerates flood, fine rice quality	Vazhuvarai	Neithavasal, Vanagiri, Sirkazhi block	6 months	Cultivated at Kedathalai medu area
11	Kundali	Dry land paddy, tolerates flood and drought, red rice, good fodder for goats and tolerates grazing of cow and goat, suited to early monsoon sowing	Vazhuvarai	Thoduvai and Thirumullai vasal, Sirkazhi block	3-4 months	Thoduvai and Thirumullai vasal areas
12	Kallurundai	Bold rice, flood and pest and disease tolerant	Vazhuvarai	Thiruvali area, Sirkazhi block	4 months	Presently not cultivated
13	Kuruvai and Ottadiyan (two species vella (white) and sivappu (red)	Sown by mixing these varieties, it is very tasty and filling, appetite resistant. Drought and flood tolerant	Vazhuvarai	Neithvasal, Vanagiri and Melaiyur	Kuruvai- 3 months and ottadaiyan 6 months	Presently not cultivated

14	Kuzhivedichan	Black bold grain, nutritious, tasty, with unique flavour	Vazhuvarai	Vedarnyam Thaligayiru	5 months	Cultivated in Pushpavanam and vella pallam villages
15	Kattasamba	-	Vazhuvarai	Thaliagayiru	4 months	Thaliagayiru area
16	Poonkar	-		Thaliagayiru	3 ½ months	Thaliagayiru area
17	Karadan samba	Good for food, high fodder yield, able to produce yield even with less rain.	Illavarai	Puspavanam	3 ½ months	Pushpavanam area
18	Vellakurvikar	Medium duration, flood tolerant, gives good grain yield and fodder, stem has sweetness. Prone to rodent attack,	Illavarai	Pusphavam, Vettaikaran irrupu	3 ½ months	kallimedu area
19	Ramakurikar	Outer coat is red	Illavarai	Naaluveda	pathi	Pushpavanam area
20	Valseppu	Grows to 6 ½ feet ht	Valzhuvarai	Periya kuthagai	4 ½ months	Pushpavanam areas limited to few housholds
21	Surakuruvai	Stem is thick, able to resist water stagnation	Ilavarai	Naaluveda pathi, Vettaikaran irrupu and Puspavanam	70 days	Pushpavanam areas limited to few housholds
22	Narikuruvai	Stem is thin	Illavarai	Puspavanam		Presently not cultivated
23	Kaivarasamba	Needs more water and nutrients	Vazhuvarai	Puspavanam	6 months	Presently not cultivated

24	Seenginikar		Illavarai	Vettaikaran irruppu	3 ½ months	Presently not cultivated
25	Karungkuruvai		Illavarai	Vettaikaran irrupu	3 months	Presently not cultivated
26	Pungan Samba	Red coloured grain and pale coloured rice, and white when cooked.	Vazhuvarai	Manikka pangu, Anaikovil	5 ½ months	Presently not cultivated
27	Thanga Samba		Vazhuvarai	Kelaiyur and Neithavasal	6 months	Presently not cultivated

These varieties are classified as *Illavarai* and *Vazhuvarai* which means primarily early and late maturing crops, also it denotes less and more tolerant to continuous rain and flood respectively.

Local Seed Systems:

Generally farmers rely on their own source of seeds. They adopt a series of steps to select seeds for the coming season, and store them separately either in gunny bags or traditional seed storage containers made of rice straw ropes smeared with cow dung. The practice of seed exchange is not usually encouraged, and in case of non-availability of seeds, farmers depend on other farmers with credible social relationships. The other notable point is the practice of '*vithai muhurtham*' (ceremonial seed sowing) to test the seed germination and viability carried out during the month of Avani (Aug - Sep). Only after this practice, farmers give seeds to other needy farmers. This can be considered as a cultural constraint, which hinders the easy flow of seed from one farmer to other needy farmer. This also creates an uncertainty on the availability of preferred seeds. In case of seed exchange, the usual practice is called "*nellukku nellu*" - whereby the farmer who borrows, has to return the same quantity after the harvest.

In this situation, to ensure easy flow and timely availability of the preferred variety of seeds, a Community Seed Bank was introduced in two of the project villages. The seed bank is managed by farmers, and operates on the basis of the norms and rules evolved for collection and distribution. In the future, it is expected to enhance the seed quantity and number of suitable varieties to meet the requirement of the entire farming community in these villages.

V. Capacity Building, Farmers Feedback, Group Formation and Way Forward

Training and Capacity Building - Towards Knowledge Intensive Agriculture

Training and Capacity building programmes are organized to enhance skill and knowledge and to develop an attitude to accept change and to make sure that the targeted audience performs to the best of their ability. Capacity building empowers people and enables them to gain control over their own livelihood practices and environment. The long term aim is to empower people to become self sufficient and self reliant. At the begining group discussions were held with Farmers Group in each of the five villages to assess their training needs. Interactive discussions, field visits and exposure trips are being adapted to conduct the different training programmes. In each village, around 25 to 30 farmers were trained on soil reclamation, soil management, pest and disease management, and water management. These farmers would emerge as local resource persons. The following are the training plans prepared for all the villages.

- Green manuring and leaching methods
- Seed treatment techniques
- Soil management with focus on enhancing soil organic matter
- Integrated Pest Management
- Water saving irrigation methods - gravity drip and sprinkler systems; Mulching using coconut husks
- High value multi purpose tree crops - annual Moringa, Agathi, Castor
- Livestock management –Goat and Dairy Management – Improved breeds, feeding systems and disease management
- Fodder crops
- Biofertilizers and Effective Microorganism (EM) usage
- Improved agronomic practices for Groundnut cultivation
- Composting techniques - Vermicompost
- Pest management in Coconut and cashew
- Post harvest technology and value addition

As per the plan prepared jointly with the community, based on the needs identified, the training and capacity building programmes were organized in all the five villages; it combined exposure visit and demonstration, and provided opportunity to practice it in the field. It provided an opportunity to observe and share the experiences and knowledge among themselves.

During the reporting period, training and capacity building programmes were organized on soil reclamation, Integrated Pest Management in paddy, and seed treatment techniques using biofungicides and biofertilizers, water saving irrigation methods, high value multipurpose tree crops and fodder crops, livestock management – especially the small ruminants, vermicomposting and Effective Microorganism usage, improved agronomic practices for Ground nut cultivation etc These farmers are slowly emerging as local resource persons.

Training and Capacity Building

Theme	Technical Support/Resource Person
Soil reclamation process - soil testing, Green manuring, Farm Yard Manure (FYM) application and Leaching	MSSRF, Tamil Nadu Agricultural University (TNAU), Agricultural College & Research Institute, Trichy
Vermicompost	Private Farmer - Entrepreneur, Cuddalore
EM Technology - Composting	MSSRF
VAM production technology	TNAU, Coimbatore.
Biofertilizer application	TNAU, Coimbatore, Tamil Nadu Rice Research Institute, Aduthurai and State Agrl. Extension Dept.
Seed treatment and Nutrient Management for Paddy	MSSRF
Integrated Pest Management for Paddy	MSSRF
Integrated Crop Management for Groundnut	TNAU, Sugarcane Research Institute, Cuddalore and MSSRF
Irrigation Methods: Pedal Pump Irrigation	Water for Third World, Kolkatta
Pest and Disease Management Coconut	Agricultural Research Station, TNAU, Veppankulam
Integrated Farming System (IFS) - evolving Village specific models	MSSRF

Goat and dairy management - Improved breeds, feeding systems disease management	Livestock Research Station, Tamil Nadu Veterinary and Animal sciences University, Chennai

In order to enhance the awareness among the farmers about Biofertilizers, a 'Biofertilizer Day' was organized at Vettaikaran irruppu village, with the support of Department of Microbiology, Tamil Nadu Agricultural University, Coimbatore, Agricultural Department and Tamil Nadu Rice Research Institution (TRRI), Aduthurai. In the meeting, about 120 women and 60 men participated. Exhibits were arranged on the different types of biofertilizers, and methods of preparation, and demonstrations were organized on the methods of use on different crop seeds.

Allied Eco-enterprises for Income Generation

In order to strengthen the income generating sources for the small and marginal farmers, as well as for the agricultural labourers, both women and men, appropriate technologies which are relevant to the local agro-ecosystem was promoted. Technology transfer, skill building, credit access and ensured forward linkage with the market are all mandatory for the sustainability of an enterprise. MSSRF facilitates linkages with Financial Institutions and forward linkages with markets and backward linkages with the academic/research institutions. To promote the soil health in the fields and generate additional income to the farmer and labourer households, AM Biofertilizer and Vermicomposting were identified. The participating farmers and the members of the women SHGs from labourers' families were involved in training and establishing production units.

Case study: A farmer in the Neithavasal village in the Sirgazhi Block, Nagapattinam District, underwent the training programme. As a follow-up, he prepared a customized vermi heap using the coconut husk as the base layer to support the heap. The heap is with five kg of earthworm and about 100 kg of cow dung. Every day he added five buckets of slurry from the biogas unit which is near the vermi pit in his backyard. At the end of 45 days, he collected around 800 kg of vermicompost, sold for Rs. 3200/-. The worms multiplied to an extent of an additional two kilos. He increased the number of production units, and till now he has five units, and produced 3000 kgs worth of manure for the market value of Rs 12,000/. He planned to use it for his own fields and sell the surplus to others, and thus earn additional income. He has been already entered into discussions with private marketing agencies for regular production and selling of vermicompost.

Arbuscular Mycorrhiza (AM) Biofertilizer Production: By looking at the cropping pattern in the coastal region, which is rich in agro forestry resources (Cashew 266 hectares, Mango 167 hectares), decentralized production technology was demonstrated in Vettaikaranirrupu village. Tamil Nadu Agricultural University, Coimbatore provided the technology and necessary training for skill enhancement. Members of one Agricultural labour Women's Group have taken up an enterprise with a capacity of 400 Kg/pit. Quality analysis was carried out by TNAU which shows 98 % spore count within the duration of 60 days after inoculation. Based on the success, as well as market opportunity, it is planned to upscale the production in the unit and expand the number of units to other villages. The local production cost comes around Rs 6.00 per kg, and the approximate market price varies with the minimum price of Rs 20-25 per k of the product. More than 50 percent of the total product produced was locally marketed to the tree growing farmers. The local farmers associations have come forward to introduce the product through the organic farmers network operating in the region.

Vermicomposting: In order to improve the soil fertility and enhance the soil organic matter content, by considering the availability of cow dung and other crop residues and wastes, vermicomposting technology was demonstrated in four villages. 30 farmers were trained in the production process, both by hands-on experience, and exposure visit to the production unit, and as a result, all 30 farmers are successfully following it, and 60 other farmers have shown interest to practice. The local production cost is around Rs 0.85 per kg, and the cost benefit ratio is 1: 2.09. Based on the availability of the resource material, as well as profit, a market link was identified and negotiated to supply 10 t of product during the next two months.

Farmers Feedback and Future Planning

The farmers perceived that the practices followed in the field demonstrations are adoptable and replicable. Following are the major points that emerged during the discussion and need to be taken care in the future course of action.

1. To enhance crop diversity, the farmers requested both technical and material support - like providing seedlings for sweet potato, mango, cashew, slips of Cumbu Napier grass slips etc.
2. Requested to carry out participatory field trials for the other vegetable crops.
3. Need support to improve the market linkages for crops like coconut, cashew, groundnut etc, and the possible value addition technologies.

4. Training and intervention is required on breed improvement (cross breeding with elite species) and stall fed system.
5. Introduction of multi purpose tree crops to be grown on farm ponds and canal bunds.
6. Suggested to test ground water quality for the irrigation in the farm ponds. New farm ponds have to be developed in the areas. The water harvesting structure has to be developed and drainage facility has to be improved
7. Based on the output of the initial demonstration of the vermicompost activity, more number of farmers requested the technical support, which could upscale the production.
8. Requested technical support to promote suitable allied agro based enterprises like dairy, goat rearing etc with forward and backward linkages
9. Required demonstration on drip and sprinkler irrigation for judicious use of water and enhanced water use efficiency

Farmers Groups - Way Forward

The participating farmers in four villages were mobilized into four groups in their respective villages and formed into village-based farmers groups. These farmers are slowly emerging as a cadre of local resource persons. The groups started working on savings and micro credit among themselves and linked to banks. This would facilitate the credit flow from the banks, and to secure external support to the farmers to meet their 'timely' credit needs. A one-day consultation was held with the participating farmers at Chennai, on the relevance and usefulness of the demonstration as well as training programmes. Based on the discussion it was planned to demonstrate village specific Integrated Farming System (IFS) model in each of the village. It was also decided to continue the application of green manure wherever possible, in combination with vermicompost and summer ploughing. It is also planned to de-silt the existing village ponds with the support of line departments in the district. Facilitating the replication of the Farmers Group would promote horizontal mobilization and partnership among the farmers in the region. The village level farmers groups and networks would act as forum to prepare the farmers to encounter any future disaster, and respond effectively in the post disaster situations.

Summary and Conclusions

It is learnt that it is essential to develop generic as well as site-specific rehabilitation and mitigation measures in terms of suitable methods, techniques, structures, and community

based institutions. Also, the Participatory process mode adopted helped to ensure joint monitoring and output based planning and management.

Unexpected natural disasters like Tsunami, cause a great deal of damage to agricultural land and water bodies, which needs multi-stakeholder participatory diagnoses and suitable consensus. 'One size fits all' approach is not suitable, efforts and resources are not effectively used, and ultimately the purpose of reclamation is not achieved. Traveling workshop mode with spot measurements with multidisciplinary experts representing various organizations to provide area/regions specific guidelines covering multiple dimensions is appreciated as the good approach.

The analysis of soil quality parameters and close monitoring of the field situation indicates that though the soil quality has been improved since the Tsunami, the shallow water tables used for second annual crop or tree crops cultivation through small farm ponds, were salanized. The salinity affects the growth of crops and becomes un-potable. Hence studies are necessary to record the degree of damage on coastal aquifers and evolve suitable reclamation strategy.

As a long term strategy of improving the soil fertility it is essential to continue the practices like green manuring, leaching the excess salts, biofertilisers application wherever possible with vermicompost etc. Also, it should be seen as an opportunity to enhance the skill of the farmers on sustainable soil management.

The advantage of participatory approaches facilitates continuous need based skill building for men and women farmers, promotes an enabling environment and supports the sustainability of the activity.

It is Suggested to develop towards site specific Integrated Farming System to address the long-term livelihood security of the small and marginal farmers of the region. This could promote crop diversification (area specific) with the potential crops like sweet potato, *Gloriosa superba*, moringa, etc. Need to concentrate more on the introduction of tree crops as a risk management strategy to cope up with disasters like long drought season and heavy flood as well. Farm based allied enterprises like dairy, goat rearing, apiculture, agro-forestry etc need to be promoted with possible backward and forward linkages for effective resource utilization and to generate employment opportunities. Meeting the balanced fodder requirements of milch animals and stall fed goats, could reduce the dependency on open grazing and to overcome the problems like salinization of grazing lands, drought, flood etc. Effort should be

made to develop crop and livestock balance, livestock management is poor in many of the households which needs further strengthening.

It is well recognized that coastal vegetation as well as sand dunes mitigate the disasters like Tsunami, cyclone etc. Suitable multi-layered plantations could be jointly identified in consultation with local communities for planting, which would help sand dune stabilization. Strengthen the integrated drainage/irrigation system at the community level through desilting of all drainage/ irrigation canals to prevent the possible inundation and crop damage and loss.

Promotion of community seed banks, since the area is prone to different types of natural disasters there is a need to promote decentralized community based seed banks as a back up storage facility. It is realized gender differential knowledge exists pertaining on these traditional cultivars, hence it is important to collect women's knowledge exclusively and also involve women in the management of the seed banks in the future. Participatory breeding of saline and flood tolerant varieties needs to be developed focusing on the local germplasm.

To promote horizontal transfer of knowledge the participating farmers were mobilized in to groups in their respective villages. Need based linkages were established with banks for credit support and research stations and government departments for technical support. This would enable to gain access to existing government development programmes.

Based on our experience it is learnt that in the post disaster rehabilitation activities, the support extended by multiple actors in the field need to be continued till the normalcy in the quality of soil and water resources are restored.

Annexure I

Traveling Workshop on Agronomic Rehabilitation of Tsunami Ravaged Lands

In this situation, to understand the multi-dimensional nature of the problem and to develop soil health rehabilitation package a traveling workshop was organized from 16th to 18th July 2005 with multidisciplinary experts (Soil survey, soil testing, agronomy, soil science, livelihoods, natural resources, Plant breeding and genetics, Anthropology etc) from different parts of the country. The villages (indicated in the map 1. and given in the following table) were selected across the region to cover the different type and the range of the damage happened. Spot measurements for pH and EC were conducted in 18 fields and discussions were held with men and women farmers at five locations viz., Pushpavanam, Vellapallam, Thirukadaiyur, Neithavasal & T.S.Pettai in Nagappatinam and Cuddalore districts on 16th and 17th July 2005 and on 18th at Chennai the team discussed the observations and arrived at certain conclusions to address the field problems and recommendations for follow-up action.

S.No	Village	Block	District
1	Pushpavanam	Vedaranyam	Nagappatinam
2	Vellapallam	Thalainaiyiru	Nagappatinam
3	Manikapanku	Sembanarkovil	Nagappatinam
4	Kumarakudi	Sembanarkovil	Nagappatinam
5	Kalamanallur	Sembanarkovil	Nagappatinam
6	Neithavasal	Sirkazhi	Nagappatinam
7	Thirumullaivasal	Koolidam	Nagappatinam
8	T.S. Pettai	Parangipettai	Cuddlaore

I. Soil Reclamation

The soil as well as water sources were severely affected and the type and intensity of the damage to the soil varies across the affected area (see map). It can be broadly classified into four categories

1. Deposition of slushy grayish brown clay deposit

1. Dislocation and deposition of coastal sand and
2. Seawater intrusion, which receded (within 3 hrs to one week from the field) leaving salts in the field
3. Contamination of farm ponds, community ponds and other irrigation sources by seawater

(i) Deposition of slushy grayish brown clay deposit

This kind of damage was exclusively noticed in the southern parts of Nagapattinam district where the deposit thickness varies from 5cm to 50 cm height on wet and after drying it was 2mm to 50mm thick.

Problem of clay surface deposits

1. Crust formation leading to physical barrier for aeration and germination
2. High amount of salts leading to development of salinity
3. Danger of any toxic material (heavy metal)

The analysis shows that the chemical analysis of the deposited material is rich in organic matter (0.6 to 1.2 %), having good water holding capacity and cation exchange capacity with an Exchangeable Sodium Percentage of 55%. During the field visit (16th July 2005), the pH and Electrical Conductivity (EC) of the sediments, which are scrapped and heaped in the field is nearly 8.6 and 12.7 ds m^{-1} respectively.

The following table shows the heavy metal composition of the deposits (Annexure II)

Management of clay deposit

- The deposit can be mixed with soil by ploughing and it will improve soil texture especially of the surface soil, water holding capacity and soil fertility. The incorporation of deposited material will not act as physical barrier since it forms crack on drying and after mixing. The higher amount of salts will get leached down after the rainy season and thus it will not be a permanent source of salts, which could affect the root growth.
- In some of the farmer's fields the deposit was scrapped and kept in the field itself as heaps. It should be spreaded and incorporated into the soil to avoid the development of localized salinity.

ii. Deposition of sandy soils

This kind of damage is noticed in the mid and northern villages of Nagappatinam districts and southern regions of Cuddalore district. The thickness of the deposit varies from 2-5 cms. In many of the farmer's field the deposit was scrapped and heaped in the field itself. The analysis during 16th and 17th July 2005 shows the pH of nearly 6.5 and the EC of 8.3 ds m$^{-1.}$

Management of sandy soils

Need not be scraped, instead ploughed back in the field itself. Where ever the material has been collected and left in the field as small heaps, it should be spread again in the field and mixed with the soil, leaving as such in the form of heap will aggregate local salinity.

iii) Sea water entered and receded leaving salts

This kind of damage is noticed in few areas of Nagappatinam and Cuddalore districts. The seawater entered into the field directly as well as through backwater canals. The entered water receded with in a few hours (quickly) in some areas and five to seven days (slowly) in some other parts. Soil analysis shows that the soils have become salanised and not sodic and the soluble salts are dominated by Cl and SO4 and not by CO3 and bicarbonates. Hence during leaching the pH will not go up, ESP and EC will decrease simultaneously during the reclamation process. Different soil depth analysis indicate that the top 0-2 cm depth soil has an EC of 25-120 ds m^{-1} with a pH of 7.2 – 8.2. Hence leaching with sufficient amount of canal water or rainfall shall help to overcome the problem. Under the blanket recommendation of government, gypsum is supplied to the farmers irrespective of the kind of damage in their field.

Use of gypsum for redamation

- There is no need to have a blanket application of gypsum for reclamation in the entire affected areas. Gypsum application should be location specific i.e. where the pH is >8.5, ESP>15 and cases where during reclamation the pH increases. It should be followed purely on the basis of soil test results.

Alternatively, the gypsum supplied to the farmers could be used up to 500 kg per hectare to meet Calcium and Sulpur nutrition needs of oil seed crops like Gingelly and groundnut or rice @ 200 kg/ha.

Use of Organic Manure

Since the soils are sandy in texture, the practice is mono-cropping, have low amount of organic Carbon and farmers are encouraged to go for green manuring in addition to judicious application of FYM and compost etc and application of biofertilizers.

II. Contamination of small water ponds with sea water and deposits

Most of the small water ponds located in the fields which, are the source of irrigation for the second and third crop, were severely affected and at present it is saline in nature. Therefore it is suggested that

- Physical removal of contaminated water through tankers and connected pipelines and paving ways to recharge with monsoon rains
- Surface leaching thro rainfall and canal water
- Promoting rain water harvesting – household and farm ponds
- Desilting and interlinking drainage channels which facilities the easy flow of water

III. Cropping

1. Suitable Crops and Varieties suggested for the forth coming season

Tolerant crops / varieties have to be grown in the first year and the first crop should be preferably rice

- Rice - TRY 1, TRY (R) 2, CO 47, ADT 43 and ADT 36
- Ragi - TRY 1, Sunflower - CO 4, Groundnut - VRI 2
- Green gram (K 851, Pusa bold)
- Brinjal (PLR 1, AU 1), Cluster bean (Pusa Now bahar)
- Jack (Palur 1), Pomegranate (Ganesh), Sapota (PKM 1)
- Cashew (VRI 2 & 3), Amla (BSR 1) and Tamarind (PKM 1)

2. Specific agronomic practices for Rice

- Aged seedlings (one week more than normal age) may be planted
- Higher number (4 - 6 Nos.) of seedlings per hill may be planted
- 25% extra N at basal may be added
- Higher dose (40 kg/ha) of zinc sulphate has to be applied
- At panicle initiation and 15 days after, foliar spraying of DAP 2% along with 1% urea and 1% potash may be done for increasing the yield
- STL based P application or apply 15 kg P/ha as maintenance dose

- Sowing sprouted seeds 3 DAS under delayed canal water/excess rainfall

3. Application of FYM and Micronutrients: *Upto 12 t/ha may be followed for all the crops* and recommended dose of Zinc sulphate in alkali soils with pH above 8.5.

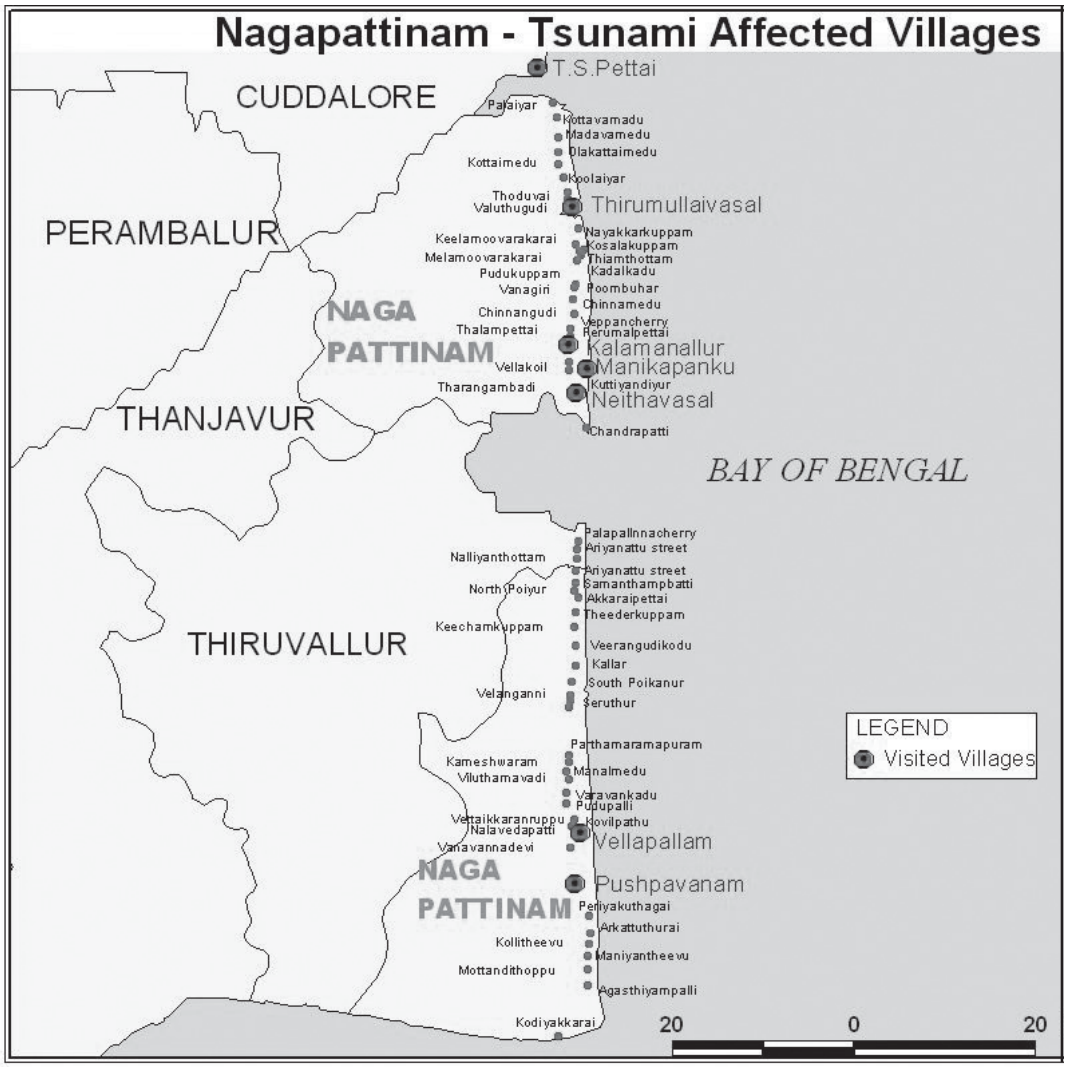
4. Introducing field specific suitable Integrated Farming System models *involving crop-animal combination with suitable animal breeds and allied enterprises*

5. *Crop diversification*: Promotion of horticulture and tree crops and value addition by primary processing of the produce

6. *Multiple Livelihoods:* There is a need to promote additional on-farm and non- farm enterprises like coconut based value added product preparations, apiculture, dairy, small growers poultry estates, cashew processing, production of biofertilizers and biopesticides etc with appropriate backward, lateral and forward linkages. This would promote multiple employment opportunities not only to the majority of small and marginal farmers but also to the landless labourers who also form a sizable part of the local population and who have lost their livelihood opportunities.

Names of the Participating Organizations in the Traveling Workshop

1. Central Soul Salinity Research Institute, Karnal
2. Indian Agricultural Research Institute, New Delhi
3. National Bureau of Soil Survey and Land Use Planning, Regional Centre, Bangalore
4. ICRISAT, Hyderabad
5. Central Salt and Marine Chemicals Research Institute, Bhavnagar
6. National Institute of Oceanography, Goa
7. Tamil Nadu Agricultural University, Adhuthurai and Trichy
8. State Department of Agriculture, Joint Director of Agriculture (Nagapattinam and Cuddalore)
9. M.S.Swaminathan Research Foundation
10. NGOs Coordination Committee, Cuddalore


Nagapattinam - Tsunami Affected Villages
CUDDALORE
PERAMBALUR
NAGA PATTINAM
THANJAVUR
THIRUVALLUR
NAGA PATTINAM
BAY OF BENGAL
T.S.Pettai
Palaiyar
Kottavamadu
Madavamedu
Olakattaimedu
Kottaimedu
Koolaiyar
Thoduvai
Valuthugudi
Thirumullaivasal
Nayakkarkuppam
Kosalakuppam
Thiamthottam
Kadalkadu
Poombuhar
Chinnamedu
Veppancherry
Kalamanallur
Manikapanku
Neithavasal
Chandrapatti
Keelamoovarakarai
Melamoovarakarai
Pudukuppam
Vanagiri
Chinnangudi
Thalampettai
Rerumalpettai
Vellakoil
Kuttiyandiyur
Tharangambadi
Palapallnnacherry
Ariyanattu street
Nalliyanthottam
Ariyanattu street
Samanthampbatti
North Poiyur
Akkaraipettai
Theederkuppam
Keechamkuppam
Veerangudikodu
Kallar
South Poikanur
Velanganni
Seruthur
Parthamaramapuram
Kameshwaram
Viluthamavadi
Manalmedu
Varavankadu
Pudupalli
Vettaikkaranruppu
Nalavedapatti
Kovilpathu
Vellapallam
Vanavannadevi
Pushpavanam
Periyakuthagai
Arkattuthurai
Kollitheevu
Maniyantheevu
Mottandithoppu
Agasthiyampalli
Kodiyakkarai
LEGEND
Visited Villages
20
0
20

Annexure II

Analysis of Soil Sample for Heavy Metals

Introduction: Soil quality assessment is the process of measuring the suitability of the soil for the intended use. The ultimate purpose of assessing soil quality is to provide the information necessary to protect and improve long-term agricultural productivity, water quality, and habitats of all organisms, including humans. Metal contaminated soil poses a number of problems, threatening the food chain and groundwater supplies, as well as rendering the land unusable for humans and unsafe for wildlife. The usual source of contamination is industrial and solid waste dumping sites. In this study, an unusual sample, clay deposits from Tsunami waves on to agricultural lands is analyzed. The main objective of this study is to estimate the concentration of heavy meatals such as Chromium, Lead, Zinc, Copper, Nickel, Cadmium and Mercury present in the clay deposits from Tsunami waves.

Methodology: For analysis, the heavymetal ions have to be extracted from the solid phase into the liquid phase. Extraction was done by acid digestion with 3% HNO_3. One gram of a representative soil sample was pulversied and taken in a conical flask. 25 ml of 3% HNO_3 acid was added and stirred for one hour in a mechanical shaker. The heavy metals leach out from the solid phase to the liquid phase. The leachate was filtered through Whatman filter paper No. 40 and made up to known volume with distilled water. The fltrate was analysed for heavy metal concentration. The instrument used for the analysis was Atomic Absorption Spectrophotometer, Perkin Elmer, USA, Model Analyst 800 (Graphite Mode).

Results: Heavy metals concentration in the extracted liquid were analyzed, and the results are given in Table1. The concentration of Mercury, Nickel, Zinc, Chromium and Cadmium are comparitvely less than that obtained for other metals like Copper and Lead. For comparison, the permissible standards prescribed for composts applied to agricultural land have been used. The results have been compared against both Indian and USEPA standards.

Table 1. Test Results for Agricultural Soil Sample

S.No	Parameters	Results mg/kg	Indian Compost Standards*	USEPA Compost Standards**
1	Copper as Cu	99.8	300	1500
2	Chromium as Cr	35.5	50	1200
3	Zinc as Zn	32.5	1000	2800
4	Nickel as Ni	12.0	50	420
5	Lead as Pb	56.0	100	300
6	Cadmium as Cd	31.0	5	39
7	Mercury as Hg	ND	0.15	17

All the values are expressed in mg/kg
ND = Non detectable
** MSW (Management and Handling) Rules, 2000*
*** US Composing Council, 1997*

Condusion

The concentration of the heavy metals tested was below the permissible limits except for Cadmium. Although it does not meet Indian compost standards, it does meet the USEPA standards. Mercury concentration was below the detectable limits, which is well below the Indian permissible limits.

References

4. Municipal Solid Wastes (Management and Handling) Rules, Ministry of Environment and Forests, Government of India (2000)

   US Composting Council, "Test methods for the examination of composting and compost (Interim Draft)", Bethesda, Maryland (1997)

Annexure III
Soil Test Results of Participating Farmers Field

1. Aanaikovil, Manikkapangu, Tarangambadi, Nagapattinam

No	Name of the Farmer	EC(dSm-1)			PH		
		Oct 05	Dec 05	Apr 06	Oct 05	Dec 05	Apr 06
1	Mr. V. Gopalakrishnan	0.21	0.15	4.00	7.7	8.30	8.20
2	Mr. A. Balaiyah	1.06	0.32	6.03	7.7	6.73	8.05
3	Mr. S. Baskaran	0.36	0.26	1.57	8.7	7.32	6.35
4	Mr. K. Senthilkumar	0.15	0.19	1.50	6.9	7.46	8.08
5	Mr. N. Ramakrishnan	0.30	0.21	0.84	8.4	5.66	8.64
6	Mrs. K. Parvathi	0.18	0.42	6.00	8.2	7.73	8.34
7	Mr. S. Sankar	0.32	0.30	2.78	9.1	7.46	7.38
8	Mr. P. Jayaraman	0.49	4.13	4.06	8.6	6.98	8.02
9	Mr. M. Kaliyaperumal	0.15	2.60	4.86	8.8	7.98	7.32
10	Mr. D. Arumugam	0.73	0.25	3.66	7.6	8.12	8.46
11	Mr. V. Mohanasundram	1.1	0.31	5.88	8.1	8.26	8.01
12	Mr. V. Sugumaran	0.2	1.70	1.17	8.1	8.30	7.38
13	Mr. Shanmugam	0.44	0.60	0.80	7.1	7.72	5.10

II. Neithavasal, keelaiyur, sirkali, Nagapattinam

S. No	Name of the Farmer	EC (dSm - 1)			PH		
		Oct 05	Dec05	Apr 06	Oct 05	Dec 05	Apr 06
1	Mr. Ponnambalam	1.65	0.77	1.06	7.3	6.63	7.67
2	Mr. Palaniyandi	0.23	0.65	1.46	8.2	6.71	7.19
3	Mr. Thangappan	1.23	0.75	1.08	8.0	6.78	7.24
4	Mr. Pitchaikannu	3.3	1.59	1.65	7.4	7.82	7.45
5	Mrs. Uma	3.6	1.57	1.40	6.9	7.86	8.00
6	Mr. Balasundram	1.41	0.83	1.34	6.9	6.53	7.66
7	Mr. Rajeshkanna	0.36	0.60	1.04	8.3	6.80	7.42
8	Mr. Bharathiraja	1.02	0.79	1.20	7.2	6.90	7.56
9	Mr. Sounderrajan	2.29	1.39	1.43	7.6	7.97	7.84
10	Mr. Selvam	0.56	0.69	1.24	8.2	7.09	7.80

III. Vellappallam, Vedharanyam, Nagapattinam

S. No	Name of the Farmer	EC (dSm - 1)			PH		
		Oct 05	Dec 05	Apr 06	Oct 05	Dec 05	Apr 06
1	Mr. G. Thangavel	1.10	0.313	1.58	6.3	8.26	8.14
2	Ms. Selvi	0.70	0.303	0.91	6.4	7.46	8.75
3	Mr. Sathayamoorthy	0.45	0.246	1.1	6.8	8.12	8.43
4	Mr. N. Krishnamoorthy	0.68	0.320	1.27	7.3	6.73	8.52
5	Ms. Thilagavathy	0.50	0.602	1.66	7.2	7.72	8.20
6	Mr. Shanmugavel	1.35	2.60	0.83	6.6	7.98	8.03
7	Mr. R. Thangavel	2.09	0.260	1.27	6.6	7.32	8.05
8	Mr. C. Lakshmanan	1.25	0.186	3.60	6.5	7.46	8.44
9	Mr. M. Mariyappan	1.19	0.206	0.89	6.9	7.66	8.10
10	Mr. M. Ramachandran	0.72	0.206	0.86	7.8	8.33	8.10
11	Mr. K. Perumal	3.54	1.703	1.72	6.9	8.02	8.34

IV. Vettaikaraniruppu, Vedharanyam, Nagapattinam

S. No	Name of the Farmer	EC (dSm - 1)			PH		
		Oct 05	Dec 05	Apr 06	Oct 05	Dec 05	Apr 06
1	Mr. Vijayaragavan	1.06	0.650	0.80	6.9	6.71	8.16
2	Mr. A. Thirunavukarasu	0.38	0.830	0.66	6.8	6.53	8.52
3	Mr. C. Balakrishnan	0.42	1.57	0.99	7.3	7.86	8.18
4	Mr. C. Rajasekaran	1.06	0.600	0.68	6.9	6.80	8.33
5	Mr. T. Govindasamy	0.62	0.785	1.06	7.0	6.90	8.20
6	Mr. C. Kalaiselvan	0.22	0.773	0.72	7.2	6.63	8.30
7	Mr. C. Thamaraiselvan	0.10	0.753	0.86	7.6	6.78	8.42
8	Mr. N. Sivaguru	0.32	0.686	0.90	7.9	7.09	8.28
9	Mr. Jeyamurugan	0.18	1.590	0.98	6.7	7.82	8.56
10	Mr. Muthukrishnan	0.16	1.394	0.90	7.5	7.97	8.78

Annexure IV

Monitoring at benchmark sites for the natural resources.

Repeated soil samples and spot analysis for pH and EC in the selected fields (bench mark sites) over three times indicate that the soil quality has come back to the normal situation. The following table shows the changes in the soil pH and electrical conductivity over the period of time since the tsunami damage. Due to the high amount of rainfall during the North East Monsoon the soil pH and soluble salt contents has been reduced in all the sites except in Pushphavanam village where the soil pH increased during summer 2006. As most of the soils are sandy with very low or no clay content the possibility of sodium being retained in the exchange sites (Exchangeable sodium percentage [ESP]) is remote. Also there is no possibility of development of soil alkalinity /sodicity due to excessive leaching as sodium chloride readily dissolves in rain water and the sandy nature of soil permits infiltration and percolation of saline water into the ground water. During monsoon seasons, if the good quality ground water which floats over saline water in coastal regions (separated by an impervious layer of clay barrier) is not over exploited, there will always be a water current running towards sea, which will carry away the leached salts towards sea. Seasonal fluctuations in soil and ground water salinity (EC) are common phenomenon in coastal regions. The observations made after monsoonal rains confirms this.

No	Bench mark site	Type of damage	Soil depth (cm)	EC			pH		
				July 2005	Jan 2006	April 2006	July 2005	Jan 2006	April 2006
1	Pusphavanam	Clay	15	3.36	0.94	0.05	7.73	7.58	9.22
	Field I	deposit	30	-	0.17	0.30	-	8.11	8. 5
2	Field II	Clay	15	3.30	0.14	0.45	8.60	7.74	9.12
		deposit	30	-	0.42	1.17	-	8.34	8.46
3	Field III	Clay	15	0.30	0.37	0.46	7.80	6.75	7.45
		deposit	30	-	0.06	0.77	-	6.60	7. 51
4	Vellapallam	Clay	15	4.92	0.02	0.93	8.60	6.85	8.04
		deposit	30	-	0.05	1.02	-	7.19	8.20
5	PR Puram	Clay	15	2.46	0.48	0.78	8.24	0.63	8.63
		deposit	30	-	0.36	0.64	-	0.68	8.13
6	Anaikovil	Sea water	15	23.00	0.14	4.06	7.24	6.92	8.02
		stagnation	30	-	0.16	8.28	-	7.32	8.72
7	Neithavasal	Sea water	15	0.8	0.16	1.46	7.20	5.87	7.19
		stagnation	30	-	0.14	1.00	-	4.81	7. 50
8	Vellapallam,	Sand	15	0.64	0.82	0.04	7.20	6.80	6.40
	Neithavasal	deposit	30	-	0.78	0.02	6.84	6.46	5.90
9	Thirumullai	Sand	15	0.31	0.12	0.06	6.20	6.70	6.24
	vasal	deposit	30	0.55	0.04	0.01	4.60	5.60	5.80
10	TS pettai	Sand	15	11.84	0.86	1.02	6.94	6.80	6.42
		deposit	30	5.74	0.13	0.86	8.14	6.78	6.48

[1] *Soil Survey Report of Tsunami affected area in the coastal belt of Nagapattinam District*

Tsunami damage in the Agricultural fields

Paddy field

Groundnut field

Palmyra tree

Cashew tree

Agronomic rehabilitation - Major interventions
Soil management


Traveling workshop


Heap of clay encrustation


Spot measurement


Application of vermicompost

Water management

Tsunami affected farm pond

Removing the saltwater and desiltation

Desilting the irrigation canal

Imundated Paddy field

Traditional irrigation method

Pedal pump - Gravity drip irrigation method introduced

Crops in the Tsunami affected field

Paddy traditional land race - Kulivedichan

Paddy - High Yielding Variety

Groundnut

Sweet potato

Training, Capacity Building and Farmers groups

Production of Arbuscular Mycorrhiza

Pest management in the Paddy field