Sustainable Coastal Livelihood: Integrated Mangrove Fishery Farming System (IMFFS)

Final Report (October 2008 to December 2009)

1.0. Introduction:

Livelihood security of the coastal communities and ecological security of the coastal zones of India are under stress due to high population density, urbanization, industrial development, high rate of coastal environmental degradation, and frequent occurrence of cyclones and storms. This made more than 100 million people, who directly or indirectly depend on coastal natural resources for their livelihood security. The problem is going to be further aggravated by increase in sea level rise due to climate change. An estimate indicates that the predicated sea level rise would lead to inundation of sea water in about 5700 km^2 of land along the coastal states of India and nearly 7 million coastal families could be directly affected due to such inundation[1]. Farming families and fishers, fish farmers and coastal inhabitants will bear the full force of these impacts through less stable livelihoods, changes in the availability and quality of fish, and rising risks to their health, safety and homes. Many fisheries-dependent communities already live a precarious and vulnerable existence because of poverty, lack of social services and essential infrastructure. The fragility of these communities is further undermined by overexploited fishery resources and degraded ecosystems

However, the projected increase in sea level rise and consequent salinization of land provide opportunity to increase fish production through aquaculture. It is predicted by the Coastal Zone Management Subgroup of the Intergovernmental Panel on Climate Change that in many coastal areas people would modify landuse pattern and subsystems to ensure that such changes take care of new threats such as salinization and flooding due to climate change. One of the major landuse change predicted is conversion of saline affected agriculture lands into aquaculture farms[2].

[1] Aggarwal, D and M.Lal, 2001. Vulnerability of Indian Coastline to sea level rise. Paper published by Centre for Atmospheric Sciences, Indian Institute of Technology New Delhi, New Delhi.

[2] IPCC, 1990. Report of the Coastal Management Subgroup: Strategies for adaptation to sea level rise.

However, the current situation of aquaculture in India warrants a more responsible and sustainable aquaculture systems and practices. Development and demonstration of new approaches such as seawater/brackish water based integrated agro-aqua farming system would not only ensure livelihood security of the poor coastal families and ecological security of the coastal areas but also enhance adaptive capacity of coastal communities to sea level rise and climate change.

2.0 Current scenario in coastal aquaculture in India

In India, aquaculture mainly the coastal land based shrimp farming - otherwise called prawn farming - emerged as an important sector of fisheries in late 1980s and it is characterized by small-scale family-operated farms. Currently more than 1.5 lakh farmers are growing prawns in about 1.6 lakh hectares of brackish water areas both on the east and west coasts of the country.[3] During early phase of prawn farming, semi-intensive culture system was followed, which increased prawn production at the rate of 8.4% per year till mid 1990s. Since then coastal aquaculture has suffered setbacks in terms of production, value and acreage.

If Andhra Pradesh alone is taken as a case study, shrimp farms occupied only 6000 ha in 1990 which rose to about 78 702 ha in 2000. Out of these about 75% of the total area is owned by small farmers with less than 2ha farm holding (59 175 ha); 8.0 % of the area is in farm holdings of 2 to 5 ha (5 811 ha); 17 % in farms of larger than 5.0 ha[4]. The average rate of shrimp production was above 1000 kg per ha during 1993-1994, which dropped to about 630 kg per ha in 1998-2000. Out of the total 78 702 ha, 75 625 ha (96%) is based on brackishwater/ estuarine creeks and 3 077 ha (4%) is based on sea.

Monoculture, disease, poor seed quality, excessive use of artificial feed, increased input costs and decreased market value are considered as important factors for such decline in aquaculture production. Above all, poor environmental management and lack of different activities to diversify livelihoods within the aquaculture farming system is also responsible for the current status of coastal

[3] Businessline: 2007 India may be first to produce certified organic scampi**;** _http://www.blonnet.com/ bline/2007/05/15/ stories/2007051500871200.htm

[4] http://aquaculture.nic.in/pdf/FAO%20Aqua-book1-40.pdf

aquaculture in India. In 1996, Supreme Court of India banned semi-intensive and intensive type of shrimp farming but allowed traditional or improved traditional system of shrimp farming. All these resulted in abandoning of shrimp farming in thousands of hectares both by small farm holders and corporate farming groups. According to MPEDA (2007-2008) in Andhra Pradesh alone about 29000 ha of shrimp farms have been abandoned. In Tamil Nadu, shrimp farm were developed in about 6335 ha of which farms in about 3500 ha is abandoned.

The social impact of decline in prawn farming is enormous. Many of the farmers, who converted their agriculture land into aquaculture farms, are now getting no income either from agriculture or from aquaculture; many of these families now migrate either temporarily or permanently in search of employment and livelihood. In this situation, Integrated Mangrove Fishery Farming System, wherein cultivation of mangroves, halophytes (salt-loving plants) and culture of fish, crab and prawn are integrated, provides some tangible solutions to make coastal aquaculture sustainable and also strengthen resilience of coastal communities. This also provides opportunity to integrate livelihood and mangrove bioshield. Keeping this as mind, MSSRF started developing and demonstrating IMFFS model in 2006 with the support of a private shrimp farmer and details of this model is given below.

3.0 Previous MSSRF model of Integrated Mangrove Fishery Farming System

3.1 Conceptual framework

Most of these prawn farms in India are rectangular shaped earthen ponds of about 1 ha in size and a cluster of farm contains about 5 to 20 such ponds. They are pump-fed – brackish water is periodically pumped in and out of the ponds to maintain water quality - and a kind of semi-intensive type of culture system is followed. Hatchery produced post larvae of prawn are transferred to ponds where they are fed with artificial feed until they reach marketable size, which takes about four to six months. As a result of this practice, inputs cost is always high and artificial feed increase organic load leading to pollution.

In the Integrated Mangrove Fishery Farming System, earthen ponds are designed in such a way to provide space for growing saline-tolerant vegetations including mangroves and halophytes. Space for planting is created by constructing

bunds inside the pond in a zigzag manager or as small mounds as shown in Fig 1 and 2.

Fig 1: Hypothetical design of a seawater based integrated agro-aqua farming system with inner bunds

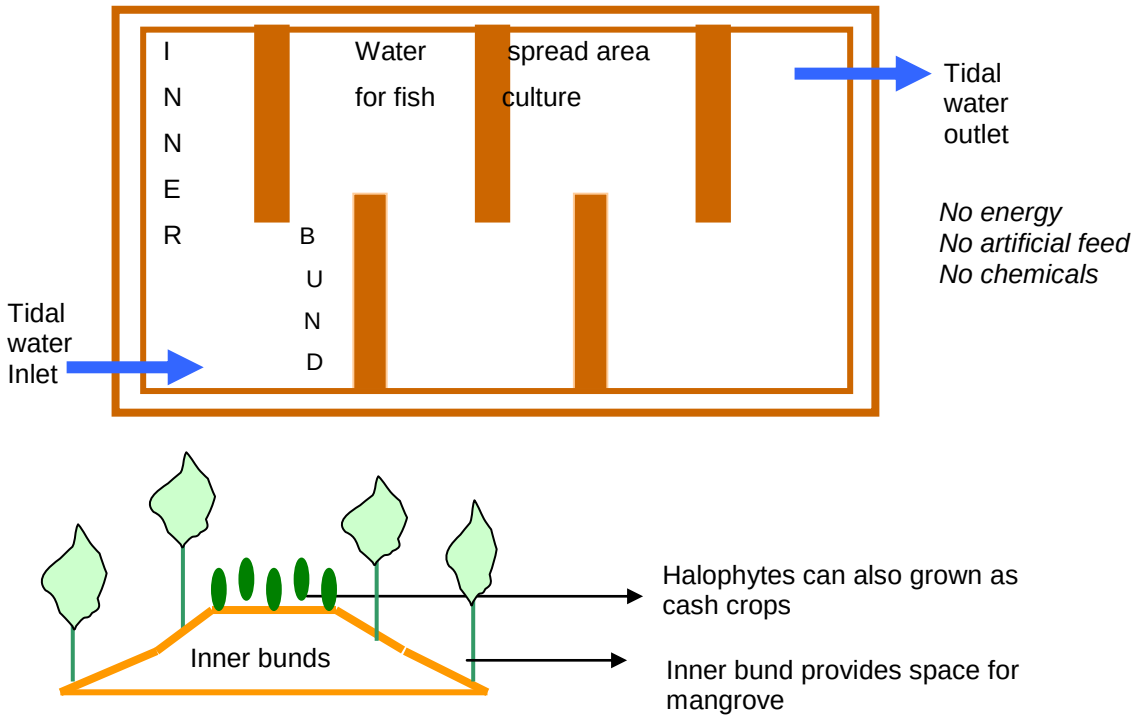
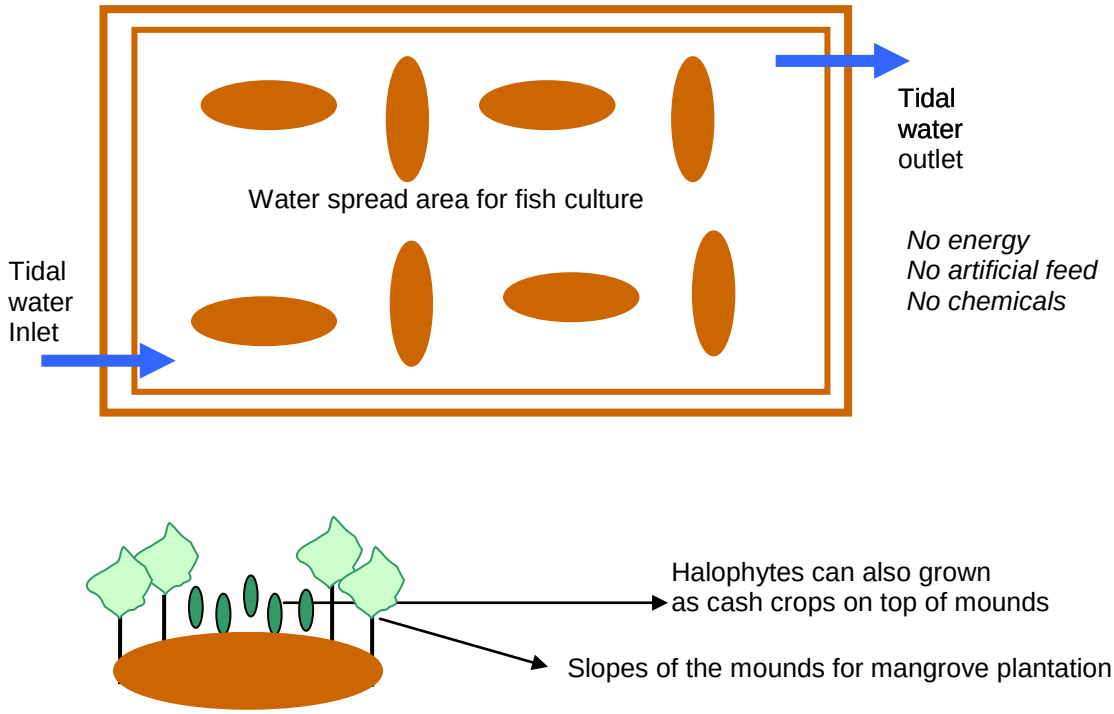


Fig 2: Another design of the seawater based integrated agro-aqua farm with earthen mounds



These bunds and mounds are created by digging the soil from the bottom of the pond. As a result of this, the pond becomes deeper and bottom level goes below the tidal level. Due to this, tidal water enters the pond during high tide and drain out during low tide by gravitation. The pond can be made deeper to allow 3 to 4 feet of water remain in the pond as standing water for fish culture. The tidal water inlet and outlet are established at opposite ends of the farm or a single structure can be used both as inlet and outlet. The ponds are designed in such a way that nearly 30 to 35% of the space is left for planting mangroves and halophytes whereas remaining 70 to 65% is left for holding seawater for fish culture.

3.2 Advantages of Integrated Mangrove Fishery Farming System

In IMFFS ponds, mangrove trees can be grown along the inner and outer bunds and mounds. On top of the bunds, halophytes such as *Sesuvium* or *Salicornia* or any other commercially valuable salt-loving plants can be cultivated. Fish can be grown in the water spread area. The mangrove plants, when they grow as trees in about 4 to 5 years, will act as a bioshield. They also provide necessary nutrients and feed to fish/crab/prawn growing in the pond. The matured leaves, twigs and other plant matter, which fall into the water, will degrade and release nutrients and result in the formation of detritus (finely decomposed particle). These detritus particles become substrate for bacteria and fungal to grow and they convert nitrogen present in the detritus into protein. In addition, a variety of enzymes, are also produced during the process of decomposition. The presence of nitrogen, carbon, protein, enzymes, and fungi increase the nutritive value of the detritus. Both crabs and prawns nourish Detritus and thus, they get naturally balanced feed. Thus, IMFFS ponds are ideal for extensive culture of fish, prawn and crabs. Many halophytes, which are salt loving plants, can be grown as commercial crops on top of the bunds and can be harvested periodically for marketing. In the water spread area, initially fish and prawn can be grown together and later crabs can be cultivated.

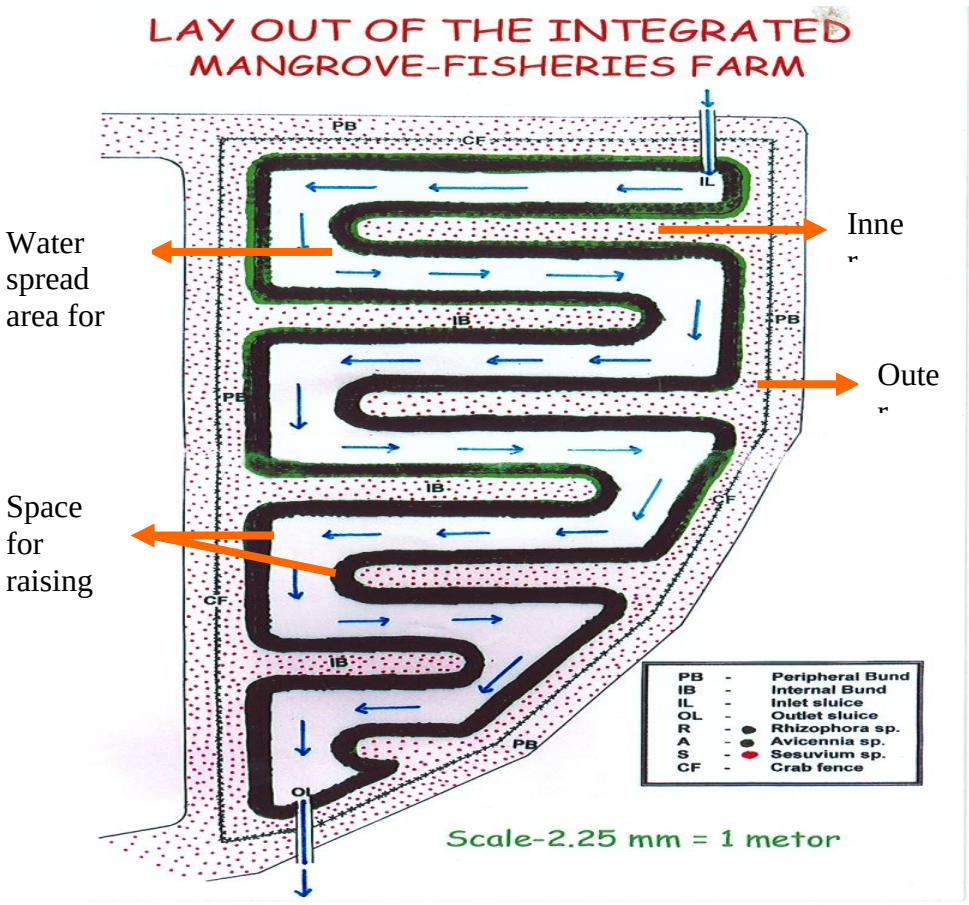
Another advantage in Integrated Mangrove Fishery Farming System is that only very limited energy is required for operation. Since water is exchanged daily by tides through gravitation pumping water in and out of the ponds to maintain water quality is not required. There is also no need to use aerator for increasing oxygen content of the water. Secondly, daily exchange of water brings in lot of fresh food in

the form of planktons (microscopic plants and animals that float and drift in large numbers in sea and brackish water) to the pond. This avoids using artificial feed. Zero use of energy and artificial feed greatly reduces input cost and also avoid environmental pollution.

3.3 Model IMFFS

In order to test the above hypothetical model, an Integrated Mangrove Fishery Farming System was started in the year 2006 in partnership with a private entrepreneur and local community in Puliyanthurai region of Nagapattinam District. This farm occupies an area of about 1 ha. This farm has physical provisions in the form of inner bunds as shown in **Fig 3** to grow mangrove plants and halophytes and enough water spread areas to culture fish, prawn and crabs

Fig 3: Design of the Integrated Mangrove Fishery Farming System started in 2006



Mangrove plantation*:* A total number of 1723 *Rhizophora* saplings, and 327 *Avicennia marina* saplings were planted during February 2006. *Rhizophora* saplings were planted in two rows along the lower edges of the bund whereas *Avicennia* saplings were planted about 2 m above the *Rhizophora* plantation. Both *Rhizophora* and *Avicennia* were planted at 5 m intervals in a row. At the end of November 2009, all *Rhizophora* and *Avicenna* saplings are found surviving and *Rhizophora* reached an average height of 2.26 m with about 46 stilt roots. *Avicennia* reached a height of about 1.69 m with more than 60 aerial roots.

Halophyte plantation*:* A succulent halophyte namely, *Sesuvium portulucastrum*, which has commercial potential as a component of salads, was planted on the top and sides of the bunds in January 2007. Stem cuttings of about 15 cm in length were planted at an interval of 1m. The fresh weight of the plantation, measured at monthly intervals, showed that values increased from 542 g/m^2 in September 2007 to 1132 g/m^2 in January 2008 and about 1344 g/m^2 in April 2009. Observation indicates that the growth of this plant reaches its peak only during the northeast monsoon season.

Fish culture: Culture of the commercially important fish *Lates calcarifer* (sea bass) was started in the farm during September 2007. About 2500 fingerlings, each about 2.5 cm long, were purchased from the Rajiv Gandhi Research Foundation, Thoduvai, as availability of fingerlings in the wild was limited. They were kept in large bags made of fine nylon net (*happa*) in the farm water itself for acclimatization, but survival of the fingerlings at the end of three months was only about 9%. This was due to the small size of the fingerlings, which could not adapt themselves to the environmental conditions existing in the farm. In the next attempt, 500 fingerlings of 8 cm length were purchased in December 2007 and again acclimatized in the farm itself. At the end of January 2008, nearly 85% of the fingerlings survived and reached a length of 13 cm. They were released into the farm in February 2008. Totally, 125 kg of sea bass was harvested in October 2008, along with about 161 kg of other fishes such as milk fish, mullets, tilapia and prawns. Overview of this IMFFS farm, mangrove plantation, halophytes and fish harvested from the farm is shown in **Fig. 4**

Fig 4: A view of the Integrated Mangrove Fishery Farming System developed in a saline affected area in April 2007

A view of the IMFFS farm in October 2009

Exposure visits organized regularly to fishing and farming communities and private shrimp farmers

Harvesting fish in the IMFFS pond (Oct.2008)

Harvested sea bass fish

3.4 Weakness of the model

One of the major weaknesses of this model is that initial cost is relatively high. Secondly, this model is developed without the participation of local community and hence, their inputs in design, construction and operation of the farm could not be included. It is felt that local people's participation would have reduced the initial cost to some extent. Thirdly, application of this model in restoring abandoned shrimp is yet to be tested. To overcome these shortcomings, the present project was taken up.

4.0 Goal and objectives of the present project

4.1 Goal

The overall goal of the project is to develop and demonstrate community-based brackish water farming system that link the livelihood security of the coastal communities and the ecological security of the coastal areas in a symbiotic manner.

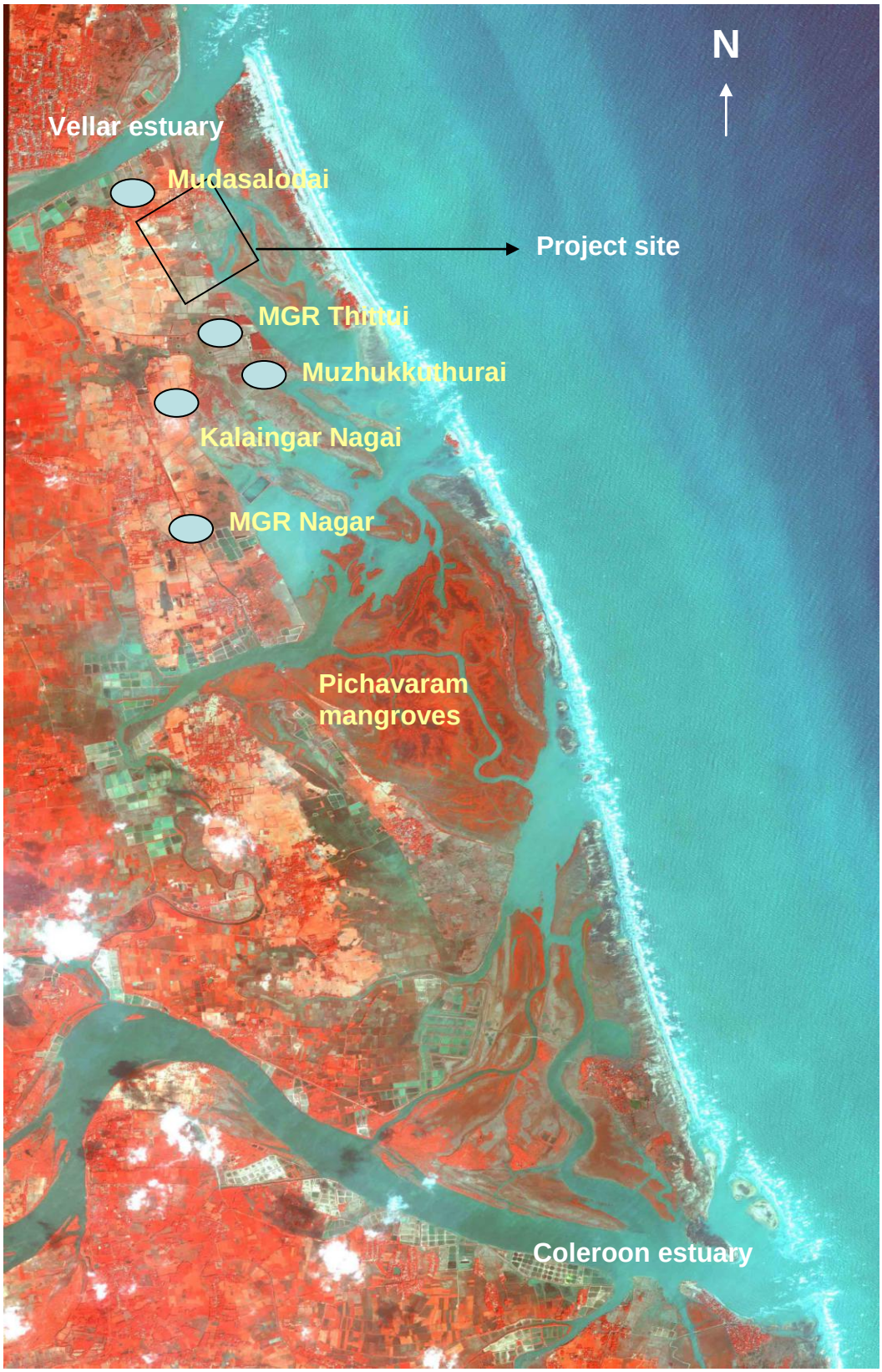
4.2 Objectives

1. To create awareness among the local community and other stakeholders about current status of coastal livelihood and need for creating alternative and or additional natural resource based income generating activities
2. To demonstrate a brackish water and mangrove based farming system that provide direct income to the poor fishers without damaging the coastal environment
3. To enhance the capacity of the local community, women groups, Panchayats and local NGOs and government agencies in developing integrated mangrove-fishery faming system through orientation and training
4. To raise and address issues relating to policy support needed adapting integrated mangrove-fishery faming system for replication under various government developmental schemes

5.0. Project Site:

The project site is located in the southernmost part Cuddalore District in Tamil Nadu. A large estuarine system called Vellar-Pichavaram-Coleroon estuarine complex is situated in this region **(Fig 5).** A mangrove wetland called Pichavaram mangrove (Reserve Forest and under the control and management of the Tamil Nadu Forest Department), which occupies an area of about 1400 ha is located in the middle portion of this estuarine system. It is connected to Vellar estuary in the north and Coleroon

Fig.5 Map showing Vellar-Pichavaram-Coleroon estuarine complex, project site and project villages



estuary in the south through backwater canals. In this estuarine region, a total number of 9 fishing hamlets are located within a distance of about 2 km from the sea. Around the Pichavaram mangroves, small-scale shrimp farms mainly owned by individual farmers were started in large scale during early 1990s. A kind of semi-intensive type of farming was followed in these shrimp farms. However, most of the farms were facing recurrent loss mainly due to disease, increased input cost and poor environmental management. In 1996, the Supreme Court of India banned semi-intensive and intensive type of shrimp farming. Because of all these reasons, many of the shrimp farms in this area were abandoned. Since the area is prone to tidal water inundation and both soil and ground water is saline these farms could be reclaimed for any other land use. Following the approval of the project, a rapid feasibility study was conducted in the entire Vellar-Pichavaram-Coleroon region to select suitable site for Integrated Mangrove Fishery Farming System. In the feasibility study the following factors were taken into consideration:

a) land should be outside the Pichavaram Reserve Forests
b) willingness of the community living around the site to participate in developing and managing IMFFS and
c) ownership of lands (government land that is classified as wasteland is preferred to privately owned land)

Though Integrated Mangrove Fishery Farming System can be raised both north and south of Pichavaram Reserve Forest, only the northern part is being covered in the project because of the presence of more number of settlements with high population density in this region and interest shown by the community.

6.0 Project hamlet

6.1 Selection of project hamlets

Between Vellar estuary in the north and Pichavaram Reserve Forest in the south five fishing hamlets namely, Muzhukkuthurai, MGR Thittu, MGR Nagar, Kalaingar Nagar and Mudasalodai are present. Except Kalaingar Nagar, all other villages are part of the project and these villages are selected based on their willingness to participate actively in developing and managing Integrated Mangrove Fishery Farming System. All the four project hamlets suffered damages during the tsunami. A large number of abandoned prawn farms are present between Mudasalodai

in the north and MGR Thittu village in the south. Many of these farms are owned by fishing families of the Mudasalodai and they developed these farms in government wasteland.

6.2 Profile of the project hamlets

Profile of the four project villages is developed based on the information collected from the villagers as well as from secondary data such as records of the village administrative officers.

Profile of Mudasalodai

- Mudasalodai (with two sub-hamlets namely Nadu Mudasalodai & Vadakku Mudasalodai) is one of the fishing hamlets of the Killai Panchayat
- It is located 25 km east of Chidambaram
- Total number of household is 235 and total population is about 1175
- The primary livelihood of the families is fishing
- 75% of the families are engaged in fishing in the sea and remaining 25% in the backwater. Some of the fishers own fish trawlers
- Totally 96 (41%) women in this village are engaged in fish vending in nearby towns by head loads
- 80% of the people in the village are literate. Most of them are studied up +2, only 20% are illiterate
- One of the traditional leaders has raised mangrove plantation in about 3 to 3.5 ha, which was affected by recent tsunami.

Profile of MGR Thittu

- M.G.R Thittu is another fishing hamlets of the Killai Special town Panchayat, located 15 km away from Chidambaram.
- Total number of household is 159 and total population is about 795
- The primary livelihood of the families is fishing
- All the families in the M.G.R Thittu are engaging fishing only in the sea water. No fishing activities in the mangrove water.
- 45% of the fishing women are engaging in fish marketing nearby towns by head loads.

- Some of the families have raised casuarinas and coconut plantation in the beach. Since the land belongs to government these families have legal ownership on these plantations
- One fishing family is having a prawn farm but could not grow prawn and crab on commercial scale successfully
- According to Fisheries Department, Govt. of Tamil Nadu (2000), 34% of the people are literates. Primary education -71 persons, High school 201, Higher secondary 01, total literates is 273.
- As in the case of Muzhukkuthurai, all the families in MGR Thittu have got new houses, which are built in a well designed settlement.
- All the families now got Fiberglass reinforced boats, which are having outboard motor engines.

Profile of Muzhukkuthurai

- Muzhukkuthurai is one of the fishing hamlets of the Killai Special town Panchayat, located 15 km away from Chidambaram.
- Total number of household is 161 and total population is about 805
- The primary livelihood of all the families is fishing. Nearly 90% are engaged in fishing in the sea and others fish in Pichavaram mangrove water. Before tsunami only a 10 families had fiberglass reinforced boats but the number of FRB have raised considerably
- 60% of the fishing women are engaged in fish marketing in nearby towns by head loads.
- According to the Department of Fisheries (2000), 37% of the people are literate: Primary education - 70 persons and High school - 212 persons
- All the families now got new houses and their new settlement is well designed and it is located just next to the old settlement
- All the families now got Fiberglass reinforced boats, which are having outboard motor engines.

Profile of MGR Nagar

- MGR Nagar is one of the fishing hamlets of the Killai Special town Panchayat, located 13 km away from Chidambaram.

- Total number of household is 132 and total population is about 705
- The primary livelihood of all the families is fishing. Nearly 96% are engaged in fishing in the sea and others fish in Pichavaram mangrove water. 80 country boats were used for fishing
- 50% of the fishing women are engaged in fish marketing in Pichavaram by head loads.
- According to the Department of Fisheries (2000), 40% of the people are literate:
- All the families now got new houses and their new settlement is well designed and it is located just next to the old settlement

7.0 Project Components

7.1 Component: 1 Stake holder Mobilization and Organization

a) Stakeholders identification

The following are the stakeholders identified for the present project (Table 1).

Table 1: Major stakeholder and their roles and responsibilities

Major Stakeholder	**Roles and responsibilities**
Local fishing community and community based organizations such as traditional Panchayat, Youth groups and women groups	• Assessing ecological, economical and social suitability of the IMFFS model • Participating in the design and implementation of the project • Assessing socio-economic benefits of the IMFFS model
Tamil Nadu Fisheries Department	• Assessing technical viability of the project • Assessing ecological, economical and social viability of the project • Extension of the technique, if appropriate
Tamil Nadu Forest Department	• Providing mangrove propagules • Assessing technical and ecological benefit of the project • Identifying suitable area for extension
Tamil Nadu Revenue Department	• Providing land for demonstration • Providing land for extension
Local NGOs	• Assessing environmental, ecological and social suitability of the project • Extension of the technique, if appropriate

b) Orientation to stakeholders - community

Three different approaches were followed to provide orientation of the project to the stakeholders. Firstly, in each project village a meeting was held with traditional leaders, leaders and members of youth and women groups and members other village level institutions. In this meeting, objectives of the project and technique of the Integrated Mangrove Fishery Farming System (IMFFS), which is going to be demonstrated and approach of the project were explained in detail. Following this, a committee was formed in each village. This committee consists of three women and three men including representatives of traditional panchayat, elected self-government, women group etc. Following the formation of committee, two orientation workshops were conducted to the committee members and other interested member of the public. On 15th June 2009, first orientation workshop was organized in which people from MGR Thittu and Mudasalodai participated. The second orientation programme was organized on 25th June 2009 for the villages of MGR Nagar and Muzhukkuthurai. In the morning session of the orientation meetings, the following topics were discussed: i) current status of aquaculture, ii) conceptual framework of IMFFS and its advantages, particularly its sustainability and iii) model developed in Pulianthurai village. Followed this exposure visit was organized to model IMFFS developed at Pulianthurai. This opportunity was also used to identify suitable land for demonstration. The District level officials of the Tamil Nadu Fisheries, Forest and Revenue Department have been contacted and objectives approach and proposed IMFFS technique are explained in detail and their support was also sought for the demonstration of the IMFFS model.

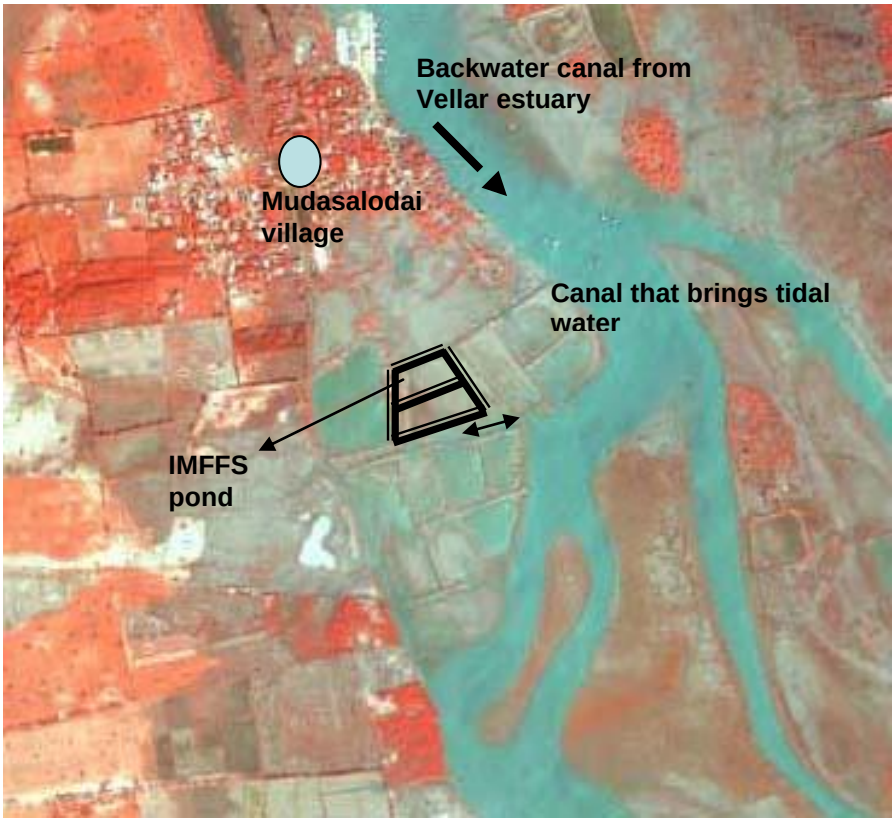
Component 2: Demonstration of an Integrated Mangrove Fishery Farming System

a) Identification of suitable area

Suitable site for the development and demonstration of IMFFS was identified near to one of the project villages namely, Mudasalodai. On the southern side of this village, shrimp farms were developed during early 1990s in the lands owned by the Tamil Nadu Revenue Department with its permission. Due to reasons explained earlier, all these farms are now abandoned. One of the fishers of the village, who owns more than 5 ha of farm, provided his two farms of about 4.5 acre for the

demonstration of the IMFFS farm. Location of the farm where IMFFS is going to be demonstrated is shown in **Fig 6.**

Fig 6: Location of the IMFFS pond and source of tidal water



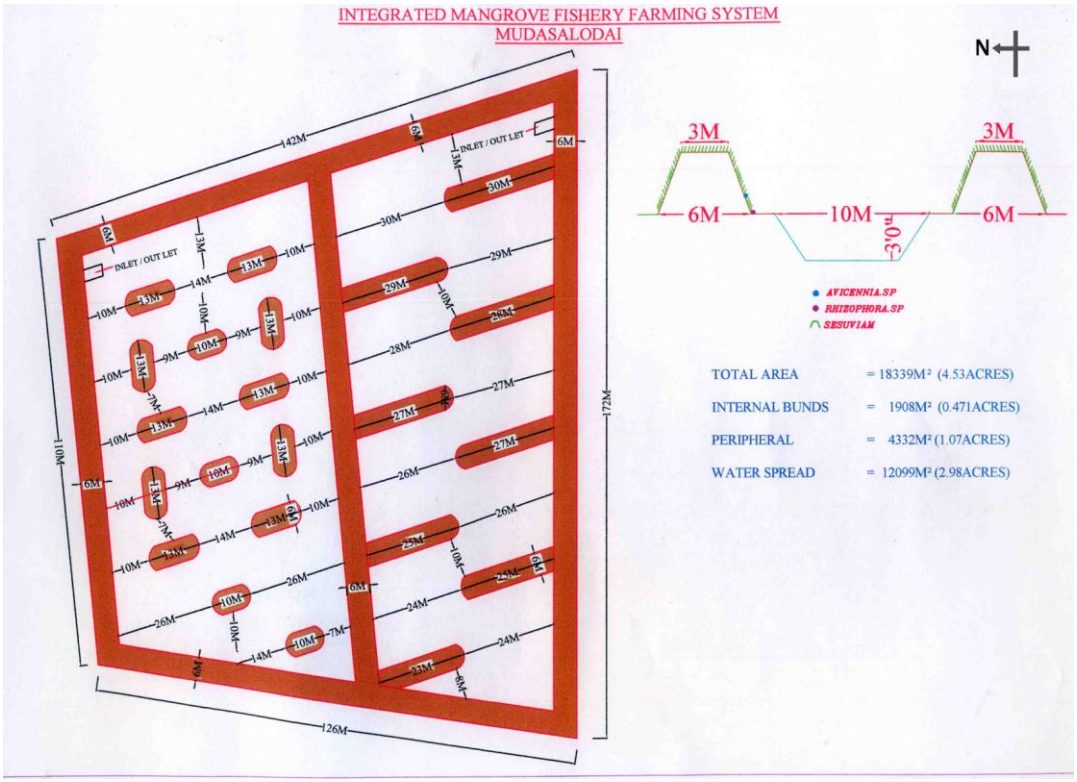
b) Design and lay out of IMFFS

The design and lay out of the IMFFS farm was developed in consultation with local community, representatives of Fisheries Department and Revenue Department and local engineers and is shown in **Fig.7.** The present IMFFS farm has two models.

In Model 1, physical space for taking up of mangrove plantation is created in the form of inner bunds. These inner bunds are nothing but extension of peripheral (outer) bunds. In Model 2, inner bunds are replaced by mud mounds. Mangrove plantation is taken along the inner bunds and peripheral bunds and mounds. On the eastern side of the farm, a large brackish water canal is present, which is connected to Vellar estuary in the north and Pichavaram mangroves in south. Through these canals tidal reaches the farm during high tide and drain out during low tide. Each pond

system has one sluice gate, which acts as inlet during high tide and outlet during low tide. Complete details of the two models are given below.

Fig 7: Design and lay out of the Integrated Mangrove Fishery Farming System



Model 1

Model 1 is developed in Pond 1, which occupies an area of about 3 acre and has 8 inner bunds in the form of mitochondria. The physical details are given below (Table 2)

Table 2: Details of physical structure of Model 1 (Pond – 1 Southern side)

Area	3 acre
Water Spread area	about 1.85 acre
Area for planting mangroves	about 1.15 acre
Outer bund - total length	478 m
Inner bund 8 Nos (23 to 30 m in length) – total length	288 m
Gap between each inner bunds	10 m

Source of brackish water is located at about 15 m on the eastern side of the pond. In order to bring tidal water an intake canal of about 15 m, which is an open

canal, is dug from the source of brackish water. The inlet, which also acts as outlet is in the middle of the farm and it has a concrete pipe of about 12 m length and 2 m wide through which tidal water reaches the pond during high tide and drains out during low tide. The sluice is supported by cement structure of about 2.25 m in height. The sluice has two slide gates, one with stainless steel mesh and the other with nylon mesh. They prevent auto entry of fish, prawn and crabs into the pond during high tide and escape of culturing organism during low tide. Slide gate with stainless steel is established to prevent entry of crab, which can easily cut nylon mesh.

Model 2

Model 2 is developed in Pond 2, which occupies an area of about 1.5 acre and it has10 mounds and 2 inner bunds (Table 3)

Table 3: Details of physical structure of Model 2 (Pond – 1 Southern side)

Area	1.5 acre
Water spread area	about 0.6 acres
Area available for plantation	about 0.9 acre
Outer bund length	416 M
Inner mounts 10 Nos (13M each)	130 M
Inner bund 2 Nos (36M each)	72 M
Gap between Inner mounts and bunds	10 M

In order to bring brackish water to this pond, a canal of about 240 m is dug from the source of brackish water. It is an open canal, soil is slightly sandy, and hence, sides of the canals are strengthened with soil filled bags. The inlet, which also acts as outlet of farm is located on the eastern side of the farm and has a concrete pipe of about 12 m length and 2 m in width. As in the case of Pond 1, two one stainless steel and one nylon mesh slide gates

The total area of the two ponds is about 4.5 acres of which internal bunds and mounds occupy an area of about 0.5 acres and peripheral bunds occupy about 1 acre. The remaining 2.98 acres is water spread area where fish/prawn/crab is grown Construction of the pond system and inlet and outlet was started during June, and August completed in 2009. Machineries were used for pond construction.

c) Road for accessibility of the villagers

The 240 m length of intake canal for pond 2 cut through the foot path used by the community of Mudasalodai and MGR Thittu. Hence, a path was constructed across the canal with 4 concrete pipes of about 2 m length and 0.6 m width.

d) Mangrove plantation

The mangrove species selected for plantation are *Rhizophora mucronata* and *Rhizophora apiculata*. They are selected because of their stilt root system, which provides space for fish, crab and prawn to grow and also strengthen the bunds. In pond 1, a total length of 1006 m is available for raising mangrove plantation, in which, mangrove propagules are planted at an interval of 2m in a single row. Thus, about 500 propagules are planted in Pond 1 and in Pond 2, 477 propagules are planted. In total, about 977 mangrove plants are being raised in the farm. Plantation was carried out in September 2009, and propagules collected from nearby Pichavaram mangrove were used for plantation. Above the *Rhizophora* plantation, *Avicennia sp* will be planted at interval of about 15 m and it will be carried out only in the later stage. In the previous model, *Rhizophora* propagules were planted at 1m interval, which seems to be very close. It is predicted that canopy from such close plantation will shadow the entire water spread area, which may affect water quality. Hence, in the present model, *Rhizophora* propagules were planted at 2 m interval. Survival and growth performance are being monitored once in three months. Till December 2009, Survival is about 92% and plants had reached an average height of about 15 cm.

e) Halophyte plantation:

A succulent halophyte namely, *Sesuvium portulacastrum*, which has a commercial potential as a component of vegetable salad and as a salad to sea food, is also being grown on the top and sides of the bunds. Stem cuttings of about 15 cm in length collected from nearby mud flats were planted at an interval of 1m in October 2009. The fresh weight of the plantation, measured at monthly intervals.

f) Fish Culture

Three different types of experiments are going in fish culture. In the first experiment prawn and detrivorous fish are grown together, in the second type sea bass

(carnivorous) fish is grown in large number (high stocking) where as in third type of experiment low stocking of sea bass is done. These experiments are being done to analyze economics of different types of culture, particularly to understand which culture method is more profitable in a shorter period of time.

Experiment 1 (Pond 2): Composite culture of Prawn and fish

- **Water spread area (WSA):** 0.605 ha (6050 sq. m)
- **Species selected for culture prawn:** Tiger prawn *(Penaeus monodon*) and finfish Mullet *(Mugil cephalus*)
- **Culture period**: eight to ten months
- **Water level**: 1.5 m
- **Stocking density:** As per the pond water holding capacity, 0.82 prawn and 0.17 fish per are stocked per sq.m

In this experiment, about 5000 disease free prawn seed purchased from hatchery and 1000 fish fingerlings collected from the wild will be stocked together. Prawn seeds are now stocked and fish stocking will be done after 30 days interval or after prawn attaining an average body weight 3 grams. Initially survival rate of prawn seeds will be assessed by stocking 100 post larvae of prawn in a *happa* (of about 1 m x 1 m x 1m) and survival rate will be assessed for a period of 72 hours. About 1000 numbers of fingerlings of mullet will be collected from Pichavaram and Coleroon estuary and will be stocked in the pond. The weight of these fingerlings should be 30 to 50 grams

Expected survival:

Approximately 60% and 50% of survival is expected for prawn and fish respectively at the time of harvest. The average body weight (ABW) at the time of harvest is expected for prawn is 35 to 40 grams and for fish one kilogram. The biomass of the harvested prawn would be around 105 kg and that of fish would be 500 kg

This experiment was started in December 2009

Cost – benefit analysis

The cost-benefit analysis of this experiment is given in Table 4.

Table 4: Cost benefit analysis of composite culture of prawn and mullet

Activity	**Amount**
Removal of auto entry	1000.00
Organic manure	500.00
Mullet 1000 nos @ rate of Rs 10/-	10000.00
Prawn seed 5000 nos @ rate of .30 paise per prawn	1500.00
Transportation of fish seeds and testing for diseases	3000.00
Happa 3 nos @ rate of Rs 1500	4500.00
Watch man cum pond man 10 month x 45000/2pond	22500.00
Harvest charges	3000.00
Total expenses	**46000.00**
Total income after harvest Prawn 105 kgs @ rate of Rs280 =29400 + fish 500kgs @ rate of Rs 60 =30000	59400.00
Gross profit	**13400.00**

Activities

The following are the activities relating to this experiment

1. Removal of auto entry animals (predators) from the pond
2. Application of organic manure (application of cow dung to improve the zooplankton density and the interval is 5 days till the end of culture period)
3. Introduction of live feed into the ponds like crustacean *Acetes*.
4. Stocking of prawn
5. Stocking fish after a period of 30 days
6. Weekly monitoring of water quality parameters such as dissolved oxygen pH, salinity, hardness, alkalinity- (carbonates and bicarbonates), ammonia, vibrio count (yellow and green colony), temperature, transparency, and average body weight of stock and clinical checking. Some of the parameters will be analysed in standard laboratory.
7. Grading of fish and removal of suitors (fast growing ones).
8. Partial harvest for thinning the density to avoid dissolved oxygen depletion and stunted growth.
9. Complete harvest.
10. Dry out for next culture

Experiment 2 (Pond 1): High stocking of Sea bass

Water spread area (WSA): 1.85 ha

Species selected for culture: *Lates calcarifer* (Sea bass)

Culture period: eight to ten months

Water level: 1.5 m

Stocking density: 0.33 sea bass per sq.m will be stocked

About 2500 fingerlings of sea bass purchased from Rajiv Gandhi Aquaculture Centre, Thirumullaivayal (Nagapattinam, District) will be stocked in the pond. The size of the fish stocking will be around 10 cm. The fish will be conditioned and graded in the *happa* and then it will be released in to the pond. Before stocking the sea bass the Tilapia brooders will be introduced in the happa and they will act as bio feed by supplying fries to sea bass.

Expected survival:

Approximately 50% to 80% of survival is expected for sea bass at the time of harvest. The expected average body weight (ABW) at the time of harvest is half kilogram and thus the total expected catch will be around 750 kg. Harvest will be done in two times. The first harvest will be carried to thin the stocking density, which will reduce avoid competing among grown up fish for feed, space and oxygen. In this thinning 250kg of fish will be harvested, which will be done at the end of 5 to 6 month of culture period. The remaining 500 kg will be harvested after a period of 2 months from thinning.

Cost - benefit analysis (Table 5)

Table 5: Cost benefit analysis of high stocking sea bass culture

Activity	**Amount**
Removal of auto entry	1000.00
Organic manure	500.00
Sea bass juveniles 2500nos @ rate of Rs 10/-	25000.00
Transportation of fish seeds	1000.00
Happa 3 nos @ rate of Rs 1500	4500.00
Tilapia 50 nos @ rate of Rs.10/-	500.00
Watch man cum pond man 10 month x 45000/2pond	22500.00
Harvest charges	4000.00
Total expenses	**59000.00**
Total income after harvest 750kgs@rate of Rs.120	90000.00

Gross profit	**31000.00**

Activities

1. Removal of auto entry animals (predators) from the pond
2. Application of organic manure (application of cow dung to improve the zooplankton density and the interval is 5 days till the end of culture period)
3. Introduction of Tilapia brooders in happa; fries of tilapia, which escape from happa will become food for sea bass
4. Acclimatization of fingerlings to pond condition in happa
5. Releasing of acclimatized fish into ponds
6. Weekly monitoring of water quality parameters such as dissolved oxygen pH, salinity, hardness, alkalinity- (carbonates and bicarbonates), ammonia, vibrio count (yellow and green colony), temperature, transparency, and average body weight of stock and clinical checking. Some of the parameters will be analysed in standard laboratory.
7. Grading of fish and removal of suitors (fast growing ones).
8. Partial harvest for thinning the density to avoid competition for food, dissolved oxygen and stunted growth.
9. Complete harvest.
10. Dry out for next culture.

Experiment 3: (Pond 2) Low stocking of sea bass

Water spread area (WSA): 1.85 acre

Species selected for culture: *Lates calcarifer* (Sea bass)

Culture period: eight to ten months

Water level: 1.5 m

Stocking density: 0.17 fish per sq.m

About 1000 fingerlings of sea bass will be purchased at Rajiv Gandhi Aquaculture Centre, Thirumullaivayal (Nagapattinam, District). The size of the fish stocking is 10 cm. The fish will be conditioned and graded in the happa.Then it will be released in to the pond. Before stocking the sea bass the Tilapia brooders will be

introduced in the happa and they will act as bio feed by supplying the fries to the sea bass. The happa (1 x 1 x 1) 40 mesh sizes are required.

Expected survival:

Approximately 50% to 60% of survival is expected for sea bass at the time of harvest. The average body weight (ABW) at the time of harvest is expected for fish one kilogram. The biomass of the harvest for sea bass is 500Kg.

Cost benefit analysis

The cost-benefit analysis of this experiment is given in Table 6.

Table 6: Cost benefit analysis of low stocking density sea bass culture

Activity	**Amount**
Removal of auto entry	1000.00
Organic manure	500.00
Sea bass juveniles 1000nos @ rate of Rs 10/-	10000.00
Transportation of fish seeds	1000.00
Happa 2 nos @ rate of Rs 1500	3000.00
Tilapia 30 nos @ rate of Rs.10/-	350.00
Watch man cum pond man 10 month x 45000/2pond	22500.00
Harvest charges	4000.00
Total expenses	**42350.00**
Total income after harvest 500kgs@rate of Rs.120	60000.00
Gross profit	**17650.00**

Activities

1. Removal of auto entry animals (predators) from the pond
2. Application of organic manure (application of cow dung to improve the zooplankton density and the interval is 5 days till the end of culture period)
3. Introduction of Tilapia brooders in happa; fries of tilapia, which escape from happa will become food for sea bass
4. Acclimatization of fingerlings to pond condition in happa
5. Releasing of acclimatized fish into ponds
6. Weekly monitoring of water quality parameters such as dissolved oxygen pH, salinity, hardness, alkalinity- (carbonates and bicarbonates), ammonia, vibrio

count (yellow and green colony), temperature, transparency, and average body weight of stock and clinical checking. Some of the parameters will be analysed in standard laboratory.

7. Grading of fish and removal of suitors (fast growing ones).
8. Partial harvest for thinning the density to avoid competition for food, dissolved oxygen and stunted growth.
9. Complete harvest.
10. Dry out for next culture.

All the above experiments will be conducted with the participation of the community, who will be involved in monitoring and evaluating the results

Component: 3.Orientation Workshop on Coastal fisheries and livelihood for community

Two workshops, one for leaders, women and youth of the project villages and the other for field and middle level managers of various government agencies were organized. The aims of the workshop were i) to assess the current scenario of culture and capture fisheries and ii) to identify activities that can be taken up to increase income from fisheries and sustain fisheries.

a) Orientation Workshop for community

Date and Venue: 15.7.09 – Hotel Saradharam, Chidambaram

List of participants: 20 participants including 8 participated in the workshop. The participants were representatives of traditional panchayat, elected local government , women groups, self-help group etc.

Programme:

Morning session

1. Perception of the community on current status of coastal fisheries - Participatory assessment – Process facilitation by Dr.Rajeswaran, Independent Development Expert
2. Presentation and discussion on current status of capture fisheries – Dr. Rajamani, Principal Scientist, Central Marine Fisheries Research Institute, Mandapam

3. Presentation and discussion on current status of culture fisheries – Dr.Chandrasekar, Principal Scientist, Central Institute of Brackish water Aquaculture, Chennai
4. Presentation and discussion on various government schemes for fishermen – Mr. Tamil Mani, Assistant Director, Tamil Nadu Fisheries Department

Afternoon session:

1. Participatory assessment of opportunities available to increase income from capture fisheries – Process facilitation by Dr.Rajeswaran
2. Participatory assessment of alternative livelihood opportunities - Process facilitation by Dr.Rajeswaran
3. Integrated Mangrove Fishery Farming System for sustainable coastal aquaculture- Dr.A.Sivakumar, MSSRF

Proceedings

1. Participatory assessment of the perception of community on current coastal fisheries

- Compared to past, quantity of fish catch is greatly reduced now
- Sizes of fish caught of almost all species have become small
- Previously less number of fishing vessels got large quantity of fish and at present more number boats but total catch is less
- Compare to past input cost is high now particularly fuel cost is very high and consumes most of the profit; maintenance of boat has also become costlier now because of the introduction of Fibre Reinforce Boat
- Sea bottom fishing grounds has changed drastically after tsunami, which affects recruitment of fish to traditional fishing grounds; this could be one of the reasons for present lesser catch
- Mouth of the Pichavaram mangrove estuary is closed for nearly 9 months in a year due to sand deposition from the sea; this prevents fish recruitment in the back water and also affects accessibility of fishermen to sea
- Fishing in the mouth region when it is opened also affects recruitment of fish, prawn and crab into mangrove backwater
- Ice boxes helping the fishermen during the overnight stay

2. Current status of capture fisheries in Tamil Nadu

- Tamil Nadu with its 1076 km of coastline (13% of country's coastline), 0.19 million sq km of EEZ (9.4% of India's EEZ) and a continental shelf of about 41,412 sq km is a leading State both in culture and capture fisheries
- Of all the maritime States in India, the maximum number of fish landing centres 376 including 24 landing centres in the Union Teritory of Pondicherry has been recorded in Tamil Nadu
- 615 fishing villages are present along the coast of Tamil Nadu
- Total fishing population is 7.37 lakh of which 2.80 lakh fishermen are actively engaged in fishing
- The estimated annual marine fish production in Tamil Nadu has fluctuated from 0.35 million tonnes to 0.47 million tonnes with an average annual landing of 0.40 million tonnes
- The marine fisheries potential of the State is estimated at 0.719 million tonnes - 0.369 million tonnes from less than 50 m. depth and 0.35 million tonnes beyond 50 m.depth;
- Fisheries resources from less than 50m already overexploited
- Capture fishery of crustaceans (prawn and crabs) and mollusc (squid) reduced by about 18%
- The number of boats engaged in the fishery has decreased significantly from 1375 units (in the year 1987) to 740 units in the present investigation (2006-'08).

- The reason for the decrease in the number of units is attributed to poor income due to poor catch

Response of the community

- Machanized fishing, particularly fishing by trawler using banned nets such as purse seines and modified purse seines are responsible for over exploitation of fishery resources
- Fishing of berried female prawns and crabs are responsible for reduction in the catch of prawn and crabs
- Government should strictly enforce laws

3. Current status of culture fisheries in Tamil Nadu

- For decades coastal aquaculture practices have been the traditional extensive systems, such as: *'Pokkali' culture of Kerala,* and *'Bheris' and 'Bhasabhada' of* West *Bengal*
- Commercial scale intensive shrimp farming started in late 1980s
- But for the traditional aquafarming in the extensive systems in West Bengal, Kerala, Karnataka and Goa, the shrimp farming has been the main stay of brackishwater aquaculture
- The total shrimp produced through brackishwater aquaculture during 2005-06 was 1,29,780 **t**onnes, from 1,21,274 ha area, accounting to a productivity level of 1.07 t/ha/yr. (MPEDA, 2007).
- *Pond Culture:*
  - Postlarvae of 20-25mm size stocked @ 10 nos./m2 under improved traditional and extensive farming systems
  - Size attained - 15-25g in 4 months
  - Production of 1.2-1.5 t/ha
  - Average income around Rs.1-1.25 lakh
- Shrimp farming started in late 1980s; picked up momentum during 1990-94.
- Over-stocking resulted in disease out-break in late 1994, devastating the industry, pulling down the production in 1995.
- Leaped back to normal followed by another attack in 1997.
- Shrimp production was further reduced in 1999-2000 due to the "Super Cyclone" in Orissa.

Response of the community

- Community expressed their unwilling to undertake culture of Prawn farming because it causes environmental pollution, social problems etc
- Pollution comes mainly because of use of artificial feed in large quantities
- Prawn farm discharges are the main cause for disappearance of certain fish species.
- Interested to undertake culture of other marine organisms in a saline affected areas

- Is there any cost-effective model available for sustainable coastal aquaculture farm?

Response of Chandrasekaran

- Dr.Chandrasekaran explained other types of coastal aquaculture such as culture of pearl oyster, edible oyster, green mussel, brown mussel, clam, cockle and Gastropod Molluscs like abalone, conch and finfish culture and (seabass, milk fish, mullet) culture of aquatic plants such as seaweed culture. Also other echinoderms: sea -cucumber, sea urchin
- He also explained about Integrated Mangrove Fisheries Farming System as one of the models of sustainable coastal aquaculture system.

4. Presentation on government schemes in support for fisheries development

- Housing scheme - Rs 50000/-per family
- Out board engine subsidy worth Rs 30000/-
- Construction of boat subsidy worth Rs 250000/-
- Diesel subsidy rate requires registration in fishermen society
- Emergency services provided by the coast guard
- Group insurance paid by the Government during the demise of the fishermen by flood and cyclone. Rs.100000/-
- Insurance premium for forty rupees by the private insurance company
- Rs 3000/- for fishermen students who scores district level ranks
- Rs 50000/- for those who are studying the marine engineering course.
- Support for self help group members involving in crab fattening and fish culture.

Response of the community

- Ban on fishing is implemented for 45 days during fish breeding season. But Government provides assistance only after the ban period is over. The community feels that the amount may be released during the ban period.
- Loan for fish stall requested and the AD responded that loan facility will be provided to group (NABARD) not for individuals.
- Grinding Machine for oil sardine which is main raw material for poultry and SHG members only will get the loan responded by AD.

5. Participatory Assessment of livelihood enhancement

Present Livelihood situation:

When viewing the existing present livelihood situation in the context of fisheries and sea-based livelihood activities, the value realization in broad terms were as follows:

Types of existing business & value:

a. *Fish – Dead* - *85%*
b. *Fish – Live* - *5%*
c. *Waste fish* - *10%*

It was agreed that the existing product lines be first tapped, before venturing into new areas. The objective was accordingly, for each product-line methods to increase higher price realization / more to profit were discussed. The following are ideas generated by the community (Table 7).

Table 7 : Ideas generated by community on how to increase higher price realization or more profit from existing livelihood activities

Product Type	Purpose	Method
Fish – Dead	Improve quality	1. Use ice for chilling 2. Use crates for storage
	Increase value	1. Modern Outlets 2. New markets 3. Reduce wastage 4. Dressing 5. Segregate quality-wise 6. Transparent sales procedures
	Reduce financial cost	1. Use bio-diesel 2. Formal debt finance 3. Common cold store
Fish – Live	Increase value	1. New markets 2. Culture, fatten and sell
Waste fish	Increase value	1. New product lines 2. New markets

To begin with:

It was felt that instead of attempting on all fronts, a beginning can be made in one or two ways to achieve the stated objectives. They are:

i) Air-conditioned Retail chilled fresh fish-stall

a) In Chidambaram town (2 nos.)
b) Consumer marketing
c) Operated by women groups
d) Time frame 6 months
e) Finance = own+grant+debt
f) Project report to be prepared

ii) Organic pesticide (using waste fish)

a) Produced by individual women
b) Sold by women groups
c) Time frame 3 months
d) Standard Operating Procedures to be learnt
e) Sales strategies to be developed

iii) Integrated mangrove fishery farming system

a) Utilize shrimp farms of the Department of Fishery
b) Request Revenue Department to allot saline affected areas
c) Operation through SHG
d) Fund from bank, Integrated Rural Development Project or Tsunami Livelihood project
e) Technical guidance MSSRF

6. Integrated Mangrove Fishery Farming System

Dr.A.Sivakumar, Senior Scientist, MSSRF explained in details about the concept, methodology and experiences in developing and demonstrating IMFFS. Many of the participants had already seen the IMFFS farm developed in a private farm and also the one which is being developed in the project.

Response of the community

- What are the criteria should be used in selecting land for IMFFS
- Cost involved in the Construction and Maintenance
- Whether, apart from mangroves, any other plants can be planted in the bund of IMFFS
- SHG members can be involved

b) Orientation Workshop on Coastal fisheries and livelihood for representatives of government agencies

Date and Venue: 21.7.09 – Hotel Saradharam, Chidambaram

List of participants for orientation workshop for representatives of government agenceis

S.No	Name	designation	organization
1	C.Ravindran	State Coordinator	NETFISH-MPEDA, Tuticorin
2	R.Sankar	M&E Coordinator	IFAD, Cuddalore
3	J.Balasubramanian	CDO	IFAD, Cuddalore
4	S.Ganapathiraman	Field Manager	NaCSA, Nagapattinam
5	K.Manikandan	State coordinator	NaCSA, Nagapattinam
6	N.Veeramani	VAO- Killai-II	Revenue dept
7	T.Srinivasan	AD Fisheries	Tamilnadu state Fisheries dept
8	Dr.Prince Jayaseelan	Professor & Head	FCRI, Tuticorin
9	S.Pandiarajan	Project Manager	RGCA, Sirkazhi
10	T.M.Vasanthan	S.O	CAS in Marine Biology, Parangipettai
11	Dr.A.GopalaKrishnan	Lecturer	CAS in Marine Biology, Parangipettai
12	R.Natarajan		
13	K.S.Rajan	Ranger-Pichavaram	TN Forest Dept
14	M.Veerapandian	Forester-Pichavaram	TN Forest Dept
15	G.Muthukumar	Guard-Pichavaram	TN Forest Dept
16	K.Velmurugan	Watcher-Pichavaram	TN Forest Dept
17	V.Vijayan	Ranger-Chidambaram	TN Forest Dept
18	V.Tamilmani	AD Fisheries	Tamilnadu state Fisheries dept
19	V.Gunasekaran	Inspector of fisheries	Tamil Nadu state Fisheries Dept.
20	R.Karunakaran	Research Assistant	Tamil Nadu state Fisheries Dept.
21	S.Chidambaram	Forester-Chidambaram	TN Forest Dept

Programme:

Morning session

1. Presentation and discussion on current status of capture fisheries – Dr. Rajamani, Principal Scientist, Central Marine Fisheries Research Institute, Tuticorin
2. Presentation and discussion on current status of culture fisheries – Dr.Chandrasekar, Principal Scientist, Central Institute of Brackish water Aquaculture, Chennai
3. Presentation and discussion on participatory assessment of livelihood enhancement in fisheries sector – by Dr.Rajeswaran
4. Presentation on the concept, method and experiences in developing Integrated Mangrove Fishery Farming System – Dr.A.Sivakumar

Afternoon session

1. Field visit to IMFFS farm, which is already developed in Pulianthope near Pazhayar in a private owned land
2. Field visit to IMFFS farm being developed with the support this project in Mudasalodai, near Pichavaram in abandoned prawn farms

Proceedings

1. Current status of capture fisheries in Tamil Nadu

Content as present in the first workshop

Response of the participants

- Latest landings of Tamil Nadu is very informative
- Reduction in landings of prawns, crabs – how to overcome this problem?
- Conflict between mechanized sector and artisanal sector – how it affects fisheries resources needs to be studied
- Marine organisms, seaweed and sea grasses discarded during fishing as trash is seriously affecting marine fisheries – how to overcome this problem?
- Sea grass as a fodder for the goat
- Need to regulate the push net
- Reason for the reduction in the number of gears operated needs to be further probed

- Regulatory and management measures suggested
- Artificial reef and its importance in marine fish production and explained about the MSSRF initiative in the artificial reef.

2. Current status of culture fisheries in Tamil Nadu

Content as present in the first workshop with additional information on

- Sustainable shrimp farming practice without diseases
- Better Management Practices and also adopting the bio-security measures
- Bird netting, crab fencing
- Introduction of Pacific white shrimp L.vannamei for better growth
- Diversification of Coastal and Brackish water aquaculture- potential candidate species for culture such as shell fish (Oyster and mussel), fin fish (sea bass grouper, mullet, milkfish) and aquatic plants (sea weed)

3. Field visit – opinions suggestions given by the participants

All the participants visited IMFFS farm, which is already developed in Pulianthurai near Pazhayar in a private owned land as well as the new one being developed in abandoned prawn farms near Pichavaram. They provided the following suggestions.

- Should be tried in large scale and lessons learnt from such trial should be used for replication
- Availability of land is the biggest issue though a large tract of saline affected lands are available in the coastal area of Tamil Nadu; most of the lands belong to government agencies
- There should be policy support for allotting land to IMFFS
- Instead of monoculture of fish or prawn polyculture of fishes such as sea bass, milk fish, mullet, crab and prawn
- Avoid carnivorous species
- Stock the juvenile fishes of about 7 to 9 cm in length would yield better results
- Rope culture of mussel can be tried in the pond along with fish culture; mussel has great demand in Kerala
- Possibilities of growing other trees such as coconut and casuarina can be tried
- Economics of the farming system should be worked out

Resource Persons

Experts from Central Institute of Brackish water Aquaculture, Chennai, Central Marine Fisheries Research Institute, Mandapam, Department of Fisheries, Tamil Nadu, MSSRF, Chidambaram and an independent development expert participated in the workshop as resource persons.

8.0 Output and Outcome

The project envisaged 4 outputs namely, i) demonstration of 2 different models of Integrated Mangrove Fishery Farming Systems, ii) demonstration and exposure to 100 women and men from community to IMFFS, iii) orientation and exposure to 30 managerial and field level staff of government and non-government agencies and iv) preparation of 1 manual for community to replicate IMFFS model. As shown in the report two IMFFS models, one model with inner bunds and another model with mounds have been developed and demonstrated. A total number of 94 community members including 36 women are given orientation and exposure to IMFFS. A total number of 21 staff belonging to various state government agencies such as Forest Department, Fisheries Department, Revenue Department and central government agencies such as Marine Products Development Authority of Ministry of Commerce, National Centre for Sustainable Aquaculture, Rajiv Gandhi Centre for Aquaculture of Ministry of Agriculture participated are given exposure and orientation to Integrated Mangrove Fishery Farming System. However, preparation of a manual on IMFFS in local language for community to replicate the models is yet to be done.

The outcomes of the project include i) acceptance of IMFFS by community as a system of aqua farming, ii) consideration of government agencies to include IMFFS as one of the schemes for government support under developmental schemes and iii) reorganization of IMFFS as a model of sustainable fish farming system. Fishing community is very reluctant to accept aqua farming as a source of income because of its past experiences such as pollution of nearshore fishing grounds (such as backwaters, estuaries, lagoons and even neritic water), which destroyed the basis of their livelihood, salinization of land and water etc. However, after given exposure to IMFFS model they accept that this kind of semi-natural farming system can be

developed in saline affected areas as a source of income mainly to young fishermen. Secondly, they also believe that mangroves once grown will also act as a bioshield against natural hazards such as cyclone, storm surges and tsunami. Another interesting development is that Tamil Nadu Fisheries Development and National Centre for Sustainable Aquaculture have informally recognized IMFFS as a model system for promoting sustainable aquaculture.

9.0 Potential for policy interventions

It is envisaged that the present IMFFS demonstration may lead to following interventions in policies relating to rural development, coastal aquaculture and adaptive capacity to climate change.

i) *Inclusion of IMFFS in rural development schemes:* The State and Central Government (Government of India) implement various schemes and projects for poverty alleviation. employment generation, capacity building, youth development, social and economic empowerment women and income generating activities in the rural areas through Rural Development and Panchayat Raj (local self government) Department. It is informed by the Block Development Officer of Cuddalore District, who recently visited the farm that IMFFS can be included as an income generating activities for coastal panchayats and can be supported financially under development programmes for Self-Help Groups and Women Development. It is to be mentioned that coastal aquaculture is not included in rural development schemes since it is considered as a polluting activity. However, Block Development Officer indicated that since IMFFS is environment friendly and capable of providing sustained income it can be included as a scheme for promotion through Rural Development Programme.

ii) Restoration of abandoned shrimp and other coastal aquaculture farms: As described in section 2.0 Current scenario in coastal aquaculture in India of this report, many of the shrimp farms are now abandoned due to poor environmental management, disease and increase in input cost. For example in the state of Andhra Pradesh 1,74,000 ha of potential area available for shrimp farming in which shrimp farms developed in about 84,950 ha of which about 29,845 ha is now abandoned (Table 8). These abandoned farms can be restored with IMFFS so that livelihood

security of the farm owners and ecological security of the coastal areas can be secured.

Table 8. Area of abandoned shrimp farms in different districts of Andhra Pradesh

No	District	Potential area for shrimp farming (ha)	Area in which shrimp farms developed (ha)	Area in which shrimp farms abandoned (ha)
1.0	Srikakulam	10000	1165	400
2.0	Vizianagaram	4000	71	45
3.0	Visakapatnam	7000	533	250
4.0	East Godavari	13000	8987	2200
5.0	West Godavari	25000	14367	1500
6.0	**Krishna (Project District)**	**50000**	**36243**	**19000**
7.0	Guntur	20000	10884	3500
8.0	Prakasam	15000	4777	50
9.0	Nellore	30000	8024	3000
	Total	**174000**	**84951**	**29845**

iii) Enhancing adaptive capacity of coastal community to sea level rise

As described in Introduction predicated sea level rise would lead to inundation of sea water in about 5700 sq.km of land along the coastal states of India and nearly 7 million coastal families could be directly affected due to such inundation. Many fisheries-dependent communities who already live a precarious and vulnerable existence because of poverty, lack of social services and essential infrastructure would be severely affected by such increase in sea level. The fragility of these communities is further undermined by overexploited fishery resources and degraded ecosystems. However, the projected increase in sea level rise and consequent salinization of land provide opportunity to increase fish production through aquaculture. It is predicted by the Coastal Zone Management Subgroup of the Intergovernmental Panel on Climate Change that in many coastal areas people would modify landuse pattern and subsystems to ensure that such changes take care of new threats such as salinization and flooding due to climate change. One of the major landuse change predicted is conversion of saline affected agriculture lands into aquaculture farms. However, the current situation of aquaculture in India warrants a more responsible and sustainable

aquaculture systems and practices. In such a situation, the present IMFFS model, which integrate agro-aqua farming system that takes care of both livelihood security of the poor coastal families and ecological security of the coastal areas can be utilized to enhance adaptive capacity of coastal communities to sea level rise and climate change.

10.0 External monitoring of the project

The project was monitored by a team consisting of Ms.Hanying Lee, Programme Officer officer, IUCN, Bangkok and Mr.William Bourne, Consultant, IUCN, Bangkok. The monitoring visit was made during 14th to 16th November, 2009, which includes discussion with project leader and staff, village community, private entrepreneur and field visit to IMFFS farm that is being developed with the support of the project. The conclusions of the monitoring visit are as follows: i) the project was found relevant in terms of design and beneficiaries targeted; ii) tt is too early to comment on the overall effectiveness of the project. The model has been set up and a degree of awareness had been built amongst key stakeholder groups. One year time duration is considered too short a time given that it will not be until 3 years or so that the model will be fully developed and iii) the future impact could be immense, if this model proved economically and financially viable as a means to rehabilitate derelict coastal areas to perform productive and protective functions. The team also suggested that a) this model should be managed for another 3 years, b) awareness and capacity building programme should cover wide range of stakeholders, c) a comprehensive financial and economic analysis should be undertaken to determine its viability and return on investment and d) assuming economic and financial viability, an intensified efforts at higher levels should be taken to show the benefit of this system of farming. In addition, it also mentioned that given the envisaged opportunities and importance of this work in a national or global perspective it is recommended that a large proposal is drafter to consolidate the results and further promote this technology.

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