Annual report for the project, “Development of multi-trophic Aquaculture systems in Sindhudurg District, Maharashtra”. (April 2015-June 2016)

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Mangrove cell, UNDP Sindhudurg Project

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Background

Aquaculture has become the major source of seafood owing to the increasing demand for seafood coupled with the declining wild fish stock,. Modern brackishwater aquaculture in India has primarily been based on mono-specific (single species) shrimp culture since its inception during 1980s. Although shrimp aquaculture has grown dramatically during the last few decades, there have been several problems yet to be resolved particularly the issues related to the environment. These issues include discharge of waste water, eutrophication of receiving ecosystem, problems due to the feral population and disease occurrence in the wild stock. In order to develop a sustainable aquaculture and to protect the ecological integrity of the coastal ecosystem, the current aquaculture, which is based on single species, has to be replaced or refined with a system which is more innovative, responsible and profitable. Integrated multi-trophic aquaculture, IMTA, has been a system that has potential to play a crucial role in attaining this objective. IMTA consists of farming of aquaculture species from different trophic levels with a complimentary ecosystem functions. In this farming practice, uneaten feed, nutrients, wastes and energy of one crop are recaptured and utilized as fertilizer, feed and energy for other crops. Although a distant prototype of IMTA existed in traditional aquaculture forms, the importance of IMTA as sustainable management option has been recognized recently.

Brackishwater Aquaculture in Sindhudurg district

District Sindhudurg is the southernmost coastal district of state Maharashtra with 121 km coastal length and 8000 ha of brackishwater area. A total of 1268 ha of brackishwater area is developed for aquaculture. Although climate and geography of the district is suitable for brackishwater aquaculture, the potential of this district has not been optimally used. Many farms which were operational during the initial phase of aquaculture are presently remained to be defunct due to the disease outbreak and resultant crop failures. A preliminary analysis of socio-economic aspects of brackishwater shrimp farming in this area indicate that monoculture of shrimp would not sustain in this area as it is prevailing in the states on the east coast of India. Therefore, a sustainable and profitable brackishwater aquaculture, which is specific to this region, should be developed considering the socio-economic aspects of farmers and specific characteristics of coastal ecosystem of the state. At this context development of IMTA could be a potential farming option for aquaculture development in Sindhudurg.

Project approach:

In 2015, a one- year research project, "Development of multi-trophic Aquaculture systems in Sindhudurg District, Maharashtra" supported by Mangrove cell Maharashtra aimed at the demonstrations of IMTA to the farmers of Sindhudurg.

Objectives:

- To quantify and evaluate the production and ecological characteristics of IMTA sysemes
- To demonstrate the combination of resource and production efficiency of IMTA as compared to existing monoculture production systems
- To estimate the nutrient balance of IMTA farms, and use them as indicator for farm sustainability
- To popularize the IMTA model to brackishwater farmers

Project activities and achievements

Study area and sites

After the extensive survey, 3 farmers/self-help groups were selected for the collaboration with the project (Table 1). In order to demonstrate the IMTA farming systems in farmers pond, demonstration design has been formulated (Figure). As the ponds are larger, two pens of 250 m^2 were made in each pond for IMTA demonstration and monoculture control. In IMTA pond, shrimp (*Penaeus indicus*)), finfish (*Etroplus suratensis/Chanos chanos/Mugil cephalus*) and bivalves (*Crassostea madrasensis*) were stocked. Ponds were cleaned, bleached and limed (Figure). The fertilization was carried out using fermented rice bran (50 kg), jaggery (5 kg) and yeast (0.5 kg). Water quality characteristics of the experimental ponds and source water were regularly monitored. Salinity in the ponds at the time of stocking was below 10 ppt, and all other water quality characteristics were within the acceptable limits. In the open water IMTA systems two types of cages were constructed and installed (Figure). Hatchery produced *P. indicus* seeds were initially stocked in hapa and reared for one month in hapa in order to prevent escape from the pen, and the details of stocking in pens and open water cages are given in the Table

Map of Sindhudurg showing study sites

Table 1 Details of the farmers and self- help group

Taluka	Name of the farmer	Farm area (ha)	Model
Devagarh	Mr Neelesh	Round cage: 6 m dia (outer) and 5 m (inner) outer mesh 36 mm and inner mesh is 16 mm Cage 5 x 5 m Mesh 16 mm	Open water estuarine area Etroplus, milkfish, shrimp and bivalves
Kochare	Mr Raju Chavan	10,000 sq m	Pen in the pond after dividing the pond into two
Vengurla	Ms Vaishnavi Babu Malabari and Supriya	80000 sq m	Pen in the pond (traditional tide fed farm)

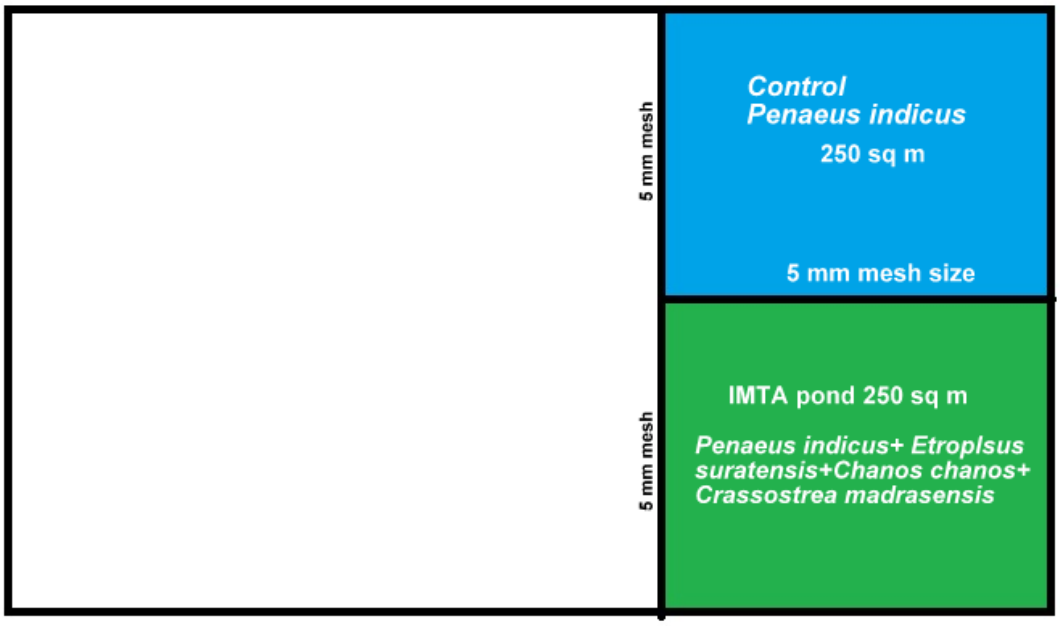


Figure 1 Experimental design for the pond based demonstration system

IMTA site at kochra

IMTA site at Vengurla

IMTA cages constructed in the open estuarine site at Devagarh taluk

Oyster spat collection

Table 2: Details of stocking in IMTA and control pens in the pond based IMTA systems

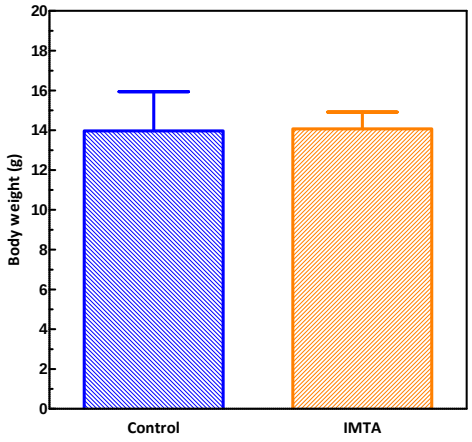
IMTA (stocking density)	**Control (stocking density)**
Penaeus indicus (2 no/ m^2)	P. indicus (3 no/m^2)
Chanos chanos (4 no/m^2)	
Etropolus Suratensis (1 no/$m^2$2)	
Mugil cephalus (0.5 no/m^2)	
Crassostrea madrasensis (0.5 no/m^2)	

Table 3: Details of stocking in in open water IMTA system

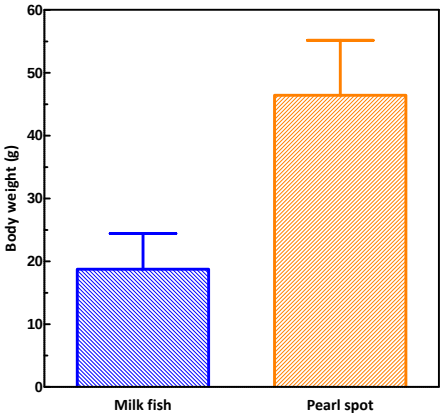
Species	**No/cages**
Penaeus indicus	200
E suratensis	252
Chanos chanos	20
Crassostrea madrasensis	1000

Growth and production

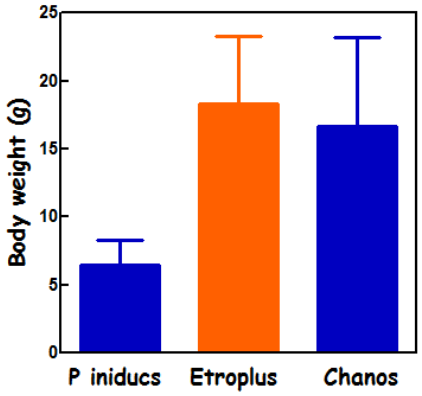
In pond based system, shrimp (*Penaeus indicus*) grew from an initial average weight of 1.6 g to 14.07 g whereas in control pond the final average weight was 13.4 g. The pearl spot grew from 2 g to 45 g whereas milk fish grew from 4.3 g to 19. 3 g. In the open water based system the growth of species were found to be comparatively lesser than the pond based system (Figure).



Average body weight of Penaeus indicus in pond based IMTA system



Average weight of finfishes in the IMTA system after three months of rearing



Growth characteristics of shrimp and finfishes in open water IMTA system

Table 4 Estimated productions in pond based IMTA system

Species	Estimated production (kg per pen)	Estimated productivity (kg/ha)
P.inidicus	10	400
Chanos chanos	80	2000
E. suratensis	75	1000
M. Cephalus	25	1000

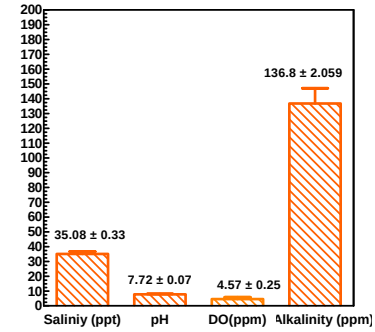
C. madrasensis		

Table 5 Estimated production in the open water IMTA system

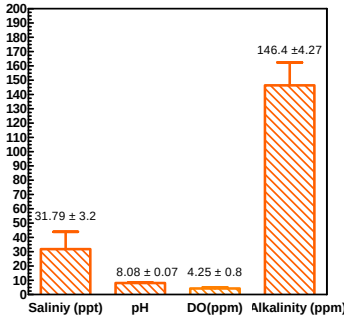
Species	estimatd productivity ($kg/m^2/yr$)
P indicus	1.2
E. Suratensis	1
Chanos	1

As the final harvest is yet to be carried out, the estimated production is calculated from the average latest body weight and expected percentage survival. Estimated production in the demonstration trials are given in the Table 4 and 5. Total production is estimated to be 4400 kg/ha with a highest estimated production for milk fish.

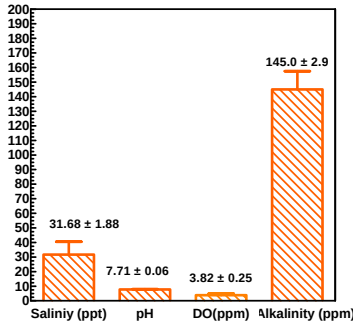
Water quality characteristics of IMTA sites



Mean water quality characteristics of Devagarh



Mean water quality characteristics of Kochra



Mean water quality characteristics of Vengurla

Mean salinity was highest at Devagargh site whereas Kochra and Vengurla sites had similar salinity, and minimum salinity of Kochra and Vengurla site was 10 ppt and recorded during the month of June (Figure). Ammonia and Nitrite were below 0.25 during all the sampling period

and it is within the admissible level. DO of all the IMTA sites fell around 2 ppm during March and February months, and except these two readings DO concentration were higher than 3 ppm in all the sampling period.

Economic analysis

The following Table shows the economic analysis of IMTA production carried out in the land based IMTA system. Benefit cost ration of 1.5 indicates the economic viability of the land based IMTA

Items	**amount/ha**	**Price rate (Rs)**	**IMTA**
Operational cost Seed			
Penaeus indicus	20000	0.2	2000
Chanos chanos	20000	2	20000
Etroplus suratensis	10000	1	10000
Mugil cephalus	10000	2	20000
Crassostrea madrasensis	5000	0.2	2000
Bleaching powder (Kg); 15 ppm , 1 m depth	200	25	5000
urea (Kg)	100	10	1000
ssp (Kg)	100	8	800
Labour man days	200	270	54000
IMTA feed	9000	40	360000
Total operational cost			474800
interest on operation cost 6 month	12%		28488
Total cost (Rs)			503288
Total revenue (₹)			
Shrimp	400	250	100000
Chanos chanos	2000	150	300000
Etroplus suratensis	1000	150	150000
Mugil cephalus	1000	200	200000
Profit (Rs)			750000
Profit/kg (Rs)			170.5
BCR			**1.5**

Remarks

Based on the initial analysis, it is indicated that it is possible to set IMTA concept in Sindhudurg district, particularly in land /pond based system. These findings also provided the areas to be refined with regard to the stocking of finfishes and extractive crops such as bivalves or seaweed. Most land based sites had extremely low salinity during the monsoon period, and during this period survival of bivalves or seaweed is problematic. These crops should be harvested before the onset of monsoon. Availability of finfish seeds is seasonal and the culture work should be correlated with the availability of these seeds.

With regard to the growth characteristics, the growth of *P. indicus* is found to be lesser than the reported growth rate for the similar stocking density and days of culture. Although control and IMTA ponds showed similar growth rate, it is interesting to note that in IMTA pond, the growth was slightly higher even total stocking density in the pen was higher than the control pond.

Follow up

As IMTA concept is new to this region as well as to farmers, in order to refine this culture technology suitable to this area, pilot runs had to be taken up. Therefore, on the basis of present findings, it is essential to carry out one more culture trial to achieve the original objectives of the project. Further, in the original project proposal, the request for two crops has been included. At this context an extension of project for another six month would enable us to carry out the remaining aspects of the project objective.