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COMMERCIAL PROSPECTS FOR FARMING SPINY LOBSTERS

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ABSTRACT

Tropical spiny lobsters are fast growing and highly adaptable to captive conditions. Their gregarious and non-cannibalistic behaviour makes them suitable for aquaculture. Research on breeding, larval rearing, feed requirements, growth and mass culture in indoor growout systems shows that three species (*Panulirus ornatus, P. homarus* and *P. polyphagus*) are suitable for farming. *P. ornatus* is the most promising among these, as live specimens of this species weighing above 500 g are in great demand and fetch the highest value in the export market.

One of the major constraints to spiny lobster culture is the difficulty in rearing the phyllosoma larvae to postlarvae (puerulii) in controlled conditions. Early growth of puerulii is also slow and it is uneconomical to grow them to the prime size of 500 g. Juveniles weighing above 100 g can, however, be grown to the target size within 8-12 months with good feed and water management. In India, large numbers of juveniles are caught along with commercial sized lobsters and these can be purchased cheaply and utilised for farming. Fattening of larger sizes (250-350 g) to 500 g can be achieved in a shorter period. In the laboratory, with minimal water management and feeding exclusively on clams, *Meretrix casta, P. ornatus* and *P. homarus* have been grown from 100-400 g in a year. A substantial reduction in growing time has been achieved by eyestalk ablation. *P. ornatus* weighing 100 g has been grown to 1 500 g in 8 months. Eyestalk ablation as a tool for accelerating growth for commercial farming purposes and consumer acceptance of ablated lobsters need further investigation.

A commercial farming facility should be sited in an area where annual seawater temperature and salinity fluctuations are minimal and juvenile lobsters and feed are available. Among the different culture systems, an on-shore production facility consisting of several indoor growout tanks with flow through seawater is convenient. The optimum water quality requirements of spiny lobsters have been worked out. Feeding trials have shown that molluscan (especially mussel) meat is the most preferred diet of spiny lobsters. The best growth rate, however, is obtained when a mixed diet consisting of mussel, clam and fish is fed daily at a rate of 3-10% of the live weight, depending upon the size of the lobster. Feed is the largest single item (60-70%) of production cost in lobster farming. The development of a growth-efficient formulated diet is essential for success of lobster farming. Diseases may not be a serious problem in spiny lobster culture. However, preventive measures, such as maintaining sanitary conditions in the rearing system and regular treatment of infected lobsters, are necessary.

Production cost analysis of a generalised production facility has been made and the potential profitability of growing different sizes and quantity of lobsters to the target size of 500 g has been calculated. The high value of live lobsters, attractive profit margin (50-85%) and quick return on investment (3-8 months) make commercial farming of spiny lobsters economically promising.

INTRODUCTION

The world catch of lobsters recorded in 1988 (FAO Year Book of Statistics, 1990) exceeded 205,000 mt of which 38% consists of spiny lobsters. At present, lobsters, fetch the highest unit price among the exploited marine resources and are one of the most esteemed seafood delicacies. The current production from fisheries is inadequate to meet the high demand for live lobsters and other lobster products in the international market. Of the several possibilities for increasing supply, perhaps the most imaginative strategy is farming in captivity. Successful cultivation might reduce current fishing pressures on lobster stocks and thereby conserve this important natural resource.

Tropical spiny lobsters are fast growing and highly adaptable to captive conditions. Their gregarious and non-cannibalistic behaviour makes them suitable for farming. Realising their importance, the Central Marine Fisheries Research Institute of India, as early as 1976, initiated a research project on lobster culture with the main objective of developing suitable technology for farming spiny lobsters. As a result, extensive information on reproduction, nutrition, growth and other components essential for lobster aquaculture has been obtained. Experimental farming in indoor grow-out systems has indicated the farming potential of three species of spiny lobsters occurring in Indian waters, *i.e. Panulirus ornatus, P. homarus* and *P. polyphagus*. In this paper, the commercial prospects for farming spiny lobsters and the major constraints are discussed.

BROODSTOCK AND LARVAL CULTURE

Tropical spiny lobsters breed almost throughout the year. Berried lobsters occur in commercial catches regularly and they can be easily reared in captivity. But one of the critical problems is the protracted larval development of most species. No research group has so far succeeded in rearing a tropical palinurid from egg to puerulus stage. Recently, Kittaka (1988) succeeded in completing the life history of three temperate and two sub-tropical species. This achievement has opened up the possibility of developing hatchery technology for spiny lobster seed production. However, commercial production of lobster seeds may take some time. Until then, farming has to depend upon naturally available postlarvae (puerulii).

PUERULII AND THEIR AVAILABILITY

The final stage phyllosoma larvae metamorphose into the puerulii in offshore waters and swim towards the shore and settle on suitable benthic habitats along the coast. Several investigators have developed devices to capture them and a number of species have been grown to commercial size. Chittleborough (1974) reared the puerulii of western rock lobster, *P. cygnus* to the legal harvestable size (76 mm carapace length and 387 g weight) in 30 months at an optimal temperature of 25°C. Michel (1979) claims to have reared postlarval *P. ornatus* to 300 g in 10 months. *P. polyphagus* puerulii have been grown to 300 g in 27 months under laboratory conditions on an exclusive diet of *Meretrix casta* (Radhakrishnan and Devarajan, 1986). Lellls (1990) was able to grow *P. argus* puerulii to a marketable size of 454 g in 18 months at a constant elevated temperature of 29 °C. Compared to several other commercially farmed crustaceans, the time period required to grow puerulii to adult size is too long. Moreover, collection of large numbers of them for stocking a culture system is capital-intensive and impractical. For the present, therefore, growing juveniles to commercial size looks a more feasible proposition.

JUVENILE AVAILABILITY

The puerulii which settle on the nearshore rocky and seagrass habitat grow to become juveniles. In countries where a minimum legal size for capture is strictly enforced, catching and holding undersized lobsters is illegal. In India, since a minimum legal size for capture has not been rigorously implemented, tangle and trammel nets are used for lobster fishing in many areas. Juveniles form 30-40% of the commercial catch in certain areas, and can be procured at a reasonable price and used for farming. On the north-west coast of India, in Gujarat, juveniles of *P. polyphagus* are trapped from intertidal areas using a stake net called *bandhan* and sold to farmers. Unrestricted exploitation of juveniles may adversely affect natural recruitment processes. Limited, strictly controlled exploitation from densely populated areas can, however, be considered.

GROWTH OF EARLY JUVENILES

Chittleborough (1974) successfully reared *P. cygnus* juveniles (average size 45 g) to their legal harvestable size (387 g) in 17 months under near optimal conditions in the laboratory, whereas Lellls (1990) was able to grow similar-sized juvenile *P. argus* to 454 g in 14 months on a mixed diet of ground fish, clam and squid. *P. homarus* has been estimated to take 12 months to grow from 80 g to 400 g and *P. ornatus* a little less than this period (Radhakrishnan and Vijayakumaran, 1990). Through improved water management and feeding of a variety of diets, growth rates of tropical species can be enhanced significantly. Lobsters weighing 100-150 g can be grown to the prime size of 500 g in 8-12 months in mass culture systems. So, for the present, growing larger juveniles (100 g and above) to the commercial size looks more promising than rearing the puerulii to the required size.

FATTENING LARGER SIZES

Another attractive proposition is growing larger sizes (300-350 g) to the prime size of 500 g in a shorter period. Lobsters of this size range can be procured from commercial catches and grown to the required size. The fast growing tropical species *P. ornatus* can be grown from 350-500 g in 3-4 months. Other species such as *P. homarus* and *P. polyphagus* may take 30% more time to grow to a similar size.

GROWTH ACCELERATION BY EYE-STALK ABLATION

Growth in tropical spiny lobsters can be accelerated several fold by bilateral eyestalk ablation (Radhakrishnan and Vijayakumaran, 1984; 1990). Ablation was found to accelerate moulting and weight gain significantly. An increase in weight of the order of 3-7 times the original weight, was obtained in different size groups of *P. homarus*. *P. ornatus* weighing 100 g reached a weight of 1500 g in 8 months by this method. Survival was 70% in ablated lobsters compared to 95% in the control group under experimental conditions.

ENVIRONMENTAL REQUIREMENTS

The major water quality parameters for spiny lobster culture are known (Table 1). Spiny lobsters are hardy and can tolerate extreme environmental conditions, but such an exposure for prolonged periods can affect growth drastically. The major environmental parameters which should be monitored regularly are, temperature, salinity, oxygen, pH and ammonia. *P. homarus* and *P. ornatus* are strictly marine whereas *P. polyphagus* is euryhaline and can grow in lower

Table 1: Water quality requirements
for lobster farming

Parameters	Optimum level
Temperature (°C)	26-33
Salinity (ppt)	25-35
pH	6.8-8.5
Dissolved oxygen (ppm)	>3.5
Total ammonia nitrogen (ppm)	<1.0

salinities (20-25 ppt) satisfactorily.

Most of the spiny lobsters are oxygen conformers and can adjust to low oxygen conditions. However, higher oxygen levels are required during the night when lobsters normally feed and undergo moulting. Depression of oxygen levels to <3 ppm may result in mortality of moulting lobsters. Ammonia is the main excretory product and care should be taken to keep ammonia levels within safe limits. Since accumulation of metabolities will be at a peak during the early morning, vigorous aeration and continuous flow of fresh seawater through the rearing tanks during this period is essential to maintain the water quality.

Spiny lobsters are generally gregarious. They grow faster when provided with communal shelters. This prevents excessive crowding and thereby enhances growth. It also helps the newly moulted lobsters to hide until their exoskeleton gets hardened. The shelters can be stacked one above the other and this may help in better utilisation of the water column.

Proper maintenance of light intensity and photoperiod in the rearing system is essential for optimal growth. Lobsters being nocturnal, they hide under the shelter during the daytime and come out at dusk for feeding. Those maintained under subdued light have been observed to grow faster.

Information on space requirements of spiny lobsters is limited. Stocking density will depend on the size of the lobsters to be stocked. Optimal stocking will not only improve growth rate but will have a major effect on the overall cost of production. A stocking density of 10 lobsters/m² has been recommended for the rearing of lobsters from 100-150 g to 500 g in intensive farming.

FOOD AND FOOD UTILISATION

Although lobsters accept a wide range of food, they are selective feeders, preferring shellfish to finfish. Green mussels are the most preferred diet. In the laboratory, they have been grown on clams as well as on trash fish. Daily feeding at a rate of 3-10% of the live body weight is required depending upon the size. Mean gross feed conversion ratio (on a wet weight basis) is 5.0 for mussel-fed lobsters, 5.8 for clam-fed lobsters, 6.6 for fish-fed lobsters and 4.8 for lobsters fed a combined diet containing all the above items in equal proportions. However, for successful commercial lobster farming, a suitable artificial diet promoting efficient growth rate, is essential.

DISEASES AND THEIR CONTROL

Lobsters maintained on good feed and water quality are rarely infected by any disease. ' water quality and hygiene in the rearing system may provide favourable conditions for the growth of epiphytic protozoans, fungi and bacteria. Protozoan infestation can be controlled by treating with 20-30 ppm formalin for one hour. Furazolidone (10 ppm/hr) treatment is effective against bacterial infections. If any lobster is found to be infected, they have to be isolated and treated in a separate tank for a specific quarantine period.

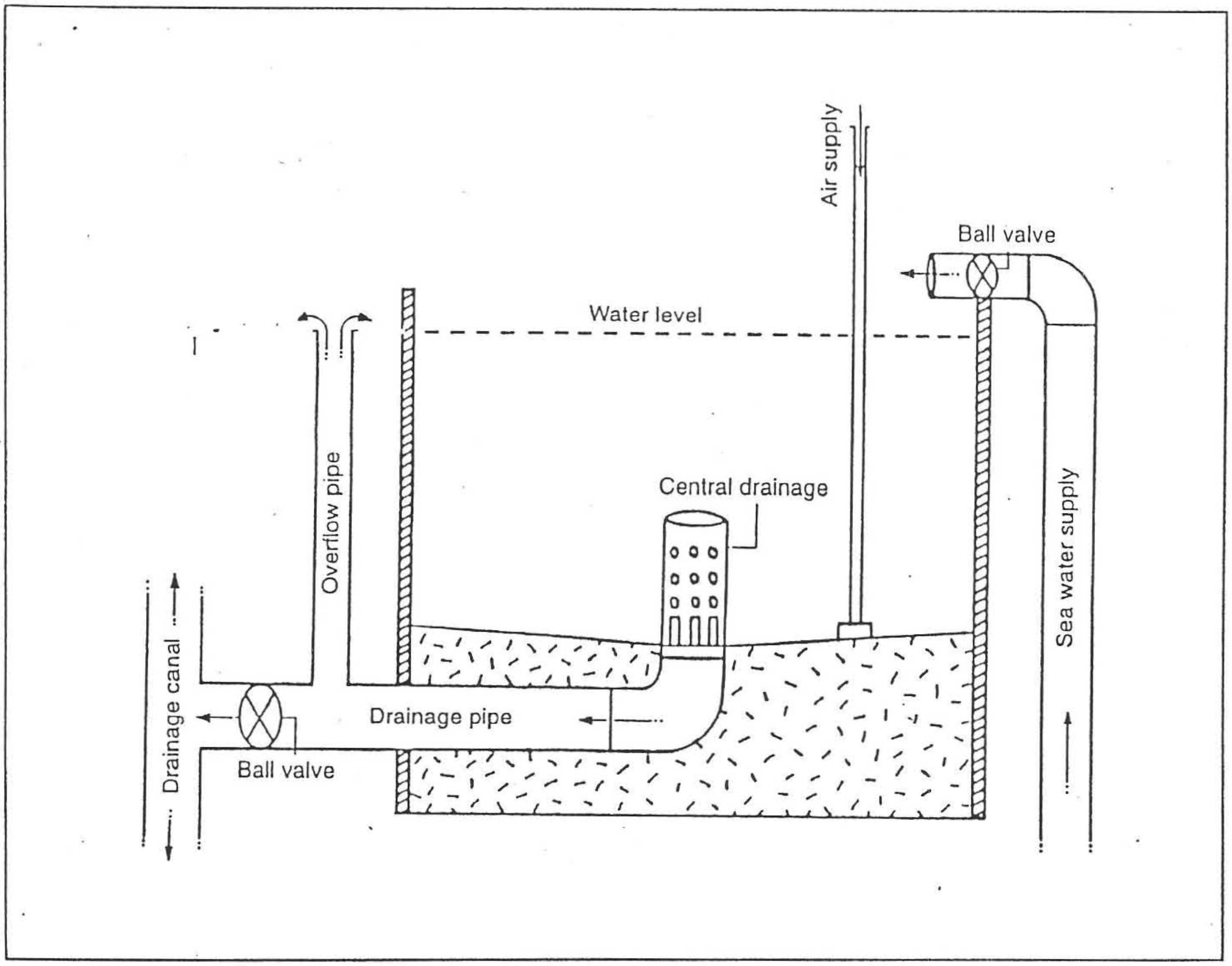
SITE SELECTION AND DESIGN OF CULTURE FACILITIES

Selection of a suitable site and an efficient design of the rearing system will determine the success of a commercial lobster production facility. The culture site should be located in an area where seawater temperature and salinity fluctuations are minimal. The facility should be nearer to a good source of feed and also where juvenile lobsters are available. In case the food source is away from the lobster population, it might be more economical to transport the lobster to the culture facility which should be located closer to the food source.

Farming lobsters in an indoor growout system consisting of several independant units is advantageous as the different units will be easily accessible for feeding, cleaning and maintenance. Circular tanks with a central drainage and over-flow pipe will be the most appropriate (Figure 1). Circular design will prevent formation of eddy currents and maintain uniformly aerated water in the tank. It may be more economical to construct a series of interconnected square tanks with an inner circular design (Figure 2) as it might yield considerable savings in space as well as in terms of structural expenses.

Spiny lobster culture in open growout earthern ponds may not be practicable at the present time for various reasons. Since farming presently has to depend upon naturally available juveniles, it may not be always possible to collect a sufficiently large number of juveniles to stock 'extensive' systems. Stocking different sized groups in a rearing tank is not advisable,

Figure 1: Schematic diagram of a lobster culture tank



as it will be difficult to decide the quantum of food to give and this may also result in feeding dominance of larger lobsters.

ECONOMICS OF SPINY LOBSTER CULTURE

Most of the biological information required for establishing a lobster culture facility is available. The initial outlay of capital for development of infrastructure will be substantial. The cost of the farming operation will depend on the quantity of lobsters to be farmed. Initial stocking size and the proposed harvest size will decide the quantum of feed required and the cost of maintenance.

An examination of Table 2 shows that the greatest single cost in lobster culture is associated with feed. Feed forms 30-70% of the total production cost, depending on the initial size of the lobster to be stocked and the period of growth. Farming of any organism cannot entirely depend on natural feeds because of uncertainty of supply and difficulty in storing them. Artificial diet is considered critical for reliable commercial production. A successful artificial diet for spiny lobsters is yet to be compounded. A dry but not easily disintegrable diet with high elasticity to suit the unique feeding behaviour of the lobsters is necessary. Until a suitable diet is commercially available, farming has to depend on natural live feeds. Green mussels, clams and oysters are well accepted by lobsters. If mussels can be cultured at a sufficiently low cost, the mussel meat could be converted to the higher priced lobster meat.

The second major cost of production will be the purchase price of seed lobsters and this will again depend on the size to be purchased. If sufficient quantity is not available near the facility, seed lobsters procured from other fishing centres can be transported with minimum stress.

The relative contribution of various cost factors to the overall cost of production in a farming facility with a production capacity of 10 mt/annum has been estimated. For growing lobsters from an initial stocking size of 150 g to a harvestable size of 500 g in a period of 8 months, the feed and seed cost will be 71% and 13%, respectively, of the total production cost. For an

Figure 2: Layout of an indoor lobster culture facility

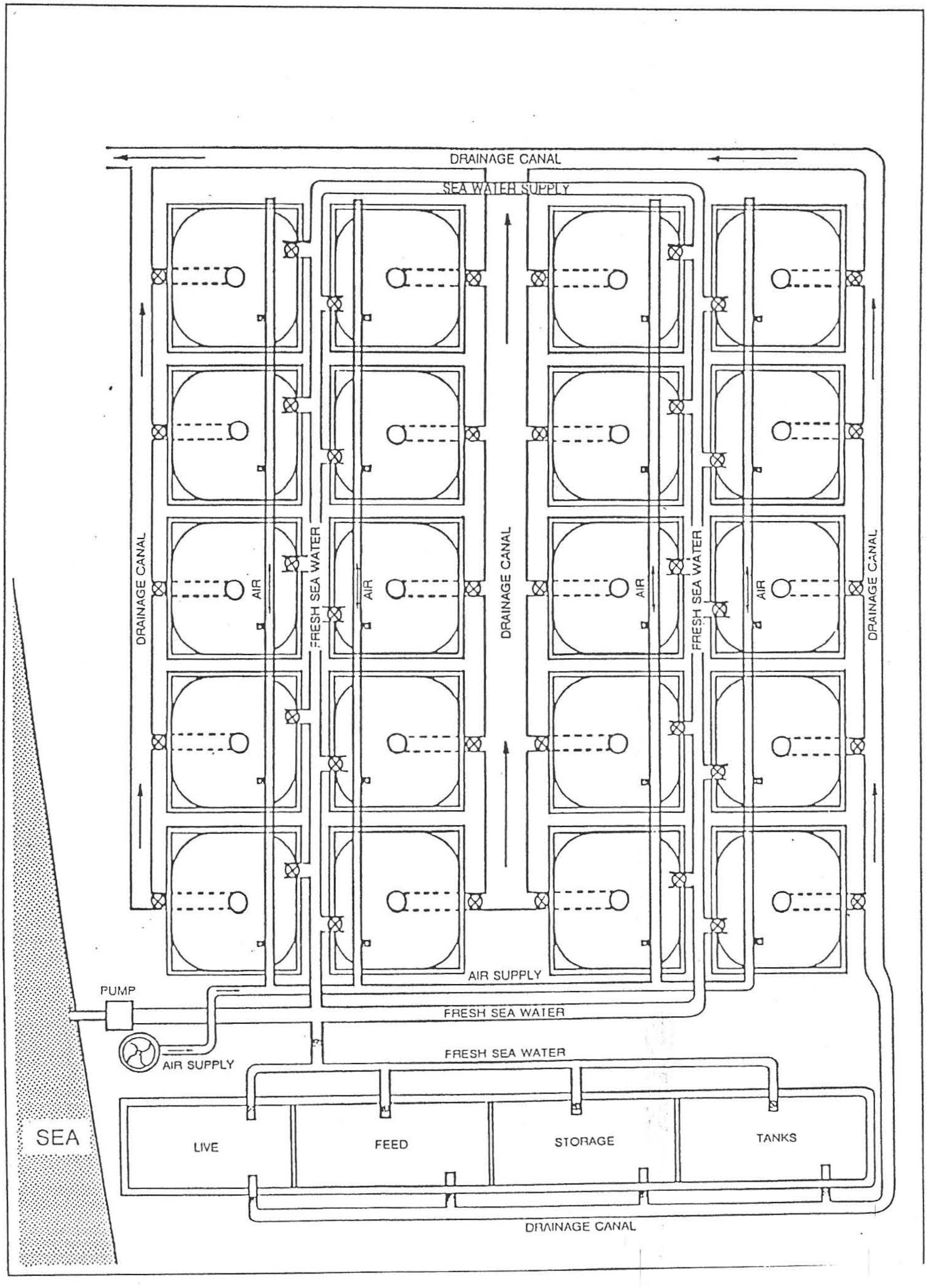


Table 2: Production cost analysis of a hypothetical lobster farming facility*

Cost factors	Percent of total production cost
Seed	13.0
Feed	71.3
Energy	9.0
Labour	3.0
Maintenance	3.7

*Estimated for growing 3000 kg of lobsters from an initial stocking size of 150 g to a harvestable size of 500 g in a period of 8 months.

initial stocking size of 250 g, the feed and seed costs are estimated at 44% and 24%, respectively and for 350 g size, the same will be 31% and 45%, respectively. The rest of the cost comes from energy and labour.

For establishing a commercial lobster farming facility with an annual production of 10 mt, the estimated capital investment, the operational cost and the gross profitability are given below:

a. Development cost : IRs* 7 000 000
b. Operational cost (for growing 150 g size to 500 g) : IRs 5 500 500
c. Income from sales (9055 kg of lobsters @ IRs 1200/kg) : IRS 10 900 000
d. Gross profitabity = Income from from sales - (10% depreciation + operational cost for next crop) : IRs 4 700 000

*1US$ = IRs 32 approximately.

Thus the estimated profitability is 84.0% of the operational cost in a period of 8 months. If the initial size of stocking is 350 g, the profitability percentage is estimated as 66.7 for a growth period of 3 months.

FUTURE PROSPECTS

Although the rearing of spiny lobsters in 'extensive' culture systems utilising growout ponds several hectares in size appears to be attractive, it may not be possible at the present time. The absence of a reliable hatchery technology and an efficient formulated diet are the major constraints. The possibilities for the present are: (i) fattening lobsters weighing 300-350 g to 500 g in order to fetch the highest unit price, (ii) growing juveniles weighing 100-150 g to 200-250 g for the purpose of whole cooking, or (iii) rearing 100-150 g size to 500 g.

There are no legal or technical barriers for lobster farming in India. Growth can be enhanced substantially by manipulation of environmental conditions. Further acceleration is possible by eyestalk ablation; however, consumer acceptance of ablated lobsters needs to be tested. Commercial farming with an annual production of 10-20 mt is practicable. Although extensive information on feeding and growth characteristics of spiny lobsters in captivity is available, based on which the above prospects for farming are proposed, a high priority for research on larval culture, nutrition, space requirements and pathology is required to perfect spiny lobster culture technology. Considering the inadequate production from natural fisheries and the high market price of lobsters, the prospects for commercial farming seem to be bright.

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