



PEN CULTURE IN FLOODPLAIN LAKES



CENTRAL INLAND CAPTURE FISHERIES RESEARCH INSTITUTE

Indian Council of Agricultural Research

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Pen Culture in Floodplain Lakes

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FOREWORD

Pen culture of fish and prawn has been found to be an effective way of fisheries enhancement in inland water bodies, especially floodplain lakes. This mode of enhancement has a special significance in management of floodplain lakes, as many of them are weed-choked, leaving option for open ranching limited. In many such cases, operation of many fishing gear becomes difficult, if not impossible. Moreover, the weeds give predators and weed fishes shelter, which either destroy or compete with the stocked fish. In such cases, pen culture option provides opportunities for getting the captive stock safe and making harvesting easier.

The CIFRI has been refining the pen culture techniques by making innovations in selection of pen construction materials, site selection, species selection and other management techniques. The Institute has been able to standardize a package of practices for successful operation of pen culture in beels. This document gives a handy guide to those who want to practise pen culture in floodplain lakes. I am confident that this technique will be very useful for managers of lakes and rivers in the country in general and the eastern region in particular.

Barrackpore,
9 February 2002

V. V. Sugunan
Director

Contents

	<i>Page</i>
Introduction	1
Selection of site	2
Pen size and design	4
Pen materials	4
Pen preparation	7
Pen management	10
Fish health	12
Harvesting and production	13
Precaution	13
Pen culture – A case study in Akaipur	14
Dos and Don'ts	18

INTRODUCTION

Wetlands in India have wide range of distribution from the cold arid region of Ladakh to wet Manipur; warm arid regions of Rajasthan-Gujarat to tropical monsoonic central India and the wet humid zones of southern peninsula. They can broadly be classified into three categories viz. Himalayan wetlands, Indo-Gangetic wetlands and Coastal wetlands. The Indo-Gangetic wetlands together with Brahmaputra basin comprising oxbow lakes, sloughs, meander scroll depressions, back-swamps, residual channels or tectonic depressions are not only significant from fisheries point of view, but they also play an important role in socio-economics of the regions as a whole. An estimated area of more than 2,00,000 ha of floodplain lakes locally known as *mauns*, *chours*, *beels*, *jheels*, *tals* and *pats* are available under Ganga and Brahmaputra river basins offering tremendous scope for fisheries development. In recent times, however, these natural fishery resources have lost their pristine glory in the face of ever increasing human pressure. Most of the lakes are passing through critical and advanced phases of eutrophication leading to heavy infestation of aquatic macrophytes, high rate of siltation, unwanted change in their hydrography and sustained loss of fish habitats. While increasing rate of eutrophication manifested into thick stands of aquatic weeds and heavy accumulation of semi-digested vegetative matters and bottom muck continue to be the major problems, the wanton killing of brood and juvenile fishes are equally responsible for decline in fish and fisheries.

The present level of fish yield from these wetlands is alarmingly low (100-200 kg/ha/yr), in spite of very high production potential ranging from 1,000 to 2,000 kg/ha/yr. It is imperative, therefore, that for effective fisheries management a holistic approach, wherein environmental, stock, species and habitat enhancements should be synthesised for optimum results. The pen culture technology developed by CIFRI has been found to be an effective tool for getting additional production of fish and prawn from floodplain lakes as they provide ideal habitat for such culture practices especially in the weed infested beels where effective gear operations become difficult. Introduction of pen culture in the fishery management of floodplain lakes has an added advantage of being a low cost technology with reasonably high return. Besides, pen culture operations can be pursued towards the shallow marginal areas of a lake, as such do not interfere with the fishery of the main lake. Pre-requisites/steps required for successful pen culture operations are:

- ◆ *Selection of suitable site*
- ◆ *Pen size and design*
- ◆ *Materials for pen construction*
- ◆ *Preparation for pen area*
- ◆ *Management of culture operations*
- ◆ *Monitoring of fish health*
- ◆ *Harvesting and production*

SELECTION OF SITE

In any culture experiment, site selection is an important aspect. Ideal environment is an essential prerequisite for pen culture which decide the economic viability and success of the venture to a large extent. Before constructing a pen, a detailed engineering survey should be undertaken with special emphasis on the kind of terrain and the nature of surrounding catchment area. The shoreline should be with a gentle gradient (Fig. 1). For prawn culture, sandy-loamy or sandy-clayey bottom is more suitable than clayey soils. The site for pen installation should be shallow with a minimum depth of 1.0 to 2.0 m. Low depth helps in keeping the pen area hygienic, productive and easily manageable. However, too low a depth, say less than 1 m, leads to thermal stress to the stocked animals during summer months. The site should be towards the bank to cut down construction cost but also allows an easy approach for management and harvesting. The water stead and shore characters should be favourable, specially it should be pollution free. A large number of trees overhanging the pen area are not desirable as they could obstruct light and the leaves falling from the trees could accumulate in the bottom and release CO₂ through decomposing. Turbid water is unsuitable, if prawn is cultured. Other important factors are the availability of construction materials, cheap labour and accessibility to the site. Poaching is a very disturbing social problem. Therefore, the prevailing social atmosphere of the locality should be verified before the site is selected.



A beel



Pen installed in beel

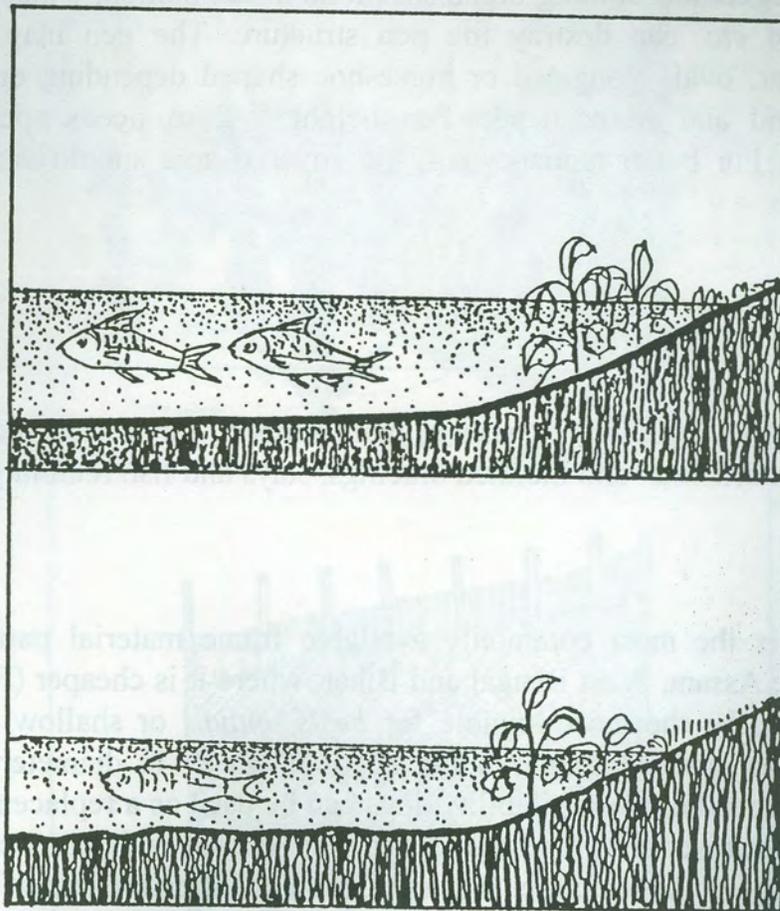


Fig. 1: Selected pen sites with gentle slopes from land to water
with sufficient working space

PEN SIZE AND DESIGN

Direct loadings (self weight) and external forces like impact of drift logs, aquatic vegetation, fouling organisms, mud accumulation, wind, surface waves, turbulence *etc.* can destroy the pen structure. The pen may be of square, rectangular, oval, elongated or horseshoe shaped depending on the nature of shore, land and water depth. Pen height > 2 m needs special protection measures. For better management, the covered area should vary between 0.1 and 0.2 ha.

PEN MATERIALS

The pen structure consists of main support, framework spanning over the supports, horizontal and inclined bracings, stays and fish retaining net linings.

Frame

Bamboo is the most commonly available frame material particularly in the states like Assam, West Bengal and Bihar, where it is cheaper (Fig. 2). Bamboo is found to be the most suitable for *beels*, *mauns* or shallow impoundments. Bamboo for making frame should be of 6" to 8" in diameter and 20-30' in length. Depending on availability, logs can be used as a replacement of bamboo poles. Galvanised iron pipe frame also can be used with iron net, for durability and rigidity of the structure. However, the cost effectiveness of these materials is to be worked out before selecting them for pen construction.

Screen (Fig. 3)

Pen screens may be of varying sizes according to the requirements. Split bamboo or canes with smooth surface and sufficient length are preferred as screen materials. Iron mesh also can be used, though very costly. Considering their durability, synthetic nets are the most suitable pen materials if the chances



Preparation of bamboo screen with nylon lining



Transportation of bamboo screen to pen site

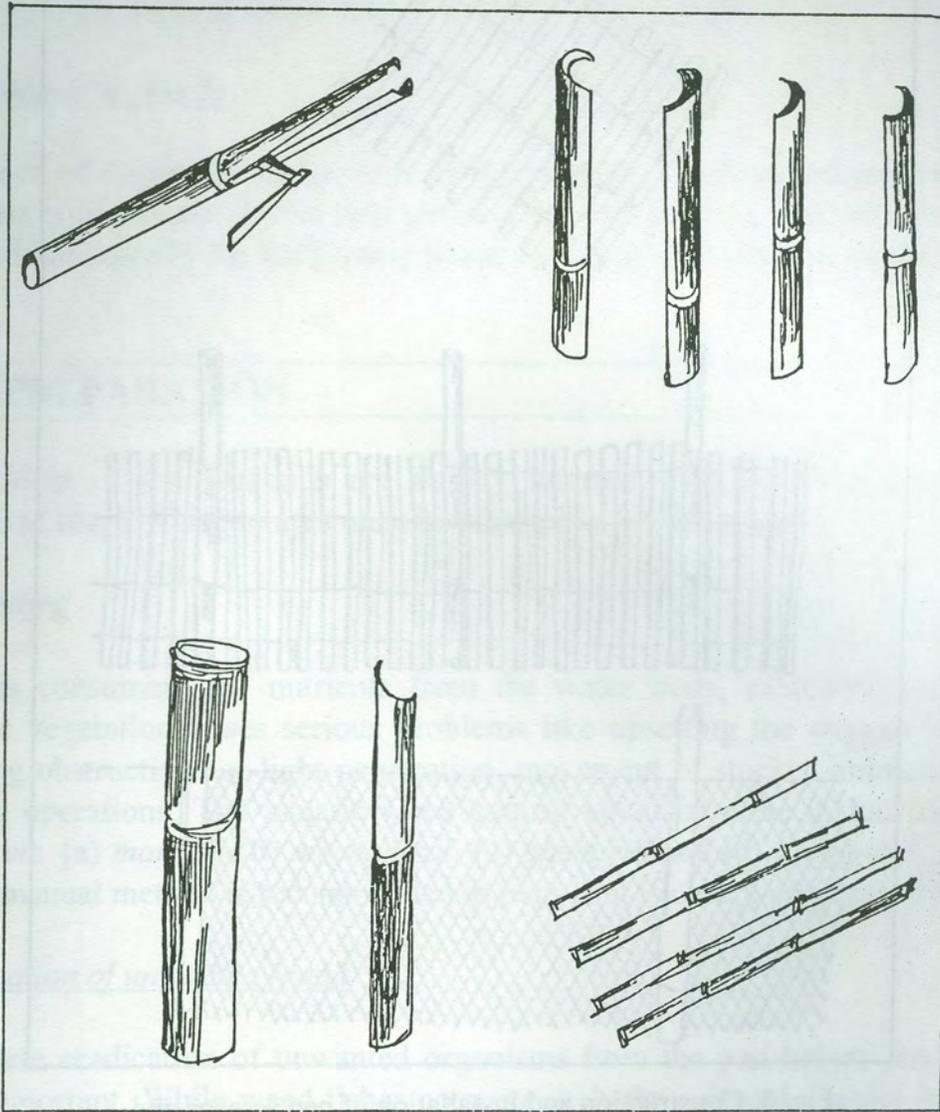


Fig. 2: Bamboo and its splits for weaving pen screens

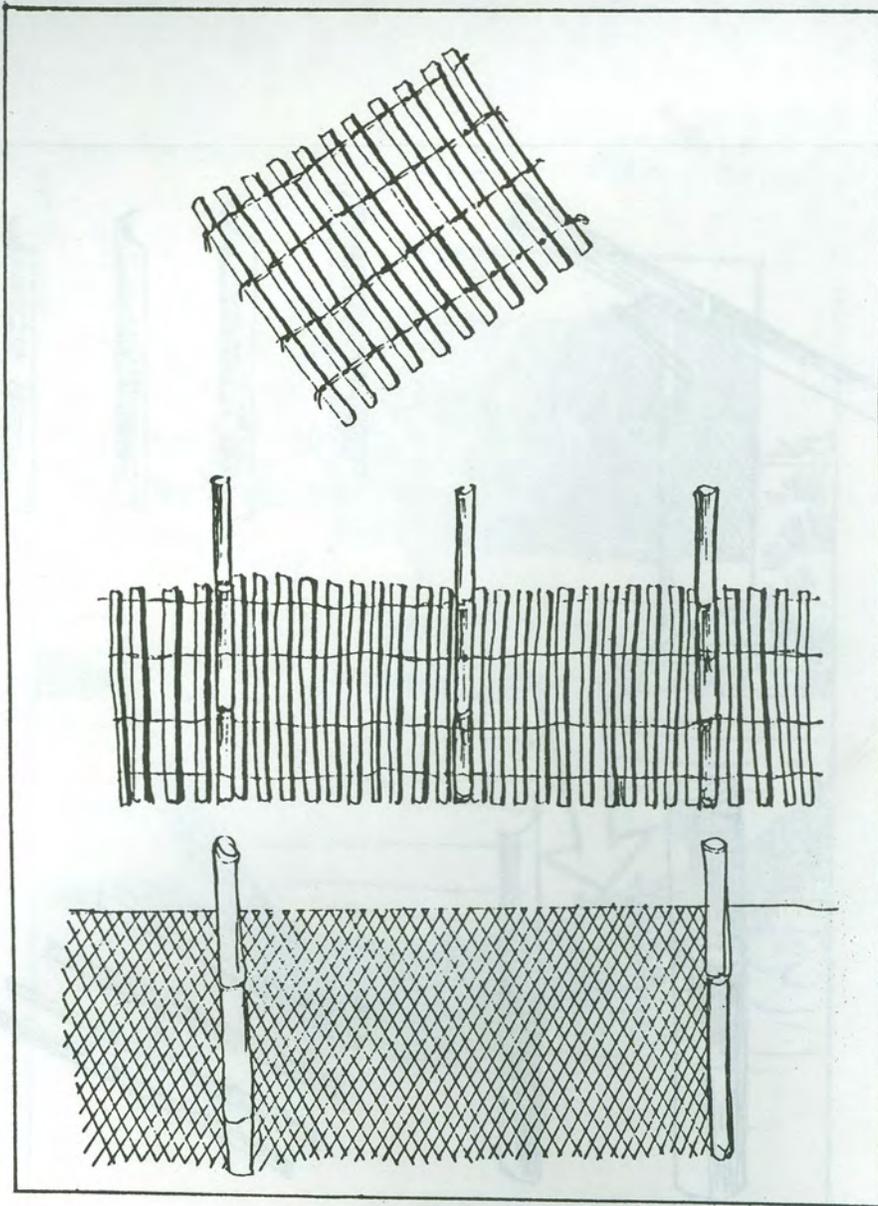


Fig. 3: Construction and installation of pen screens and Synthetic net as inner lining

of damage by various biotic agents and logs could be controlled. They are popular in countries like the Philippines, Thailand, Indonesia, *etc.* Coir ropes or synthetic threads are the best weaving materials. The mesh size of the screen is decided on the basis of initial size of the stocking materials.

Net lining (Fig. 4 & 5)

Provision of lining the frame with net is necessary to protect unwanted entry and exit of organisms. Nylon nets are used for this purpose. The nets should be cleaned periodically for facilitating water exchange and aeration inside the pen area.

PEN PREPARATION

Most of the wetlands are thickly infested with macrovegetation and unwanted fauna. The pen area must be cleaned before stocking.

Deweeding

Besides consuming the nutrients from the water body, excessive growth of aquatic vegetation poses serious problems like upsetting the oxygen balance, creating obstruction for light penetration, movement of stocked animals and in netting operations. The aquatic weed control could be done in four different ways, *viz.* (a) *manual*, (b) *mechanical*, (c) *chemical* and (d) *biological*. Among these, manual method is recommended in pens as it is cheap, easy and efficient.

Eradication of unwanted fauna

Complete eradication of unwanted organisms from the pen before stocking is very important. While weed fishes compete with the cultured species for food, space and oxygen, predators prey upon the stocked young ones. Repeated netting is the best method for eradication of fishes from the pens. This is also helps in removing other unwanted biotic communities like molluscs, insects *etc.* which could interfere with the management processes affecting production. Poisoning the pen area to eradicate the unwanted biotic communities is not advisable in pen culture.

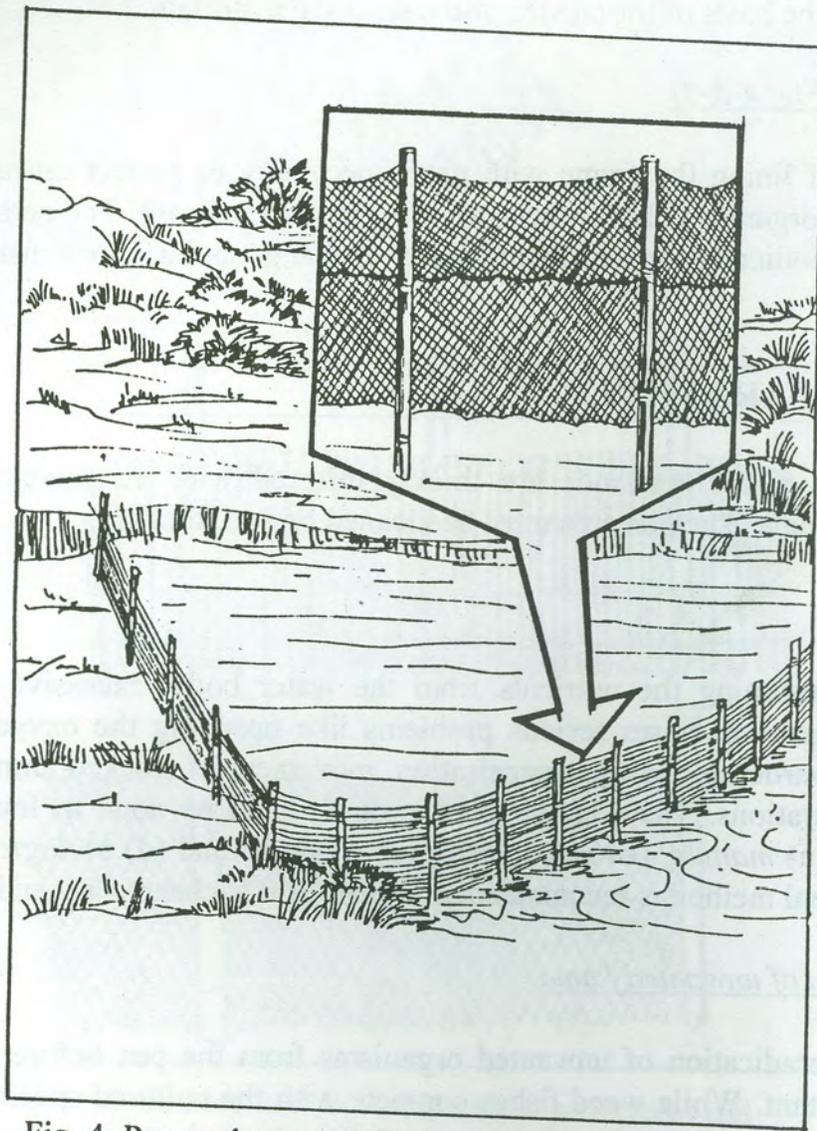


Fig. 4: Pen enclosure with inner lining of synthetic nets.



Site selection



Erection of pen

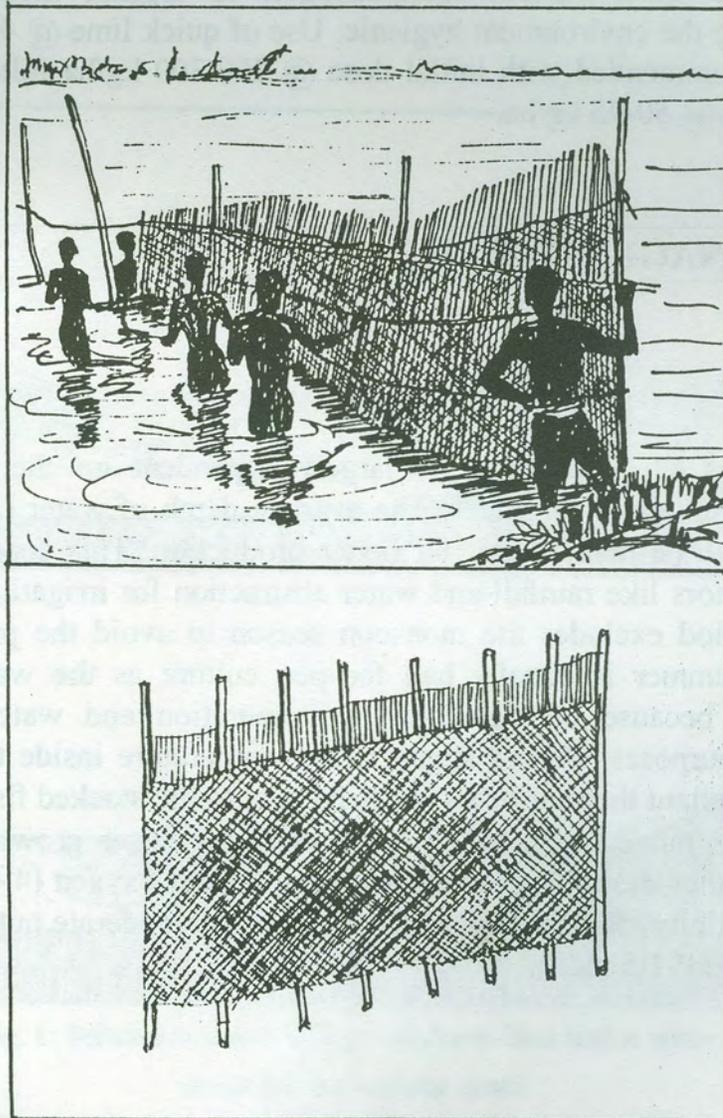


Fig. 5: Placement of inner net linings

Liming

Liming the water hastens mineralisation of organic matter and helps in maintaining the environment hygienic. Use of quick lime @ 400-500 kg/ha pen area is recommended with initial dose @ 200-300 kg/ha followed by monthly instalments @ 50-75 kg/ha.

PEN MANAGEMENT

Water

The success of pen culture is largely dependent on the productivity and ecological suitability of water. The average depth of water (minimum 1 m) in the pen is to be maintained for better production. This depends generally on various factors like rainfall and water abstraction for irrigation. Generally, pen culture period excludes the monsoon season to avoid the problems of flood. Extreme summer is equally bad for pen culture as the water level recedes drastically because of high rate of evaporation and water abstraction for irrigation purposes. During summer, the temperature inside the pen shoots up and the resultant thermal stress is detrimental to the stocked fish/prawn. A water temperature range of 30 to 36 °C is ideal for faster growth of the cultured animals. Other desirable parameters are dissolved oxygen (4-8 mg/l), CO₂ (1-2 mg/l), alkalinity (50-150 mg/l), pH (7.0-8.0) and moderate nutrient contents (N-2.0 mg/l and P-1.5 mg/l).

Soil

The bed should be sandy-clayey. The detritus load between 50 and 70 g/m² and organic matter between 1-2% are ideal for better production. Very high organic content of bed soil results in anaerobic condition at the bottom which is detrimental to the bottom dwellers, especially prawns.

Species selection

Species belonging to the group planktiphagous, detritivores and bottom feeders are the most suitable for pen farming. However, phytophagous species can also be introduced to keep weeds under control. In pen culture, the combination of indigenous and exotic carps with giant freshwater prawn has proved to be successful. However, from economic point of view, monoculture of giant freshwater prawn is more profitable. The suitable species for mixed culture of carps are catla, silver carp, rohu and mrigal. Under mixed culture of carps and prawn, catla, silver carp, rohu and *M.rosenbergii* can be considered. In monoculture, the prawns grow faster with a higher survival rate, compared to their culture along with carps.

Species ratio

Species ratio is fixed on the basis of available food in the environment, depth of the water body, seed availability, etc. In exclusive carp culture, the suggested ratio of fish species is given below:

Surface feeder	-	(<i>Catla catla</i> , 20%)	-	35%
		(Silver carp, 15%)		
Column feeder	-	(<i>Labeo rohita</i>)	-	20%
Bottom feeder	-	(<i>Cirrhinus mrigala</i>)	-	45%

The bottom slot of *C. mrigala* can be replaced with prawn (*Macrobrachium rosenbergii*) in the mixed culture.

Stocking size

It is generally advisable to stock larger fingerlings (100-150 mm) for better survival in carp culture. Stocking size of prawn juveniles is much smaller between 65-70 mm (4 g).

Stocking density

Rate of stocking is fixed on the basis of the carrying capacity of the pen. In monoculture of carps, the recommended density ranges from 4,000 to 5,000/ha. While in mixed culture, the density of carp and prawn could be 3,000-4,000/ha and 1,000-2,000/ha respectively, in monoculture of prawn stocking density could go as high as 30,000-40,000/ha.

Culture frequency

Pen farming could be done round the year, but it is advisable to avoid monsoon months. The culture period for prawns is about 4 months. Thus two crops could be raised per year per pen.

Supplementary feeding

Since the objective of pen farming is to utilize natural productivity of the water body, role of supplementary feeding is marginal except for the prawn which needs highly proteinous diet for their growth. The prawn is fed once @ 2-5% of their body weight during evening hours depending on the availability of natural food. The supplementary feeding may be done with commercially available pelletised feed or locally made mixture of animal protein with carbohydrate and fat. Cockle flesh and fish meal are well known sources of animal protein. Feeding in trays saves loss of feed and thereby reduces the cost of production.

Monitoring of stock

Periodical sampling of the stocked animals may be done at fortnightly intervals to note the growth and also to find out any other problems in the culture.

FISH HEALTH

Health management in pens especially in case of intensive culture practices is very important. The general health of the stocked animals has to be satisfactory for desired production. Maintenance of hygienic condition of pen area is not difficult in view of its small area. The diseases whatsoever rarely



Sampling of prawn stock



encountered caused mainly by bacteria, fungi, protozoa, helminths and crustaceans. In case of any outbreak or symptoms of any disease, necessary remedial measures, which are already available, should be adopted at the earliest.

HARVESTING AND PRODUCTION

Harvesting

Harvesting or recovery of fish and prawns from pen is done by nets through repeated operations. The harvesting of prawn, however, is a bit problematic, as such the nocturnal habits of prawns may be utilized to harvest them fully. These bottom dwellers come up for feeding at night and are highly attracted towards light. It is advisable that netting is done in the darkness (early hours) with the help of artificial lights. Prawns are difficult to net out in single day operation. Netting has to be repeated for several days for complete harvesting. Drag nets, cast nets and traps are the usual gear used for the harvesting of prawns.

The size of harvesting is market dependent as such harvesting of fish or prawn may be done as per the market demands and acceptability for getting better price.

Production

CIFRI experiences suggest that from carp culture 4000-5000 kg of fish can be produced from one ha pen area in a year. While in mixed culture of fish and prawn an annual yield to the tune of 2000-2500 kg of fish and 500-800 kg of prawn could be harvested from 1 ha pen area. In case of monoculture of prawns an average yield of 1300 kg/ha is possible in a culture period of four months.

PRECAUTIONS

Although pen culture paves the way for augmenting production and provides economic benefits, many potential social and environmental problems can crop up. Rapid growth of pen culture impervious to environmental concerns

can lead to disastrous consequences as happened in the Laguna de Bay in the Philippines. Rapid and haphazard development of fish pens, converted the Laguna lake from a lucrative fishery into a battery of pens reducing the open water fishing area. This caused unemployment for traditional fishers and also affected the water transport. Supplementary feeding of the stocked fish in the pen can lead to eutrophication of the lake very fast. Therefore, pen farming, though considered as very lucrative, should be practised in a balanced way as part of an overall management plan for small water bodies.

PEN CULTURE-A CASE STUDY IN AKAIPUR BEEL

The pen culture technology developed by the Institute has been successfully demonstrated in Akaipur, West Bengal. The Akaipur *beel* is an oxbow lake situated in 24 Parganas (North), West Bengal, the fishery of which is managed by the Akaipur Fishermen Cooperative Society. The Society has whole-heartedly cooperated with the Institute in field demonstration of the technology. During the Akaipur experiment, monoculture of *Macrobrachium rosenbergii* was successfully done leading to impressive profit to the Society.

In Akaipur beel, pen material was prepared from bamboo, which was locally available in plenty. Split bamboo was wooven together with coir ropes. The pen frames were made of full bamboos of 20-30 ft length. The pen structures were made of split bamboos wooven together with coir rope. The split bamboo mats were erected in the *beel* and they were covered with fine galvanised iron mesh exteriorly for protection against crabs. Three pens, each measuring 0.06 ha were erected in the *beel*. The pens were stocked with prawn juveniles of 75-80 mm size (4 g) at 12,000 nos. per hectare. The prawns, harvested after a grow-out period of 89 days were found to grow up to 230 mm length and 160 g in weight, the average being 190 mm and 86 g respectively. Lime was applied in the pen enclosures as a prophylactic measure against diseases. A locally manufactured feed was given to prawns to supplement the natural feed available in the pen. The artificial feed made of prawn meal, contained 23% protein. Feeding was done during night @ 3-4% body weight.



Harvesting of prawn





A haul of prawn

The entire produce of the pen culture operation in Akaipur was handed over to the Akaipur Cooperative Society. The Society, having convinced of the remunerativeness and efficacy of the system is regularly doing the pen culture of its own leading to accumulation of profit. The salient feature of the pen culture and mechanism are given in Tables 1 & 2.

(Note: The content of this table is extremely faint and largely illegible. It appears to be a table with multiple columns and rows, possibly detailing the 'pen culture and mechanism' mentioned in the text.)

CAUTIONS

Although pen culture is a profitable and easy method of producing fish, it is essential to take certain precautions to ensure the health and growth of the fish. These include maintaining clean water, providing adequate oxygen, and avoiding overcrowding. Regular monitoring of water quality and fish health is crucial for a successful operation.

TABLE 1. DETAILS OF PEN CULTURE IN AKAIPUR

Species	-	Macrobrachium rosenbergii
Stocking density	-	12,000 nos/ha
Stocking size	-	74.88 mm (Av. 4 g)
Feeding	-	Once a day @ 3-4% body wt.
Feed	-	Pelleted feed made of prawn meal (39% protein)
Culture period	-	3 months
Harvesting size	-	Av. 191.83 mm (86.1 g)
Gain	-	82 g
Survival	-	80%
Gross production	-	1373.76 kg/ha
Net production	-	1308.12 kg/ha

TABLE 2. ECONOMICS OF PEN CULTURE IN AKAIPUR (5 YEAR CULTURE)

A. Capital cost		(Rs.)
Bamboo and bamboo mats		4,502.50
Wire mesh		<u>14,700.00</u>
	Total A	19,202.50
B. Annual capital cost		
Bamboo and bamboo mats		900.50
Wire mesh		<u>2,940.00</u>
	Total B	3,840.50
C. Recurring cost		
Coir		200.00
Paints		700.00
Installation		450.00
Netting		1100.00
Cost of seed		5400.00
Feed		<u>1700.00</u>
	Total C	9,550.00
Total cost B + C (one crop)		13,390.50
D. Total sale proceeds (one crop)		14,850.00
Profit (one crop)	D-(B+C)	1,460.00
Cost of 2 crops	B+(Cx2)	22,940.50
Profit for 2 crops	(Dx2)-(B+Cx2)	6,759.500
Return on investment		29.5%

DOs & DON'Ts OF PEN CULTURE

<i>DOs</i>	<i>DON'Ts</i>
Site of pen installation should be with gradual slope	Do not install pen near steep bank of the lakes
Bank of the water body where pen is installed must be spacious enough for management activities	Avoid steep banks as there may not be enough working space
Install pen in reasonably protected zone	Do not install pens, where wind action is very high
Pen bottom should be reasonably flat	Site with deep pits should be avoided
Install pen in sandy-loamy soil	Rocky or muddy bottoms should be avoided
Clean the biofoulers attached to pen structures at regular intervals	Do not allow algal growth on pen structures
Erect pen in a place away from pollution spots	Do not install pen near human habitation, bathing ghats or zones of pollution
Locate pen site at easily accessible place	Avoid inaccessible areas
Feed the animals in trays for better utilization and less wastage	Do not spray or broadcast feeds to avoid wastage
Monitor the feeding regime strictly for better conversion ratio	Do not allow the left over feeds to settle in order to keep the pen area hygienic
Deweed both before stocking and during culture period	Do not allow weeds to proliferate beyond a limit

Remove forage and predatory fish species for better results	Do not use poison to remove unwanted biotic species
Harvest the stock as and when attains marketable size	Do not keep the stock beyond harvestable or marketable size
Harvest the stock with repeated netting	Do not use irrational fishing methods like poisoning etc.
Maintain the prescribed stocking ratio and species composition	Do not stock pens without a stocking plan
Keep stocking rate of fish and prawn per unit area in accordance with the prescribed density	Do not over or under stock the pens
