LOBSTER BREEDING, SEA RANCHING AND JUVENILE FATTENING

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Introduction

Lobsters are one of the highly esteemed seafood delicacies and currently fetch the highest unit value among commercially exploited marine resources. These are decapod crustaceans belonging to four families: *Nephropidae* (clawed /true lobsters), *Palinuridae* (Spiny/ rock lobsters), *Scyllaridae* (Sand /slipper lobsters) and *Synaxidae* (Coral lobsters). Representatives of the families *Palinuridae* and *Scyllaridae* constitute the lobster fishery of India.

India is one of the prominent countries in lobster production with the annual catch fluctuating between 2000-3000 tonnes. The main lobster landing centers in India are Veraval, Bombay, Kozhikode, Kolachal, Mandapam, Tuticorin and Chennai. The ever increasing demand for Indian spiny lobsters in the world sea food market and high price have led to over exploitation of the lobster resources in the seas around India. Lobsters of all sizes are fished in the absence of strict enforcement of a minimum legal size. The best way of utilizing the juveniles is to fatten them to bigger sizes for value addition. Fattening can be used for value addition of bigger lobsters and for growing lobsters in late or early moult stages, which do not survive transportation. The price of juvenile lobsters is about Rs. 250-300/kg and when grown to over 200 g, it will fetch a price of Rs. 650-800 depending on the species and season. This has led to the need for farming the lobsters, utilizing vast resource of juveniles that are caught and under utilized. Realizing the situation, the NIOT initiated a research programme on spiny lobster culture with the main objective of developing a viable technology for fattening. Research on reproduction, nutrition and growth of spiny lobsters occurring along the Indian Coast has indicated that they are the candidate species for fattening.

Very few attempts have been made to increase lobster production through aqua farming, even though the demand for lobster meat far exceeds supply through

capture. Spiny lobsters, have good culture potential. The main constraint in farming is the inability to produce seeds in captivity due to its long and complex larval life extending over 6-8 months. However, effort has been made by the researchers of National Institute of Ocean Technology to complete the life cycle and produce seeds in captivity.

Indian Lobster Fishery

The lobster fishery of India is mainly contributed by Spiny lobsters or rock lobsters belonging to the family *Palinuridae*. While the traditional fishery is exclusively constituted by the shallow water species of genus *Panulirus*, the non-conventional lobster resources found in the deeper waters belong to genus *Puerulus*. In recent years, slipper lobsters belonging to the family Scyllaridae comprising genera *Thenus* and *Scyllarus* have assumed commercial importance and contribute significantly to the coastal fishery. The two families could be distinguished by the following characters: Body subcylindrical; antenna enlarged, cylindrical with long whip like flagellum- *Palinuridae*. Body strongly flattened dorsoventrally; antenna short, scale like, without whip like flagellum- *Scyllaridae*.

Distribution in Indian waters

Six species of shallow water spiny lobsters occur along the Indian coast, namely, *Panulirus polyphagus* (mud spiny lobster), *P. homarus* (scalloped spiny lobster), *P. ornatus* (Ornate spiny lobster), *P. pencillatus*, *P. versicolor* (painted spiny lobster) and *P. longipes* of which, the first three are exploited commercially. The mud spiny lobster *P. polyphagus* forms a major fishery along the Maharashtra and Gujarat coast. This species is found in muddy substrates and often near river mouths in depths, less than 40 m. The fishery is dominated by sizes ranging from 15-20 cm in total length. The scalloped spiny lobster, *P. homarus* is mainly distributed along the South West and South East Coast and are caught by traps, bottom set gill nets and occasionally in trawls.

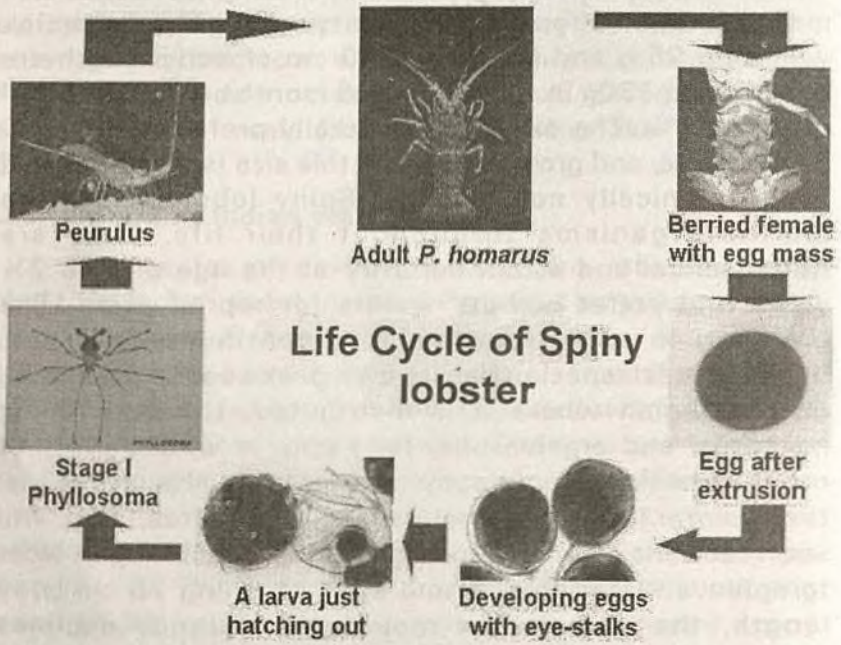
This species inhabits shallow waters mostly between 1 and 5 m in rocky areas and their size in the fishery ranges from 15-20 cm. The ornate spiny lobster, *P. ornatus* mainly forms a fishery on the South East coast of India in the Gulf of Mannar. This is one of the largest of the *panulirus* species and is caught in gill nets, as well as in trawls. The fishery is dominated by sizes ranging from 25-35 cm.

Biology

The spiny lobsters in tropical waters possess distinctive features, which make them suitable for aquaculture practices. Being adaptable under captive environment, they are less cannibalistic and fairly fast growing as compared to their counterparts in the subtropical and temperature regions. The undersized or juvenile lobsters collected from the wild has been successfully grown to marketable size in appropriate enclosures by following suitable feeding schedule and maintaining the optimal water quality. The juveniles weighing 25 g and measuring 10 cm of body length are grown upto 330g in a period of 16 months with a survival rate of 80%. The exporters generally prefer mostly 230 g and above, and growing beyond this size is also observed as economically not feasible. Spiny lobsters are true marine organisms throughout their life. They are heterosexual and attain maturity at the age of 2 to 2½ years and prefer inshore waters for reproduction. The breeding in spiny lobsters is a continuous process, however, each species has its own peak season depending on the region where it is distributed. Lobsters, being nocturnal and omnivorous, feed upon a wide variety of organisms including decaying materials. Nevertheless, they prefer bivalves, moliuscs, polychaetes, fish and seaweed. The juveniles undergo frequent moulting in order to achieve faster growth and after attaining 25 cm body length, the growth and moulting frequency declines considerably. It is also reported to survive upto a maximum of 8 years in Indian waters.

Breeding and larval development

Tropical spiny lobsters breed almost throughout the year. Sexes are separate. Females bear ovigerous setae and in case of males it is absent. During mating, the male lobster transfers a packet of sperm to the female and it sticks between last pair of walking legs and ultimately develops as a "tar spot". Eggs are released out of the gonopore present at the coxopodite of third pair of walking legs and are attached to the ovigerous setae as a conspicuous mass. The berried lobster carries eggs on the underside of the abdomen until they are hatched out as larvae. The freshly deposited eggs are orange in colour, change to brick red and then to deep brown just before hatching.



As many as 6 lakh eggs may be carried by a large adult female. In captivity the females become ovigerous at a size range of 100-175 g. The berried females can be stocked individually in 1t FRP tanks containing filtered fresh seawater. Mussel meat can be provided as feed at a ration of 5 % average body weight. The tank should be covered with a black cloth to prevent the entry of light. The eggs undergo a series of developmental stages during which the colour changes from brick red to brown. The mean diameter of the egg is about 0.45 mm. The egg hatches out into a free-swimming larva called Phyllosoma. The larva is transparent, flat and leaf like, hence called Phyllosoma (Phyllo-leaf). In nature the larvae are carried away by ocean currents to offshore sea from where they metamorphose into postlarva (puerulus) and then swim towards the coast and settles on suitable benthic habitats in inshore areas. The puerulus is glassy transparent in appearance and moults into post puerulus stage, which resembles a miniature lobster in all characteristic features.

The Phyllosoma larva has to undergo a number of moults to metamorphose into puerulus. Given the complexity of the larval cycle and the limited knowledge about the factors affecting the larvae, commercial production that relies on the production of Phyllosoma does not seem to possible at this time. Though several investigators partially succeeded in rearing the Phyllosoma larvae, Kittaka was the first to complete the larval development of the spiny lobsters in captivity. However a tropical lobster is yet to be reared from egg to puerulus. The researchers at NIOT succeeded in rearing the larvae of *Panulirus homarus* upto the 7th stage for the first time in India. The larvae were reared on a diet of freshly hatched Artemia nauplii at the early stages and a combination of enriched nauplii and minced mussel gonad at the later stages. Until the technology is perfected the lobster farmers have to depend upon naturally available juveniles for the seed requirements for fattening.

Sea ranching - the need of the hour

Since continuous over exploitation of lobsters in Indian waters has resulted in natural depletion, concerted effort has to be taken to have an in-depth study for sustained utilization of the resources. Studies related to spawning and larval development and mass rearing of juveniles through hatchery production and sea ranching in depleted areas would be helpful not only to conserve the resources but also help the coastal people to take up fishing and sea farming activities. With regard to sea ranching, the water quality, distribution of surface plankton, nekton, benthos and under water habitats were studied extensively by the NIOT research team by carrying out pre ranching surveys at Minnie Bay and Port Blair. However, sea ranching programme would be taken up only after closing down the life cycle of lobsters. The recent success achieved by NIOT in rearing the larvae upto seventh stage heralds the possibility of completing the life cycle and producing sufficient number of seeds for sea ranching.

Prospects of commercial lobster fattening

Growing lobster juveniles to suit the export requirement is a lucrative business for the aqua farmers. In countries where a minimum legal size is strictly enforced catching and holding undersized lobsters are illegal. In India since minimum legal size for capture is not strictly enforced, there may not be any legal or technical barrier for lobster fattening. Live lobsters of *P. ornatus* weighing 500 g- 1000 g are in great demand in the South East Asian market . Medium sized *P. homarus* and *P. polyphagus* are exported as whole cooked and frozen to Japan and other European countries. *P. ornatus* is the most promising species as it grows faster in captivity. Since they attain maturity only at a larger size (700-800 g weight), juveniles of this species are most suited for fattening to the target size of 500 g, which could be achieved in 3-4 months. Fattening of larger sizes (300-350 g) to the prime size might be possible in three

months. Researchers at NIOT have developed a viable technology for fattening. Lobster fattening can be carried out in indoor (cement tanks) and outdoor systems (Sea cages).

Fattening in indoor systems

The indoor system required for fattening comprise of rectangular cement tanks of about 5 tonne capacity (4mx2.5mx0.75m). An effluent treatment tank measuring 2mx2.5mx0.75m should be maintained for treating the wastewater. Aeration pipes should be fixed along the bottom of the tank so as to give a uniform water circulation. Materials such as PVC pipes (50m), hollow cement blocks or boulders, tiles etc., should be painted dark and provided as hide - outs for the animals. This will help in enhancing pigmentation, growth rate and avoiding cannibalism of the animals during molting. Quality sea water is a prerequisite for the fattening purpose. About 10 lobsters can be stocked per square metre. All species of lobsters can be held together for the fattening purpose. The rearing system should have uninterrupted power supply and aeration. The major steps involved in fattening are (a) Collection and transport of juveniles to the fattening site (b) Acclimatization and stocking(c) Feed management (d) Water quality and disease management (e) Growth monitoring/Sampling (f) Harvesting,

Lobsters weighing around 90g can be used for fattening as the growth rate is high (~ 35g/month) in this size range. Juveniles can be collected from surf ridden and coral areas by handpicking or from by-catches of fishing gears (bottom-set gill nets, trammel nets, traps, trawl nets etc.). Careful handling is essential for transportation of live lobster, starting from removal of lobsters from fishing gears, isolation of weak and injured from healthy and non-injured ones separately and maintaining them in fresh seawater with vigorous aeration till the time of packing. The live lobster can be transported to fattening site by the following procedures:

i. Floating ice blocks packed in polythene bottles should be used for chilling the holding tank in case of high temperature observed in holding tanks

ii. Lobsters should be tied with rubber band from the spine at the carapace to abdomen to reduce the movement.

iii. Wicker/bamboo baskets having a layer of straw soaked in seawater are used to transport lobsters

iv. Over this layer of straw, ice blocks packed in polythene bottles should be placed and a second layer of seawater soaked-straw should cover this.

v. Such immobilized live lobsters should be placed over the second layer of straw.

(b) Acclimatization and stocking

Animals have to be acclimatized for 2 weeks before stocking in fattening tanks. Prior to acclimatization, animals should be quarantined and fed with the proposed feed (clam / mussel) for fattening. Stocking is done as per Table 1. Approximate initial weight of each lobster should be determined so as to know the quantity of feed that has to be provided to attain target growth of the animals at the end of the fattening period.

Table 1. Suggested stocking density for various size groups of *P.homarus*

S.No	Size group (g)	Stocking density (nos./m^2)
1.	50-75	25-30
2.	75-100	20-25
3.	100-125	8-10
4.	125-150	6-8

Quarantine

Before stocking, newly collected lobsters should be maintained in well-aerated clean seawater tanks. Weak animals, if any, characterized by broken appendages, wounds and tail or pleopod erosion or black spot on the shell be removed. The healthy animals should be given malachite green bath treatment (at 0.25 ppm concentration) for 1 hour on alternate days for three times totally.

(b) Feed management

The spiny lobster is a selective feeder, preferring shellfish to scale fish. Natural food items such as mussels, clams, squids, trash fish etc. could be used as fattening diets. Artificial diets could be used as supplementary diet for fattening.

Natural food

The main natural diets fed during the fattening experiments conducted at NIOT were mussels (Aazhi), clams (Matti) and squids (Kadamba). These food items can be fed to the animals either singly or in combination as mixed diets. The mussels can be collected from shallow areas by diving and clams can be collected along the coast during low tide and both are maintained in FRP tanks for 2-3 days. Soft sandy bottom should be provided as burrowing substratum for the clams and medium sized rock pieces as attaching substratum for mussels. Continuous aeration and daily water exchange should be carried out. Prior to feeding, all the feed items should be cleaned well. Clams / mussels should be shucked to remove the intestine and squids should be removed off its tentacles and ink sac. The feed items are then washed well with fresh seawater. To start with, an initial ration of 4-5 % of body weight has to be fed to the lobsters and subsequently the ration level is increased or decreased depending upon their consumption. The unconsumed feed should be removed on the following morning. Totally around 500 kg of feed is required for 6 months operation. Feeding has to be done only once daily during the evening hours between 4 .00 – 5.00 p.m.

Different feed items could also be fed to the animals on a rotational basis. This practice stimulates better food consumption by the animals.

Trash fish from commercial trawling will be inexpensive and can be exploited as feed for lobsters. But regular supply of these foods must be ascertained. Feeding the lobsters with mussel meat could enhance pigmentation/coloration of the lobsters. Continuous usage of clam meat alone as a fattening diet would result in albino lobsters, which in turn would fetch low market value in live export.

Feed storage

The natural food items (mussel, clam and squid) should be cleaned well, packed in polythene bags and stored in a deep freezer. This would prevent the spoilage of food items. However, long-term preservation of natural food items is not possible. Feed preserved in this manner could be used only to a maximum of 2-3 weeks.

Artificial food

The natural food items must be harvested periodically from the sea or cultured artificially. Also, natural foods are not easily stored and would have to be fed quickly before they begin to decompose. Leaching of nutrients from partially eaten fragments of these foods could pollute the culture water very rapidly, and it is possible that the lobsters would not eat certain parts ofthe food such as bones, shells or skin. Thus research on the development of food for lobster fattening, especially towards the formulation of pelletised diets has been initiated at NIOT. These diets consist of moist/dry pellets made from powdered, dried ingredients. The composition of a pellet diet, which can be used as a supplementary diet for fattening, is tabulated below:

Ingredient	Quantity (%)
Fish meal	43.66
Soya meal	30.00
Corn gluten	12.80

Maida	4.00
Fish oil (menhaden)	6.04
Vitamin mineral mix	2.00
Gum acacia	1.50

A semi-moist diet has also been tried for lobster fattening. This diet is made of a mixture containing soya chunks and mussel meat mixed in the ratio 2:1. The soya chunks are soaked in boiling water for half an hour and then grind well with mussel meat. The mixture is subsequently steam cooked for 20 minutes. The cake is prepared on alternate days and stored in a refrigerator until further use. Acceptability of this feed by the animals is observed to be good. However, the growth rate attained with this diet is less when compared with the mussel meat. Hence, this diet could be used only as a supplementary diet for fattening and attempts are being made to incorporate the natural and essential growth promoting ingredients for the purpose of achieving faster growth as compared to live feeds.

Water Quality and Disease Management

Once the good source water is selected and finalized, the next problem arises from water quality deterioration caused by management inputs to enhance production. In lobster fattening the main input is the feed. Although the feed given is live, chances for the increase in the organic load is still high only. Thus the water quality management methods such as aeration, water circulation, and water exchange must be used to maintain tolerable culture conditions for lobsters. Although some general ideas about water quality in tanks can be obtained from visual observations, a much better picture can be obtained from chemical and physical measurements such as salinity, temperature, pH, dissolved oxygen, ammonia and nitrate. These parameters can be measured by commonly available water quality test kits. Following are the major guidelines to be followed by the farmers undertaking lobster fattening:

a. The source water should be filtered through a 100-micron filter bag to eliminate the suspended particles before filling in tanks.

b. The water level should be between 1.0 and 1.2 m.

c. Continuous aeration should be provided by fixing a PVC pipe (1 inch dia.) with 0.5 mm – 1.0 mm hole at regular intervals at the bottom of rearing tanks. The aerating source may be 1.0/1.5 HP blower.

d. 80 – 90 % water exchange should be given every morning. The appropriate percentage can be finalised after measuring the water quality parameters.

e. The optimal range of physico – chemical parameters of the culture water to be maintained during fattening period are;

i.) Salinity: 30.00 – 35.00 ppt.
ii.) Temperature: 26.0 – 33.0°C
iii.) pH: 7.5 – 8.5
iv.) Dissolved oxygen: >4.5 mg/L
v.) Total ammonia: < 1 ppm.
vi.) Free ammonia: <0.25 ppm
vii.) Nitrate: <0.25 ppm.

f. Give more priority to salinity and temperature as a drop in these parameters affect the survival and growth of lobsters.

g. If the salinity of source water is below 30.00 ppt., add salt water prepared by adding crystal salt to seawater and mix thoroughly until 30 ppt. is attained. The concentrated salt water is prepared by adding commercial crystal salt to clean sea water in a trough and mixed well until there is no precipitate at bottom and then filtered through fine meshed sieve or filter bag to remove dust particles in salt. Do not keep the commercial salt bags near moist surface.

h. The water exchange and depth can be minimised during a fall in salinity.

Good water quality automatically keeps the occurrence of diseases under control. Moreover lobsters are hardy animal and not too prone to disease outbreaks. Proper water exchange with adequate aeration improves water quality, reduces pathogenic load and stress, which could almost prevent any disease occurrence throughout the fattening period. None of the disease problems experienced to date appears to pose a serious threat to commercial industry provided due attention is paid to basic husbandry practices.

However, if any of the following symptoms are observed in the stock, the animals can be quarantined and treated.

Clues for identifying diseased animals:

1. Animals sluggish and lethargic in behavior.
2. Animals take too long a time to retain their normal position when kept on their back.
3. Presence of tail or pleopod erosion.
4. Presence of black spot or patch or wound on the shell.
5. Pleopods or tail become too soft.
6. Low intake of feed (loss of appetite).
7. Dirty and slimy nature of pleopods and tail.

(d) Growth monitoring/ Sampling

The farm operator can easily find out whether lobsters are growing well by sampling the animals once in every thirty days. As in any other crustaceans, growth in lobsters occurs through the moulting phenomenon. Moulting is the process of shedding of old exoskeleton or exuvia as the animals grow. The frequency of moulting depends on the size of the animal. Small sized animals have increased moulting frequency than the bigger sized ones. For instance, animals of small size group (60 –70 g) moult twice within two months whereas those belonging to large size group (150 – 160 g) moult only once within the same period. However, moulting frequency also depends upon the type of feed provided to the animals and as well as the environmental conditions prevailing in the grow-out systems. Good and sufficient amount of feed, optimum water quality parameters etc. enables the animal to moult easily. Animals which are

freshly / newly moulted (soft shelled) should be handled carefully as these are more prone to stressful conditions. Growth of the animals can be assessed on the basis of their weight increment. A top loading or a monopan balance serves the purpose. It is advisable to record the weight of freshly moulted animals only after their exoskeleton hardens (2-4 days after moulting). This will minimize the handling stress to the animals.

(e) Harvesting

Ten days before the date of harvesting the lobsters should be given a quarantine treatment using 0.5ppm malachite green for a period of one hour in order to remove the algal deposits if any in the carapace of lobsters. On the day of harvesting, water level should be decreased to 0.5 m and lobsters can be harvested using a hand net without damaging the antennae or other part of the body.

ECONOMICS OF FATTENING

Although the fattening of lobsters is attempted in several parts of the world through cage culture, pond culture etc., very little information is available on the economics of fattening of spiny lobsters. It may be a pioneer approach with a societal application. It requires a capital cost of Rs. 3,00,000 and working costs of Rs. 84,250 for achieving the production of 230 kg per year for a 50 sq.m fattening area. Out of the capital investment, 33% goes to the construction of open cement tanks.

Fattening in outdoor systems (sea cages)

The steps involved in outdoor lobster fattening are (a) site selection (b) cage deployment and stocking (c) feeding (d) sampling (e) cage maintenance

(a) Site selection: It plays a very important role in lobster fattening. Site selection determines the potential yield and cost of shed construction for the fattening activity. Some of the most critical aspects of site selection are:

(1) Locality: The site should be preferably free from cyclone and heavy rain.

(2) Water source and quality: Good quality seawater should be available and the site should be located away from areas of wide salinity fluctuations, industrial and domestic sewage waste outfall. The quantity and seasonal patterns of rainfall at the site should be studied, as salinity levels strongly influence the success of lobster fattening operation. Therefore, areas of extreme salinity fluctuations should be avoided for the fattening activity. Water supply should be as close as possible to the lobster-fattening site in order to minimise the expenses on seawater pipelines. Temperature is a fundamental determinant of lobster growth rate. If the temperture falls beyond the optimum ranges for significant periods, production potential will be impaired. So adequate care should be taken to see that the mean temperature is always within the optimum range of 26-33°C.

(3) Availability of lobster juveniles: The site should be preferably nearer to the areas where lobster juveniles are available in abundance throughout the year.

(4) Availability of live food organisms: Food organisms such as bivalves, trash fish etc. should be available in near the site, so that the cost of feed transportation can be minimized / saved.

(5) Infrastructure and communication facilities: The site selected should be accessible by road and air transport. The proximity of the site to an ice plant and to a processing unit should be considered.

(6) Power supply: Uninterrupted power supply is another important factor, which is to be considered.

(7) Labour force: The availability of cheap and skilled labour is essential for the success of fattening operation.

(8) Technical services and support: Technical support providing extension services, disease specialists and

laboratory services which can perform water quality and nutritional analysis should be available at site.

(9) Social, environmental and ecological impacts: The social, ecological and environmental impacts of lobster fattening activity should be taken into consideration from the early planning stages of the operation. The kinds of issues, which should be given attention, include possible conflicts over land-use and use of water resource. Good site selection can help to minimise the negative impacts of lobster fattening activity

(10) Market: The identification of the market for the fattened lobster is a very important factor to be considered during site selection. Therefore, proximity to the market or to efficient transport links is essential.

(b) Cage deployment and stocking

NIOT has designed a cage for lobster fattening and it has been deployed in the Gulf of Mannar islands near Challi theevu Island, Tuticorin.

Cage designed by NIOT: The cage has a main frame of 2 $^{1}/_{2}$ inch GI pipe with steel woven mesh (2m x 2 m x 1.2 m) and accommodates four inner cages (0.75 m x 0.75 m x1.1 m) with two layers of nylon mesh with sizes 15 mm x 15 mm (inner) and 5 mm x 5 mm (outer).The volume of each inner cage is 0.65 m^3. A lifting arrangement with pulleys is provided for handling these inner cages at site. The frame has four buoyancy modules made of polyethylene containers of 200 l each filled with PUF foam and sealed properly.

Stocking

The cages can be deployed about 1.5 km from the shore and juvenile lobsters can be stocked at a density of 15-20/m^2. The initial morphometric data of the animals such as carapace length, total length and body weight should be recorded, so as to get an idea about the growth increment at the end of the fattening period.

Feeding

The lobsters can be fed with the feeds available near the site like clams, trash fishes and mussels. The size of clams/mussels collected to feed the lobsters should be compatible to the size of the animal stocked in cages. If bigger sized clams/mussels are collected to feed small sized animals, then the feed should be slightly crushed with a stone and then fed. This would prevent the wastage of energy by the animals to break open the shells of the bivalves.

Sampling: Growth performance of the animals can be assessed at the end of the fattening operation or at an interval of every thirty days. For sampling, the animals should be carefully removed from the cages and weighed.

Cage maintenance: Periodical cleaning of the cages should be done to remove any adhering organisms. The animals also should be monitored regularly to check for the presence of any infestations or epibionts colonizing on them. If any algal growth is observed on the exoskeleton of the lobsters, it can be removed by scrubbing gently with a toothbrush.

Depending upon the effort taken by beneficiary the profit will vary and care should be taken on cage maintenance and proper feeding and to follow the instructions given by NIOT. If the beneficiary is able to arrange the juveniles and feed from wild, relevant cost can be added to the profit. From the second crop onwards cost of cage can be added to the profit.