Lobster Fattening Experiments in Coastal Bhavnagar Initiated by People's Learning Center

An
Evaluation Study

Aguust 2008

By
Astad Pastakia

for
Coastal Salinity Prevention Cell,
Ahmedabad

Table of Contents

Annexure 1
Terms of Reference

Annexure 2
Tables

Annexure 3
Field visit reports

Annexure 4
Package of Practices

Annexure 5
Report on debriefing session

Executive Summary

People's Learning Center for Livelihood Security and Disaster Mitigation for Coastal Communities (PLC- Coastal), has been promoted by Utthan Trust in Bhavnagar-Amreli coastal area with the broad objective of developing, promoting and protecting the livelihoods of coastal communities. PLC also has a national agenda and plans to reach out to other coastal communities in other parts of coastal India in the near future.

It is in this background that Coastal Salinity Prevention Cell (CPSC), Ahmedabad, supported a one-year project (Feb 07 to Jan 08) with the purpose of testing the idea of lobster fattening as a supplementary livelihood activity for communities dependent on seashore fishing activities. The total grant for the project was INR 0.483 million. Although PLC's mandate is to cover about 200 villages in the coastal belt of Amreli and Bhavnagar districts, the lobster experiments were restricted only to two villages, one in Mahua block and the other in Rajula.

The initial trials have led to the establishment and successful demonstration of two different methods of rock (spiny) lobster fattening: a) pit culture method practiced on rocky shores and b) cage culture method carried out in coastal creeks. Encouraged by the success of these experiments, PLC and Utthan have submitted a proposal to scale up the trials in another 10 villages along the same coast-line over a period of two years. The total project cost is estimated at INR 5.568 million of which about 70% would be requested from the donor agency and the remaining would be mobilized by PLC from other stakeholders such as Marine Products Exports Development Authority (MPEDA), Fisheries Department and others. Hence CSPC and PLC-Utthan felt the need for an independent assessment of the experiments before moving on to the next stage of trials.

The findings of this review are based on a field visit consisting of group discussion with the two mandals involved in the experiments and extensive discussions with key staff resource persons of PLC and Utthan. Perusal of internal records and documents, a brief Internet survey and a debriefing session were also part of the methodology.

The lobster fattening project supported by CSPC has shown over two seasons that this is an economically attractive proposition and that the capital costs can be recovered in the first year itself. The economics of pit-culture is somewhat more attractive than that of cage culture. Apart form this, there are indications that crab fattening can be an equally viable livelihood activity, if not more so, but this needs to be reconfirmed with the help of formal trials by the mandal. The activity is presently seen as a supplementary activity to seashore fishing. However, it also has the potential of providing year round livelihood options for local people in Bhavnagar and thereby arresting stress migration.

There are significant risk factors associated with lobster fattening, which can deter people from taking it up unless these risks are mitigated. While some risk factors are common for both the methods many are different. In general the risks are high during monsoon and more so in the creeks, making the second cycle of cage culture difficult to complete. This report presents a preliminary assessment of risks along with measures/ strategies to

preempt or mitigate these risks. Testing these ideas would become an important agenda for the forthcoming project.

The brief literature review carried out for this study shows that lobster fattening is being tried or practiced on scale in various other places in the world including India. Interestingly the methods and materials involved vary quite a bit. Therefore there is a lot to be gained by visiting such places (Tuticorin in India, Vietnam abroad) to exchange ideas and learn from each other. Some of these alternative materials or methods can also be tried out in the forthcoming project.

The report provides suggestions for reworking the new proposal submitted by PLC-Utthan to CSPC. It is suggested that the trials be conducted for a period of three years and the number of villages be increased to 15, so as to be able to generate reliable evidence on the technical and economic viability of a range of mariculture activities such as lobster fattening, crab fattening, seaweed culture, vermicomposting of seaweeds and trash fish among others. It is further suggested that PLC enter into collaboration with an agency like MPEDA in order to gain legitimacy and infuse greater scientific vigour in the trials.

In the light of PLCs plans to pursue a national agenda through a network of like-minded agencies and institutions, it is suggested that provision be made for developing training manuals and IEC materials and hand-holding at least five other agencies in other parts of coastal India to carry out similar trials. A more detailed literature review should be carried out to assess the state of lobster fattening and other forms of mariculture in India and abroad. PLC should plan visits for exchange and dialogue with other institutions such as in Tuticorin, which are engaged in similar activities. The Department of Biotechnology, which is currently financing research on lobster fattening may be approached for support.

The project should provide for administrative expenses for putting the mandals as well as trial sites on a proper legal footing. Care should be taken to ensure that the property rights of the virdas etc. are secure. A legal opinion should be taken to ascertain that mariculture does not violate the central government's regulations for conservation of coastal zone ecology. In case of any discrepancies, policy advocacy for creating a space for extensive and natural mariculture (as opposed to chemical and intensive mariculture) may be taken up by PLC as part of its national agenda.

PLC will need to set up a separate team for fisheries/ mariculture sector. Rambhai the key resource person who has taken the initiative to this level should lead this team. It should include two young fisheries graduates who would get trained over time and become valuable resource persons for supporting such activities in future. The team should also include two staff members who work on the social and institutional aspects (including gender and equity) and build the capacities of the grassroots institutions.

1. Introduction

Project background

People's Learning Center for Livelihood Security and Disaster Mitigation for Coastal Communities (PLC- Coastal), has been promoted by Utthan Trust in Bhavnagar-Amreli coastal area with the broad objective of developing, promoting and protecting the livelihoods of coastal communities. PLC emphasizes a holistic approach to development of coastal livelihoods seeking integration across sectors like agriculture, fisheries, animal husbandry, water and sanitation etc, with active participation of communities especially women. PLC provides a platform for coastal communities to come together and exchange ideas and innovations, interact with the formal researchers and come out with new solutions to their livelihood related problems. PLC also has a national agenda and plans to reach out to other coastal communities in other parts of coastal India in the near future.

It is in this background that Coastal Salinity Prevention Cell (CPSC), Ahmedabad, supported a one-year project (Feb 07 to Jan 08) with the purpose of testing the idea of lobster fattening as a supplementary livelihood activity for communities dependent on seashore fishing activities. The total grant for the project was INR 0.483 million. Although PLC's mandate is to cover about 200 villages in the coastal belt of Amreli and Bhavnagar districts, the lobster experiments were restricted only to two villages, one in Mahua block and the other in Rajula.

The initial trials have led to the establishment and successful demonstration of two different methods of rock (spiny) lobster fattening: a) pit culture method practiced on rocky shores and b) cage culture method carried out in coastal creeks. Encouraged by the success of these experiments, PLC and Utthan have submitted a proposal to scale up the trials in another 10 villages along the same coast-line over a period of two years. The total project cost is estimated at INR 5.568 million of which about 70% would be requested from the donor agency and the remaining would be mobilized by PLC from other stakeholders such as Marine Products Exports Development Authority (MPEDA), Fisheries Department and Forest Department.

Purpose of the study

Both CSPC and PLC-Utthan felt at this stage the need for an independent review of the experiments before moving on to the next stage of trials. As per the TOR (Annexure 1) the specific objectives of the study are:

- To assess and quantify the economic feasibility of the activity of aquaculture – lobster fattening;
- To document the processes involved and learning's generated from the pilot interventions;
- Scope and potential to scale up the activities to a larger number of villages with similar localized coastal eco-systems;
- To particularly study the effectiveness of the institutional interface at the village / community level to scale up the activities on a larger scale;

- To provide directions on the future in terms of second generation activities like marketing, scope for processing, potential for scaling up of the activities to include other fishing related livelihood opportunities with the target communities,
- To provide a basis for decision making on necessary improvements;

In addition, the consultant was expected to make a quick assessment of the proposal submitted by Utthan and make suggestions for improvement.

Methodology

The methodology consisted of the following:

- Informal interviews with various resource persons including Rambhai Ogania, PLC's consultant and key resource person for fisheries
- Four-day field visit to the two villages where the experiments were carried out (10th to 13th Aug '08)
- Perusal of internal reports and documents
- Brief internet survey on the state of lobster fattening
- Debriefing session at Utthan office on 14th Aug. (see Annexure 5)

Due to unprecedented rains on the days of visit, it was not possible to visit the actual site of the experiments. Detailed group meetings were held with the members of the SHGs in both the villages, who took the trouble to assemble at the appointed time and place in spite of the heavy rains. The disadvantage of not being able to visit the actual site did not come in the way of completing the study. This is because the author had the benefit of having visited the project site a few months ago (Jan '08) in connection with a mid-term evaluation of PLC-coastal. At that time the Akhtariya site had been visited along with a representative of MPEDA. The Chanch Bawadia site had not been visited at that time. Fortunately however, PLC had made a on-site training video of about 25 minutes duration which provided a fairly good idea of the cage method being deployed by the SHGs.

Considerable time was spent with Rambhai, the resource person, discussing the problems and prospects of this and allied activities like crab fattening in the region. Time was also spent in collating available information in separate reports, documentations in Gujarati and from Rambhai's own diary.

2. Lobster Fattening as a Livelihood Activity

Concept of lobster fattening

Lobster farming and lobster fattening:
The spiny or rock lobsters (*Panulirus spp*.) are marine crustaceans (shellfishes) commonly found in rocky shores and grow up to a body length of 60 cm. The dominant and most widespread species of the Pacific is the golden rock lobster. Other common

species are the painted lobster, the striped leg lobster, and the ornate lobster. Eight species of spiny lobsters, six shallow water species and two deep-sea species and the sand lobster contribute to lobster fishery of India. The shallow water species are: *P. homarus, P. ornatus, P. polyphagus, P. pencillatus, P. versicolor* and *P. longipes*).

A quick review on the Internet showed that scientists in different parts of the world are working on techniques to raise different species of lobsters on a commercial basis. In the opinion of many scientists working with the American lobster, commercial aquaculture can be achieved in the near future with a sufficient level of effort. Future projections for similar culture of the spiny lobster are not however, optimistic. There is considerable research investment in Australia and New Zealand to develop hatchery propagation and optimal grow-out culture and feed technology for spiny lobster aquaculture. Research to close the life cycle of rock lobsters in captivity has been conducted in Japan for more than 30 years, but commercial success has been elusive. Unlike the American lobster, which has a relatively short larval life (several weeks), the rock (spiny) lobster has a larval life of about six or seven months. The technical difficulties presented by the fragile, demanding requirements of the early life stages discount the use of traditional hatchery methods. The advantage of *lobster fattening* is that it skips that difficult stage of larval life, allowing the capture of juvenile lobster for commercial cultivation. (www.lobster_farming.net).

Sea Ranching:
An alternative approach to aquaculture is known as sea ranching. Unlike lobster farming and fattening, sea ranching of lobsters involves hatching of lobsters on shore and releasing of larvae into the sea where they grow in the wild and are harvested later. At a lobster farm at Kvitsoy, in Norway, experiments are on with the blue lobster (*Homarus gammarus*). The hatching lobsters are placed in black boxes. When they hatch, the larvae drift to the surface and are carried by the water down to translucent bottles where they are stored before releasing into the sea.
(www.uwp.no/bilder_uwp/man_and_ocean_Aquaculture_Lobster_farming.asp)

It is worth noting that the two approaches are not mutually exclusive and both can therefore be pursued simultaneously. Besides lobster fattening may not be feasible in all places because of non-availability of suitable rearing sites. In such cases sea ranching can be taken up without any difficulty. However, in order to make significant economic impacts on the fishing communities, sea ranching would need to be taken up on scale and in areas where sea currents do not affect the stock of lobsters in a big way.

Lobster fattening abroad

On-growing of wild-caught seed lobsters is widely practiced in Vietnam, the Philippines, and Indonesia. Farming is typically on a subsistence scale (limited by the availability of seed) although the magnitude of production in Vietnam is collectively very large (estimates vary from 1,000 to 1500 tonnes annually). In Australia and New Zealand, lobster seed cannot be taken for aquaculture except under strict and limited pilot license conditions. However, there is some in-sea and on-land holding of legal-size lobsters for

weight gain and/or more favourable (niche) marketing. At present, the Rock Lobster aquaculture industry in South Australia involves taking a small proportion of legal sized Rock Lobster (from the fishery) and holding them in sea-based pontoons in Port Lincoln and Kangaroo Island until the off-season. In doing this, it is possible to make the lobsters available to the international markets all year round (www.pir.sa.gov.au).

Although lobster fattening has been found to be technically feasible in various countries, ***Vietnam is probably the only nation doing spiny lobster farming on a large scale***. Here juveniles are harvested from the wild and stocked in cages and fattened upto market size of one kilograms within 12 to 18 months. (www.shrimpnews.com/FreeNewsBackIssues/FreeNewsMar2007016.html) In Vietnam, cage culture of lobsters started in the year of 1992 in the Khanh Hoa province, and significant expansion took place in the Southern Central Vietnam from Da Nang city to Binh Thuan province in the year of 2000 Ornate or spiny rock lobster (*Panulirus ornatus*) is the most important cultured species among others (*P. hormarus, P. timpsoni, and P. longipes*). There are approximately 35,000 cages of which approximately 20,000 cages are located in the coastal waters mainly of the Khanh Hoa sea. These marine cages are responsible for approximately ***1,500 metric tonnes of products and valued more than US$40 million in 2003.*** The average profit margin is 50%. Therefore, lobster cage culture is a profitable industry with the profit more than US$ 20 million annually. This industry involved more than 4,000 farmers/households and created 100 employment in grow-out farms a year (Tuan, and Mao, 2004).

Cages are designed in various ways depending on characteristics of culture areas and the farmers' financial conditions. Three main types of cages in use are described below (Tuan, and Mao, 2004):

Floating cage:
The bag of the floating cage is supported normally by a wooden frame with buoys. Lobster cages in the Nha Trang bay (Khanh Hoa) belong to this kind. This kind of cage is commonly located in waters with the depth of 10-20 m, e.g. in the Nha Trang bay.

Wooden fixed cage
The framework is made of salt-resistant wood. Wooden stakes with 10-15cm diameter and 4-5m length are embedded every 2 meters so as to create a rectangular or square shape. The bottom area of a farm is normally 20-40 square meter, but may be as much as 200-400 square meters. The

cage size is also varied. Each cage normally has a cover. The cage may be on or off-bottom. Fixed off-bottom cage is about 0.5 m far from the seabed. Fixed on-bottom cage is lined with a layer of sand. This kind of cage is suitable for sheltered bays and behind islands where there is shelter from big waves and typhoons.

Submerged Cage:

The framework is made of iron with a diameter of 15-16mm. The bottom shape is rectangular or square with an area normally between 1-16 square meter. The height is 1.0-1.5m. The cage has a cover and a feeding pipe. This kind of cage is common for nursing lobster seed in Nha Phu lagoon, and for grow-out farming in the Cam Ranh bay in Khanh Hoa, and in Ninh Thuan, Phu Yen provinces.

Lobster fattening in India

The development and progress of coastal aquaculture efforts in India have been concentrating mainly on shrimp or scampi so far especially in the coastal areas on the landward side due to their economic importance, as well as the ready availability of technology and ready market for the produce. Pilot or experimental trials have been attempted for other species of commercial importance. The Indian research institutes have already standardized the breeding technologies for many of the potential species in our waters. However, commercialisation of such efforts has not materialized due to various reasons. The potential candidates for mariculture in Indian coast are listed in the following table (Vishnu Bhatt and Vinod, n.d.):

Table 1: Potential Aquatic species for sea farming in India

Sl. No.	Name of Species	Scientific name
1	Asian sea bass	*Lates calcarifer*
2	Grouper	*Epinephelus spp*
3	Milkfish	*Chanos chanos*
4	Mullet	*Mugil cephalus*
5	Silver Pomfret	Pampus argenteus
6	Cobia	*Rachycentron spp.*
7	Tunas	*Thunnus sp, Euthunnus sp.*
8	Mud Crab	*Scylla serrata*
9	Rock lobster	*Panulirus spp*
10	Edible oyster	*Crassostrea spp.*
11	Pearl oyster	*Pinctada fucata, P.margaritifera*
12	Mussels	*Perna viridis, P. indica*
13	Clams	*Anadara granosa, Paphia malabarica*
14	Sea cucumber	*Holothuria scabra*
15	Sea weeds	*Gracilaria, Gelidiella, Kappaphycus etc.*

It is estimated that cultured shrimps constitute 63% of the quantity of shrimps exported from India. Therefore, in order to diversify the export basket, the Marine Products Export Development Authority (MPEDA) has set out an action-oriented plan which envisages increasing the share of non-traditional cultured varieties to about 50% of the total production from aquaculture. MPEDA has therefore, constituted a separate Society viz, ***Rajiv Gandhi Centre for Aquaculture (RGCA).*** RGCA has embarked upon various missions to standardize and popularize the aquaculture of potential species in Indian waters, which have commercial significance (*op.cit.*)

The following are some of the activities recently taken up by this organization.

a) Breeding of Asian Seabass (*Lates calcarifer*)
b) Cage culture of Asian Seabass
c) ***Fattening of Rock Lobsters***
d) ***Breeding and culture of Mud Crabs*** (*Scylla serrata*)
e) Artemia production
f) Breeding and culture of Groupers
g) Tilapia culture

On the basis of a survey commissioned by MPEDA in the nineties, it was concluded that about 2000 sq. km. of sea surface is ideally available to take up offshore farming and a production potential of 8 million tones of high quality marine fish is harvestable through cage culture practices. According to a vision formulated by MPEDA, the seafood export from India is targeted to reach US $ 4 billion by 2009-10. The contribution of aquaculture sector is expected to rise from the current level of US $ 0.7 billion to about US $ 1.5 – 2.0 billion for making this vision in to a reality (*op.cit.*).

.

In India, apart from PLC, Bhavnagar, Tuticorin is emerging as a center for lobster fattening. According to a news item in the *Hindu* (20th Oct. 2007) twenty women participated in a two-day training programme on the subject, organized by the Fisheries College and Research Institute, Tuticorin at its shore laboratory. The institute was advocating culture of juvenile lobsters (less than 50 gms.) in ***cement tanks***. Various factors required for fattening of lobsters such as stocking density, type of feed, formulation of pellet feed, assessment of growth rate, feeding rate and water recycling proves inside the tank were explained. The undersized lobsters were expected to attain about 300 gms in weight within four months and enable the farmers to fetch a price of Rs. 1500/kg. in the market. More details can be obtained by contacting K. Venkataramani, Dean FCRI.
(www.hindu.com/2007/10/20/stories/2007102053400300.htm)

Another report of the same initiative mentions that the package developed by FCRI is a result of a research and extension progarmme of the Department of Biotechnology, GoI. The case study of M. Francis, a fisherman of Tharuvaikulam near Tuticorin shows that the farmers are gaining significantly from the training. The method followed by him is a cage culture method. The ***cage is made of fiberglass reinforced plastic***. The first crop recently yielded 35 kg. lobsters, which were sold at a price of Rs. 700/kg. to exporters. Francis started with 200 juveniles weighing less than 100gms in the cage, which was provided to him by Maritech Research Center owned by FCRI. The cage was kept immersed in the sea at a depth of two meters for a period of 90 days and the juvenile

lobsters fed with food such as bivalves and trash fish twice a day. The average weight was 250 gms when sold and the survival rate of the lobsters was 80%. According to Francis, he made a clear profit of Rs. 18,000/- from the first crop of 35 kgs. (His gross income was Rs. 25,500/- while the cost of purchasing lobster seeds, feed and labour for maintenance of the cage was Rs. 6500/-). (Vimal Kumar, 2008).

The Suganthi Devadason Marine Research Institute (SDMRI) of Tuticorin is another institute providing technical support to fishermen and women interested in mariculture. The SDMRI joined hands with Tuticorin Multipurpose Social Service Society (TMSSS), which has under its fold 98 women's SHGs with a total strength of 2019 members. In Vellapatti village, SDMRI was instrumental in promoting crab-fattening project with financial support from Tuticorin District Administration. An amount of Rs. 5 lakhs was sanctioned to five SHGs to construct 12 tanks of two-ton capacity, a settlement tank and other equipment. The community-based crab-fattening project is the first of its kind in Tuticorin coast and has proved to be a great success. Each SHG is getting a net profit of about Rs. 2800 per crop through this project (Patterson, 2008.).

3. Background of the Bhavnagar Initiative

Initiation of Fishery SHGs

PLC's intervention in the fisheries sector began in 2004, when an initial survey was carried out to assess the dependency on fishing as a livelihood. A training programme in Victor village followed this where 58 people came forward for a two-day training. The people were all from the Vaghri community, which is not a traditional fishing community but its members are adept at catching small wildlife and many were practicing sea-shore fishing, albeit without legal permits and without proper equipment. After the training at Victor 32 people decided to come together to set up a self help group on a cooperative basis. 21 of these were involved in temporary fishing while 2 to 3 were practicing fisheries on a regular basis. Due to poor catch, and harassment by officials most of these people were unable to make a livelihood out of fishing and had to migrate to survive. The cooperative made it possible for them to:

- Gain legitimacy by procuring license for seashore fishing as well as deep-sea fishing.
- Access loans to buy fishing gear and boats.
- Get technical guidance from PLC's resource-person as well as from Fisheries Department to carry out sustainable and profitable fishing.
- Get a better price for their produce in the market

Fishing intervention and its impacts

On the suggestion of Rambhai, several changes in the fishing methods and norms were made (see Table 1, Annexure 2) which began to bear fruit in terms of increased productivity and income on a sustainable basis. Where the daily income from fishing was

Rs. 30-50/- before, now it has increased to about Rs. 70-80/- per day. On an average a family began to earn an additional Rs. 1000/- month and as a result, migration levels began to come down. Soon more villages began to join the movement and by the beginning of 2008 there were 21 such SHGs (Table 2, Annexure 2). These groups have been formed keeping the cooperative norms in view as there are plans to register them as cooperatives in due course.

Genesis of Lobster fattening and other mariculture opportunities

While working with the fisheries groups, Rambhai encouraged them to be innovative and make small experiments. At Akhtariya (as also other villages), there was a tradition of using small pits to store fish for a few days (say 10-15) and then sell them in order to get the right price. Rambhai recalled that during an exposure visit to Hindustan Lever at Chennai he had seen experiments on lobster fattening. He therefore proposed to the people at Akhtariya to try it out. This resulted in the development and standardization of the pit culture method for lobster fattening. The species of rock lobster found here is *Panulirus homarus.* The pits were made in soft rock on the seashore where the pits were flushed regularaly by tidal water. Pits of small size (*virdas*) as well as larger sized tanks were made to find out the best option.

At Chanch Bawadiya there are many creeks. The people used to carry fish and lobster in bags made of net and keep them for a while before marketing. Rambhai asked Bachubhai Verabhai, one of the members to put some juveniles in a net bag and tied it in a creek. After three months the lobsters had grown from 50 gms to 70 gms. And after another two months they became 150gms in weight, making them marketable. However, predators had damaged the legs of the lobsters affecting their market value. The experiment paved the way for developing the cage method and standardizing the culture procedures. The cages were made of bamboo sticks and nylon nets were tied in two or three layers around the bamboo structure.

In the same way, crab-culture was also initiated recently and the results are very promising. Although crabs fetch a lower price than lobsters, they are less prone to the kind of production risks faced by the latter. These experiments/trials and their outcomes are discussed in more detail in the next section.

4. Experiments on Fattening for Rock (Spiny) Lobsters

The information provided here on the lobster fattening experiments is based on the discussions with members of the mandals in the two villages (see Annexure 3 for reports).

Pit Culture at Akhtaria

Experiment/ trial details

The *Sagar Khedur Matysa Mandal* at Akthariya has 15 members (6 women and 9 men). About 8-10 members are actually involved in fisheries activities. Bharatbhai an active member of the mandal recalled that his uncle had made a pit for stocking *teetan* (lobster) about 15 years ago which was 10' x 10' x 5' in dimensions. He had made Rs. 60,000/- out of the venture. However, the risk of sabotage was great. People used to put the milk of *thor* (*Calotropis*) to kill fish. So the experiment was discontinued.

After the formation of the mandal it was possible to get permission for titan fattening. The Custom officials have certified that the mandal is not involved in any illegitimate activities on the shore. The Panchayat has given a no objection certificate and based on these documents the FFDA (Fish Farmers Development Agency) has issued permits to members of the mandal to carry out aquaculture on selected sites in the village.

Seed for titan culture (juveniles) are available for two months during *Bhadarwa* and *Aso*. They believe that about 50,000 juveniles can be collected from the coastline of the village. As per the experience gained so far, lobster fattening can be carried out in two cycles of four to five months each starting from November. The end of the second cycle runs into monsoon where there is danger of the salinity levels getting affected due to rainwater. Hence the second cycle may have to be cut short sometimes.

After selecting the proper site, the mandal made 28 small *virdas* (pits) of size 8' x 6' x 3' and three tanks of size 20' x 30' x 5'. Only two of the large tanks were used for fattening since one spare tank was needed to stock the titan during cleaning operations. The *virdas* were located at a slightly lower level where they were regularly flushed by the tidal waters. In the case of the tanks which were located at a higher level, about 1/4th of the water had to be drained out and fresh water pumped in with the help of a pump installed on the site.

Outcomes

The results were good. However, the journey was not smooth and they encountered numerous problems on the way to success. Lobsters are very sensitive to certain environmental factors such as temperature, salinity, acidity and alkalinity, and presence

of silt in the water etc. They are also vulnerable to attacks from natural predators in the water.

As the experiment progressed the members noticed that the lobsters at the base of the tanks became red. This did not happen in the *virdas*. Reddish lobsters are not diseased but considered weak and fetch a poor market price. They turn red due to a variety of reasons such as lack of oxygen, over crowding, lack of nutrition etc. When the temperature became high they put wet sacks on top of the nets to control the temperature in the *virdas.* Hot water currents were experienced soon after *Holi* festival (March). By March, the first season had ended.

They also had to take clean the pits regularly and ensure protection from predators like *vishad* (a snake like marine creature which predates on lobsters). During December to February the silting rate was the highest. They lost about 800-900 juveniles in a big tidal wave. Such a wave comes once in 20 years. If they had prior warning of the wave they could have saved the stock of juveniles by removing them from the pits and putting them in wet sacks till the danger was gone. Once they lost 51 *teetans* due to ingress of sweet water, which affected the salinity levels in the pits. On an average they lost about 25-30% of the juveniles because of these difficulties.

Most of the lobster culture work such as stocking of juveniles, cleaning the pits, replacing water, feeding etc was done by the men, although some women also took interest and knew what was to be done. Women's main role in the mandal was to sell the fish in the local village market. Thanks to the mandal and PLC's intervention they were now getting a decent price of Rs. 700-750/- in the village itself. The merchants from nearby markets like Una, Veraval etc came and collected the lobsters from the village fish market. In the past they could not dream of such a price. In some of the other villages fishermen still sold their produce at Rs. 300/kg to merchants in Mahua. Table 3, Annexure 2 provides the market information collected in 2005 for local markets. Similar data needs to be tabulated now to see the differences. Also market information from the Veraval market needs to be collected.

The trial showed that lobster fattening is a highly viable economic activity. Details of the economics of cultivation are provided in the section 5 of the report.

Cage culture at Chanch (Bawadiya)

Experiment/ trial details
The *Dariyai Putra Matsya Mandal*, Chanch (Bawadiya) has 33 members (15 women and 18 men). Bachu bhai Virabhai, an active member of the mandal, shared his experience of the *teetan* experiment, which he first did on Rambhai's suggestion. He kept some juvenile *teetan* in a small net bag and placed the bag in the creek. After about 4-5 months the *teetan* grew to about 5 kg. He remembers selling 2 kg to a fisherman in exchange for 60 liters of diesel as he was in need of diesel at that time while the fisherman was tempted to have a meal of *teetan*!

After this experiment they decided to go for cage culture. The *mandal* bought 800 sticks of bamboo (*Dendocalamus strictus*) all the way from Bharuch as these were not available locally. The other larger variety of bamboo is not considered suitable. The members themselves prepared the cages with design inputs from the resource person. After a process of trial and error the optimum dimensions of the cage were fixed at 6' x 4' x 3'. The shape of the cage was broad at the base and tapering towards the top. This was done with a view to prevent damage by wave action on the top. Each cage required labour worth Rs. 200/-, which was contributed by the members themselves. One cage could be prepared from 10 to 12 bamboo sticks. The bamboo pieces were fastened together with bamboo pegs because metal was to be avoided – being susceptible to corrosion. After the structure made of bamboo was ready this was covered by two or three layers of nylon net of 20 mm mesh. The cages were to be submerged in saline water in the creeks while ensuring that they did not touch the muddy base of the creek.

Outcome

In all 66 cages were placed in the creek. Now only 40 are left, since the rest were lost to the sea during a major tidal wave some time ago. Two cycles of production were undertaken and both the times they sold lobsters worth about Rs. 50,000/- The third cycle was when the disaster took place and they could recover only about Rs. 10-15,000/-. Each cage can accommodate 7-8 titans. Details of the economics of lobster fattening by cage method are provided in section 5 of the report.

Enthused by the success in the cage culture, a group of fifteen made on their own initiative a large pit / tank where they began to stock *teetan* for fattening. They had invested about Rs. 5 lakhs in the venture in terms of labour to make the tank and were expecting to harvest lobsters worth 12 lakhs at the end of the cycle.[1] Unfortunately they faced a major setback in the form of sabotage. Due to jealousy within the village some one put Endosulphan, a broad-spectrum pesticide, in the pit leading to heavy attrition of the juvenile *teetan*. Ultimately they could sell only 20 kgs and recover about 15,000/- from the investment. This was a clear case of sabotage and if the members had wanted they could have approached the village *Panch* to find out the culprit on the basis of suspicion. However they chose not to do so as it would have created internal social problems. Until this

[1] These figures could be exhagerated. The author did not have the opportunity to visit the site and make his own assessment.

problem is resolved at a social level, the members feel insecure in undertaking any such ventures in the near future.

The members are more enthusiastic about crab fattening as it is a less risky proposition. In a recently concluded experiment, one of the members kept juvenile crabs for two months in a tank of dimensions 30' x 10' x 7'. He had stocked about 6500 juveniles and had to provide 5 kg of feed per day. When the crabs became 150 gms which is a marketable size, he sold them in the local market at a price of Rs. 100/kg. Assuming that he was able to sell about 60% grown ups, he must have made a gross income of about Rs. 3.9 lakhs! However, the economics of crab fattening can only be ascertained once the mandal carries out trials similar to the ones done for lobsters. The species of crab cultivated in Bhavnagar is different from the one, which comes from Jamnagar coast in the local market. The former fetches more than double the price of the latter as local people prefer its taste. It was also mentioned that the best price is obtained between 150-450 gms. After 500gms the price drops as the meat becomes tougher and is not preferred by clients.

Budget and its utilization

The total cost of the project was Rs. 5.565 lakhs of which CSPC's contribution was Rs. 4.835 lakhs (see Table 3, Annexure 2) and the balance Rs. 0.73 lakhs (representing 13.11%) was contributed by Utthan mainly in terms of human resources deployed by it. Of the nine budget heads, the most significant were infrastructure development for rearing lobsters (48.6%), capacity building (25.0%), Operational cost (12.2%), traveling expenses (6.2%) and documentation and communication (4.9%).

The budgets for capacity building, travel expenditure and documentation were exceeded by 9.93%, 38.06% and 12.36%. This was compensated by the savings in infrastructure by 13.2%. (see table 3, Annexure 2). Based on this experience a more realistic budget may be put forward in the next phase. The new budget would also be guided by additional activities that may have to be taken up as shown in the assessment below.

5. Assessment based on the Experiments

Technical feasibility

The first year's experience in lobster and crab fattening has provide a rich source of knowledge to the mandals and PLC alike. The environmental conditions at the culture site for both the methods are different through different parts of the year. These varying conditions and the associated risks have been noted carefully especially with respect to the risks and opportunities (see separate discussion on risks below). Two cycles could be taken in the first year. The results show that technically lobster fattening is viable in the project area provided adequate attention is paid to monitoring the environmental parameters and risks involved and taking action to preempt and or mitigate the risks. In

the case of cage culture it was felt that perhaps only one cycle could be taken because the risks involved in the fluctuating conditions of the water during monsoon were too great.

For any biological experiment of this nature the trials should be continued for at least three seasons (years). Also given the encouraging results in the first year it would be worth scaling up the trials to a few more villages preferably in different ecological conditions. This would help to validate and standardize the methods and generate more information for contingency planning. The idea of a second project to consolidate and deepen the understanding of lobster (and other marine species amenable to culture) fattening is therefore justified and logical.

The present team has already developed a good understanding of technical aspects such as a) criteria for site selection b) design parameters for culture c) process of culture d) parameters for effective marketing e) quality control and f) parameters for monitoring and evaluation. PLC would be advised to develop a handbook based on this understanding so that the scaling up process may be facilitated. As a part of this exercise I have tried to put down the basic information available with PLC on the *package of practices* to be followed for both the methods (see Annexure 4). However, in due course this will need to be refined and developed in more detail during the second phase.

The second phase would enable a) refinement of the existing pit culture technology b) exploration of alternative cage material for the cage method d) exploration of ways to minimize the risks during the second cycle so as to be able to take two cycles instead of one e) standardization of crab fattening methods f) exploration of seaweed utilization in villages where these pose to be a major menace for fishing g) experimentation with other species which can be domesticated for extensive aquaculture. Since the methods adopted here are not intensive and all natural, environmental externalities would be expected to be minimal. However, future studies should also take into account an assessment of environmental impacts on the coastal zone on account of such activities if undertaken in a big way. This is particularly important in view of the sensitive nature of the seacoast ecology and the stringent central government rules that control this area through Coastal Regulation Zone (Notification) under Forests Act, 1986, amended 2001.

Marketing feasibility

The marketing intervention for fisheries in general had started with the formation of the fisheries SHGs in 2005 itself. The ability of the SHGs to get a dramatic price realization and that too sitting in the village is commendable. The lobster price before intervention was about Rs. 150-200/kg. It has now gone up to Rs. 700-750/kg. This represents a jump of about ***four times*** which can be attributed to a) organized effort b) better access to market information and c) aggregation of produce (although the full potential of this is yet to be achieved).

There is scope to improve the price realization even further during the second phase when more number of registered cooperatives would be able to aggregate their produce and put it in the market. During this phase it would be possible to sell directly to the export

processing houses located at Veraval. They sell lobsters to foreign markets, which are frozen in blocks of ice individually. Each such lobster sells at $ 6-7 (about Rs. 2500/). A preliminary inquiry has shown that if the cooperatives can offer 500kg of lobsters at a time they would be happy to come down to the site to collect it at a higher price that what the local market can offer.

These are the aspects that need to be explored in the second phase. It is suggested that a ***marketing study*** be carried out to clearly identify the value chain, the prevalent prices at each link in the chain, the services offered by each member of the chain and finally the opportunities to jump the chain and assimilate some of the existing functions within the federation (proposed) of cooperatives

In the long run the federation of the cooperatives can think of collective marketing directly to the export houses and or any other suitable strategy to gain better control over the market. However, in the ***short run*** however, as mentioned by the people at Akthariya, there are several advantages of selling locally:

- While taking the *teetan* to distant markets they experienced a loss in weight of about 15%.
- While selling at the village the merchants could not cheat them in weighing.
- Since the price was negotiated on the weight of the lobsters, merchants would often pass off borderline cases in the lower weight slab. If they did that here (in the village) the fisherwomen could refuse to sell.
- Now the cooperatives are connected to 8-10 merchants by mobile and have access to the prevailing price on a given day. This helps them to negotiate price better.

Market Information

The current prices at Aktharia fish market were as follows: Lobsters (700-750/kg), prawns (Rs. 200/kg.) crabs (Rs. 100/kg), other fish (Rs. 100/kg.). PLC has been routinely keeping track of prices in the local markets, which include Chaach, Khera, Victor, Katpar and Akhtariya. Table 4, Annexure 2 shows the information on prices collected during 2005. Similar information needs to be collected from the market at Veraval. Although Rambhai has a fair idea of the seasonal variation in prices at Veraval due to constant exposure, it would be good to collect the past data on monthly prices to study the trends in the same. This can be collected through the good offices of MPEDA, which has an office in Veraval. The factors affecting prices at Veraval need to be studied in more detail and can be part of the marketing feasibility study mentioned earlier.

Economic feasibility

Reports of lobster fattening in other parts of the world have concluded that the margin can range from 50 to 100%. The initial trials and the sale of produce in the local markets has given PLC and the *mandals* a rough idea of the present economics as well as the potential for future. Income and expenditure of the first round of trials for both the methods is provided below.

Pit Culture Method*:*

The accounts provided below are taken from the recordings made by Rambhai in his diary, since the books of accounts of the cooperative could not be accessed during the visit. The income and expenditure shown for the first cycle is indicative of the economics of lobster fattening. The economics is highly favourable because the lobsters are fed with trash fish, which was otherwise wasted. The only out of pocket recurring expense is the cost of the net for catching juvenile lobsters, which has a life of less than one year.

First cycle: 15/6/07 to 10/12/07
Duration of cycle: about six months. The cycle was delayed due to lack of experience and time taken to collect seed (juveniles).
Total area of 28 *virdas* and 3 tanks: 3144 sq feet.

Income: ***Rs. 80,317/-***
(This is an aggregation of sales that took place on different days in different quantities. The prices ranged from Rs. 550 to 750/kg.. Assuming an average price of Rs. 650/kg. the total production was 123.5 kg.)

Expenditure	***Amount(Rs.)***
Capital Expenditure:	
1) Earthwork to make *virdas* (life 10 yrs.)	27,320/-
2) Cover net (life 3 years)	35,000/-
3) Diesel machine, PVC pipe etc.	23837/-
4) Hand-pump (drinking water facility on-site)	2160/-
5) Cement and stone material	12410/-
6) Weighing machine	500/-
7) Insulator box (received from FFDA)	3000/-
Total capital expenditure	104,227/-
Recurring Expenditure:	
1) Labour for preparing pits, cleaning, changing water, etc.	1440/-
2) Cost of feeding (includes imputed cost of feed @ Rs. 1/kg)	900/
3) Watch and ward	900/-
4) Cost of nets for catching juveniles (half allocated)	3000/-
Total recurring cost	6240/-
Contribution towards Capital Expenditure and cooperative overheads:	74,077/-

Second Cycle: The complete information was not available. However total income was similar at Rs. 80,076/- and the expenditure was likely to be similar.

The above results show that the capital costs can be recovered during the first year itself.

Cage Culture Method:

First Cycle: From 23/5/07 to 12/12/07

Income (from 65 cages):	***Rs. 54,118/-***
Expenditure:	
Capital Expenditure:	
1) Bamboo material (life 10 yrs)	37,000/-
2) Cover net (life 3 yrs)	29,000/-
3) Weighing machine	500/-
4) Labour to make cages	4000/-
5) Labour to tie double cover nets	2700/-
5)	
Total Capital cost	73,200/-
Recurring costs:	
1) Watch and ward	900/-
2) Placing and anchoring the cage	400/-
3) Marketing cost	180/-
4) Repair of cages	700/-
5) Cost of feeding	400/-
6) Nylon nets to catch lobster (half cost allocated)	17,000/-
Total recurring cost	19580/-
Contribution towards capital cost and overheads	34,538/-

Second Cycle: The total income was 54000/- from 66 cages and the expenditure pattern was similar.

The above figures indicate that the economics of cage culture is also attractive although not as much as that of pit culture method. Besides, the nets are subject to wear and tear, being attacked by predators. Provision must also be made for cages, which are lost to the sea during tidal waves and storms. The cost of cultivation seems to be lower since the lobsters get natural feed in the flowing water. The growth is considered to be better that in the *virda* method because the surroundings are less artificial. However, the risks are greater and losses are more due to predators, tidal waves, fluctuations in salinity due to release of water from saltpans etc Therefore, the economics needs to be seen in conjunction with the risk factors. More trials would give a better understanding of the risk factors and how to mitigate or pre-empt them, thereby making the economic

proposition more attractive. A more detailed discussion is provided on risk assessment later in the report.

An effort has been made to work out the economic viability of a typical crab-fattening pit based on the initial experience of one of the members of the Chanch Bawadia mandal (Table 5, Annexure 2). Though tentative the estimates indicate that the economics of crab fattening may perhaps be even more attractive than that of lobsters. At the same time the risk factors are even less. However, it is too early to jump to conclusions on the basis of one observation. There is a need to take up more extensive trials during the next phase with detailed and proper documentation.

Social and institutional feasibility

The fisheries SHGs are drawn mostly from one community. Hence the social cohesion among the members is expected to be high. However, the emerging prosperity of these groups can pose a threat to other local leaders and this may be the prime reason for sabotage. Unfortunately marine aquaculture is highly vulnerable to sabotage. Hence the social issues need to be given more attention.

Another issue worth considering is that not all members of the fisheries SHGs are involved in fishing or related work. This can in the long run create problems especially in terms of benefit sharing etc. These people who are not engaged in fisheries at present may have joined the mandal in order to lend support to the others who are their kith and kin. Some of them may eventually take up fisheries when they find that it is more paying than their present occupation. This does not seem to have happened as on 29th June 2007, as show in the collective data for 17 mandals (see Table 2 below and for details see Table 6, Annexure 2). As the table shows, about 45% of the members are engaged in fisheries while the remaining 55% are not. There is scope to involve the 52 women who are currently only housewives and the 68 who are engaged in ordinary labour. This is something that the mandal leadership as well as PLC facilitators can work out together.

Table 1: Occupational profile of members

Particulars	Men	Women	Total
Total members	137	180	317
Members engaged in fishing activities	59	83	142
% members in fishing activities	43.1%	46.1%	44.8%
Household work	52	-	52
Salt pan workers	NA	NA	14
Diamond polishing	NA	NA	8
Labour	NA	NA	68
Others	NA	NA	33

The norms for working with virdas and cages need to be worked out by the mandals. In the past the trials were done collectively with a group of member pooling their labour and sharing the benefits. Such a system may not work when large number of virdas / cages

are involved. In such case it may be best for the mandal to allocate a fixed number of virdas/ cages to each family according to their capacity and their need. Aggregation can be done for the purpose of purchase of inputs like nets and bamboos etc. and for marketing of produce. The social wing of PLC will need to put in more efforts to get the mandals organized while keeping the values of equity, gender and sustainability in view, as it does in all its projects.

SWOT Analysis

Strengths

- The main strength exists in terms of the institutional capital that has been built up over time in the form of 21 fisheries SHGs, which are working on cooperative principles. These SHGs will need further capacity building inputs from the staff of PLC.
- Lobster and crab fattening have already been demonstrated in two villages and this has evoked a lot of interest among the target community who see it as a possible way out from stress migration.
- A repository of experiential knowledge has been built up on the subject and a team of workers have been trained who can help replicate the model in other villages.
- Although the method has been developed locally, the fisher-folk are open to the use of scientific principles and methods. They routinely measure the temperature, pH and salinity using modern instruments provided to them, under the guidance of PLC's resource person.
- PLC as a facilitating institution can provide the necessary guidance, support and linkages for the activity to grow and flourish

Weaknesses

- Many members of the SHGs are engaged in non-fishing livelihoods and may not have the same commitment as the ones who are actually doing the fishing work.
- The books of accounts of the mandals are presently written in a manner that makes it difficult to extract information about the lobster trials. Hence the mandals' accountants may need some guidance to write the accounts in a manner that reflect the performance of the trials separately and/ or to bring out periodic statements on the income and expenditure of the trials.
- Both PLC and the SHGs are presently dependent on Rambhai as the key resource person. Since Rambhai is a senior citizen and has recently had an angiography done, there is an urgent need to build up a youthful team which can pick up the necessary knowledge and skills under his guidance.
- PLC is expected to be a knowledge center apart from a platform for sharing issues, ideas and innovations. It should be strong in documentation, procuring information from other institutions and providing the necessary linkages. This does not seem to be happening to the extent that it should. As such the documentation team and knowledge center needs to be strengthened.

Opportunities

- Lobster is a high value produce, which fetches a good price in the local market itself.
- There is scope to move up the value chain over time and keep on improving the price realization through collective marketing. Veraval located about 100 kms away is a major center for exporting fish. It has at least two large processing houses, which deal with lobsters.
- Even when consumed locally it is good as it has high nutritive value
- The local shore-line has some good spots where juveniles are found in adequate quantities
- Plenty of suitable sites are available on the local shoreline for both the methods of lobster fattening. The use of alternative methods and materials e.g cement pits can further extend the scope of this activity in other sites as well.
- There is scope and interest among the target communities to develop this activity as this can save them from distress migration. Opportunities for diversifying into other forms of mariculture also exist and remain to be tapped.
- Similar experiments are being conducted in Tuticorin with support from the Department of Biotechnology. In other countries such as Vietnam lobster fattening is a big industry. There is much to learn from these and other such experiences.
- The overall trend in coastal areas shows that agricultural productivity is affected due to salinity ingress and fisheries is declining. In arid coastal areas such as Bhavnagar-Amreli this is leading to severe migration and alternative livelihood options need to be generated to restore the lives of these families to normalcy.

Threats

- Lobster fattening is a risky business because of a number of environmental factors that may not always be easy to control. These factors can lead to both loss of stock as well as equipment. The risk factors are somewhat different for the two methods of culture as shown in tables 2 and 3 below.
- The fishermen themselves are at risk while working in the creeks as baby sharks and poisonous marine creatures can attack them. Many people prefer not to take up this occupation because of such risks.
- In some villages social equations are not favourable leading to jealousy. Lobster fattening is particularly vulnerable to sabotage and ways of protecting the stock must be found out.
- Less than half the members in the SHGs are actually involved in fishing activity. The existing institutions need to be strengthened and membership rules as wells as rules for sharing responsibility and benefits need to be worked out.

Risk Assessment Strategies for dealing with them

Table 3 presents an assessment of the main risks for pit culture along with possible ways of minimizing these. Some of these alternatives could be explored in the next round of experiments.

Table 3: Risk Assessment of Pit culture Method

Risk Factor	**Magnitude**	**Probability of occurring**	**Alternatives for Mitigating**
Hot weather and hot water flows can adversely affect the juveniles	High	Moderate	Avoid hot season; Monitor temperature twice a day, temporarily remove juveniles in case of sudden hot water currents
Rainfall can affect the salinity levels and lead to attrition	High	High during monsoon	One alternative is to locate the pits on "bets" (mini islands on or near the seashore)
Crabs and other predators can easily hide in the very holes provided in the sides of the pits as protection for moulting lobsters.	High	High	Explore ways of fastening the cover nets very firmly; Find out ways to trap and or deter predators
Mud and silt can adversely affect the growth	High	High during December to February when silt load in the water is observed to be more than usual	Regular cleaning of pits; Can explore possibility of using filters that prevent silt from entering; Select a location where silt is trapped naturally – e. g. on the *bets* the southern side gets muddy with high silt load, so pits should be located on the northern side of the *bet*.
Risk of nets opening up during stormy weather and strong tidal waves	High	High	Search for methods to secure the nets more firmly; Change the location to higher spots such as *bets*
While making the pits, if the rock is hollow beneath, sweet water can enter	High	Low	This risk can be avoided by carefully studying the site during site selection.
Risk of pollution due to increasing industrialization on the sea-coast	Low to High depending on the source	High	If the industrial activity is likely to affect fisheries in a big way, PLC may have to take the initiative to protect the interests of fishermen by participating in open forums held before Environmental clearance is given to industry. If prevention is not possible, the industry may be asked to internalize their externalities or carry out safe disposal of wastes. Sites close to existing jettys, ports, industries etc should be avoided.
Market risks – risk of fluctuating prices	High	Low	This risk is low as of now because there is a high local demand and the produce can be sold locally at a reasonable price. Once the operations are scaled up the produce is sold to export houses, the nature of market risks may

			change.
Risk of sabotage – by putting fish poison in the waters	High	High in some villages only	If there has been a precedence as in the case of Chanch, the culprits should be exposed and/ or social sanctions against such acts be made known in the village PLC's strong backing for the mandals should be made known and the possibility of resorting to legal action as a measure of last resort be considered
They may be evicted by government officials without notice because property rights not secure	V. High	Low	FFDA has given them permission to individual members of the mandals to carry out fishing on the seacoast. However the legal position of the land is not clear and such land has not been given on lease to the cooperative. Hence the property rights are still insecure. To rectify this situation PLC must ascertain the legal status of the land and find out which rules govern its usage. Following this, suitable permissions from the relevant agencies must be sought for the mandals rather than individuals.

A similar risk analysis has been carried out for the cage culture method also, which is shown in table 4.

Table 4: Risk Assessment of Cage culture Method

Risk Factor	**Magnitude**	**Probability of occurring**	**Alternatives for Mitigating**
If the bamboo is not of good quality the cages may disintegrate quickly	Moderate	Low	This can be avoided by not compromising on the quality at the time of purchase; Bamboo sticks with smaller inter-nodal space should be preferred Can explore alternative materials for building cages – fiberglass, plastic drums etc.
Water quality not in our control in the creeks; risk of salinity levels dropping suddenly due to release of rainwater from salt pans upstream	High	High during monsoon only	The only way to avoid this is to avoid culture during monsoon season.
Attack of predators like *visher* (snake like) and crabs is much higher in creeks	High	V. High	Make double or even triple layer of cover nets on the cage, each layer being separated by and 1 to 1.5 inches; also wrap the nets in such a way that the meshes are crisscrossed making it difficult for crabs to attack and serving as a trap for *visher* Explore alternative material for building cages – for instance fiberglass material used by the institute in Tuticorin or plastic drums with suitable perforations etc.
Predators like *magri* (baby sharks) can also attack the legs of human beings working in the	High	Moderate	Insurance of fishermen involved in such work; Protective gear could also be explored

creeks			
If the cage gets severed and falls to the bottom, the juvenile lobsters will die as they cannot tolerate clay and silt	High	Low, except in case of sabotage, or during stormy weather	Routine checking of the cages; proper system of watch and ward can take care of this risk Selection of creeks closer to home is an obvious solution to mitigate this risk, although this may not always be available
During a combination of high tide and storm in the sea the chances of loosing cages to the sea are there	V. High	Low	At present stones and logs are being used as anchors to tie the cages in the creeks; during a major storm even 20 kg anchors are not enough as the stones are also dragged away by the waters; The only way to preempt this risk is to develop an early warning system and to follow the calendar of high tides (which tides are strong and which are weak depend on the position of the moon and are predicted by the lunar calendar). The cages may have to be removed to a safe place at such times.
Market risks – risk of fluctuating prices	High	Low	This risk is low as of now because there is a high local demand and the produce can be sold locally at a reasonable price. Once the operations are scaled up the produce is sold to export houses, the nature of market risks may change.
Risk of sabotage – by putting fish poison in the waters	High	High in some villages only	If there has been a precedence as in the case of Chanch, the culprits should be exposed and/ or social sanctions against such acts be made known in the village PLC's strong backing for the mandals should be made known and the possibility of resorting to legal action as a measure of last resort be considered
Risk of pollution due to increasing industrialization on the sea-coast	Low to High depending on the source	High	If the industrial activity is likely to affect fisheries in a big way, PLC may have to take the initiative to protect the interests of fishermen by participating in open forums held before Environmental clearance is given to industry. If prevention is not possible, the industry may be asked to internalize their externalities or carry out safe disposal of wastes. Sites close to existing jettys, ports, industries etc should be avoided.

It has been noticed that the risks involved in crab fattening are much less. A similar risk assessment needs to be done for this activity as well. Crabs are less prone to predator attack. However, they are more likely to cut the nets and escape or make burrows in the side of the pits and escape. Regular feeding, slippery sides and other measures are recommended to minimize these risks.

Some general strategies:
A general solution for both the methods for lobster fattening would be to explore the possibility of getting *insurance cover* for both the stock of lobsters as well as fishermen.

Since the economics is attractive, the cooperative/ mandal would be in a position to pay the premium collectively. Apart from that efforts should be made to reduce the period of one cycle from five to four months so that two cycles could be accommodated in a year without running into the monsoon months when the risks are very high. This could be achieved through better feeding and culture practices. The use of commercial feed to supplement the trash fish currently being fed could be explored. Husbandry methods that lead to earlier moulting could also be explored. In one experiment carried out at Akhtariya, the "moustaches" of 16 lobsters were trimmed (see report on village meeting at Akhtariya in Annexure 3). It was noticed that four of these experienced early moulting by a month. Also the body weight of treated lobsters was 15 gms more than that of control lobsters. However, the local people did not find it attractive because the "moustaches" did not grow again – thus the net weight of the lobsters sold was not significantly different. Such experiments could lead to breakthrough in reducing the cycle, which is very important from the viewpoint of reducing the risk factors. In the short run, it is advisable to go for only one cycle so far as the cage method is concerned, since the risk factors in the creek are far greater during the monsoon months. Instead, more number of cages can be placed in the creek to achieve the desired turnover. However, it will have to be seen how this affects the economics of cage culture.

6. Scope for Scaling Up of Trials

Pit Culture method

That there exists considerable scope for scaling up this activity on the Bhavnagar coastline was known to the PLC. To ascertain this in a more precise manner PLC's resource person, Rambhai made a survey of fourteen villages. In these villages he got together a group of fishermen from the mandal and did a PRA in order to assess the suitability of potential sites for the pit culture method. Rough sketches using PRA methods have been prepared indicating the approximate position of the identified sites. The findings of the survey are still in the form of notes and it is recommended that these be compiled in the form of a pre-feasibility report so that it may serve as a base for further study.

The summary of the findings are provided in Table 7, Annexure 2. As the table shows, suitable sites were identified in 9 out of the 14 villages. There are 17 potential sites covering an approximate area of 24.5 ha. The potential members who can get involved in this activity are about 150. The potential area for catching lobsters in these villages is estimated at 329 ha.

The above assessment has been made with the help of in-house expertise and local knowledge. It needs to be supplemented with scientific assessment of various environmental parameters at various points in time during the day and across seasons. The key measurements include *salinity* levels of water, *temperature* of water, *pH* of water, *siltation and clay* levels in the water at the chosen sites. To carry out this assessment, it is suggested that PLC take the help of the Fisheries College at Veraval.

Budgetary provision may be made in the second phase to engage the services of a professional institution to complete this task. In addition, members of the cooperative may be identified to make observations at the proposed sites at various times of the year to assess other environmental factors such as – population of predators, currents of sweet water, currents of warm water etc.

Cage culture method

In addition to the above, there are a number of villages where cage method can be taken up such as Visaria, Victor, Chanch Bawadia, Chanch Bandar, in Rajula taluka and Kathpar, Neep, in Talaja taluka, Sartanpura and Krishnapura in Ghoga taluka. A survey similar to the one described above may be carried out by PLC to identify the suitable creeks for cage culture. The services of the same formal institute may be taken to assess the sites identified through PRA, on the scientific parameters mentioned above.

7. Institutional Support for Trials

Existing

In the present institutional set up at PLC, the main responsibility for fisheries is borne by Rambhai, who serves as a consultant to PLC. The idea of employing him as a consultant was that in due course he would provide consultancy to the mandals who would pay him for his services. Hence a decentralized self-supporting model was visualized. However, this does not seem to have worked. PLC and Utthan need to find out why the proposed model did not work, whether it can be made to work in future and if not, what provision can be made in the budget to ensure that Rambhai gets his due.

Rambhai is being provided institutional support for facilitating the work of the mandals, ensuring gender sensitivity etc by various other members of PLC. However the present reporting lines are a source of friction. This again needs to be sorted out in the short run.

Suggested

The second phase envisages implementation of trials in at least 10 new villages over the next two years. I have proposed an even more ambitious target of 15 villages over three years (see next section). Given Rambhai's age and health, he cannot be expected to carry on the show on his own. This is something the PLC is aware of and efforts are being made to recruit two graduates from the fisheries college in Veraval. To implement the next phase of the trials it is suggested that these two youthful graduates report directly to Rambhai as apprentices. In addition, two persons with social science background from PLC be allowed to join the fisheries team on a full time basis. Much work will need to be done to build the capacities of these institutions so that they can handle social issues such as village level jealousies and latent conflicts that are affecting the programme adversely. Initially a senior person from PLC may be asked to spend time to find out what happened

at Chanch Bawadia (reference to sabotage incident), and how it can be prevented in future.

8. Recommendations for modifying draft proposal

In the light of the findings of this review, the following changes may need to be made in the proposal. These changes can be made after due consultation between PLC-Utthan and CSPC.

i) The proposal should include a summary of the main achievements of the previous project. It should also highlight some of the difficulties faced during implementation.

ii) It should include a brief literature review of the state of mariculture in India and of lobster fattening in particular.

iii) At present the draft proposal does not show any intention of continuing with cage culture method. It is suggested that at least a few villages (say five) be include where the cage method can be pursued further. In this connection the risk analysis presented in this report would serve useful to modify the strategies for future.

iv) In the light of PLCs plans to pursue a national agenda through a network of like-minded agencies and institutions, it is suggested that some provision be made for developing training manuals and IEC materials.

v) For the same reason, PLC should plan to help at least five other agencies in other parts of coastal India to carry out similar trials with the coastal communities that they may be working with. This will help to validate the experiments in different climatic conditions and deepen the understanding of the process. It will also help in the diffusion of the new technologies.

vi) It is suggested that PLC should collaborate with the two research and training institutions that are active in Tuticorin and are currently engaged in developing lobster and crab fattening technology on similar lines (see section 2 of this report). It should also contact Department of Biotechnology, which has sponsored the research project on fiberglass cages at Tuticorin, for financial support and for carrying out trials with similar cages in Bhavnagar area.

vii) The project should have active collaboration of MPEDA, which is involved in extension for mariculture. This would enable PLC to explore the other available opportunities in mariculture and also help to bring in more scientific vigour in the present experiments.

viii) It is proposed that the number of villages be raised to 15 (adding five villages for cage culture) and the time project be increased to three years. Three years is considered optimal because usually the first year goes in preparing the ground, getting necessary permits, organizing groups etc. For any biological experiment involving cultivation/ husbandry of plant / animal species, the thumb-rule is that the experiment should generate evidence over a period of at least three years. If the first year is lost in

preparatory work, PLC would not be able to generate scientific data of trials over three years.

ix) The project should provide for administrative expenses for putting the mandals as well as trial sites on a proper legal footing. This means handholding and expenses related to registering cooperatives, obtaining no objection certificates from various departments and getting permits from FFDA etc. Since multiple agencies are involved in controlling activities on the seashore, a lot of time and energy is expended in clearing the administrative hurdles, which the project should take note of and make suitable provisions for.

x) Regarding choice of formal institutions, PLC-Utthan should take a decision in consultation with the mandals as well as legal experts. One alternative is to keep the mandals as informal institutions, which form the building blocks of just one formal institution for marine aquaculture/ fisheries. This institution could either be a cooperative or a producers' company. The other alternative is to register each village level institution as a cooperative. (Registering these, as producer companies at this level would not be practical because the minimum equity to be raised would be way above the capacity of individual mandals). The advantage of having just one formal institution is that it would cut down the administrative and legal costs dramatically and also make it easier to get the permits.

xi) In order to facilitate trials in 15 villages and provide handholding support to the mandals over a period of three years, PLC will need to set up a separate team for fisheries/ mariculture sector. Rambhai should lead this team. It should include two young fisheries graduates who would get trained over time and become valuable resource for supporting such activities in future. The team should also include two staff members who work on the social and institutional aspects (including gender and equity) and build the capacities of the grassroots institutions. The head of the team should report directly to the head of PLC instead of reporting to the team leader NRM, since the present NRM team has expertise only in agriculture and animal husbandry. Fisheries and marine aquaculture require a different set of skills and knowledge base.

9. Conclusions and Recommendations

The lobster fattening project supported by CSPC has shown over two seasons that this is an economically attractive proposition and that the capital costs can be recovered in the first year itself. The economics of pit-culture is somewhat more attractive than that of cage culture. Apart form this there are indications that crab fattening can be an equally viable livelihood activity, but this needs to be verified with the help of formal trials by the *mandals*. The activity is presently seen as a supplementary activity to seashore fishing. However, it also has the potential of providing year round livelihood options for local people in Bhavnagar and thereby arresting stress migration.

There are significant risk factors associate with lobster fattening, which can deter people from taking it up unless these risks are mitigated. While some risk factors are common for both the methods many are different. In general the risks are high during monsoon and more so in the creeks, making the second cycle of cage culture difficult to complete. This report presents a preliminary assessment of risks along with measures/ strategies to preempt or mitigate these risks. Testing these ideas would become an important agenda for the forthcoming project.

The brief literature review carried out for this study shows that lobster fattening is being tried or practiced on scale in various other places in the world including India. Interestingly the methods and materials involved vary quite a bit. Therefore there is a lot to be gained by visiting such places (Tuticorin in India, Vietnam abroad) to exchange ideas and learn from each other. Some of these alternative materials or methods can also be tried out in the forthcoming project.

Crab fattening is emerging as a less risky form of mariculture and also has a lot of potential. The local variety fetches more than double the price than that of the variety, which comes in the local market from Jamnagar. Other alternatives of mariculture such as use of seaweeds etc can also be explored and tried on a small scale during the forthcoming project. This would help to broaden the base and provide different alternatives to cover the entire year.

It is suggested that the trials be conducted for a period of three years and in collaboration with an agency like MPEDA in order to gain legitimacy and infuse greater scientific vigour.

Suitable changes in the draft proposal need to be made as recommended in the previous section. The budget would also need to be reworked according to the new activities proposed and longer duration of the project.

The project should provide for administrative expenses for putting the mandals as well as trial sites on a proper legal footing. Care should be taken to ensure that the property rights of the *virdas* etc. are secure. A legal opinion should be taken to ascertain that mariculture does not violate the central government's regulations for conservation of coastal zone ecology. In case of any discrepancies, policy advocacy for creating a space for extensive and natural mariculture (as opposed to chemical and intensive mariculture) may be taken up by PLC as part of its national agenda.

Finally, PLC will need to set up a separate team for fisheries/ mariculture sector. Rambhai the key resource person who has taken the initiative to this level should lead this team. It should include two young fisheries graduates who would get trained over time and become valuable resources for supporting such activities in future. The team should also include two staff members who work on the social and institutional aspects (including gender and equity) and build the capacities of the grassroots institutions.

References

Bhatt Vishnu and P. N. Vinod (n.d.) "Development of Sea Farming in India – Perspectives from an Export Angle." Kochi: The Marine Products Export Development Authority, GoI.

Patterson Jamila, (n.d.) "Capacity building among fisherwomen – a case study from Tuticorin coast of Gulf of Mannar, Southeast coast of India". Tuticorin: SDMRI

Tuan, L.A. and Mao, N.D., (2004). "Present status of lobster cage culture in Vietnam." *Proceeding of the ACIAR lobster ecology workshop*, p24-30. Institute of Oceanography, Nha Trang, Vietnam.

Vimal Kumar R. (n.d.) "Training in lobster fattening helps fisherman turn entrepreneur." *The Hindu*

Annexure 1
Terms of Reference

The assignment:

1. An assessment of the activities carried out by UTTHAN under the Aquaculture Programme (Lobster fattening) in Akhtariya villages of Mahuva Taluka and Chanch Villages of Rajula Taluka;
2. Appraisal of the proposal submitted by UTTHAN for scaling up of the above Aquaculture activities to at least 8 – 10 villages in the coastal villages;

Objective of Exercise

The overall objective of this exercise is to assess the aquaculture pilot (lobster fattening) project carried out by UTTHAN in two coastal villages, viz. Akhtariya and Chanch and quantify the impacts of the various physical interventions, review progress towards the project's objectives and outcomes, efficiency and cost-effectiveness of how the project has moved towards its objectives and outcomes.

More specifically,

- To assess and quantify the economic feasibility of the activity of aquaculture – lobster fattening ;
- To document the processes involved and learning's generated from the pilot interventions;
- Scope and potential to scale up the activities to a larger number of villages with similar localized coastal eco-systems;
- To particularly study the effectiveness of the institutional interface at the village / community level to scale up the activities on a larger scale;
- To provide directions on the future in terms of second generation activities like marketing, scope for processing, potential for scaling up of the activities to include other fishing related livelihood opportunities with the target communities,
- To provide a basis for decision making on necessary improvements;

Scope of Services

- The exercise will involve visits to the pilot project activity located in both the villages and interacting with the beneficiaries to understand the details of the processes involved and the economics of the activity;
- Carrying out exploratory visits to couple of the new locations identified for the scaling up of the pilot;
- The visit includes 3 days field visit and a day interacting with project staff at the UTTHAN field office.
- Detail of the synergies established by the project with the different government programme;

A detailed draft document consolidating the total information would be submitted within 4 days on completion of exercise. It should have the following chapters in addition to others:

1. Executive summary
2. Chapter 1: Background
3. Chapter 2: Details on the findings and recommendation to be further detailed in different sections for various areas of interventions viz technical considerations, institutional effectiveness, economic feasibility etc.
4. A comprehensive feedback note based on the appraisal and analysis of the phase – II proposal submitted by UTTHAN for scaling up of the aquaculture project - various activities suggested, its relevance & completeness, a SWOT analysis of the proposed activities in the perspective of can the proposed aquaculture activity contribute towards evolving a viable & supplementary source of livelihood to the fishermen communities in the coastal salinity affected villages;
5. Annexure: Daily reports of the field visits and details of the discussions with the communities and field staff
6. Annexure: Brief of feedback session
7. Annexure: all necessary material to supplement chapter on findings and recommendations

- On overview of draft report, and receipt of the feedback from CSPC, you would be requested to submit the final document.

Final Output that will be required of the consultant

- A detailed report on the assessment to CSPC with a comprehensive chapter on findings and recommendations.

Time Frame

Following is the schedule (the broad outline is fixed; though the specifics may change):

Day	**Task**
August 4 to 9, 2008	Desk appraisal of the phase – II proposal submitted by UTTHAN; Field visits to project areas (3 days) and one day discussions with the UTTHAN field team one day travel from Ahmedabad – Mahuva - Ahmedabad
August 9 – 16, 2008	Report Writing, submission of the Draft report to CSPC and UTHAN. (8 days)
Total consultancy assignment duration - 12 days	

Annexure 2
Tables

Table 1
Fishing Norms adopted by the Fishing SHGs

1) Juvenile fish and crustaceans were put back into the sea, so as to make fishing a sustainable activity.
2) India disco net used by them earlier was replaced by Japan disco net of the same mesh (3" X 3"). This net lasts only for a month, but catches more fish and is more productive to use in the long run.
3) While fishing in the creeks, the position of the nets is changed from time to time to get batter catch. This was not being practiced before.
4) Certain fish and marine animals, which are endangered, are banned for fishing by the state – such as turtles, shark etc. Awareness was created and cooperative members desisted from catching these.
5) Similarly, no fishing was allowed during the breeding season. According to a government circular, nets of less than 18 mm mesh are not allowed during this season, so as to prevent the seed stock from getting caught.
6) There is also a ban on destroying mangroves, as the members perceive mangrove ecosystem to be beneficial for marine life. In fact mangrove planting has been initiated in two ha on the creeks and these are growing well.
7) Repairing of nets etc is done during the breeding season of the fish (15th June to 30th Aug).

Table 2

List of Mandals (fisheries SHGs) established so far

Sr.No	Group's Name	Village	Block	Members			Date of Establishment
				M	F	T	
1	Dariyai Putra Matsya Mandal	Chanch Bavaliya	Rajula	18	15	33	24/7/2005
2	Savai Pir Matsya Mandal	Rampura	Rajula	6	7	13	2/3/2006
3	Chamunda matsya Mandal	Pipavav	Rajula	7	6	13	23/3/2006
4	Dariyai Shakti Matsya Mandal	Victor	Rajula	12	10	22	11/7/2005
5	Khodiyar Matsya Mandal	Chanch	Rajula	16	9	25	1/10/2005
6	Ratnsagar Matsya Mandla	Chanch	Rajula	6	6	12	24/4/2006
7	Sikotar Matsya Mandla	Chanch	Rajula	6	5	11	1/10/2005
8	Sagar Matsya Mandla	Vishaliya	Rajula	6	4	10	14/3/2006
9	Sagar Nauka Matsya Mandla	Khera	Rajula	27	8	35	1/1/2007
10	Swaman Matsya Mandla	Khera	Rajula	00	20	20	1/1/2007
11	Mahila Matsya Mandla	Khera	Rajula	00	15	15	6/1/2007
12	Sikotar Matsya Mandla	Khera	Rajula	8	12	20	1/1/2007
13	Shakti Matsya Mandla	Dodiya	Mahuva	5	6	11	17/8/2005
14	Khodiyar Matsya Mandla	Dodiya	Mahuva	14	5	19	17/8/2005
15	Surya Sagar Matsya Mandla	Dugeri	Mahuva	15	8	23	1/1/2006
16	Sagar Khedu Matsya Mandla	Akatariya	Mahuva	9	6	15	13/7/2005
17	Dariyapir Matsya Mandla	Katpar	Mahuva	14	7	21	18/5/2007
18	Sagarpir Matsya Mandla	Katpar	Mahuva	7	4	11	18/5/2007
19	Dhavadi mata Matsya Mandla	Kuda	Ghogha	14	14	28	8/2/2008
20	Mastya Pakadas Matsya Mandal	Hathab,Lakhanka,Thalsar	Ghogha	14	14	28	8/2/2008
21	Matsya Pakdas Mandal	Mithivirad i	Talaja	12	11	23	in process
	Total			**216**	**192**	**408**	

Table 3
Budget and its utilization

Paraticulars	Total Cost	Contb Utthan	Contb. CSPC	Actual Expend.	Difference from budget	% over or under spending
Capacity building	120,950		120,950	134,281	(13,331)	(9.93)
Infrastructure for lobster fattening	235,000		235,000	203,982	31,018	13.20
Travel expd.	30,000		30,000	41,419	(11,419)	(38.06)
Operational cost	59,000		59,000	59,000	-	-
Social security and gender needs	3,000		3,000	3,000	-	-
Documentation and communication	24,000		24,000	26,967	(2,967)	(12.36)
Survey	3,000	3,000		872	2128	70.93
Human resources	70,000	70,000		70,000	-	-
Administrative Overheads (1 + 2 + 3@ 3%)	11,580		11,580	11,580	-	-
Total	556,530	73,000	483,530	551,101		

Table 4
Market Information of Local Markets (2005)

No	Type of fish	Rajula				Mahuva			Bhavnagar				
		Chanch		Kadiyali	Victor	Doliya	Akhtariya	Dudheri	Krusnapura	Kuda		Ghogha	
		Village	Bavaliya							Retail	Wholesale	Retail	Wholesale
1.	*Papoda*	40	15	-	-	-	-	-	-	-	-	-	-
2.	*Bumla*	20	20	20	40	20	20	20	35	30	12	20	12
3.	*Moti Machali*	50	50	40	50	50	50	50	40	50	15	40	15
4.	*Dhoda Zinga*	80	50	50	50	40	40	40	45	50	15	30	15
5.	*Lal Zinga*	50	40	50	50	40	40	40	45	50	15	30	15
6.	*Levta*	40	40	-	40	-	40	40	30	40	15	40	15
7.	*Titan*	100	-	-	300	250	250	40	-	-	-	-	-
8.	*Kokra/Vara/ dhagar/Rekhu*	-	-	50	-	-	-	40	-	-	-	-	-
9.	*Boy*	-	-	50	50	40	40	40	45	50	15	30	15
10.	*Kantiya*	-	-	-	40	40	-	-	20	40	15	30	15
11.	*Karchala*	-	-	-		-	-	-	50	50	15	40	15
12.	*Paplate*	-	-	-		80	-	-	-	-	-	-	-
13.	*Surmai*	-	-	-		50	-	-	-	-	-	-	-
14.	*Mangari*	-	-	-		40	-	-	-	-	-	-	-
15.	*Palava*	-	-	-		40	-	-	-	-	-	-	-
16.	*Other*	40	40	40	40	40	40	40	50	50	15	40	15
17.	*Sagedo*	-	-	-	-	-	40	-	-	-	-	-	-
18.	*Fansti*	-	-	-	-	-	-	-	-	-	15	-	-
19.	*Magri*	-	-	-	-	-	-	-	-	-	15	-	-
20.	*Varedi*	-	-	-	-	-	-	-	-	-	15	-	-

Table 5
Tentative Economics of Crab Fattening

Assumptions

a) A stone masonry tank of dimension 70' x 30' x 5' would be ideal for crab fattening
b) Stocking density of 10,000/- juveniles
c) Average marketable weight would be 100 gms. For which average price would be Rs. 80/kg.
d) Four cycles of two months each during a year would be conservative
e) On a conservative count, 60% grown up crabs would be sold – rest may either die or escape

Particulars		**Amount (Rs.)**
Capital Expenses		
Construction of stone masonry tank		65,500/-
a) estimated labour	- 18,000/-	
b) material expense	- 47,000/-	
Recurring Expenses for one cycle		9,600/-
a) collecting seed material (10,000 nos)	– 4,000/-	
b) Mud filling30 bras @ Rs. 100/-	- 3000/-	
c) Feeding trash fish 6kg/day @Rs. 5/-	1200/-	
d) Maintenance work for 60 days	300/-	
e) Harvesting labour	800/-	
f) Marketing cost	300/-	
Total Recurring expenses		
4 cycles @ Rs. 9600/-		38,400/-
Expected Production		
4 cycles @ 800 kgs per cycle	3200 kgs	
Expected Annual Gross Income		
3200 kgs @ Rs. 80/kg		256,000/-
Contribution towards Capital Exp. and overheads		
Gross annual income less total recur exp**.**		**217,600/-**

Hence the project would break even in the first year itself and cover most of the capital expense in the first cycle itself.

Table 6
Occupation Profile of Members

No	Name of Group (Mandal)	Total Membership			No involved in Fisheries			Members Involved in Non-fisheries Activities				
		F	M	Total	F	M	Total	House Hold	Salt Work	Diamond	Labour	Others
1.	Dariyaee Shakti-Victor	10	12	22	02	6	08	05	04	01	02	02
2.	Sagar Khedut-Akhtariya	04	11	15	01	4	05	03	00	00	04	03
3.	Shakti- Doliya	05	05	10	01	5	06	04	00	00	00	00
4.	Khodiyar-Doliya	05	14	19	03	4	07	02	00	03	04	03
5.	Dariyaee Putra- Chanch Bavaliya	15	18	33	06	8	14	06	00	00	09	04
6.	Khodiyar- Chanch	10	15	25	06	10	16	02	04	00	00	03
7.	Surya Sagar- Dudheri	08	15	23	03	3	06	04	00	00	13	00
8.	Savai Peer- Ram Para	07	06	13	02	4	06	02	00	00	03	02
9.	Sagar- Visaliya	04	06	10	03	3	06	02	00	02	00	02
10.	Kuda	08	09	17	04	3	07	02	00	00	06	00
11.	Ratna Sagar- Chanch	06	06	12	01	4	05	02	00	02	05	00
12.	Sikoter- Khera	12	09	21	03	3	06	04	02	00	09	00
13.	Sagar Nauka-Khera	08	27	35	06	8	14	02	04	00	03	00
14.	Mahila Matysa Mandal-Khera	15	00	15	10	0	10	03	00	00	02	00
15.	Sagar Peer- Katpar	08	12	20	02	8	10	04	00	00	06	00
16.	Dariya Peer- Katpar	06	07	13	04	06	10	03	00	00	00	00
17.	Chamunda- Pipavav	06	08	14	02	04	06	02	00	00	02	00
	Total	137	180	317	59	83	142	52	14	8	68	19

Table 7

Scope for Scaling up trials – findings of preliminary survey

No	Name of village	Name of potential site	Rating of Sites			Total Lobster fishing Area	Scope of potential sites		Availability of juvenile lobsters (area)			Expected catch	Overall assessment
			Good	Medium	General		Fattening area	Fishermen	Good	Medium	General		
1	Doliy-Mahuva	Darmda Dungar-1	1 ha	6 ha	-	40 ha	2.5 ha	20	10 ha	10 ha	-	30%	Good
		Padvadhar Dungar-2	4 ha	10 ha	-	30 ha	4 ha	43	23 ha	-	-	30%	Good
		Khara Dungar-1	-	0.5 ha	-	6 ha	0.5 ha	20	-	6 ha	-	5%	
2	Khera-Rajula	Handa Vistar	-	1.5 ha	6 ha	30 ha	1.5 ha	23	-	20 ha	-	5%	
		Ardh Gol Vistar	-	0.5 ha	-	8 ha	0.5 ha	08	-	8 ha	-	5%	
		Hamirbhai Vistar	1 ha 0.5	2 ha	-	10 ha 8 ha	3 ha 0.5 ha	16 -	-	10 ha 15 ha	-	20% 15%	Good
		Zandur Dariya	-	2 ha	-	10 ha	1 ha	10	-	10 ha	-	15%	
		Kodiya Beyt	30 ha	-	-	30 ha	3 ha	06	30 ha	-	-	30%	Good
3	Dudheri-Mahuva	Thapan Beyt	2 ha	4 ha	-	20 ha	1 ha	23	2 ha	4 ha	5 ha	30%	Good
4	Katpar-Mahuva	Katpar- Light house coastal area-north	1 ha	2 ha	5 ha	30 ha 6x1 k.m. area	1 ha	23	1 ha	2 ha	20 ha	30%	Good
5	Visaliya-Rajul	Chanch bandar- coastal turning area	1 ha	2.5 ha	10 ha	15 ha	1 ha	11	1 ha	2.5 ha	-	20%	Medium

6	Chanch-Rajula	creek port area –opposite to Vasram Golan's house	1 ha	-	-	10 ha	2ha	25	1 ha		5 ha	20%	Medium
7	Dayal	coastal area-near fisherman's house	3 ha	-	-	20 ha	1 ha	-	3 ha	10 ha	-	30%	Good
8	Kuda	southern coastal area from Kudagiri Mataji	3 ha	-	-	20 ha	1.5 ha	18	10 ha	-	-		
		Bungalow area-kodiyak Coastal area	2 ha	-	-	20 ha	0.5 ha	10	3 ha		-		
9	Chanch-Bavaliya	Khera Coastal area	1 ha	3 ha	-	20 ha	1 ha	20	1 ha	3 ha	-	30%	Good
10	Dhashiya	costal area-near check-dam	-	-	2 ha	2 ha	-	-	-	-	-	2%	
11	Gadhada	coastal area-near village deeper from land to sea 100-150	-	-	30 ha	30 ha	-	-	-	-	-	10%	Not suitable
12	Uncha Kotda	east and north side entire coastal area	-	-	40 ha	-	-	-	-	-	-	10%	Not suitable
13	Neep	east and north side entire coastal area	-	-	2 ha	2 ha	-	-	-	-	-	3%	Not suitable
14	Vaghnagar	east and north side entire coastal area	-	-	0	0	-	-	-	-	-	0%	Not suitable

Annexure 3
Field visit reports

(A) Report on Group Meeting at Chanch (Bawadia)

The meeting was held with the available key persons/ members of the SHG at Chanch Bawadia at the residence of Bhupat bhai Bachu bhai, one of the members. The following people from the SHG were present in the meeting:

1) Bhagwan bhai Bav bhai
2) Bachubhai Vira bhai
3) Jeel bhai Vira bhai
4) Jesar ben Bachu bhai
5) Gordhan bhai Natha bhai
6) Sajan ben Natha bhai
7) Vasur bhai Teja bhai
8) Bhupat bhai Bachu bhai
9) Bhupat bhai Natha bhai

Chaanch is a big village with a population of about 7000 people. Chanch Bawadia is a small falia (hamlet) on the outskirts of the village, inhabitated by about 60 families. The average family size is about 10. The entire village consists of only one community viz Vaghri. Hence there is no social stratification on the lines of caste. However, there is a lot of social inequity. The people of Bawadia falia are particularly poor.

The village is located right on the coast. At one time Chanch had the dubious reputation of being a village of pirates, which is how it got its name. Now majority of the people migrate in search of employment. They return only during the monsoon. Hence monsoon is the time when people are available and most of the marriages also take place then.

The people in Bawadia were dependent on seashore fishing and hence interested in forming the mandal (SHG). There are three other mandals in the village. The Bawadia mandal has 35 members. The mandals were formed after Rambhai and others from PLC came to the village about thee years ago. They underwent 10 days of training when they came to know among other things about sweet water fishing. They were taken to Rajula, Victor etc. for exposure.

The mandal has enabled them to get licenses for fishing and thereby legitimize this as a source of livelihood. The mandal made it possible to buy fishing nets at 75% subsidy (from CSPC) and loans. During the first year net of 140 kgs was purchased at a price of Rs. 350/- Because of bulk purchase they got a bulk discount of about Rs. 30/- on the price of the net. Some members have boats of their own which cost between 10-15 thousand and are used for fishing in the sea. The mandal has been given loans worth Rs. 1.7 lakhs so far for purchase of equipment, nets and boats etc.

The economic impact of the mandal has been positive. Earlier they could only get enough to subsist. The average catch per day was about 2-3 kgs., which was sold at about Rs.

100-150/- After the mandal, the average catch has gone up to 5-6 kgs/day which fetches about Rs. 400-500/day.

Bachu bhai shared his experience of the Titan (lobster) experiment, which he first did on Rambhai's suggestion. He kept some juvenile titan in a small net bag and put it in the creek. After about 4-5 months they grew to about 5 kg. He remembers selling 2 kg to a fisherman in exchange for 60 liters of diesel as he was in need of diesel at that time.

After this experiment they decided to go for cage culture. 70 cages were placed in the creek. Now only 40 are left, since the rest were lost to the sea during a major tidal wave some time ago. Two cycles of production were undertaken and both the times they sold titan worth about Rs. 50,000/- The third cycle was when the disaster took place and they could recover only about Rs. 10-15,000/ Each cage can accommodate 7-8 titans. The labour involved in making it from bamboo and nets is about Rs. 200/-

Enthused by the success in the cage culture, a group of fifteen made on their own initiative a large pit / tank where they began to stock titan for fattening. They had invested about Rs. 5 lakhs in the venture in terms of labour to make the tank and were expecting to harvest lobsters worth 12 lakhs.[2] Unfortunately they faced a major setback in the form of sabotage. Due to jealousy within the village some one put Endosulphan pesticide in the pit leading to heavy attrition of the titan. Ultimately they could sell only 20 kgs and recover about 15,000/- from the investment. This was a clear case of sabotage and if the members had wanted they could have approached the village *Panch* to find out the culprit on the basis of suspicion. However they chose not to do so as it would have created internal social problems. Until this problem is resolved at a social level, the members feel insecure in undertaking any such ventures in the near future.

The members are more enthusiastic about crab fattening as it is a less risky proposition. It does not get affected much by fluctuations in salinity levels and it can even be cultivated during monsoon. In a recently initiative one of the members kept juvenile crabs for two months in a tank of dimensions 30' x 10' x 7'. He had stocked about 6500 juveniles and had to provide 5 kg of feed per day. When the crabs became 150 gms which is a marketable size, he sold them in the local market at a price of Rs. 100/kg. Assuming that he was able to sell about 60% grown ups, he must have made a gross income of about Rs. 3.9 lakhs.

Vasu bha Teja bhai who was present in the meeting spoke about his experience in the mandal. Earlier his economic condition was very poor and he used to migrate for almost the entire year with his family. After the mandal he got a disco fishing net and could catch enough fish to subsist without having to migrate. Later he saved enough to buy a small boat. Soon he was able to take a loan of about 1.5 lakhs from the mandal to buy a boat for deep-sea fishing. He now catches fish worth about Rs. 5.0 lakhs per year. He has already repaid his loans and his economic condition has improved dramatically. He was truly grateful to Rambhai and PLC for having showed him the way to prosperity.

---

[2] These figures could be exaggerated. The author did not have the opportunity to visit the site and make his own assessment.

(B) Report on Group meeting at Akhtaria village

The meeting was held at the Sarpanch's residence. The following members attended the meeting:

1) Bharat bha Laxman bhai
2) Rupai ben Vegji bhai (chairperson)
3) Mani ben Laxman bhai
4) Mohan bhai Amir bhai (vice-chairperson)
5) Vinod bhai Bhagwan bhai Gohil
6) Chagan bhai

The secretary Kesu bhai was not present at the time. The mandal has a committee of seven members.

Rupai ben explained that earlier they used to carry out *kinara* (sea-shore) fishing for subsistence. However the police harassed them and the catches were also poor because they had old nets, which were torn. For 2-3 years they decided to do only labour as catching fish was not viable. It is at this stage that Rambhai and others from PLC came and advised them to start a mandal. In the beginning no one was prepared to join. Vinod bhai who is a Gohil by caste felt that it was not a suitable occupation as it involved killing innocent life. He was however, convinced after PLC staff explained that this was also a kind of farming and that every farming involved certain amount of violence. It was Vinod who provided the leadership during the formative stages of the mandal. There are 25 members (13 Male and 12 female). The mandal is involved in savings activity apart from fishing. They save Rs. 20/month. Mohanbhai the ex-*sarpach* joined the mandal in order to give the impetus and other then followed. Only about 8-10 people are actually involved in the fishing activity. The income from fishing comes to them while the rest get about 2% of the income.

Initially they took a loan of Rs. 30,000/ from the *Sanstha* (PLC) to purchase nets. Later they got another loan to buy a *Masbo* (small boat) worth Rs. 52,000/- After the mandal was formed they got licenses and registration with the Customs Dept. Local officials were helpful because of PLC's influence. Nets were also purchased for deep-sea fishing but the season was over by that time and they will have to wait for the next one. At this stage, due to personal tragedy of his brother Vinod bhai could not give enough time to the mandal's activities. Bharat bhai then took over and has played an active role in the titan experiments on the seashore.

Bharatbhai recalled that his uncle had made a pit for stocking titan about 15 years ago which was 10' x 10' x 15' in dimensions. He had made Rs. 60,000/- out of the venture. However, the risk of sabotage was great. People used to put the milk of *thor* (*Calotropis*) to kill fish. So the experiment was discontinued. Another problem is that the Custom officials do not allow any digging on the seashore. After the formation of the mandal it was possible to get permission for titan fattening. The Custom officials have certified that the mandal is not involved in any illegitimate activities on the shore.

Seed for titan culture (juveniles) are available for two months during *Bhadarwa* and *Aso*. About 50,000 juveniles can be collected from the coastline of the village. After selecting the proper site, the mandal made 28 small *virdas* of size 8' x 6' x 3' and three tanks of size 20' x 30' x 5'. Only two of the large tanks were used for fattening since one spare tank was needed to stock the titan during cleaning operations. The results were good. However, they noticed that the titan at the base of the tanks became red. They turn red due to a variety of reasons such as lack of oxygen, over crowding, lack of nutrition etc. the red titans do not fetch a good price. When the temperature became high they put wet sacks on then top of the nets to control the temperature in the *virdas.* Hot water currents were experienced soon after Holi festival (March). By March, the first season had ended. They also had to take clean the pits regularly and ensure protection from predators like *vishad* (a snake like marine creature which predates on lobsters). During December to February the silting rate was the highest. They lost about 800-900 juveniles in a big tidal wave. Such a wave comes once in 20 years. If they had prior warning of the wave they could have saved the stock of juveniles by removing them from the pits and putting them in wet sacks till the danger was gone. Once they lost 51 titans due to ingress of sweet water, which affected the salinity levels in the pits. On an average they lost about 25-30% of the juveniles because of these difficulties.

Most of the work of attending related to stocking, cleaning, replacing water, feeding etc was done by the men, although some women also took interest and knew what was to be done. Women's main role in the mandal was to sell the fish in the local village market. Akhtaria village had a population of about 7000 and there was a good demand for fish since the people were non-vegetarians. The annual sale of fish at Akhtaria was worth Rs. 3.6 lakhs. The other local markets were at Chaach, Khera, Victor, Katpar villages. People from those villages also came here to sell and viceversa. The other local markets are more distant and located at Rajapara near Diu, Una, and Veraval.

Earlier the brokers at Mahua used to buy the titan at a low cost.of about Rs. 150/kg. PLC and mandal office bearers went and contacted the large merchants in the distant markets at Veraval etc. They realized that at the end of the value chain the price was as high as Rs. 1700 to 1800/kg. The export houses are located at Veraval. They sell lobsters, which are frozen in blocks of ice individually. Each such lobster sells at $ 6-7 (about Rs. 2500/). Because of the mandals the merchants were attracted to come to these villages and procure lobsters in bulk. They began to offer better prices. The present price ranges from 600 to 700/kg. In the long run the federation of the mandals can think of collective marketing directly to the export houses. For the moment there are several advantages in selling locally:

- while taking the titan to distant market they experienced a loss in weight of about 15%.
- While selling at the village the merchants could not cheat them while weighing.
- Since the price was negotiated on the weight of the lobsters, merchants would often pass off borderline cases in the lower weight slab. If they did that here the fisherwomen could refuse to sell.

- Now the cooperatives are connected to 8-10 merchants by mobile and have access to the prevailing price on a given day. This helps them to negotiate price better.

The current prices at Akthariya fish market were as follows: Lobsters (700-750/kg), prawns (Rs. 200/kg.) crab (Rs. 100/kg), other fish (Rs. 100/kg.)

This year they have collected 400 juveniles so far. They will collect about 1200 and put them in the *virdas*. The construction of a jetty at a distance of about 3-4 kms. from the village represented a threat as it could impact the availability of seed material. They also get juveniles from non-member fishermen. In fact the idea of a "titan bank" was proposed in the discussion. This would be a big tank in which they could collect titan from different fishermen and stock them till these were big enough to sell in bulk to merchants. In this way they could get a price of Rs. 800-900/kg.

Some time back Mr. Maruti of MPEDA visited their site. He suggested that if the moustaches of the titan were cut this might translate into more body weight, which would be preferred in the market. To test this hypothesis the mandal decided to carry out an experiment in the *virdas*. They cut the moustaches of 16 lobsters. They found that on an average the body weight increased by 15 grams. But the moustaches did not grow again, so they lost that weight while selling in the market. So in the end they did not feel any significant gain by adopting the practice of cutting moustaches. It was noticed that 4 of the 16 lobsters came into moulting early. This may be the reason for gaining weight quickly.

Apart from the fisheries mandal the village now has other mandals like youth mandal, women's groups etc. According to Vinod bhai, the work done by these mandals is changing the image of the village. The impact on migration has been positive. Earlier 80% used to migrate. Now this has come down to 40%. The people have now started looking after their land. The village has faced a major setback in agriculture due to salinity ingress. Earlier it used to be well known for its onion crop, which is a cash crop. The land was good, so they also cultivated vegetables and fruit crops like banana, papaya, etc. Even now there are some *dadam* (pommegranade) coconut, chikoo vadis.

Annexure 4
Package of Practices – Lobster Fattening on Bhavnagar Coast

This note is an attempt to put together the package of practices developed by PLC team in collaboration with the fisheries mandals in Bhavnagar, through their own experiential learning during the one-year project supported by CPSC. The note covers the following aspects of lobster fattening:

a) seed (juvenile) collection
b) site selection
c) pit preparation
d) recommended practices for pit culture
e) preparation of cages
f) recommended practices for cage culture

This package of practices is subject to revision as more knowledge and understanding of the environmental factors at play and response of rock lobster to these factors is gained in subsequent trials, in different environmental conditions. Other social aspects such as building a suitable village level institution, getting the necessary permits from various government organizations etc. could be incorporated later. An expanded version with suitable illustrations could serve the purpose of a training manual.

a) Seed (juvenile) collection

Juveniles are not easily available everywhere. The natural habitats are usually located in areas, which have soft rock bottom - lobsters avoid clayey and silty bottoms. Juvenile seed material is available during the two monsoon months of Aso and Bhadarwo. The seed material collected thus can be stocked in a virda until mid October when the first cycle begins.

Catching lobster juveniles is a specialized job and 2-3 members of the mandal can specialize in it. Juveniles are best caught with Japan disco net of gauge 3" x 3". Such nets are costly, and last only for a month, but the cost can be recovered in one day itself because marketable lobsters would also be caught along with the juveniles. At current prices the net costs Rs. 500/- for every 200 ft. The cost of total length of net required would be about Rs. 2000/-. In Bhavnagar area, these nets are easily available in the Rajual market.

Juvenile lobsters can also be bought from other fishermen who do not belong to a mandal and who are happy to sell their produce at a lower cost in order to get immediate cash.

b) Site selection

Lobsters are sensitive to certain environmental factors. Hence care should be taken to ensure that such factors are favourable in the chosen site. The following criteria may be used for selecting a suitable site:

i) The first and foremost condition is to look for soft stone areas where tidal water is 2-3 feet deep. Stony areas with sharp edges should be avoided as this will make it difficult to clean the pits and to move about in the mariculture site. The site should be level as far as possible. Care should be taken to ensure that there are no hollows in the stone site and that there are no sweet water aquifers beneath. Sometimes if sweet water finds its way through the hollows, it can adversely affect the salinity levels and cause mortality. Muddy water should be avoided at all costs.

ii) Tidal waves should be coming on the site two times a day. Ideally the salinity level of the water should not exceed the range of 24 to 28 ppt. Areas where salinity of the water can fluctuate beyond this range should be avoided. Sites, which are inundated with sweet water currents, should be avoided.

iii) In case the pits are located above the level of the tidal water, arrangements should be made to pump water into the pits and drain out water from the lower end. About a fourth of the water should be changed once in every three days.

iv) Lobsters are very sensitive to temperature. The temperature should be between 18-20 degrees C. In summer if the tidal water is hot their metabolism gets affected. Wet sacks can be placed on top of the pits in summer to prevent the water in the *virdas* getting hot. Sites, which are frequently inundated with hot water currents, must be avoided. Sites with black stone should be avoided as these can get heated up more quickly.

v) If a *dungra* or *bet* (small raised islet on the coast) is selected care should be taken to avoid the side facing the sea, as this side tends to get muddy.

vi) The pH of the water should ideally be 7.5 and can range from 7 to 8. The pH gets affected also when sweet water flows come into the creeks or pits, especially during monsoon.

vii) Areas with high predator population should be avoided to minimize loss of juveniles to predators and damage to the nets - in case of cage method.

viii) Avoid sites where the water current is too strong to cause damage to the pits or cages.

ix) Some times people may select a site that is difficult to access so that it is not vulnerable to damage / sabotage by other human beings. But this could also make it difficult to attend to the routine work related to husbandry of the lobsters.

x) While selecting a creek for cage culture, care should be taken that there are no river flows in the creek or that saltpans are not located upstream as the latter release rainwater from their pans in monsoon. Very small creeks (with water flows of only 1 ft deep) should be avoided, as these will bring in mud or hot water flows.

xi) Creeks, which have a high load of seaweeds, are generally not preferred for cage culture as this can mean more labour for keeping them clean. However, if the weeds can be converted into vermicompost, as done in other parts of coastal India that can serve as an additional source of income.

c) Preparation of *virdas* / tanks

i) Although the size of pits can vary, two sizes have been found to be useful. The "*virdas*" are small pits of dimension 8' x 6' x 3'. The *virdas* must be spaced out to allow enough space for movement between them – say about 5 feet. The layout would depend on the shape of the available site. The large pits or tanks with dimension 20' x 30' x 5' have also been tried. The borders of these tanks are made firm with a cemented stonewall about one foot in height. The *virdas* are located at lower levels where the tidal water flushes take place two times a day. Hence the dissolved oxygen and nutrients flow in naturally. In the case of the tanks an outlet with a valve is located at the lower end from where the lower muddy water can be drained out. Provision for pumping in fresh seawater must be made. The pump needs to be located on a pedestal and protected from tidal water.

ii) Pits are made with hand tools, since the rock is soft. Often the time available between tides is less and the time available during a given day for digging may be only a couple of hours. This implies that more number of people may be needed in order to accomplish the work in stipulated time.

iii) In the sides of the pits, small holes of half a foot are made so as to provide a hiding spot for the moulting lobster. Heaps of loose stones on the bottom of the pit can also serve the same purpose.

iv) The pits must be covered with nylon nets that prevent the lobsters from being taken away by tidal waters. The nets must be fastened in such a way that the force of the water does not easily remove them. If the nets open up, not only can the fattened lobsters be lost, but predators can also enter the pits and cause harm to the stock.

v) The entire site should be cordoned off so that it is not affected knowingly or unknowingly by any other human activities.

d) Recommended practices for pit culture

i) Only male juveniles are used for lobster fattening. The seed consisting of male juveniles should first be stocked in a separate pit. The seed can be stocked for the entire year. About half the seed will be used in the first round of 4-5 months. The other half will remain in the stocking pit without growing. After five months they can be removed and used in the next cycle for grow out.

ii) The pits should be prepared first by cleaning them. The tidal water should be allowed to wash the pit at least twice. The quality of water should be tested on all the various parameters like pH, salinity, temperature, and dissolved oxygen (only in case of tanks where fresh water does not enter twice a day).

iii) Stocking density – Juveniles should be stocked in such as way that each lobster get 2.5 sq ft of floor space of the pit. In the case of cages, the

stocking density can be 1.25 times that of pit method. For a cage of size 6' x 3' about 7-8 lobsters is optimum.

iv) Juveniles of the same weight and size should be kept together so that they all undergo moulting at the same time as far as possible. Due to cannibalism large lobsters may feed on small ones or on ones that are in the moulting stage. For the same reason, moulting lobsters should be placed in a separate pit.

v) The quality of seed should be checked before releasing into the *virdas*. The tail should not be damaged in any way. The seed should be disease free. The incidence of disease so far has been rare, but elsewhere certain fungal and bacterial diseases are reported due to over-stocking.

vi) The *virdas* must be cleaned once in 3 days and the tanks once in 15 days.The water should be emptied out and filled again after cleaning. To test if the pit needs cleaning other than the routine cleaning, tie a saucer to a string and hang it in the water. If it can be seen clearly upto 2 feet in depth the pit does not need cleaning. If the water is murky/ muddy, it needs to be cleaned.

vii) During cleaning operations, the lobsters should be removed and placed in another pit. After cleaning the pit, the routine of pit preparation should be repeated. Sort out the lobsters based on size, moulting stage etc. and re-start the pit.

viii) Measurements of environmental variables must be taken thrice a day (before sunrise, at 12 noon and after sunset) and entered in a logbook. Action may have to be taken to protect the stock from any sudden changes in temperature, salinity or pH values. Periodic weighing of the juveniles is also necessary to monitor the growth in different pits.

ix) In order to maintain sanitation and hygienic conditions, it is recommended that only one or two people be designated to do the cleaning work and others should not enter the pits. The use of rubber shoes and gloves is recommended for the same reason.

x) Feeding practices: trash fish like *chipla* (snails), *boomla* (Bombay ducks) and *sundhi jinga* (small sized white marine prawns) and undersized *boi* fish are considered ideal feed material. These are all fish which fetch some market value, but when undersized they don't get fetch any value and therefore considered trash fish. Other types of trash fish do not lead to good growth and should therefore be avoided. The trash fish should be minced and fed in accordance to the weight of the lobsters. It is recommended that the feed should be about $1/10^{th}$ of the weight of the lobsters. If excess feed is given, it leads to wastage or indigestion.

xi) During stormy weather, protection is needed. The fishermen should ensure that the nets are fastened securely with galvanized nails that do not dislodge or corrode easily.

xii) Protection from human interference, pilferage and sabotage is important. Some system of watch and ward may be needed in villages where the social threat is high. Although oil spills can affect the cultivation, this is

not an issue in these parts of the coast. Sand and silt coming from near by jettys and ports can create problems.

xiii) If any specific experiments are to be carried out to measure the impact of different treatments on growth etc. this should be done in separate *virdas* marked out for the purpose.

xiv) The lobster must be alive when taken to the market. Live lobsters fetch a better price in the market. The quality of the lobsters should be checked before placing in the market. Lobsters reddened due to lack of nutrition or oxygen etc, may not fetch a good price and must be segregated. They must also be segregated by weight since price is fixed according to weight and size of the lobster.

e) Preparation of cages

i) The structure of the cage can be made from any salt-tolerant wood material. Bamboo sticks (*Dendocalamus strictus*) can easily be procured at a reasonable price and used for the purpose. In selecting this material sticks with smaller inter-nodes should be preferred. Unlike the larger bamboo species, microorganisms in the water do not attack this variety. Approximately 10-12 bamboo sticks are needed to prepare a cage of size 6' x 4' x 3'. The cage has a rectangular base and tapers towards the top so that seaweeds and other material would not cling to it and it would not be broken easily due to wave action of water.

ii) The fishermen can themselves prepare the cage with or without the help of a local carpenter. It is recommended that the poles be fastened together with nails made from bamboo splinters instead of using metal nails, which may corrode in the water. The approximate labour for making one cage at current prices is Rs. 200/-

iii) Once the structure is ready, it must be covered with nylon nets of 20 mm mesh. At least two layers of net, each separated from the other by a distance of 1-1.5" is recommended. This is because predators like crabs can cut through the nets and attack the juvenile lobsters in the cage. Sometimes snake like predators also get in through holes cause when the cage gets damaged. The mesh of the two layers should criss-cross each other so that snake like predators would get stuck in them.

iv) A small round feeding gate is made at the top end of the cage by cutting the net. It should be large enough for a human hand to go through and should be stitched together each time after feeding operation.

f) Recommended practices for cage culture

i) The cage should be placed in a suitable site in a near-by creek. It should be fastened or anchored down with the help of a large boulder or a heavy log.

ii) It should be submerged at least 75% but should not lie on the bed of the creek, which is bound to be muddy and where predator attack is likely to be high.

iii) About 7-8 cages can be stocked in a cage of the size mentioned above. The first cycle starts from mid October and takes about 4-5 months.

iv) The cages should be inspected regularly to see if any predators have attacked, to repair the nets of the cages, to clean it from seaweeds and silt.

v) The same trash fish mentioned for pit culture should be fed through the feeding hole in the same proportion mentioned earlier. However, since fresh water is continuously passing through the cage, it brings natural feed into the cage, which can also sustain the lobsters. Hence even if the fisherman misses feeding on a particular day because of some urgent commitment, the lobsters would not be adversely affected.

vi) Watch and ward of the cages and constant vigilance to check the salinity and temperature of the water are important factors for success.

g) Equipment for monitoring environmental variables

The following equipment is needed for measuring the variables mentioned earlier:

v) Refractometer, which can measure salinity ranging from 0 to 100 ppt.

vi) Litmus paper strips to measure pH. If budget allows, a pH meter can also be considered.

vii) Thermometer to measure temperature of the water.

viii) Weighing machine to measure the growth of the juvenile lobsters from time to time.

Annexure 5
Debriefing Session

The debriefing session was held at Utthan's office the day after returning from the field. Although most of these issues were discussed with the field staff of PLC on the last day, these were discussed again with Nafisa Barot, and Kaushik Rawat of Utthan Trust, the following day.

The issues discussed were as follows:

i) The potential of cage method of lobster fattening needs to be explored further. Although the risks are great in the second cycle, these risks can be addressed in various ways and minimized. At least a few villages need to be included in the next stage of trials. There was agreement on this issue.

ii) As the books of accounts were not accessible during the visit, the consultant had to rely on Rambhai's diary for the details of the economics of trials. It was clarified by Kaushik bhai that the books of accounts are available and would be brought to Ahmedabad for the consultant's perusal.

iii) Marketing data of the local markets have been documented well since 2005. However, similar data has not yet been collected for the Veraval market. This should be taken up with the help of MPEDA in order to develop the long-term marketing strategy. In this context the enter value chain needs to be studied properly to work out the marketing feasibility for the second stage of trials when the quantity of production would jump up significantly, and local markets may not be able to support the same price due to excess of supply over demand.

iv) The legal status of the *virda* land is not clear. Although FFDA has given permission to individual members to carry out fishing activities on the seashore, specific permission to carry out mariculture on the designated site should be obtained in the name of the cooperative. If possible the land could be taken on lease to make property rights more secure. Also the regulations and restrictions under Coastal Zone Regulation act must be ascertained.

v) Since less than half the members are actually engaged in fishing activities, this could in the long run create problems of responsibility and benefit sharing between fishing and non-fishing members. This issue needs to be taken cognizance of and handled in future as well while devising the boundary rules and membership rules for the mandals.

vi) The mandals need to be registered in order to have a legal standing. Alternatively, only one cooperative or producer company could be registered with all the mandals being a part of the same institution. The choice should be made after taking into account the administrative and legal considerations.

vii) The problem of sabotage at Chanch Bawadia has not been tackled. This could prove to be a big disincentive for lobster fattening in future in that village. A senior person from PLC should investigate and try to find an amicable solution by meeting the elders of the village.

viii) At the moment the marketing is done by individuals members and aggregation is not done. A plan to carry out collective marketing should be worked out in order to get a better price. The benefit sharing rules are also not very clear, since 8-10 members work on the activity collectively, some contributing more and others less. It may be possible to allocate a fixed no of virdas to different members in future so that they are responsible for those virdas and would get only the produce from the same. These ideas need to be discussed in the mandals further.

ix) The survey done by Rambhai to identify new sites in neighbouring villages needs to be compiled in the form of a pre-feasibility report. This will make it easier for any research institution to carry out scientific validation of the sites chosen through PRA.

x) Tuticorin is emerging as another center for lobster fattening with research grants from the Department of Biotechnology. PLC should get in touch with them for exchange of ideas and for potential collaboration.

xi) A proper team would need to be set up to implement the project, with Rambhai at the helm. However, considering his age and health situation, care should be taken that he does not overexert. He should be utilized for his expertise in designing and monitoring experiments and for training at least two new fisheries graduates. Rambhai's salary also needs to be upgraded in the light of his contribution and potential role as team leader in the next phase of the trials. He may report directly to the head of PLC instead of through Team Leader, NRM, since the latter deals mainly with agriculture and allied subjects. Fisheries sector requires a different kind of understanding and expertise.