Bay of Bengal Programme

Development of Small-Scale Fisheries

PEN CULTURE OF SHRIMP BY FISHERFOLK:
THE BOBP EXPERIENCE IN KILLAI, TAMILNADU, INDIA

BOBP/WP/49

SWEDISH INTERNATIONAL DEVELOPMENT AUTHORITY

FOOD AND AGRICULTURE ORGANISATION OF THE UNITED NATIONS

<<

BAY OF BENGAL PROGRAMME
Development of Small-Scale Fisheries

BOBP/WP/49
GCP/RAS/040/SWE

PEN CULTURE OF SHRIMP BY FISHERFOLK: THE BOBP EXPERIENCE IN KILLAI, TAMIL NADU, INDIA

by Edeltraud Drewes

Socio-Economist
Bay of Bengal Programme

G. Rajappan
Senior Research Assistant
Tamil Nadu Department of Fisheries

Executing Agency:

Food and Agriculture Organization
of the United Nations

Funding Agency:

Swedish International
Development Authority

Deveiopment of Small-Scale Fisheries in the Bay of Bengal. Madras, India, April 1987.
Mailing Address: Post Bag No. 1054, Madras-600 018, India.
Street Address: 91, St. Mary's Road, Abhiramapuram, Madras-600 018, India.
Cables: FOODAGRI. Telex: MS-311 FISH. Phones: 71294, 71296, 71587, 77760.

<<

This paper describes a shrimp pen culture pilot activity at Killai, Tamil Nadu, India under which selected fishermen operated small-sized shrimp pens, applying a technology package for Ki!lai conditions devised earlier during 21 months of technical trials by the small-scale fisheries project of the Bay of Bengal Programme (BOBP).

The paper discusses the project's socio-economic and tecnnical approach, the problems faced during implementation, the results, and some recommendations for better profitability.

A BOBP socio-economist and a senior administrative officer of the Tamil Nadu Directorate of Fisheries were responsible for the overall planning, implementation and monitoring. Technical inputs were provided by a BOBP aquaculture technologist. The field team at the project site consisted of two aquaculture technologists (biologists) of the TNDF, while a social worker engaged by BOBP liaised with fisherfolk and the technology team.

This is the third paper on the Killai prcject. BOBP/WP/35 discussed the findings of 21 months of technical trials during 1982—84, while BOBP/WP/32 discussed a techno-economic end social feasibility study of shrimp pen culture, based on field surveys in the region conducted late 1983, after the technical trials.

The BOBP's small-scale fisheries project is funded by SIDA (Swedish International Development Authority) and executed by the FAO (Food and Agriculture Organization of the United Nations). It seeks to help improve the conditions of marine small-scale fisherfolk in member-countries; the immediate object is to develop, demonstrate and promote, through pilot activities, technologies and methodologies by which such betterment can be attained. The project covers five countries bordering the Bay of Bengal — Bangladesh, India, Malaysia, Sri Lanka, and Thailand.

<<

CONTENTS

<<

1. BACKGROUND

In 1980, the Directorate of Fisheries of Tamil Nadu requested BOBP's assistance in developing brackishwater aquaculture in the State in order to:

- better utilize the large stretches of coastal fallows and backwaters
- meet the increasing demand for fish, both nationally and for export
- provide employment opportunities in rural areas.

BOBP responded and two aquaculture technologists assessed brackishwater areas and low lying coastal land. They found that 71,000 ha of brackishwater and low lying land areas had potential for aquaculture (BOB!WP/1 8).

As the next step BOBP sponsored two aquaculture technologists from the Thailand Department of Fisheries to explore the possibilities for brackishwater acquaculture in Tamil Nadu (especially cultivation of shrimps), keeping in mind that the technology suggested should be appropriate for the small-scale sector and secure optimum utilization of locally available resources and skills. The mission visited various sites which had potential for aquaculture, and suggested that pen culture of *P. indicus* and *P. monodon* and *Chanos chanos* be developed in the backwaters of Killai. To them this area appeared ideal for this technology. They also concluded that pen culture investment costs would be low enough to encourage fishermen to adopt culture fisheries.

On the basis of shrimp catch statistics, the mission concluded that shrimp juveniles, especially *P. indicus,* would be available in abundance in the backwaters all year round and that a 1hatchery was therefore not required. They advised the use of supplementary feed, but the type and source of feed were not specified.

Based on these findings and suggestions, a 20-month project was prepared to test whether pen culture could be used as a possible technology for shrimp farming in the state of Tamil Nadu.

After the project was approved by the Government of Tamil Nadu in May 1982, a suitable 4 ha area was selected, a field "office" constructed in the mangrove zone and the first four pens set up. Ten months later, in February 1983, two more pens were constructed; and three more in April 1983. The nine pens were of five different sizes [0.02 ha (1); 0.06 ha (2); 0.1 ha (2); 0.125 ha (2); 0.5 ha (2)].

Different mesh sizes of pen walls, pen layouts, stocking densities, seed sizes and species, feeding rates and feed compositions, hydrological factors (water flow, salinity, temperatures) and predator control techniques had to be tested. While the project was under way, the implementors concluded that a 20-month technical trial period was insufficient for conclusive technical findings. The shrimp production had ranged from total losses to 1,057 kg per crop per ha (BOBP/WP/35).

Problems faced in the trials were:

- changing hydrological conditions (salinity and high water temperatures) which influenced survival and growth rates;
- auto stocking of shrimps during the culture period which made the calculation of feeding rates difficult and thereby influenced the growth rate of shrimps;
- lack of appropriate feed (animal protein/trash fish) which caused either high production costs or low growth rates;

low feed conversion ratio or loss of feed.

To find solutions to these problems, further technical trials were carried out. During the same time a study was conducted to assess the economic potential of shrimp pen culture and to find out whether fisherfolk around the Killai backwaters are interested and able to take up the new technology once its viability has been proven. In addition to the backwater areas suitable for pen culture, the quantity of wild seed available during different seasons and the available quantity of feed (trash fish, pelleted feed) were to be estimated.

The studies identified about 600 families in the area who lived mainly on backwater fishing and pointed out that only 85 ha of the entire backwaters were suitable for pen culture. It was found that *P.indicus* seeds were available in the backwaters in plenty, though possibly not throughout the year and that sufficient feed would be available in the region to supply 85 ha of pen culture. It was estimated that the technology would be feasible and that 1 ha units would be profitable. It was suggested that banks should be approached to finance a few entrepreneurially-minded people to start commercial shrimp farming, and that after they had proven successful the banks should extend credit to more entrepreneurs (BOBP/WP/32).

The results of the study and the data on which the conclusions had been based were critically analyzed in a consultation on the social feasibility of coastal aquacuiture organized by BOBP in late 1984. (National Swedish Board of Fisheries— Fisheries Development Series No. 16; and Bay of Bengal Programme— BOBP/MIS/2, Madras, 1985.)

It was suggested that fishermen and banks should not be advised to start commercial shrimp pen culture until further technical trials demonstrated that its technical feasibility and economic viability were ensured. It was recommended that further culture trials be carried out by BOBP to determine and demonstrate a suitable technical package and analyze its economic performance by using actual costs and earnings data rather than extrapolated or assumed data.

It was suggested that such demonstration trials be carried out by local fisherlolk in order to find out whether they could manage the technology.

This paper discusses the conduct and execution of demonstration trials, the results and the lessons learned from them.

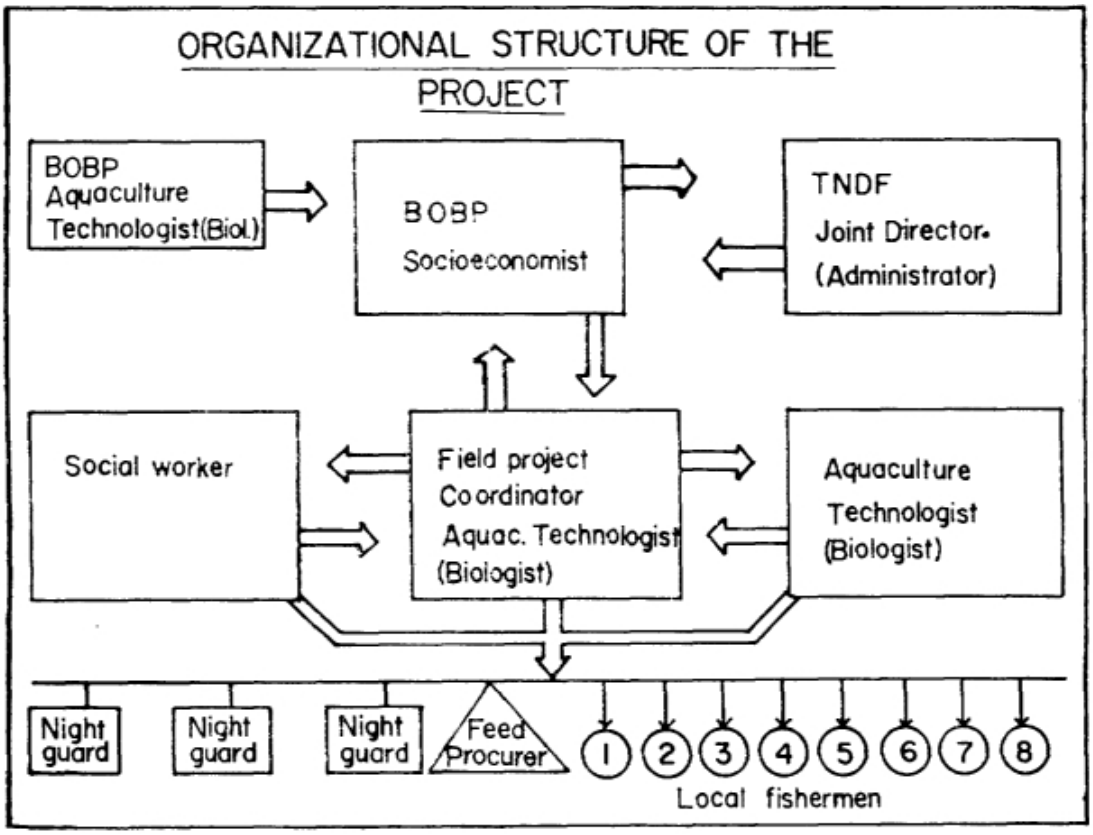
2. OBJECTIVES AND **ORGANIZATIONAL STRUCTURE**

The objectives of the activity were to demonstrate a technically feasible pen culture package, identify its economic viability and determine the local fisherfolk's adaptability to it.

The activity was initially scheduled for 1 1/2 years, including a four-month preparation phase, which started in January 1985.

The first step was to decide on personnel inputs to implement the activity. As tasks of an economic and social nature had to be carried out in addition to technical work, BOBP decided to appoint a field team comprising two aquaculture technologists (biologists) and a social worker experienced in working with fisherfolk. The Tamil Nadu Directorate of Fisheries (TNDF) provided the technologists and BOBP the social worker. The responsibility for overall planning, implementation and monitoring the activity rested with a BOBP socioeconomist and a TNDF senior administrative officer. Technical inputs on this level came from a BOBP aqLlaculture technologist (biologist). The chart on page 3 illustrates the organizational structure of the project.

The two field team aquaculture technologists had participated in a previous activity; therefore they were familiar with all the technical aspects of shrimp culture. The social worker was recruited because of her qualifications in conducting socio-economic field studies of fisherfolk and because of her experience in working with fisherwomen.



3. FISHERFOLK'S PARTICIPATION IN TECHNOLOGY TRIALS

During the experimental phase of the project, local fisherfolk had already been involved in the culture trials with the purpose of meeting labour requirements. They were paid at the local market rate for agricultural labourers (Rs. 10 a day, including food) and treated as labourers.

At this stage fisherfolk were to be involved for different reasons, namely to determine their level of adaptability to aquaculture practices, their ability and interest to manage a pen unit by themselves and their specific needs for technical training and management support.

Fisherfolk therefore were not required to work full time on the project, although they were paid monthly wages—the amount based on their earnings from backwater fishing. Their labour was needed to help determine whether shrimp pen culture could become a means of alternative employment opportunities and possibly improved earnings for Killai fisherfolk.

Each family was briefed on the type of work and responsibility to be assumed by the persons who were to participate in the culture operations. A special effort was made to encourage fisherwornen to apply. However, this did not succeed, as pen culture operations require water-based work to which women belonging to fishing communities are not accustomed. *

* There are women in the Killai area who go fishing with their men but do not belong to the target group according to criteria laid down by the Government. (For further details see BOBP/WP/32).

<<

After all the house visits were completed by early March, 10 fishermen expressed interest in joining the project for a maximum of one year at a wage of Rs. 14 for an eight-hour working day. The fishermen to be selected were expected to meet the following criteria. They should be:

- active backwater fishermen
- open to new technological and other ideas regarding fishing
- sincere and accepted as honest by other fisherfolk
- self-confident and hardworking enough to achieve set targets
- healthy; not suffering from sickness or disease; sober by habit
- not overburdened with family responsibility
- not active in party politics
- not too old for physical work.

Other non-essential but desirable attributes taken into account in making the selection were:

- literacy, and ability to carry out simple calculations
- should be married, with children
- should be ambitious, should want to improve the living conditions of self and family.

After the project field team had selected eight of the 10 applicants, two changed their minds and withdrew. They were unable to cope with the pressure from their families and neighbours. The two remaining applicants were then selected. Most of the eight fishermen needed strong motivational support and encouragement from the project field team in order to cope with their new work and duties. The social worker in the field team dealt with this task while the aquaculture technologists concentrated on preparing the technical package for the shrimp pen culture trials.

Initial contact with Killai fisherfolk had revealed that they strongly opposed the introduction of aquaculture in the Killai backwaters as they feared the loss of their capture fishing areas without being offered access to aquaculture technology. These attitudes resulted from their earlier experience with aquaculture technology trials in the backwaters since 1980 when the Government began to implement a 5 ha shrimp culture pond (see Appendix 2). Soon after (in 1981), BOBP and the Government took over another 2 ha for the experimental shrimp pen culture unit. Though the fishing area the fisherfolk were deprived of constituted only a tiny portion of the 1300 ha backwaters, it is located in the immediate vicinity of the fisherfolk's settlement (Killai village) and is accessible to all fishermen, even those who do not possess a boat to travel to more distant backwater areas (See Appendix 3, area number 8.) In addition, fishermen had developed negative attitudes towards aquaculture technology, both pond and pen culture, as nobody had explained to them how they could benefit from the technology should the experiments prove successful. What the fisherfolk observed was that costly inputs, such as construction materials, shrimp feed and shrimp juveniles were used by the officers to produce marketable shrimps. This led to the belief that the technology would not be appropriate for them, would deprive them of their fishing grounds and result in competition regarding resources as large numbers of post-larvae and juvenile shrimps might be required in future. Some fishermen even insisted that their shrimp catches had been reduced owing to the experimental culture operations in an area of 7 ha. This however could not be proved and is unlikely, since the overall catches from the backwaters had increased as a result of the reopening of one large silted bar mouth in 1983.

Given this negative attitude towards shrimp culture technology, the task of identifying and selecting fisherfolk to participate in pen culture trials and demonstrations was difficult and had to be dealt with systematically. The first step taken was to arrange a meeting with a group of fishermen and their leaders in which the intention to select eight fishermen was announced. The fishermen were asked to air their views and reach a consensus. It proved that most of them

<<

had very little information on what had happened so far at the pen culture project site. Pen culture and pond culture (the government's project) meant one and the same thing to them. It had never been explained to them what these experiments were about and whether and how they could benefit from them. Most of the fisherfolk reported that they had not been allowed to fish close to the project sites and therefore felt hostile towards the technology. Some reported that those fishermen who had been hired as labourers by the project were not treated right; they were regarded as no different from lower caste agricultural daily wage labourers. They felt that the working conditions created too much dependency on employers and masters. Most preferred to work as capture fishermen and thereby be their own masters. All this explains why the project found it difficult to hire fishermen as labourers during the experimental stage.

Though this first group meeting with fishermen and their leaders did not get rid of their doubts about pen culture technology, it helped mitigate their hostility. They appreciated being consulted and the project's effort to arrive at a consensus before going ahead with culture trials and demonstrations. After they had been assured that no more than 4 ha would be taken over the leaders agreed to make an official announcement in the village that eight persons would be chosen to participate in the technology trials.

As the 30-odd fishermen who attended the meeting did not constitute a representative sample of Killai fisherfolk, it was necessary that further contact be established with fisherfolk in order to find out whether attitudes towards pen culture depended on varying economic and social backgrounds and occupational patterns; also to explain the purpose and scope of shrimp pen culture to Killai fisherfolk and to brief them on the type and conditions of work which shrimp pen culture would demand.

Contacts with fisherfolk were established and information on socio-economic and attitude patterns obtained by means of house visits. These house visits and interviews were made in two of 13 fisherfolk settlements around the Killai backwaters: Killai and Muzhukuthurai (for locations see Appendix 3). These two settlements were selected as they are located close to the pen culture area. In Killai, which accounts for 68 per cent of the total number of fisherfolk families (i.e. 600) around the backwaters, all families (209) who earn exclusively from backwater fishing were contacted and interviewed. The remaining 200 families were intentionally excluded as they are engaged in sea fishing for several months a year and therefore migrate to temporary settlements close to the seashore. Because of their migration and occupational pattern, it was assumed that their acceptance of aquaculture working conditions would not be as whole-hearted as that of fisherfolk living in one place. Moreover, it was felt that people fishing exclusively in the backwaters and in particular in areas taken over for aquaculture trials, should be given preference for participation in pen culture operations, as compensation for the lost fishing areas. The same applied to Muzhukuthurai fishing families of which 15 are migrating families and 91 are exclusively backwater fishing families. As in Killai all families in the latter category were contacted and interviewed.

After contacting families through house visits, a certain change in people's attitudes towards shrimp pen culture technology could be perceived and a few fishermen began to show interest in participating in the technology trials and demonstration.

The interviews also revealed important information on the fisherfolk's working and income conditions and attitudes. All families, except for the few without a male working member, posses their own fishing gear, consisting of either castnets or dragnets or both. A few families also own canoes which serve as a means of transport to fishing grounds and as a means to operate castnets in deep water (more than 1.20 m) otherwise not exploitable. Fishermen without canoes reported that they fish on an average between three to four hours per day for which they earn around Rs. 16, except during the monsoon months (approximately 3 months), when they make only around Rs. 8. Thirty-nine per cent of the fishermen contacted reported that their average monthly income was below Rs. 250 and 42 per cent estimated it at below Rs. 500. Fishermen who possess canoes, either individually or jointly, reported average monthly incomes of about Rs. 875. The higher incomes of canoe fishermen when compared to those without canoes are attributable to higher fishing effort. Canoe fishermen's operations are not restricted by tidal variations. Moreover, they can fish in shallow as well as in deep water areas as the castnets are operated from the canoes and not from the water directly.

Therefore, one method of providing better employmant opportunities to backwater fishermen might be giving them financial assistance for acquiring canoes. Whether the resources would sustain this needs to be investigated further. One also needs to find out whether fishermen wish to increase their working hours. Women may favour this idea, as it would improve family incomes and as women were found to be working more hours than men. Nearly all families had at least one female working member. They either sort and sell the fish caught by the male family members to retailers in the local market (which takes about 2-3 hours daily) or process and retail the catch. Processors and retailers work daily for about eight hours. An eight-hour working day is uncommon among backwater fishermen, even if one includes the time spent on making and mending nets*

By marketing fish produced by male family members, women not only generate a part of the family income but also control to a great extent the entire family income since it passes through their hands. This has resulted in women having a strong influence on the decisions made in the family. Women were more strongly opposed to shrimp pen culture operations than men. This can be explained by the fact that the women bore the major responsibility for securing the family's income and thus felt more endangered by aquaculture operations. Women therefore were very much behind the protests against aquaculture in their backwaters.

The house visits proved useful to learn about fisherfolk's attitudes and the factors determining them. As the team also had female field project staff, it provided the opportunity to establish good contacts with women and make them understand that the purpose of the activity was not to deprive fishing families of employment and income but to ascertain whether shrimp pen culture technology could provide more or alternative employment opportunities.

4. DETERMINING THE TECHNICAL PACKAGE AND CULTURE CYCLE PLAN

In order to specify a shrimp pen culture technical package, the experimental culture operations, carried out from mid-i 982 until end 1984, were reviewed and the aquaculture technologists were asked to interpret data recorded.

Annual culture cycle

This resulted in the finding that no more than two annual culture cycles with wild seeds would be feasible, as post-larvae seeds are available in sufficient quantities only twice a year, during the north-east monsoon in December/January and the south-west monsoon in June/July. A third annual cycle with wild seeds, as concluded earlier (BOBP/WP/35), would be possible only if juveniles (2 g body weight and larger) are collected by castnet. However, this technique is questionable not only from the economic standpoint (as enormous effort is required to supply large numbers of good-quality uninjured juveniles within the short stocking period) but also from the standpoint of resource exploitation.

The following technical package was worked out fora one hectare pen unit:

1. Hydrological requirements

(a)	**Water depths**	: Minimum of 0.30 **m** **Maximum of 0.80 m** during low tide
(b)	Salinity	: Minimum 10 ppt Maximum 35 ppt

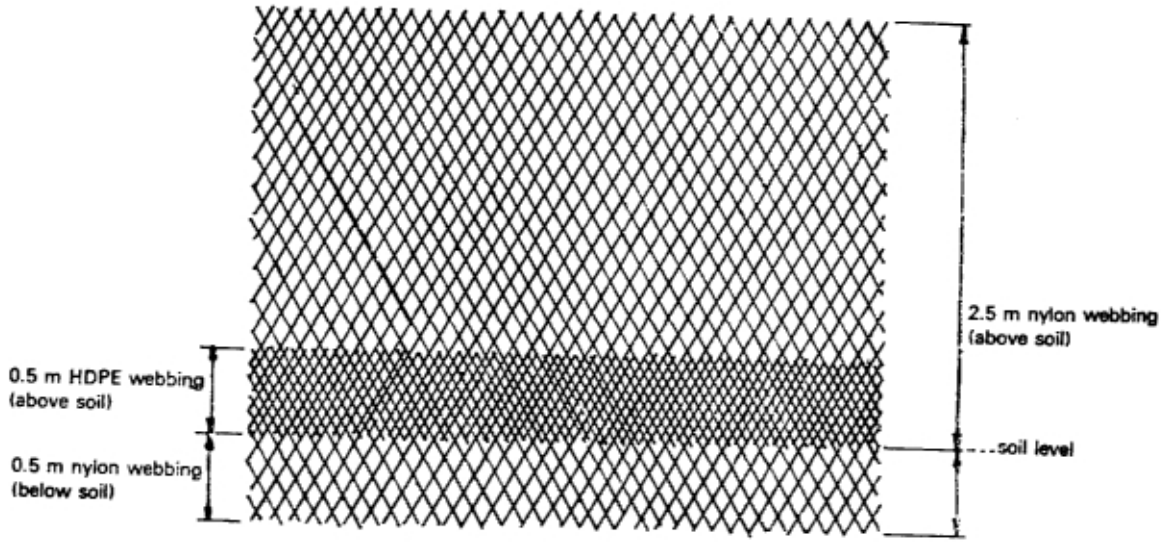
* As 38 per cent of the 300 families contacted owned small plots of agricultural land, some men also spent time on arranging for labourers to cultivate the land and harvest the crops (generally paddy) for which they paid either a paddy share or Rs. 1 0 plus food per day. Neither they nor their wives directly engaged in agricultural work.

<<

2. Pen construction specifications

(a)	**Location**	:	**Preferably** shore based for **effective pest control, harvest, safeguarding**
(b)	**Pen size**	:	One pen 0.5 ha with a **separation wall**
(c)	Layout	:	**30 mx 85 m culture area x 2 30 m x 105 m waterspread** area x2, if shore based
(d)	Height of pen walls	:	3 metres
(e)	Pen wall material		– Casuarina trees of 3.50 m length and 4.5 cm dia at bottom —10 mm mesh size knotless nylon (for details see drawing) —25 mm mesh HDPE for reinforcement of bottom portions of pen wall.

PEN WALL



3. Happas

(a)	**Layout**	:	10m 4m x 1.5m
(b)	**Numbers required**	:	**8 happas per 0.5** ha pen unit
(c)	**Material**	:	**HDPE**

4. Production details

(a)	**Pen preparation**	:	**Pre-stocking pest removal by trammel net, dragnet, castnet and hook and line**
(b)	**Culture cycle**	:	**Two crops per annum (for details see Appendix 4)**
(c)	**Source of seeds and species**	:	**Killai backwaters,** *P. indicus*

<<

(d)	Seed collection gear	Pushnets
(e)	**Stocking density and size**	36,000 *P. indicus* per ha of **2 g body weight**
(f)	Feeding rate	Nursery stage 1st and 2nd week: 100% 3rd and 4th week: **50%** of body weight Culture Stage 10% of body weight
(g)	Feed type and source	Pelletized feed, produced at project site; trash fish purchased from nearby trawler landing centre
(h)	Feed composition	40% squid offal 35% deoiled rice bran 10% groundnut oil cake **10% tapioca flour** 5% water
(i)	Feeding technique	Distributed by hand on the water surface during dawn and dusk hours
(j)	Growth control	Measuring and weighing a 0.5% sample of shrimps every fortnight
(k)	Survival/auto-stocking control	Every week 40 castnet hauls during dawn
(l)	Salinity control	On days of unexpected rainfall in early **October**
(m)	Pest control	Daily operation of hook and line, daily pen wall check

5. Harvesting details

(a)	Time of harvest	:	During night or early morning hours
(b)	Harvesting techniques	:	Dragnet with double wall (trammel net) operated by two persons and castnets, handpicking along pen walls
(c)	Handling of product	:	Stored on ice until sorted, graded, counted and sold to trader

This package was to be tried out in a 4 ha culture area with 16 pens of 0.25 ha each. (The lay-out of the pens is given in Appendix 2 and their location in Appendix 3). The criterion for selecting pen location was easy access to a fairly flood proof area in the mangrove zone of the backwaters. On the basis of hydrological conditions, several other locations could have been chosen (see Appendix 3), but they were found unsuitable for various reasons from the management standpoint (for example, safeguarding, preparation and storage of feed close to the pen site).

Therefore the pen site formed part of the same complex used earlier during the experimental stage of the project. However, the pens were not built exactly on the same spot; in that event one could have ruled out the possibility of disturbed bottom fauna, a possible outcome of two years of culture experiments.

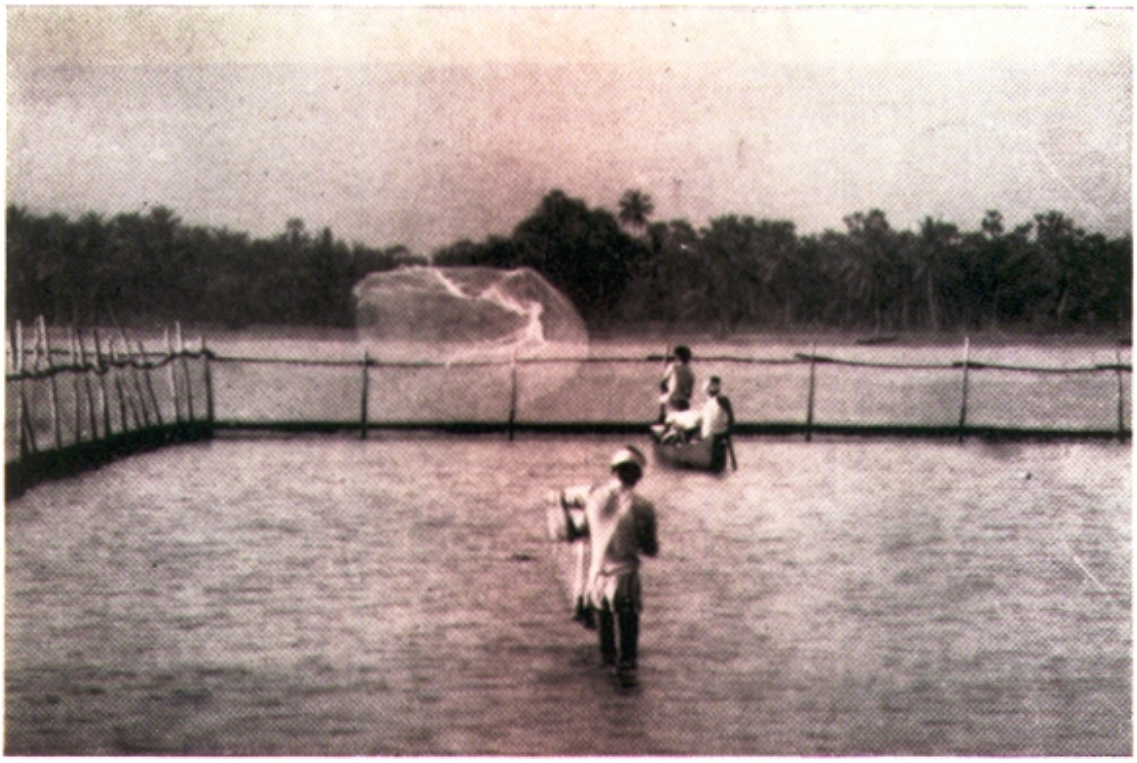
<<

Glimpses into the Killai project

The shrimp pens at K/l/al — an overview (above)

The eight fishermen selected to operate 16 pens, each of .25 ha area.

<<



Harvesting of cultured shrimp by castnet.

The fishermen-cum-pen culturists with their transport boat, a canoe.

<<

Stitching of nets for the pen wall (above) and mending of nets (alongside).

<<

5. IMPLEMENTATION OF THE ACTIVITY

Pen Construction

The project field team had to ensure that shrimp culture technology and the culture plan were explained to the eight fishermen and that they would be thoroughly trained in all aspects of the technology including construction of pens and installation of happas (nursery cages). Fishermen were instructed on seaming pen walls by hand (ready made pen wall material is not available in the market), trimming of casuarina wood poles, erecting pens, fabricating gear for pest control and seed collection, pen pest removal techniques and installation of happas.

It was observed that the fishermen were a little reluctant to carry out work like trimming wooden poles, a task they considered not fit for a fisherman — but none of them refused it; they merely took time to complete it and often expressed the opinion that it was very tedious work. Some fishermen were found to be less skilled than others in manufacturing fishing gear — indicating that they were not used to making and mending gear regularly for their own use in the backwaters.

Seed Collection

The construction of pens, happas and fishing gear took a little longer than initially assumed, as fishermen had to familiarize themselves with the work and the longer working days (fixed from 8 am to 5 pm with a one-hour lunch break).

Certain administrative problems also discouraged fishermen and the field team from accelerating construction work. Hurdles placed within government circles prevented adequate information flow from middle-level to higher-leve! officers who were to officially approve of the project's continuation. This led to uncertainty in the minds of the two field team aquaculturists on whether to go ahead with pen construction without a written order from their supervising officers. Only after the government had sent its official approval (in June, three months after the start of the project) did the work progress with greater enthusiasm.

Only six pens could be constructed instead of the eight planned for the first crop. The remaining two pens were completed later, after the first crop was harvested and fishermen had sufficient time available. The initial plan to construct a second unit of eight pens (thereby totalling 16) for the second crop had to be revised mainly because of shortage of low-cost feed. The feed problem will be discussed later in greater detail.

The construction work was followed by collection of seeds from the backwaters. This work commenced early June, when the south-west monsoon had not yet set in and consequently no post-larvae shrimps were found. Therefore the field team decided to collect juvenile shrimps by castnet to ensure that sufficient seeds would be obtained to stock all pens. They also felt that production costs would be reduced as juvenile shrimps could be stocked directly into grow-out pens, thereby saving nursing costs. However, the effort expended on juvenile shrimp collection was rather high; so was the mortality rate. On an average, 150 shrimps with a weight between 2 g and 5 g were collected per man-day.

By late June, post-larvae shrimps appeared in the backwaters and fishermen were instructed and trained to collect, sort and count these. Though they were entirely unskilled in this work, particularly in identifying different shrimp species, it was possible for a person to collect 500 post-larvae shrimps per day. The effort spent on collecting juveniles is considerably higher, and although using juvenile shrimps instead of post-larvae would help reduce feed and equipment costs, these cost reductions are nullified by the increased cost of catching them (See Section 6.1). Therefore it would be of no real economic advantage to collect juvenile shrimps for stocking unless feed prices increase. This was explained to the fishermen. As the financial risk factor is higher in the case of nursing post-larvae shrimps, the fishermen said that if the choice was left to them they would certainly opt for collecting juveniles for stocking. They were also of the opinion that by doing so they would not increase the pressure on shrimp resources since juvenile shrimps had always been captured by Killai castnet fishermen.

The fishermen were then trained in maintaining happas and nursing post-larvae seeds. This included growth control, feed preparation and feeding. The nursing period was about four to six weeks for the "winter" crop (mid-July to mid-October) and four to eleven weeks for the "summer" crop (mid-February to mid-May), depending on the size of post-larvae, water temperatures, salinity fluctuations and type of feed (shrimp heads, pelletized feed). The factors that influenced the growth of seeds were explained to the fishermen.

Feed Production and Procurement

They were also instructed in production of pelletized feed. This was started immediately after the pen construction work was completed. The field team employed an extra person (a fisherman) to collect trash fish every day from a nearby trawler landing centre. The trash fish purchaser was hired by the project and provided with a motorized canoe to make the two-hour journey to the landing centre. The vegetable ingredients required for pelletized feed production were purchased in bulk by the project team and transported by the project car to the pen farm site. The equipment for pellet production — a motorized mincer, pans, plastic containers, ladles and knives—were also provided by the project. The fishermen were thoroughly instructed in production techniques, including mixing of ingredients, forming pellets with the mincing machine, drying pellets in the sun and storing them adequately. The feed composition and the importance of each component for the growth of shrimps were explained to the fishermen.

Production of pelletized feed had never been tried out during the experimental phase of the project; using this feed now for culturing shrimps entailed some risks. Since enough trash fish was not available throughout the culture period, feed had to be stored in pellet form in gunny bags for use when trash fish supply was insufficient. The fishermen were instructed and supervised thoroughly on how to measure pellet ingredients to ensure correct composition. They (and the field staff) learned that pellets needed to be properly dried in the sun before they were packed. Moreover, it was found that if pellets are to be stored over several weeks they should not be kept in gunny bags; fungus grows on the pellets. The problem was overcome by replacing gunny bags with polyethylene bags.

Feed requirements for the first winter crop could be met without much difficulty by using shrimp heads for nursing and wet trash fish as animal protein feed component for the grow-out phase. The plan to produce a stock of pelletized feed for the second summer crop and for the third winter crop could not be implemented. Annual fluctuations in trash fish landings and seasonal shortage of wet trash fish during the monsoon months were two reasons. But the main reason was the inadequate organization of trash fish supply to the project. With time the trash fish procurer's work performance went down. He misused some of the money given to him for feed procurement and began to buy the trash fish on credit; consequently, trash fish traders at the trawler centre refused to sell to him.

There is a great demand for trash fish and shrimp heads; many small processors and a few trash fish merchants compete with each other. It was felt that the best way of ensuring regular supply of trash fish would have been to place orders with an established merchant. It was found that no merchant deals in wet trash fish; all of them deal only with dried trash fish. Using dried fish ingredients for pellet production, however, required processing equipment which had to be acquired and tried out. This could not be arranged within a short period of time; it needed various inputs which would also increase the cost of pellets.

As production of pelletized feed was started by a Madras-based private company around this time, the project decided to tap this source. This pelletized feed was used in addition to wet trash fish. Procurement and delivery of the pelletized feed was arranged by BOBP's Madras office as the manufacturer had no sales outlets. The pelletized feed was used in spite of its extremely high cost (80 per cent higher than pellets produced by fishermen with the same conversion ratio), since there was no alternative source.

The technical and economic constraints relating to feed were explained to the fishermen. They were fully aware of the feed cost and quality and also understood that shrimp culture would result in financial losses if dependent on high-priced pelletized feed.

<<

Safeguarding

Stocking of shrimps comprised transfer of seeds, which had been raised to 2 g body weighty from happas to grow-out cages. Fishermen learned to carefully handle and count the seeds to prevent mortality and ensure an adequate stocking density.

During the course of the first and second culture, the fishermen also got to realize how sensitive shrimp culture is and what careful attention and safeguarding it requires. One pen was found almost empty just after it had been stocked, as the pen wall bottom had not been properly fixed in the ground. Though it was restocked, the production was very low.

They also found that the farm must be carefully guarded. Just before stocking, fishermen found thousands of seeds dead in the happas. Samples of dead and live shrimps, a dead crab, left-over feed, soil and water were chemically analyzed; it was discovered that the shrimps had been poisoned by pesticides. It was concluded that the pesticides had been mixed with the feed and that such a plan could only have been carried out with the technical advice of non-fishermen who evidently did not have enough knowledge to effectively poison shrimps. The fishermen and two members of the field team tried to initiate a police investigation but without success. Fishermen consequently learned that in future they themselves had to carefully watch the feed. and prevent untrustworthy persons from access to feed preparation.

Harvesting

The first crop was harvested about 90 days after stocking. Fishermen were given instructions, prior to the start of the harvesting, on harvesting techniques, sorting and selling of the product. Members of the field team prepared to sell the shrimps. Several intermediate traders (mainly women) from Killai and merchants who sell directly to shrimp processing plants were informed. They appeared at the project site on the first day of the harvest. The shrimps were auctioned after grading and counting. Good prices were obtained for the product as there was heavy competition among different merchants and the shrimps were offered for sale by count rather than by eye measure. The wives and mothers of the eight fishermen were asked by the field team to help in sorting, grading and counting since they possessed the necessary skills. While the eight fishermen carried out the harvesting, the women had already begun to sort the shrimps. This way the product (each 0.25 ha pen took about six mornings to be harvested) could be sold within a few hours in an extremely fresh condition when compared with trawler-harvested shrimps.

For the crops harvested thereafter, it was not possible to keep up the price level as the merchants colluded to drive prices down. To take the shrimps to the freezing plant 40 km away was not practical as the quantity that could be harvested and sorted in a day was too low. On an average about 30 kg of shrimp was harvested and sorted by 10 persons in about four hours. Cast and dragnets were used as harvesting gear in addition to handpicking of shrimps from pen walls. The fishermen were insufficiently skilled in handpicking — which they considered to be the work of people of a lower caste (Veddars). The field team therefore hired these skilled labourers for handpicking shrimp. Except for safeguarding the pen site at night, hand-harvesting of shrimp was the only job for which labour had to be hired. All other work was undertaken by the fishermen themselves.

Training of Fishermen

By the end of October 1985, the eight fishermen were trained on the job in all aspects of shrimp pen culture. It was felt necessary to provide them with some theoretical back-up training in addition to the practical work. This included certain technical and biological aspects related to culturing shrimp as well as to economic aspects, including costs of pen technology. This theoretical training was conducted by the field team without any inputs from a training specialist. Its impact is difficult to measure. The trainees however were of the opinion that the training. which was conducted over a three-week period for about two hours daily, helped them to refresh knowledge gained during their previous seven-month work with the project field team.

Trials with hatchery-bred *P. monodon*

Although not planned at the beginning of the pen culture trials, it was decided at the end of the first crop in October 1985 to culture hatchery-bred *P. monodon* on a trial basis in one pen in order to find out whether the returns could be increased. It was planned to demonstrate (in 1986) the culture of three annual crops by using hatchery-bred seeds (see Appendix 4).

The post-larvae seeds (11 days old) were obtained from a private hatchery near Madras and transported by car in oxygen-filled polyethylene bags to the project site. The seeds were nursed in happas but as the survival rate proved to be extremely low, it was decided to nurse the next batch in a nearby government-operated earthen pond. Extremely heavy monsoon rains and management problems prevented the timely preparation of nursery ponds for *P.monodon* nursing, so the plan was abandoned.

6. RESULTS AND DISCUSSION

The field team kept detailed records on the technical aspects of shrimp production in field note books and transferred the records into a specifically prepared form (See Appendix 5a). In addition to technical records, all investment and operating costs actually incurred were recorded in field note books. Detailed data was also recorded on harvesting and sales results (See Appendix 5b).

Information on fishermen's attitudes and the acceptance of new working and income patterns obtained by observing and talking with them was recorded in monthly reports prepared by the field team.

The recorded data and information formed the basis for the economic analysis of the shrimp pen culture package. They also enabled conclusions to be drawn with regard to fishermen's adaptability to pen culture.

6.1 Yield, seed and feed

The shrimp pen culture trials have shown that it is technically feasible to culture two shrimp crops annually with wild seeds. The trials confirmed the findings from previous culture trials (see BOBP/WP/35) that *P. monodon* seeds are rarely to be found in the backwaters and that *P. indicus* post-larvae are available in plenty. As assumed, *P. indicus* was found to appear twice a year, and its appearance proved to be linked with the two annual monsoon rains in June/July (summer monsoon) and in November/December (winter monsoon). Juveniles proved to be available in larger quantities around the time of the winter monsoon, which is much heavier than the summer monsoon. Consequently the effort spent on seed collection differed from the summer to winter crop. On an average a fisherman collected 500 post-larvae per day (4-5 hours). Skilled persons were able to collect up to 1500 per day in winter.

Collection of juvenile shrimps (above 2 g) required a much greater effort than collection of post-larvae shrimps. Though the use of collected juvenile shrimps for pen culture would reduce feed (nursing) costs, it would raise seed costs. These extra costs cancel out the costs saved on nursing. If, for example, pen culture were to be carried out in a 10 ha area, 190 persons would be needed for a fortnight to collect the required juveniles for one crop.' This is not a practical solution and shrimp pen culture will therefore have to rely on collection of post-larvae seeds and on nursing of the seeds until they have reached the juvenile stage. Collection of post-larvae seeds is much less labour intensive than juvenile collection.' A 10 ha pen area would require

'10 ha: 400,000 juvenile seeds/crop required within two weeks.
Average collection per person/day: 150.
Persons to be engaged in seed collection: 190.
2 10 ha: 500,000 post-larvae seeds/crop required within two weeks.
Average collection per person/day: 500 (could possibly be increased).
Persons to be engaged in seed collection: 71.

<<

and 635 kg respectively. Pens 7 and 8 were omitted for comparative purposes, since they were not included in the 1985 summer crop. Individual pen results are presented in Appendices 6a and 6b.

If average price is taken as an indicator of size, it is clear that the 1986 winter crop produced significantly smaller shrimp (24 Rs/kg vs 30 Rs/kg) than the 1985 summer crop.

While there seems to be no difference in production between the two crops, it is presumed that the smaller shrimp harvested in 1986 were the result of very heavy autostocking of *P. iridicus.*

The foregoing discussion indicates that shrimp pen culture technology still faces problems of a technical nature which are crucial for its economic viability.

6.2 Costs and Earnings

The costs-and-earnings analysis of shrimp pen culture (which is based on earnings from two crops in a 1.5 and 2 ha area respectively and actual investment and operating costs) shows that the demonstrated technical package was not economically viable. The annual loss is calculated at Rs. 4367.' The annual costs are estimated at Rs. 36,279 while the actual gross earnings in 1985/86 were only Rs. 31,912. (See Appendix 7 for details.)

The investment costs worked out to be higher than initially assumed. The calculation is based on actual costs incurred in a one hectare pen farm consisting of four 0.25 ha pens. The investment costs include costs for pens, happas, seed collection gear, pest removal and harvesting gear, feed procurement and processing gear — the total of which amounts to Rs. 36,629. It is unlikely that these costs can be reduced by increasing the scale of operation from one hectare to a larger unit unless the technical package is modified.

One method of reducing investment costs might be to use cheaper pen wall material—for example HDPE instead of nylon. However, the required small mesh HDPE material is not yet available in the market as there is insufficient demand for it. If the HDPE material could be supplied in future it is believed that pen wall costs could be reduced by about 50 per cent.

This would reduce the total annual costs from Rs. 36,279 to Rs. 33,549 and the annual loss by Rs. 2,730 from Rs. 4367 to Rs. 1637.

If the life span of all investment materials (except casuarina poles) is taken to be as long as four years instead of three years the annual loss will be reduced by Rs. 2,788 to Rs. 1,579.

The economic viability of shrimp pen culture is very sensitive with regard to feed. Feed costs depend on both production costs and feed conversion efficiency. The poor rate of 7:1 indicates that further work is required on this problem, especially considering that quality commercial feed achieves rates of 2 to 2.5: 1. Should it not be possible to obtain commercially produced pelletized feed at a lower price than 4.5 Rs/kg the annual culture costs will increase considerably and thereby raise the annual loss from Rs. 4,367 to Rs. 9,160. Therefore the feed price factor has to be carefully considered in connection with future efforts to improve the growth of shrimp.

It might be possible to reach a breakeven point by improving the predator control system during the winter crop by which the problem of overstocking could be overcome, so that the growth of shrimp would be improved, a higher market value realized and the gross earnings increased. Assuming thai the gross earnings from the winter crop would be as high as those from the summer crop, the total gross earnings would increase by 20% and make shrimp pen culture viable. The net result would be improved by Rs. 6,382, turning the annual loss into a small profit of Rs. 2,015.

The sensitivity of the economics to various variables is illustrated in Appendix 8. Let us assume that it will not be possible to obtain feed at a lower price than 4.5 Rs/kg but possible to reduce the pen wall cost by 10%. A break-even operation could then be attained if the gross earnings were increased by a little less than 20%.

'One US $ was about Rs. 12.25.

<<

6.3 Social acceptability

By involving fishermen in the demonstration of the pen culture technology package, the project has obtained valuable **information on** the adaptability of backwater fisherfolk to pen culture. It was found that the fishermen's initial hesitation about taking part in pen culture operations was due to the following factors:

- lack of information on the new technology and its scope
- lack of trust in officers with regard to conditions of work and pay—fear of giving up their independent working patterns
- pressure from the community and its leaders not to depart from traditional socio-economic patterns.

Contact with fisherfolk through house visits and information about the new technology enabled them to slowly come forward to try out new and unknown work. The initial belief that fisherwomen (fish traders) too could be motivated to take part in pen culture work did not hold in spite of special efforts made by the female member of the project field team. Women could not get used to the idea of carrying out work which is water-based as by tradition they do not engage in fishing.

During the course of the pen culture operations it was observed that not all eight participating fishermen responded in the same way to the new tasks. Some showed keen interest in technical and management aspects. They raised questions regarding plans for shrimp culture extension in the Killai backwaters and wanted to know what kind of financial and technical support the Government would provide for fishermen. These fishermen said they joined the project with the expectation that they would acquire skills in shrimp pen culture and be selected by the Government as beneficiaries for pen culture once the demonstration project was completed. They were confident that the Government would promote shrimp pen culture by providing subsidies for them, no matter what the results were regarding its economic viability. They therefore considered themselves as pen "workers" for a limited period, bearing in mind that this was a necessary phase; they could later become independent shrimp pen farmers and hire other fishermen and Veddars for tasks they did not like to perform themselves (tasks such as construction of pens, production of feed, handpicking shrimps and safeguarding pens at night). These fishermen were confident of managing a small (one hectare) pen farm themselves, provided the Government would ensure that other fisherfolk did not prevent them from culturing shrimps. They expected the Government to ensure protection for their pens and see that the backwaters could be utilized for pen culture without disturbance from other fishermen. They seemed to feel strong enough to cope with the eventual sanctions from their community, which would see them as outsiders who had utilized economic options which did not exist for everyone. This group of four fishermen was economically better off than the others, and had a better school education. They owned a small plot of agricultural land (paddy) which they had leased to share croppers and which secured them a great part of their families' basic food requirements. They owned more fishing assets than others — one of them had a canoe and two possessed marine fishing gear. They therefore did not depend solely on the wages earned from pen culture.

The remaining four fishermen who were less educated, one of them illiterate and without any income other than from castnet and occasional dragnet fishing, had different expectations of shrimp culture operations. They joined the project to earn a regular and secure income. They were more concerned about ensuring this income than about acquiring pen culture skills. Becoming independent pen farmers some day seemed to be beyond their imagination. They seemed to be satisfied with doing what they were asked to do. They displayed less initiative than the others, who occasionally tried to order them about. This group learnt less during the theoretical training — due both to lack of interest and lack of ability to grasp certain matters as quickly as the others. Therefore they require intensive motivational support and technical guidance if included inthe target group in the event of extension of shrimp pen culture technology.

<<

7. CONCLUSIONS AND RECOMMENDATIONS FOR FUTURE ACTION

During the one-year shrimp pen culture demonstration it was found that local backwater fishermen show sufficient occupational mobility to engage in aquaculture. Depending on their socio-economic status, fishermen adapted themselves to physical pen culture work or to management tasks. Not every backwater fisherman will be in a position to adopt the new technology without close technical and management guidance. This has to be thoroughly considered when selecting beneficiaries and preparing shrimp pen culture extension plans in future.

As the shrimp pen culture demonstrations were carried out in a backwater area located relatively close to the fisherfolk's settlements, and as the fishermen participating in the demonstrations were not asked to live at the pen farm site for safeguarding it, it would be hypothetical to conclude that backwater fishermen are likely to show the geographical mobility required for pen culture operation. Such geographical mobility on the part of fishermen and their families is necessary if shrimp pen culture is going to be extended on a small-scale operational basis, since most of the potential water areas are located some distance from present settlements, and pen culture requires continuous safeguarding of pens day and night. Fishermen and their families therefore have to be prepared to settle in new areas if they decide to turn from backwater capture fisheries to pen culture. Settlements need to be established in mangrove areas and close to the seashore, depending on the location of the pen farm (see Appendix 3). These areas do not have any infrastructure and are not easily accessible. Housing, drinking water, and transport of people, farm equipment and products are problems to be considered. Female family members who earn from fish marketing would have to find alternative employment, as they would be cut off from access to fish as well as from market outlets.

Although these considerations point to the conclusion that fisherfolk will not leave their present settlements, there is reason to believe that they may be prepared to move to new areas in the backwaters. There are for example fishing families that have migrated from the main village (Killai) to areas on the seashore where men have taken up fishing in the immediate inshore waters and women have continued to process and market fish. In other words, there are fisherfolk who are both occupationally and geographically mobile. Therefore mobility will be determined to a great extent by the options that pen culture offers with respect to incomes. Fisherfolk will not switch to pen culture unless it offers a little higher or at least the same level of income as capture fisheries. The demonstrated shrimp pen culture package however was not sufficiently viable to offer fisherfolk incomes comparable with their present ones.

Unless further technical improvements of shrimp pen culture can be achieved, the technology cannot be considered an economically viable option for fishermen. It would require heavy subsidies on investment and operating costs. Should the Government consider promoting shrimp pen culture in spite of its techno-economic problems, it might face opposition from fisherfolk. This is because subsidies can benefit only a few fishermen, thus provoking unrest among the others. Even strong politically oriented village leaders who are usually chosen to select beneficiaries have faced the problem of ensuring that subsidized technology can be smoothly utilized by the beneficiaries. Fishermen who have not benefited from the subsidies often find ways and means to sabotage a project — an easy job in the case of pen culture.

While the results of pen culture trials at Killai indicate that shrimp production may annually exceed one ton per hectare, it is clear that the product value is too low to generate sufficient revenue to provide a reasonable return on investment. This low value is due to the small size shrimp, mainly *P. indicus* and the various species of *Metapenaeus.* **Poor growth seems to be an** inherent characteristic of *P. indicus* whether cultured in ponds or pens. Although initial growth is very rapid in this species, upon reaching 10 to 12 grams, the rate slows to such an extent that it is uneconomical to maintain a culture operation beyond that point.

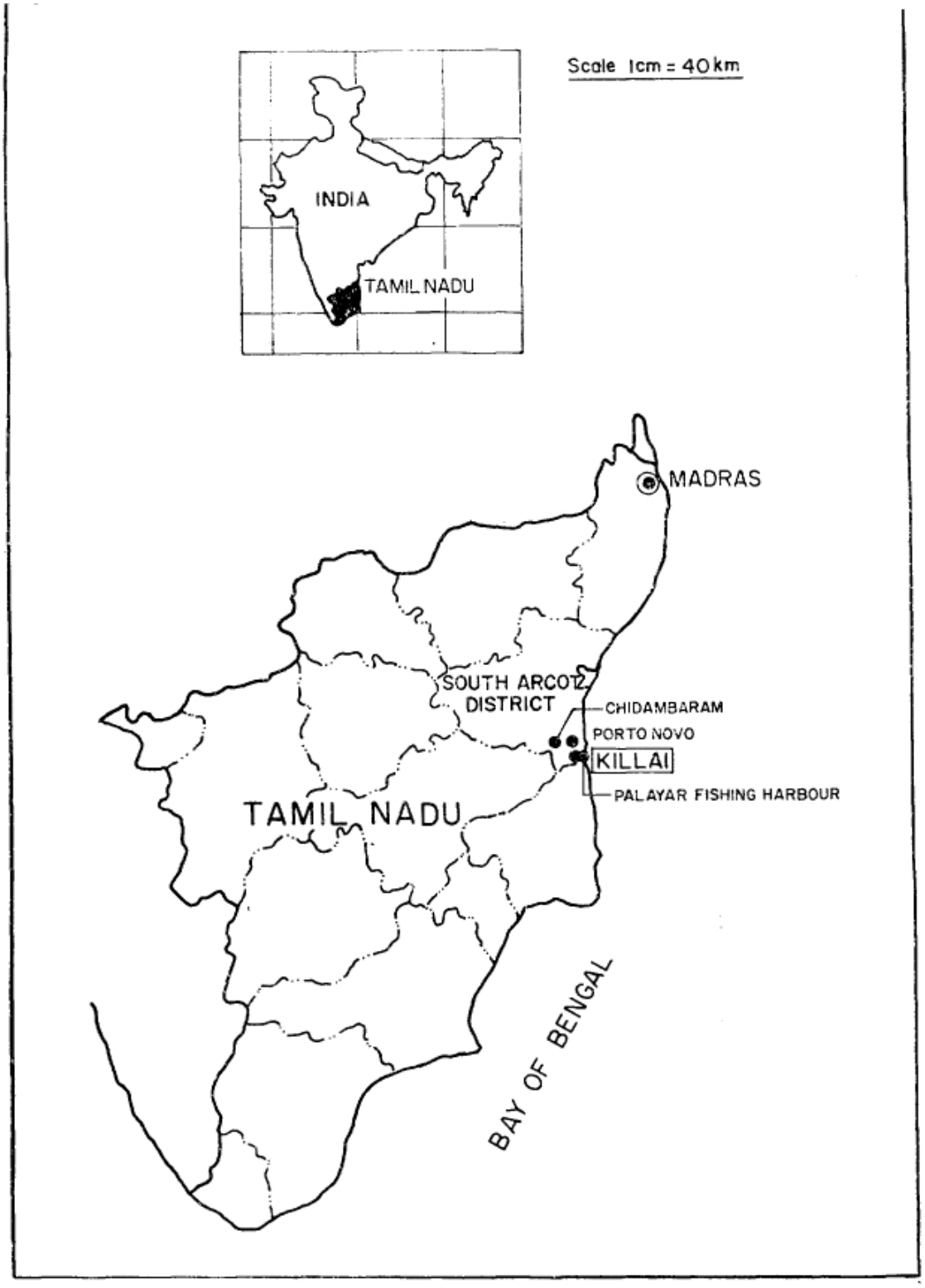
<<

While the choice of *P. indicus* was based on the local availability of post-larvae and juveniles, only *P. monodon* has the necessary growth potential to produce a large enough shrimp within the time constraints encountered at Killai. With the advent of hatcheries, it becomes technically possible to rear this species in pens. Alternatively, the transport of wild fry from Andhra Pradesh and Orissa could be arranged. By proper feeding, the yield of *P. monodon* should reach levels experienced in pond culture, making the culture economically viable. Future trials should concentrate on hatchery-bred *P. monodon* and improved feed.

It is also recommended that a suitable fish be cultured in the pens to maximize the use of the enclosed water volume. *Etrop/us suratensis* appears to have the appropriate characteristics as it is euryhaline and feeds predominantly on filamentous algae. They are presently harvested from the pens as autoentrants and their size, sometimes 500 g, indicates they survive episodes of low salinity. Bottom or detritus feeders such as *Chanos chanos* or mullets would not be suitable as they reduce the yield of shrimp. In Kerala, *E. suratensis* (pearl spot) fetches a very high price. Future pen culture trials at Killai should include controlled stocking of this species.

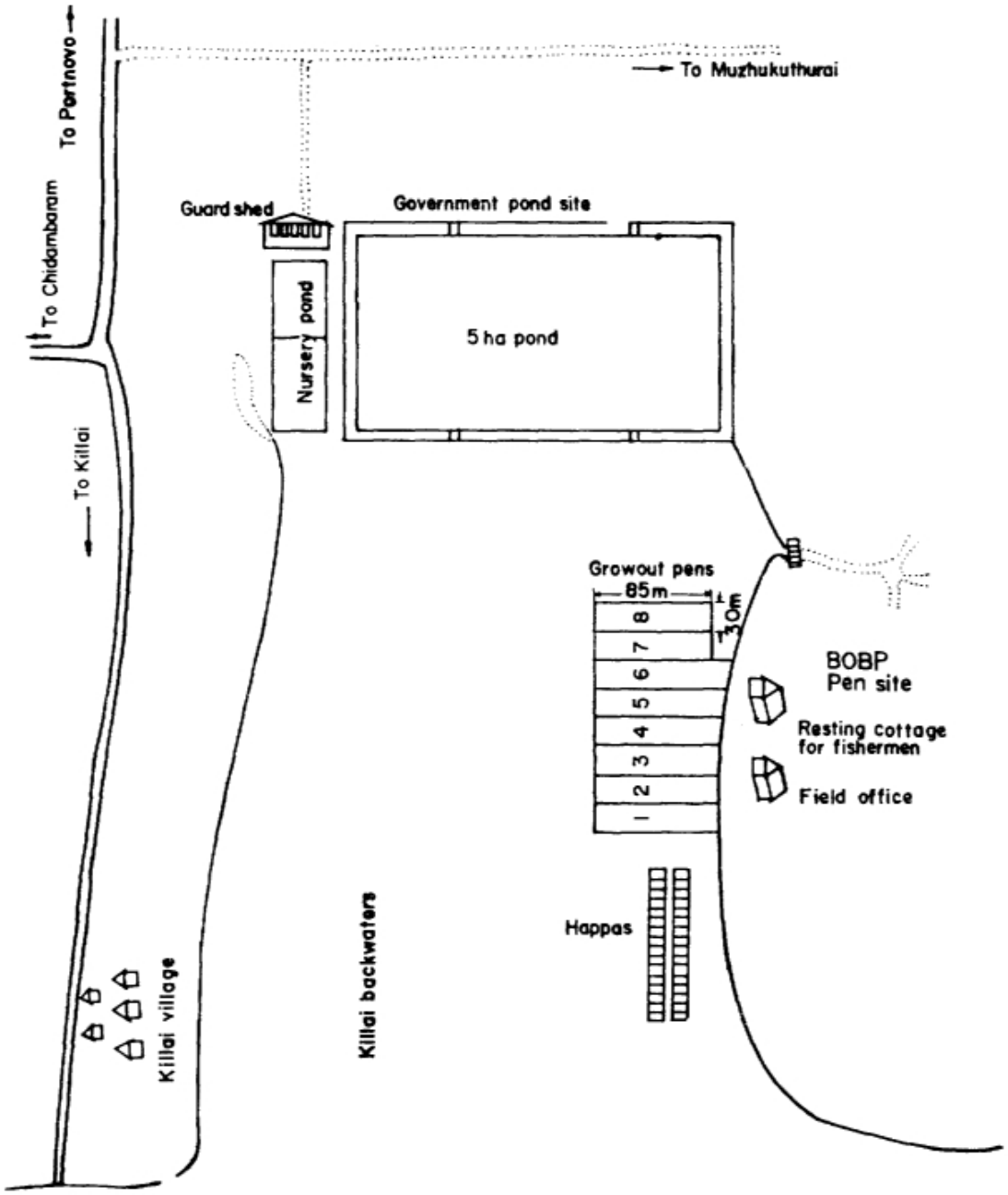
Appendix I

LOCATION OF PROJECT SITE



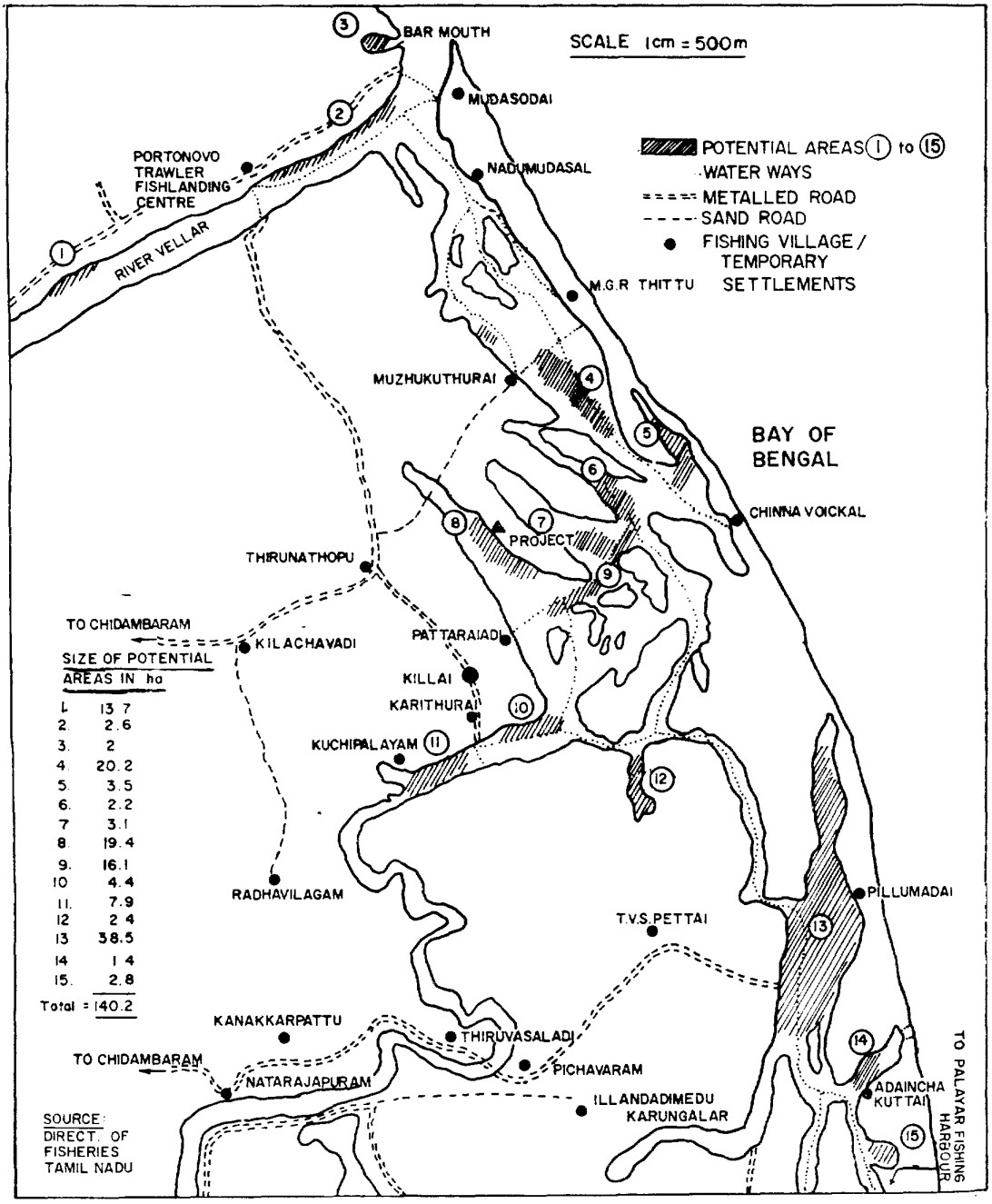
Appendix 2

LAYOUT OF PENS AND HAPPAS



Appendix 3

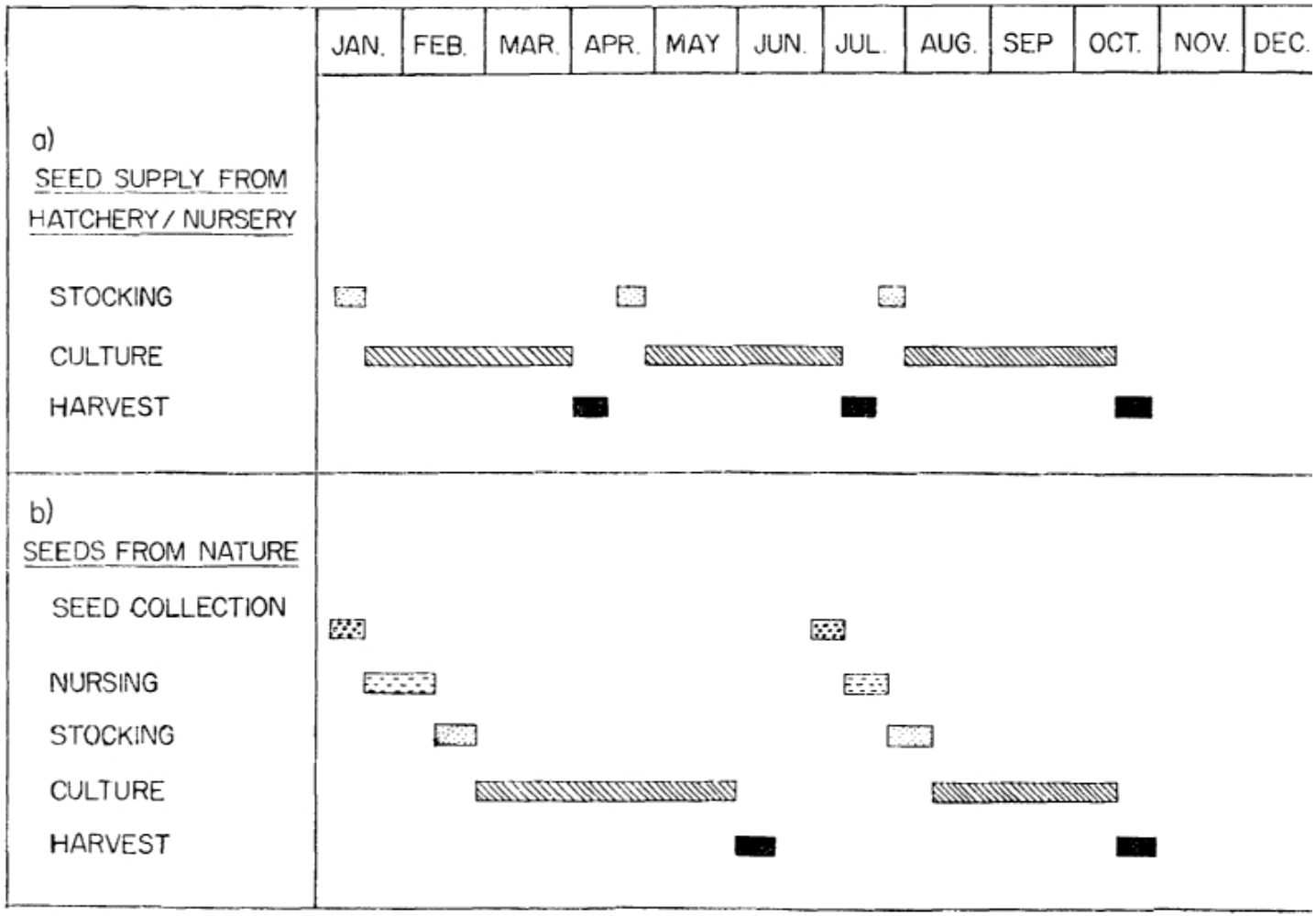
Killai backwaters: areas hydrologically suitable for pen culture (Total: l4Oha)



<<

Appendix 4

ANNUAL CULTURE CYCLE PLAN FOR NATURE AND HATCHERY-SUPPLIED SEEDS



<<

Appendix 5a

FORM FOR TECHNICAL RECORDS OF SHRIMP PRODUCTION

	PEN 1	PEN 2	PEN 3	PEN 4	PEN 5	PEN 6	PEN 7	PEN 8
Date of pen construction								
Pen size								
Date of stocking								
Stocking density								
No. stocked								
Av. weight of stocked seeds								
Total weight of stocked seeds								
Nursing period of seeds								
Av. weight of collected seeds								
Gear used								
Place of collection								
Feeding rate during nursing								
Survival rate during nursing								
Av. weight of shrimps after 2 weeks								

4

6

<<

Appendix 5a *(Continued)*

	8
	10
	12
Feeding rate during grow-out of	$\frac{\text{wet feed}}{\text{dry feed}}$
Date of harvest	
Total weight of harvested	$\frac{\text{shrimps}}{\text{fish}}$
Total gross earnings	$\frac{\text{shrimps}}{\text{fish}}$

<<

Appendix 5b

FORM FOR HARVESTING AND SALES RECORDS

Species/Count	1st DAY			2nd DAY			3rd DAY			4th DAY			5th DAY			6th DAY		
	Qty kg	Rate Rs/kg	Total amount Rs	Qty kg	Rate As/kg	Total amount Rs	Qty kg	Rate As/kg	Total amount As	Qty kg	Rate As/kg	Total amount Rs	Qty kg	Rate Rs/kg	Total amount As	Qty kg	Rate Rs/kg	Total amount Rs
P. Monodon																		
30																		
35																		
40																		
45																		
50																		
50																		
55																		
60																		
65																		
70																		
90																		
100																		
110																		
125																		

<<

Appendix 5b *(Continued)*

P. Indicus

70

75

100

120

130

140

150

180

180

190

200

220

232

390

430

440

Mètapenaejds
Total
Fish/Crab
Grand Total

<<

Appendix 6a

QUANTITY AND VALUE OF SHRIMPS PRODUCED—SUMMER CROP 1985

Size of shrimp in counts (no/kg)	PEN 1		PEN 2		PEN 3		PEN 4		PEN 5		PEN 6	
	kg	Rs	kg	Rs	kg	Rs	kg	Rs	kg	As	kg	Rs
30	2.7	278	3.7	318	–	–	–	–	–	–	0.7	48
35	1.4	117	–	–	–	–	–	–	–	–	1.0	65
40	1.1	79		–		–	–	–	–	–	2.8	212
45	–	–	0.7	49	–	–	–	–	–	–	0.6	43
50	–	–	–	–	–		–	–	–	–	4.4	281
55	–	–	0.9	47	–	–	–	–	–	–	2.8	118
60	51.5	2,988	4.2	210	3.7	168	1.9	85	31.9	1,467	11.2	550
65	–	–	–	–	–	–	–	–	–	–	6.6	306
70	0.5	25	–	–	8.7	389	7.9	356	27.5	1,238	12.3	528
75	–	–	–	–	–	–	–	–	–	–	–	–
80	0.3	10	89.1	3,562	–	–	89.3	3,127	–	–	11.5	473
85	–	–	–	–	–	–	–	–	–	–	9.6	386
90	35.2	1,371	–	–	92.4	2,863	11.2	346	29.2	905	3.6	133
95	–	–	–	–	–	–	–	–	–	–	–	–
100	3.2	120	10.3	308	–	–	–	–	–	–	15.5	485
105	–	–	–	–	–	–	–	–	–	–	6.9	238
110	4.0	100	–	–	–	–	–	–	–	–	1.8	56
115	–	–	–	–	–	–	–	–	–	–	–	–
120	–	–	–	–	31.5	662	19.0	399	–	–	1.5	47
125	–	–	–	–	–	–	–	–	–	–	2.4	50
130	1.7	41	17.0	340						–	3.9	105

<<

Appendix 6a *(Continued)*

140		–	**14.5**	**276**	**4.0**	**76**	**19.5**	**370**	**10.0**	**189**	**5.0**	**117**
150	–	–	**5.0**	**90**	**2.5**	**45**	**7.4**	**133**	**10.0**	**180**	**2.3**	**37**
160	**2.1**	**32**	–		–	–	–	–	–	–	**3.0**	**60**
170	–	–	**1.0**	**15**	–	–	–	–	**4.4**	**63**	–	
180	–	–	–		–	–		–	–	–	**1.7**	**34**
190	–	–	–	–	**1.3**	**18**	**4.5**	**63**	–	–	–	–
200	**11.9**	**217**	**1.3**	**19**	–	–	–	–	**5.2**	**73**	**7,3**	**112**
210	**1.7**	**23**	–	–	–	–		–	–	–	**4.2**	**63**
220	–	–	–		–	–	–	–	–	–	–	–
230	–	–	–	–	–	–	–	–	–	–	**4.2**	**58**
240	**4.6**	**52**	–	–	**2.0**	**28**	**3.0**	**52**	–	–	–	–
250	**8.0**	**64**	–	–	–	–	–	–	–	–		–
300	–	–	–	–	–	–	–	–	–	–	**0.3**	**4**
390	**3.3**	**32**	–	–	–	–	–	–	–	–	–	–
430	**8.0**	**63**	–	–	–	–	–	–	–	–	–	–
440	–	–	–	–	–	–	–	–	–		–	–
Meta fish/	12.2	57	1.0	6	0.9	5	1 .8	11	5.5	33	11 .5	58
crab	8.9	19	17.1	39	22.0	82	11.3	8	7.5	11	35.0	86
Total	**162.3**	**5,686**	**165.8**	**5,279**	**169.0**	**4,336**	**176.8**	**4,950**	**131.2**	**4,159**	**173.6**	**4,752**

<<

Appendix 6b

QUANTITY AND VALUE OF SHRIMPS PRODUCED—WINTER CROP 1986

Size of shrimp in counts (no/kg)	PEN 1		PEN 2		PEN 3		PEN 4		PEN 5		PEN 6		PEN 7		PEN 8	
	kg	Rs	kg	As	kg	Rs	kg	Rs	kg	Rs	kg	Rs	kg	Rs	kg	Rs
30	—	—	—	—	1.3	111	0.7	65	—	—	—	—	0.5	49	4.8	456
35	—	—	—	—	0.5	41	—	—	—	—	—	—	—	—	—	—
40	—	—	—	—	1.4	108	1.0	77	1.5	119	—	—	1.9	140	—	—
45	—	—	—	—	0.5	36	—	—	—		—	—	—	—	—	—
50	—	—	—	—	1.5	103	—	—	—	—	1.9	119	—	—	2.2	175
*50	3.1	80	—	—	0.3	6	—	—	—	—	—	—	—	—	—	
55	—	—	3.1	196	1.1	61	—	—	—	—	—	—	—	—	—	—
60	1.9	98	8.4	462	0.3	16	—	—	1.7	125	2.7	143	1.4	102	0.4	28
65	—	—	—	—	0.2	11	1.0	53	—	—	—	—	—	—	—	—
70	—	—	—	—	5.1	230	—	—	6.0	232	—	—	1.2	48	—	—
75	—	—	—	—	1.5	65	9.4	423	—	—	—	—	—	—	—	—
80	0.9	39	5.4	232	—	—	0.5	22	2.7	114	—	—	10,7	454	—	—
*80	—	—	0.5	10	—	—	—	—	—	—	—	—		—	—	—
90	1.2	50	6.4	269	0.8	34	0.9	38	21.2	890	—	—	—	—	34.0	1 348
*90	—	—	—	—	—	—	0.8	20	—	—	—	—	—	—	—	—
100	49.0	1708	2.3	70	1.3	44	10.8	376	11.9	390	3.1	92	25.0	820	4.7	141
105	—	—	13.0	394	—	—	24.0	874	—	—	—	—	—	—	—	—
110	13.9	471	3.0	84	0.4	12	—	—	18.9	642	—	—	—	—	—	—
120	—	—	19.1	610	30.7	981	6.0	192	18.4	514	6.9	219	16.6	461	—	—
125	10.5	293	1.3	19	4.1	113	18.7	523	—	—	—	—	—	—	—	—
130	4.4	119	—	—	2.3	60	9.0	239	13.3	371	54.1	1545	—			

<<

Appendix 6b *(Continued)*

140	**14.9**	**373**	_	_	**3.0**	**75**	**12.1**	**303**	**7.6**	**185**	_	_	_	_	_	_
150	**7.3**	**174**	**10.0**	**240**	**12.5**	**288**	_	_	**4.7**	**118**	**2.9**	**64**	_	_	_	_
160	_	_	_	_	_	_	**3.6**	**77**	_	_	_	_	_	_	_	_
170	_	_	_	_	_	_	**7.1**	**213**	_	_	_	_	_	_	_	_
180	_	_	**1.5**	**33**	**51.3**	**1026**	_	_	_	_	**3.0**	**65**	_	_	_	_
***180**	_	_	_	_	**1.2**	**12**	_	_	_	_	_	_	_	_	_	_
185	_	_	_	_	_	_	**5.3**	**105**	_	_	_	_	_	_	_	_
190	**9.0**	**180**	_	_	**1.2**	**18**	**11.2**	**224**	_	_	_	_	_	_	_	_
200	_	_	**3.8**	**63**	**7.6**	**121**	**6.4**	**102**	**2.5**	**40**	**14.0**	**229**	**6.3**	**109**	**0.9**	**16**
210	**2.0**	**20**	_	_	_	_	_	_	_	_	_	_	_	_	_	_
220	_	_	_	_	**6.0**	**96**	**1.2**	**19**	**8.8**	**132**	**7.4**	**149**	_	_	_	_
230	**9.9**	**158**	_	_	**5.0**	**50**	_	_	**3.2**	**51**	_	_	_	_	_	_
240	**0.6**	**6**	_		_	_	_	_	_	_	**2.8**	**62**	_	_	_	_
250	4.4	68	_		_	_	_	_	10.3	148	_	_	_	_	_	_
390	_	_	_	_	**2.0**	**20**	_	_	_	_	_	_	_	_	_	_
430	_	_	_	_	0.8	8	_	_	_	_	_	_	_	_	_	_
440	_	_	_	_	0.8	8	_	_	_	_	_	_	_	_	_	_
Meta Fish/	35.7	178	29.1	273	14.7	74	21.6	108	19.6	98	43.5	331	6.1	48	5.2	34
crab	7.8	36	16.4	50	22.9	60	18.0	49	5.3	11	9.1	37	23.4	44	18.5	30
Total	186.5	4,051	123.3	3,005	182.2	3,888	169.3	4,102	157.5	4,180	151.3	3,055	93.1	2,275	70.7	2,228

<<

Appendix 7

COSTS AND EARNINGS OF A 1 HA SHRIMP PEN UNIT

(based on actual costs and earnings of the culture year 1985/86 with seeds from nature/2 crops per year)

I.	**INVESTMENT COSTS**		*Rs. 36,629*
1.	*Pens*	**Qty.**	
	(1 ha pen with 3 separation walls, open towards the shore)		
	— nylon webbing, 10 mm mesh size 1.5 m **depth, 140 Rs/kg**	**80 kg**	**11,200**
	— **HDPE webbing, 25 mm mesh size** 1 **m** depth, 95 Rs/kg	**20 kg**	**1,900**
	— HDPE webbing 25 mm mesh size for bottom reinforcement 0.5 m depth, **95 Rs/kg**	**8 kg**	**760**
	— HDPE foot rope, 6 mm dia. **33 Rs/kg**	**14 kg**	**462**
	— HDPE twine, 2 mm dia. 40.4 Rs/kg	**1.4 kg**	**57**
	— **Coir rope, 15 As/kg**	**20 kg**	**300**
	— Casuarina posts **9-10 mm dia. at bottom 3.5 m length, 410 Rs/t**	**3.5 t (260 pcs)**	**1,435**
	— Casuarina cross bars 4.5 cm dia. at bottom **3.5 m length, 375 Rs/t**	**it (250 pcs)**	**375**
	— Metal furrower	1	**50**
	— **Spades, 25 Rs/piece**	**2**	**50**
	— Knives, 1 5 Rs/piece	**4**	**60**
	— Labour costs for pen construction: **14 Rs/man day.**		
	— trimming of poles and cross bars	40 m-d	**560**
	— seaming of reinforcement layer	50 m-d	**700**
	— attachment of foot ropes	20 m-d	**280**
	— pen erection	60 m-d	**840**
	Subtotal: Pens		*Rs. 19,029*
2.	*Happas* **(8) (size 10 m x 4 m 1.5 m)**		
	— **HDPE velon screen, 7 Rs/m**	**8 x 81 m**	**4,536**
	— **HDPE tape, 40 Rs/kg**	**8 × 1.5 kg**	**480**

— Nylon twine, 3.5 Rs/spindle	4	10
— Labour costs, 60 Rs/m-d	8 × 1 m-d	480
Sub total: Happas		*Rs. 5,510*
3. *Seed collection gear*		
— Seed storage cage 75 Rs/cage (1 m × 0.5 m × 1 m)	2	150
—push net, 97 As/net	2	194
— seed transportation container 300 Rs/piece	6	1,800
— canvas sheet, 150 Rs/piece	2	300
Sub total: Seed collection gear		*Rs. 2,444*
4. *Pen pest removal and harvest gear*		
— Gillnets, 3 types, 280 Rs/piece mesh size 30 mm, 1 piece " 40 mm, 1 piece " 55 mm, 2 pieces	4	1,120
—Trammel nets, 600 Rs/piece 40 and 60 mm mesh size 1 m depth, 40 m length,	4	2,400
— Hook and line, 25 As/piece	4	100
— Crab traps, 23 Rs/piece	20	460
— Galvanized buckets, 60 Rs/piece	8	480
Sub total: Pest removal and harvesting gear and labour		*Rs. 4,560*
5. *Feed purchase/production gear*		
— Motorized mincer mincer Rs. 520, motor Rs. 3,800, to be shared with another one ha farm unit	0.5	2,160
— Iron pan, 222 As/piece	2	444
— Plastic container, 125 Rs/piece	3	375
— Knives, 15 Rs/piece	4	60
— Iron ladles, 15.6 Rs/piece	3	47
— Canoe, Rs. 4,000 to be shared with another one ha farm unit	0.5	2,000
Sub total: Feed purchase/production gear		*Rs. 5,086*
11. OPERATING COSTS		*Rs. 21,017*
1. *Seeds (P. indicus* of 0.25 g) 50,000 x 2 crops 200 m-days x As. 14		2,800

<<

2.	*Feed1*	Rs. 12,517
	(a) Nursing: 60kg pellets x 4 pens >< 2 crops x As. 2.5=:Rs. 1,200 121 kg prawn heads x 4 x 2 x As. 0.5=Rs. 484	
	(b) Grow out: 372 kg pellets x 4 x 2 x Rs. 2.5=Rs. 7,440 606 kg wet feed *x* 4 x 2 x Rs. 0.7=Rs. 3,393	
3.	*Hire or pen pest removal and harvesting equipment* — Ice box, spring balance, balance 6 days per crop **x 2=12 days;** Rs. 30 × 12=Rs. 360 — Ice, Rs. 150 >< 2=Rs. 300	660
4.	*Labour for harvesting* 64 m-d —16m-dat7 Rs/m-d=Rs. 112 for hand picking —48 m-d at 14 Rs/m-d=Rs. 672	784
5.	*Labour for feeding, pen check, day and night watch, pest removal2* 180 m-d, 14 Rs/m-d	**2,520**
6.	*Labour for pre-stocking pest removal* 124 m-d, 14 Rs/m-d	1,736
III.	FIXED COSTS3 (3-year life span for all investment materials)	*Rs. 15,262*
1.	Depreciation	12,210
2.	Interest on investment capital 12.5%/year, annual repayment of capital: 1/3 equalized over 3 years	3,052
IV.	TOTAL ANNUAL COSTS (11±111)	36,279
V.	TOTAL ANNUAL GROSS EARNINGS4	31,912
VI.	ANNUAL LOSS	—4,367

1 based on actual costs for feed produced by the project.

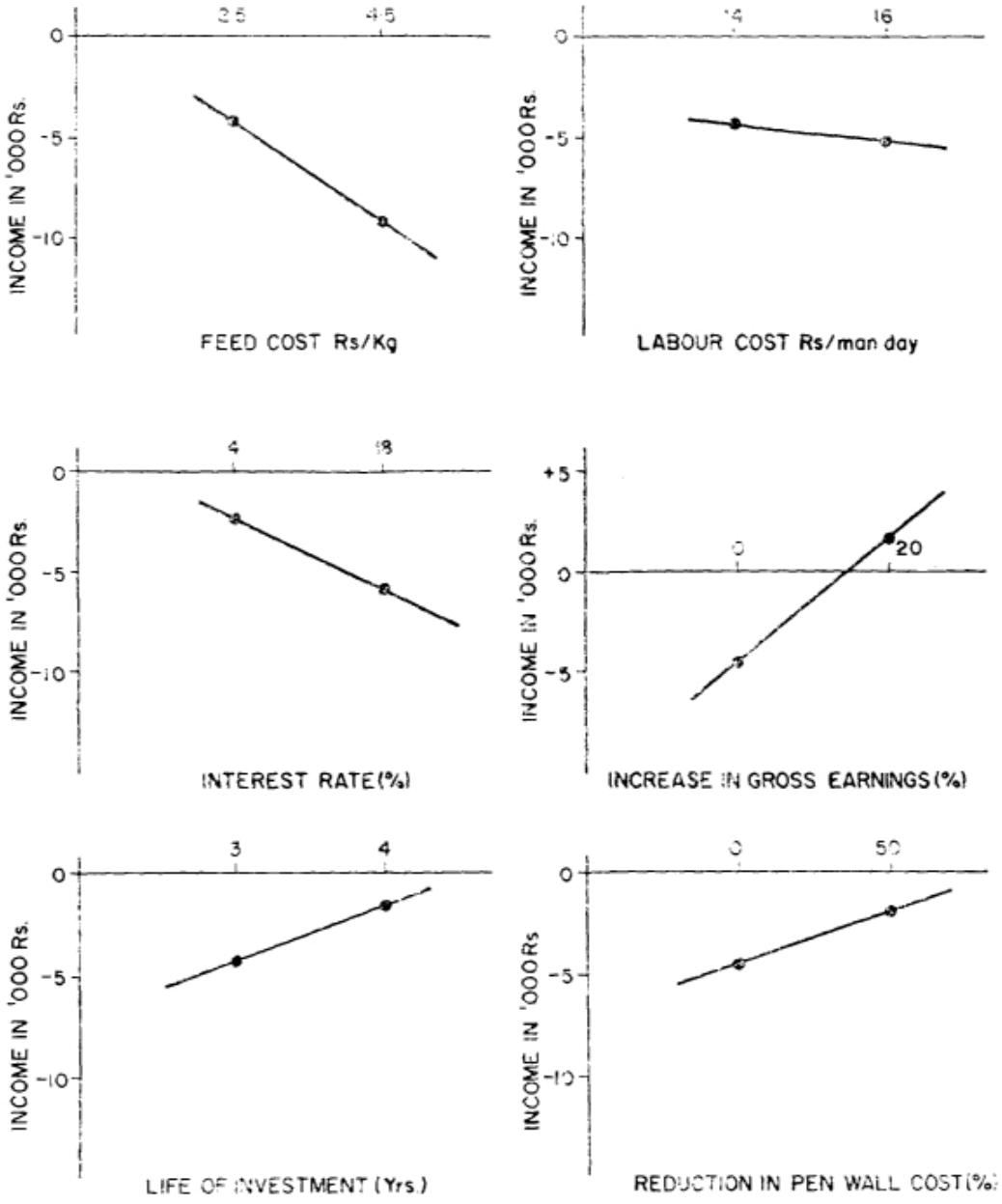
2 4 ha, one during the day and the other at night.

for the first year Rs. 1,317 should be added for interest (12.5%) on Rs. 10,535 operating costs.

based on actual average earnings from two crops; first crop: 1.5 ha (6 pens); second crop: 2 ha (8 pens) ; for production and price details see Appendix 8.

Appendix 8

CULTURE ECONOMICS – SENSITIVITY ANALYSIS



Culture economics—sensitivity analysis

	Increase/decrease of annual profit in Rs.
1. Feed costs increase	
from 2.50 Rs/kg to 4.50 Rs/kg'	—4,793
from 2.50 Rs/kg to 3.50 Rsjkg'	—1,337
2. Gross earnings increase	
by 20% from Rs. 31,912 to Rs. 38,294	±6,382
by 10% from Rs. 31,912 to Rs. 35,103	±3,191
3. Labour costs increase	
from Rs. 14 to 15	—351
from Rs. l4to 16	—702
4. Lifetime of all materials (except casuarina poles) increases	
from 3 years to 4 years	±2,788
5. Interest rate on investment capital	
not subsidized, e.g. 18% interest	—1,341
further subsidized, e.g. 12.5 to 4%	±2,075
6. Pen wall costs reduced	
by 50% from Rs. 13,100 to Rs. 6,550	+2,730
by 70% from Rs. 13,100 to As. 3,930	+3,821

1 In this case investment in feed production gear is not necessary

<<

Appendix 9

FEED COSTS FOR NURSING AND CULTURE OF SHRIMPS

Pen	Nursing Period	Culture Period	Qty. fed in kg. for Nursing Dry	Qty. fed in kg. for Nursing Wet	Qty. fed in kg. for Grow-out Dry	Qty. fed in kg. for Grow-out Wet	Feed Costs in Rs. for Nursing	Feed Costs in Rs. for Grow-out	Feed Costs in Rs. for Total	Gross Earnings in Rs.	Feed Costs as % of gross
1.	15-6-85—19-7-85	20-7-85—20-9-85	68	93	171	973	116	859	975	5,686	17
2.	29-6-85—24-7-85	25-7-85—25-10-85	69	93	179	1132	116	882	998	5,279	19
3.	04-7-85—31-7-85	01-8-85—26-10-85	95	134	161	813	178	766	946	4,336	22
4.	08-7-85—01-8-85	02-8-85—27-10-85	86	136	572	33	162	1,434	1,598	4,940	32
5.	02-8-85—13-8-85	14-8-85—27-10-85	24	118	585	25	60	2,640	2,701	4,159	65
6.	4-9-85—14-11-85	15-11-85—15-2-86	122	185	465	838	388	2,099	2,487	4,752	52
1.	24-11-85—31-1-86	1-2-86—1-5-86	46	85	300	741	189	831	1,021	4,051	25
2.	—No nursing—	14-2-86—15-5-86	-nil-		532	36	-nil-	2,381	2,382	3,005	79
3.	—No nursing—	18-12-85—18-3-86	-nil-		248	1067	-nil-	981	981	3,888	25
4.	—No nursing—	01-1-86—22-4-86	-nil-		592	895	-nil-	1,650	1,650	4,102	40
5.	5-12-85---2-1-86	03-1-86----23-4-86	39	57	521	724	104	1,483	1,587	4,180	38
6.	21-12-85—28-2-86	01-3-86—16-5-86	47	160	357	18	142	1,605	1,749	3,055	57
7.	21-12-85—15-3-86	16-3-86----15-5-86	41	190	294	638	176	806	982	2,275	43
8.	12-12-85—25-01-86	26-1-86—20-5-86	20	85	229	549	97	629	728	2,228	33

1 Feed components are presented in paragraph 3.3.

<<

Annexure

BACKGROUND MATERIAL ON SHRIMP CULTURE OPERATIONS GIVEN TO THE FISHERMEN

Shrimp seed collection areas

- *Vadakkumuttu:* The water spread area found in between the pen culture site and Chellankuttai, which is a shallow area infested with *Ha/ophila ova/is, Chaetomorpha* and *Enteromorpha* sp. In this area there are more subadults (30-50 mm in length).

- *Naduthittu:* Small islet found opposite to the Chellankuttai. The channels are sandy in nature and vegetated with *Halophila ova/is, Ha/odule uninervis, Gradilaria* sp. and *Enteromorpha* sp. This area harbours more juveniles (15-25 mm in size) and fewer subadults.

- *Chinnavaikkalmunai:* Shallow stretch of sandy zone with *Ha/odule uninervis* found on the western side of Chinnavaikkal hamlet. More larvae and juveniles (10-20 mm size) are available. The collection is difficult because of the presence of oysters.

- *Vandamunai:* This channel connects the Killal backwaters with the Vellar estuary. The deeper muddy zone and the shallow sandy zone are infested with *Ha/odule uninervis* and *Gracilaria.* More prawn larvae are available (10-20 mm size) in this area.

- *Karithurai.'* In the shallow sandy zone with vegetation of *Ha/ophila ova/is, Grad/aria* and *Enteromorpha* sp. both wild and tiger seeds are available, more larvae and juveniles are present in this place.

- *T. V. S. Pattai:* Deeper muddy portion and shallow sandy area. The shallow zone is infested with *Halophila ova/is. Halodule uninervis* at different places as patches *Grad/aria* sp. and *Enteromorpha* sp. are found as mat on these patches. Both white and tiger seeds are available (10-30 mm size) in this area.

- *Ve/lar salt pan area.'* This ground lies on the left bank of Vellar estuary at Porto Novo, marginal sandy zone with *Halodule uninervis* harbours more of post-larvae and larvae (10-30 mm size) of white shrimp.

During the first project phase various gears were depToyed to capture shrimp seeds and their efficiency was studied in order to recommend suitable gear for seed collection in the Killai backwater area.

Shrimp seed collection

Shrimp seeds can be colected from the Killai backwater area. The marginal areas are either sandy or muddy in nature. Some areas are barren and some areas are infested with macro vegetation. The macro vegetation found in this area is *Ha/ophi/a ova/is, Holodu/e uninervis* (rooted vegetation), *Grad/aria* spp., *Enteromorpha* spp., *Chaetomorpha* sp. and *Hypnea musciformis* (floating vegetation). The Killai backwater extends from Vellar estuary in the north and Coleroon estuary in the south, an area of approximately 1380 ha. The channels and creeks with algal mat and luxuriant mangrove vegetation ensure food availability and relative shelter from predation. Hence, these areas serve as an ideal nursery ground for juvenile prawn population.

Seed collection gear

- *Velon bagnet:* One piece of velon screen of 16 p. mesh 3 × 1 metre size is dragged along the marginal area by two persons. Since they have to bend down and drag the net, it is a very difficult task and not efficient. Use of this net in weed infested areas is not effective. It traps more post-larvae than juveniles (less than 15 mm size), making picking and sorting difficult.

<<

- *Dragnet:* Locally known as Kovalai or Kondavalai, this gear is operated by two persons in the deeper muddy zones. It traps more of advanced juveniles (40-60 mm size). The operation of this gear in the shallow sandy zone where more larvae and juveniles are available is limited. The operation interferes with local fishing.

- *Castnet:* The castnet (15 mm mesh) is used to collect advanced juveniles (40-70 mm size) which can be stocked directly in the pens. Since the number available is low, more effort has to be spent on collection. Collection with this gear also interferes with local fishing.

- *Pushnot:* Designed by BOB P, this bagnet has a wide mouth and narrow pursed tail portion. The front portion is made of a semi-circular stainless steel rod fitted with a flat wooden plank to which the wide-mouth portion is mounted by tying with nylon ropes. One man can push this gear on the shallow sandy vegetative zone efficiently. This is most suited for operation in the weed infested zone and traps more juveniles of 15-40 mm size (early juveniles to juveniles). The seeds required for rearing in 16 p velon cages are collected in the push net operation. Of the two people engaged for collection, one can operate the gear and another person can segregate the seeds and store them in the storage cage.

Shrimp seed species:

The shrimp seeds available in this area are: *P. indicus, P. semisulcatus, P. merguiensis, M. monoceros, M dobsonii, M. brevicornis and Macrobrachium* spp. Most of the shrimp seeds are available in the vegetative shallow sandy zones.

P. indicus seeds are available in varied numbers throughout the year. There are two peak periods of occurrence in the Killai area, noticed for both *P. indicus* and *P. monodon.* The primary peak season is during January-February, comprising 80 per cent *P. indicus* and 10 per cent *P. monodon* (in the total shrimp seed collection). The secondary peak is noticed during July-August consisting of 60 per cent *P. indicus* and 4 per cent *P. monodon.* Both *P. semisulcatus* and *P. Merguiensis* appear in the collection between May and July.

Collection

Time of collection: The most opportune time for collection is early in the morning or in the evening when the temperature is not high. *P.indicus* seeds are not resistant to high temperature. More seeds are available when the tide starts rising and when there is wind. Collection in windy weather affects the shrimps, since it chokes the gills — at times seeds die.

Collection and segregation: In pushnet collection, seeds are trapped along with weeds. Therefore seeds have to be segregated from weeds and counted species-wise and temporarily kept in storage cages (2 x 1 × m size cage) — 2,000 to a cage — before transporting them to the rearing/nursing cage at farm site. The seeds with weeds are placed over a velon piece or black plastic sheet for easy segregation. The smaller seeds of 10-30 mm size can be scooped from the storage cage by a scoop net and transferred to the round tin carrier — 2,000 per tin — for short distances (30-40 minutes travel by canoe). If they are to be transported from a longer distance, the temperature can be reduced to 20° by adding ice. If there are any signs of distress — e.g., coming to the surface or jumping — then water from the tin should be removed and freshwater from the river added. The shrimp seeds are counted and then transferred to the rearing cage kept at farm site.

Nursing of shrimps

The shrimp seeds *(P. indicus, P. monodon, and P. merguiensis)* are collected from the Killai backwaters using pushnet. The shrimp seeds collected in pushnets are of 15-40 mm size (av. wt. 0.25 g). The seeds cannot be released directly into the pens, because the seeds are small and can escape through the meshes. To overcome this problem, the smaller seeds are reared in nursery pens and nursery cages before releasing them into the growout pens.

During the previous project phase, shrimp seeds were reared in nursery pens and nursery cages. The survival rate was low (50 per cent), and retrieval was incomplete in nursery pens, whereas

the survival was high (80 per cent) and retrieval was high in cages. Therefore cages are used for rearing seeds in the new project.

Very small shrimp seeds (10 mm size) are reared in 40 p cages, 15-20 mm size are reared in 30 p cages, 20-40 mm size are reared in 16 p cages. Since the water level rises above 1 m, the height of the cages is raised from 1 m to 1.5 m and the cages are not covered at the top. The cages are fixed at the soil level by stick anchors to prevent crab cuts at the bottom and the side of the cage and to provide a natural environment. A slight attraction is made in the cages so that shrimp seeds can be removed easily. The velon portion is replaced by 10 mm mesh nylon webbing (2x2 m portion) at the bottom centre of the cage. This enables quick sieving of the mud inside the cage and easy removal of shrimp seeds when they have to be released from the cage into the pen.

The shrimp seeds collected from the wild are reared in cages (4000 seeds in 40 m^2 cages at 10 lakh/ha stocking density). The shrimp seeds are fed with shrimp head, squilla, crabs and chankflesh in cages. For the first 10 days they were fed at 200per cent of their initial body weight, between the 11th and 20th day at 100 per cent of their initial body weight and between the 21st and 30th day at 50 per cent of their initial body weight.

The average weight of shrimp seed	=	0.25 g
Wt. of 4,000 seeds ==4,000 xO.25 g		1.000 kg
200% of the body weight	==	**2.000 kg**
100%	=	1.000 kg
50%	=	0.500 kg

Feed requirement

Days xweight of feed		total
10x2 kg		20 kg
10x1 kg	=	10 kg
10 0.5 kg	=	**5** kg
		35 kg

MaIntenance of nursery cages

Important points to be noted and out during cage rearing:

— Clogging of cages may prevent exchange of water. To improve water exchange the sides have to be cleaned once a week, more often if needed.

—The soil below the cages has to be checked; if it has blackened giving out a rotten egg smell the seeds have to be transferred to cages fixed in another area.

—Owing to hydrogen suiphide formation at the bottom and lack of water exchange by clogging, oxygen depletion may cause mortality. Should this happen, the seeds will be seen at the surface, showing signs of distress by jumping movements. In this event, the seeds have to be transferred to a clean cage fixed in a new place.

—The salinity has to be recorded daily. Usually, the smaller shrimps are able to adjust to the sudden fall in salinity and do not die in low salinity conditions.

—The sides of the cage have to be checked for crab cuts, and any cuts have to be mended.

— During very high water periods, the position of the cages (height) has to be adjusted to avoid submerging the top portion of the cages.

<<

Pests and control gear

A new system of growing shrimps in pens has bee;i developed in the Kiiiai backwaters. When the pen enclosure is laid, fish and wild shrimps get trapped inside the pen. Some of the fish directly prey upon the shrimps and some (fish, crabs, prawns) may affect their food availability indirectly. The fish seeds ard prawn seeds may also enter through the pen wall meshes and grow along with the cultured shrimps. Various methods are adopted for pre-stock pest removal.

Pest removal gear a'nd mcthrids: The following gear/methods are deployed to remove the fish, crabs and wild shrimp during pre-stock removal operation and during the culture operation.

— *Castnet:* During pie-stock operation the fish, shrimps and crabs (which are not of the culturable variety) are caught by castnet.

—*Dragnet.'* The dragnet is used in the pro-stock operation. Except burrowing fish and crabs all the pelagic fish and wild shrimps are removed by this gear. More men are needed for operating this net.

— *Trammel net.* The trammel not was dragged during pre—stock removal. The bigger pelagic predatory fish (johnius, tachysurus, epinephelos, elops and so on) and shrimps were caught by this net.

—*Crab trap:* It is made of an iron ring with HDPE webbing and marked by a float. During the culture period, cr3bs can be caught with this.

—*Set gil/net:* it is an efficient gear for the capture of demersal fish and crabs; especially most of the platycephalus are caught by this net during pre-stock removal and during the first month of the culture operation.

—*Hand line:* This gear is very efficient in catching marine eels (burrowers). The hook with fish bait is thrown into the water till it is swallowed by the eel, then a jerking pull of the rope hooks the fish. A very efficient method to capture eels during shrimp culture.

—*Hand picking:* Veddars (tribal people) are able to catch the pelagic fish, burrowing fish, wild shrimp and crabs by hand during the pre-stock removal operation; they can catch fish during the culture period.

Pen stocking

The most important phase in the pen shrimp culture operation is the stocking of desirable fast-growing species at the appropriate time and in the optimum density.

Species.' P. indicus (white prawn) and *P. monodon* (tiger prawn) are the two desirable species for stocking in pens. *P. monodon* grows faster than *P. indicus* in this culture system. *P. monodon* seeds are scarcely available in Killai backwaters. The *P. monodon* that are collected could be stocked with *P. indicus.*

Stocking density: Stocking is manipulated to utilize food and space in the culture system. The stocking density depends upon the species stocked, the size of the seed, expected yield and other management practices such as type of feed and duration of culture.

Stocking of 40,000 to 50,000 seeds/ha of *P. indicus* (white prawn) or 30,000—35,000/ha of *P. monodon* (tiger prawn) is found to be the optimum density in pens.

Time of stocking: Though stocking can be done both at dawn and at dusk, the early morning hours (between 6 and 9) are preferable.

Method of stocking: Rcmoving sccd from cages.' Cages should be lifted carefully; the sediment settled at the bottom of the cages is sieved through the nylon webbing attached at the bottom (middle portion). During this operation, the water may become very turbid. Therefore the entire cage with the seed is slowly dragged 10 metres away to obviate any possible stress to the seeds. Finally the cages are folded and the seeds scooped out by means of a scoop net.

<<

— *Transfer of seeds from cages to growout pens.'* In the usual practice 300-400 seeds are scooped out and carried to the pens in buckets. This practice can be resorted to if the pens are nearby. Otherwise seeds have to be tansferred by means of a canoe using a scoop net and tin carriers.

Releasing the seed: Prawn seeds are counted before they are released into the pens. It is preferable to release the seeds at different places close to the pen wall. This helps the seed to cling to the pen wa!l and move slowly to the deeper area.

— *Counting the seed:* The total number of seed stocked in the pen should be counted carefully. Otherwise it could lead to understocking or overstocking.

— *Sampling the seed at the time of stocking:* If the seeds are stocked from different cages, a random sample of 100 from each cage should be taken and the initial average size and weight recorded.

Growth monitoring, feed calculation, water quality monitoring and pen maintenance

Growth monitoring: The shrimps are grown in pens with supplementary feed. Fortnightly samplings of shrimps are taken to regulate the feeding rate, for monitoring the growth and to know the feeding condition. Crab cuts in the nylon webbing have to be mended. Barnacles settle on the posts, and if allowed to grow for long they damage the webbing by rubbing due to wind action.

During the first month of rearing, the castnet (15 mm mesh) was used to catch the shrimps for measurements. The length of the shrimp is measured in mm from the tip of the rostrum to the tip of the telson. A hundred shrimps are weighed to determine the average weight. The average length and weight of the shrimp are recorded to know the proportionate increase in length and weight. Sometimes a linear increase may be noticed but the fattening may be less. If this happens, the feeding pattern has to be changed to include more fat in the supplementary feed. During the second and third months of rearing, castnets (15 mm and 30 mm mesh) are used to catch both small and big shrimps for measurement. If 10 to 20 shrimps are caught with each casting, the survival is understood to be better.

There is a difference between shrimp rearing in ponds and in pens. In pens, shrimps have to depend on natural productivity and supplementary feed. Also, since pests interfere with the culture, a higher percentage of feed has to be given to pen shrimps.

Feed calculation.' The feed for the fortnight is calculated on the observed weight of shrimps @ 10% of body weight:

Weight of 100 shrimps	500 g
Average weight	5 g
Total weight of 9,000 shrimps	45.000 kg
10% of boiy weight	4.500 kg
Morning 5% of body weight	2.250 kg pellet
Evening 5% of body weight	11.250 kg prawn head*

Water quality monitoring.' The salinity is recorded daily to monitor the environment condition. Sudden fall in salinity (to less than 5 ppt) due to heavy influx of fresh water is lethal to bigger shrimps (both *P. monodon* and *P. indicus).* If such a sudden fall in salinity occurs, the shrimp must be harvested immediately. Dissolved oxygen in the pen was also recorded once a weekS Oxygen depletion is normally not a problem in pen culture owing to continuous water exchange through the pen walls. However, hydrogen sulphide may form in the bottom mud owing to the accumulation of organic matter (dead algae, uneaten food etc.)

* 1 kg of prawn head contains only 200 g of flesh. So 5 kg of prawn has to be taken to get 1 kg flesh content (2.250x5=11.250).

<<

Pen maintenance.' The crab (Scylla serrata) cuts the pen wall webbings. The most vulnerable portion (up to 50 cm above the soil) is reinforced with 25 mm mesh HDPE webbing, which the crab cannot cut. However, the crab cuts above the reinforced portion on the nylon webbing have to be checked and mended daily. Barnacles settle heavily on the casuarina posts, which in turn damage the webbing by rubbing. The barnacles have to be removed with knives.

Normally the pen wall below the soil does not get uprooted. In the water movement area, the top soil may be washed away, thus the foot rope may be lifted. In such an event, additional HOPE webbing can be used at the top and the pen wall can be pressed further down into the soil. If the foot rope is lifted by heavy wind action, stick anchors have to be tied to the foot rope and pressed into the soil. As the position of the pen wall may be affected by a heavy wind, a stay post is fixed near the pen wall to hold it up in a straight position with HOPE ropes tied to the stay post and the pen wall post.

Feed formulation: Feed is the most important prerequisite for the culture of prawn seed in nursery cages and their subsequent culture in growout pens to marketable size. Different types of dry and wet feed have been identified for rearing larvae, juveniles and adults.

Plant origin.' Rice bran, groundnut oil cake and tapioca flour are the three important plant materials used as prawn feed and binder.

Rice bran: Deoiled rice bran could be procured from the nearby modern rice mill at Sembonar-koil. During the peak paddy hulling season locally available (local rice mill) rice bran also can be procured at a cheaper cost and stored for nearly six months.

Groundnut oil cake: The nearest sources for this material are Chidambaram and Cuddalore. During the peak crushing season this material can be procured at a reasonable price from any one of the oil mills at Cuddalore. This material cannot be stored for more than three months.

Tapioca flour.' This material is procured from Sabari Industries at Pondicherry. Possibilities of procuring this material from Athur and Salem at a cheaper cost should be explored.

Animal origin: Dried crabs, squilla, and squid offal can be procured from Pazhayar fishing harbour.

Wet feed: Wet feed such as squid offal, crab, squilla, prawn heads and trash fish can be procured from Porto Novo also but Porto Novo is not a dependable source.

Pelleted feed.' At present Tata Oil Mills Ltd. is the only commercial producer of pelleted feed for shrimp in India. Tata pellets can be procured from the Madras branch of Tata Oil Mills. It costs Rs. 4.50 per kg.

Pellet composition.' Four main ingredients such as squid offal, deoiled rice bran, groundnut oil cake and tapioca flour are included for sepcific reasons. Squid offal is a source of animal protein, groundnut oil cake is a source of vegetable protein and lipids (fats). Deoiled rice bran is a source of carbohydrate, protein and fibre, and tapioca flour serves as an effective binding agent and carbohydrate.

The percentage composition of the ingredients used for pellet production is as follows:

Squid offal 40%
Deoiled rice bran 35%
Groundnut oil cake 10%
Tapioca flour 10%
Water 5%

Pellet production: Boiling and mincing: Squid offal is boiled and minced thoroughly.

—Soaking of groundnut oil cake: groundnut oil cake is soaked in 5 per cent water.

— Binder preparation: One part of tapioca flour is dissolved in 3 parts of water. Water used for boiling squid offal can be reused for binder preparation as this water has a nutritive value.

<<

A glue-like substance is prepared by boiling and stirring the liquid in an iron pan over a low fire.

- Mixing of ingredients: boiled and minced squid offal, soaked groundnut oil cake, rice bran powder, and tapioca glue are put together and mixed thoroughly manually. A wet dough is prepared.
- Pelletization: the wet dough feed is finally pressed through a die in the feed mincer.
- Drying: the pellets are collected and dried in the sun.

The size of the farm produced pellets is 5 mm (diameter). This size can be better utilized by an adult shrimp than a juvenile shrimp. With the existing facilities, pellet size and water stability cannot be improved. Therefore use of machines like pulverizer, mixer and pelletizer is unavoidable in future.

Pellet storage.' Proper storage of feed is very important. Improper storage leads to weight loss, deterioration of quality and health risks. During storage the pellets are subjected to attack by insects, rodents (rats) and mould. But the problem can be effectively controlled thus: Stirring the pellets properly in plastic bins keeps them safe from insects ;storing the pellets in polythene-lined gunny bags keeps them from moulding; and storing the bags in a *pukka* store room preserves them from attack by rodents.

Harvest techniques.' The economics of the pen shrimp culture operation depend upon the quality and quantity of shrimp harvested from pens. Better harvesting techniques are important for the maximum removal of marketable shrimps.

Methods of harvest

The chief methods of harvest are castnetting, castnet-cum-trammel netting, dragnetting and hand picking.

- *Castnettinçj:* Is found to be an effective method of harvesting shrimp from pens. During the low tide one can easily wade through the water and do the castnetting in the deeper area of the pens.
- *Cast net-cum-trammel netting.'* A trammel net is laid across a pen and castnetting is done on either side of the pen. This method helps to improve gear efficiency (cast net) by reducing the area of operation. Trammel net serves as a gillnet. Big shrimps which try to escape from one side to another side of the trammel net get entangled.
- *Luring of shrimp by feeding.'* Two hours before harvest the feed is given in split doses on the shoreward sandy area. A trammel net is laid across to prevent the escape of shrimps to the deeper area. As shrimp congregate towards the shore, they can be caught very easily by cast net.
- *Dragnetting:* Is found effective in harvesting more metapenaeids than penaeids. In view of the many labour requirements and poor efficiency in catching stocked prawns, dragnetting was given up.
- *Hand picking of shrimps by Veddars:* Is a traditional and most effective method of shrimp harvest. The Veddars walk in rows and pick up everything that passes them; hardly anyhting is left in the pens.

Publications of the Bay of Bengal Programme (BOBP)

The BOBP brings Out Six types of publications:

Reports (BOBP/REP/....) describe and analyze completed activities such as seminars, annual meetings of BOBP's Advisory Committee, and projects in member-countries for which BOBP inputs have ended.

Working Papers (BOBP/WP/.. .) are progress reports that discuss the findings of ongoing BOBP work.

Manuals and Guides (BOBP/MAG/.. .) are instructional documents for specific audiences.

Miscellaneous Papers (BOBP/MIS/.. .) concern work not originated by BOBP — but which is relevant to the Programme's objectives.

Information Documents (BOBP/INF...) are bibliographies and descriptive documents on the fisheries of member-countries in the region.

Newsletters (Bay of Bengal Xews), issued quarterly, contain illustrated articles and features in non-technical style on BOBP work and related subjects.

A list of publications follows.

Reports (BOBP/REP/...)

1. Report of the First Meeting of tise Advisory Committee. Colombo, Sri Lanka, 28—29 October 1976. (Published as Appendix 1 of IOFCfDEV/78/44. 1, FAQ, Rome, 1978)
2. Report of the Second Meeting of the Advisory Committee. Madras, India, 29—30 June 1977. (Published as Appendix 2 of IOFC/DEV/78/44.1, FAQ, Rome, 1978)
3. Report of the Third Meeting of the Advisory Committee. Chittagong, Bangladesh, 1—10 November 1978 Colombo, Sri Lanka, 1978. (Reissued Madras, India, September 1980)
4. Role of Women in Small-Scale Fisheries of the Bay of Bengal. Madras, India, October 1980.
5. Report of the Workshop on Social Feasibility in Small-Scale Fisheries Development. Madras, India, 3—8 September 1979. Madras, India, April 1980.
6. Report of the Workshop on Extension Service Requirements in Small-Scale Fisheries. Colombo, Sri Lanka, 8—12 October 1979. Madras, India, June 1980.
7. Report of the Fourth Meeting of the Advisory Committee. Phuket, Thailand, 2 7—30 November 1979. Madras, India, February 1980.
8. Pre-Feasibility Study of a Floating Fish Receiving and Distribution Unit for Dubla Char, Bangladesh. G. Eddie, M. T. Nathan. Madras, India, April 1980.
9. Report of the Training Course for Fish Marketing Personnel of Tamil Nadu. Madras, India, 3—14 December 1979. Madras, India, September 1980.

10.1 Report of the Consultation on Stock Assessment for Small-Scale Fisheries in the Bay of Bengal. Chittagong, Bangladesh, 16—21 June 1980. Volume 1: Proceedings. Madras, India, September 1980.

10.2 Report of the Consultation on Stock Assessment for Small-Scale Fisheries in the Bay of Bengal. Chittagong, Bangladesh, 16—21 June 1980. Volume 2: Papers. Madras, India, October 1980.

11. Report of the Fifth Meeting of the Advisory Committee. Penang, Malaysia, 4—7 November 1900. Madras, India,January 1981.
12. Report of the Training Course for Fish Marketing Personnel of Andhra Pradesh. Hyderabad, India, 11—26 November 1980. Madras, India, Septensber 1981.
13. Report of the Sixth Meeting of the Advisory Committee. Colombo, Sri Lanka, 1—5 December 1981. Madras, India, February 1982.
14. Report of the First Phase of the "Aquaculture Demonstration for Small-Scale Fisheries Development Project" in Phang Nga Province, Thailand. Madras, India, March 1982.
15. Report of the Consultation-cum-Workshop on Development of Activities for Improvement of Coastal Fishing Families. Dacca, Bangladesh, October 27—November 6, 1981. Madras, India, May 1982.
16. Report of the Seventh Meeting of the Advisory Committee. New Delhi, India, January 17—21, 1983. Madras, India, March 1983.
17. Report of Investigations to Improve the Kattumararn of' India's East Coast. Madras, India, July 1984.
18. Motorization of Country Craft, Bangladesh. Madras, India, July 1984.
19. Report of the Eighth Meeting of the Advisory Committee. Dhaka, Bangladesh, January 16—19, 1984. Madras, India, May 1984.

<<

20. Coastal Aquaculture Project for Shrimp and Finfish in Ban Merbok, Kedah, Malaysia. Madras, India, December 1984.

21. Income-Earning Activities for Women from Fishing Communities in Sri Lanka. Edeltraud Drewes. Madras, India, September 1985.

22. Report of the Ninth Meeting of the Advisory Committee. Bangkok, Thailand, February 25—26, 1985. Madras, India, May 1985.

23. Summary Report of BOBP Fishing Trials and Demersal Resources Studies in Sri Lanka. Madras, India, March 1986.

24. Fisherwomen's Activities in Bangladesh: A Participatory Approach to Development. Patchanee Natpracha. Madras, India, May 1986.

25. Attempts to Stimulate Development Activities in Fishing Communities of Adirampattinam, India. Patchanee Natpracha, V.L.C. Pietersz. Madras, India, May 1986.

26. Report of the Tenth Meeting of the Advisory Committee. Male, Maldives. 17—18 February 1986. Madras, India, April 1986.

27. Activating Fisherwomen for Development through Trained Link Workers in Tamil Nadu, India. Edeltraud Drewes. Madras, India, May 1986.

28. Small-Scale Aquaculture Development Project in South Thailand: Results and Impact. E. Drewes. Madras, India, May 1986.

29. Towards Shared Learning: An Approach to Non-formal Adult Education for Marine Fisherfolk of Tamil Nadu, India. L. S. Saraswathi and Patchanee Natpracha. Madras, India, July 1986.

30. Summary Report of Fishing Trials with Large-Mesh Driftnets in Bangladesh. Madras, India, May 1986.

31. In-Service Training Programme for Marine Fisheries Extension Officers of Orissa, India. U. Tietze. Madras, India, August 1986.

34. The Coastal Set Bagnet Fishery of Bangladesh—Fishing Trials and Investigations. SE. Akerman. Madras, India, November 1986.

35. Brackishwater Shrimp Culture Demonstration in Bangladesh. M. Karim. Madras, rndia, January 1987.

37. High-opening Bottom Trawling in Tamil Nadu, Gujarat and Orissa, India: A Summary of Effort and Impact. Madras, India, February 1987.

Working Papers (BOBP/WP/....)

1. Investment Reduction and Increase in Service Life of Kattumaram Logs. R. Balan. Madras, India, February 1980.

2. Inventory of Kattumarams and their Fishing Gear in Andhra Pradesh and Tamil Nadu. T. R. Menon. Madras, India, October 1980.

3. Improvement of Large-Mesh Driftnets for Small-Scale Fisheries in Sri Lanka, G. Pajot. Madras, India, June 1980.

4. Inboard Motorisation of Small **G.R.P. Boats in Sri Lanka. Madras, India, September 1980.**

5. Improvement of Large-Mesh Driftnets for Small-Scale Fisheries in Bangladesh. **G. Pajot. Madras, India, September 1980.**

6 **Fishing Trials with Bottom-Set Longlines in Sri Lanka. G. Pajot, K. T. Weerasooriya. Madras, India, September 1980.**

7. Technical Trials of Beachcraft Prototypes in India. 0. Gulbrandsen, G. P. Gowing, R. Ravikumar. Madras, India, October 1980.

.8. Current Knowledge of Fisheries Resources in the Shelf Area of the Bay of Bengal. B. T. Antony Raja. Madras, India, September 1980.

9. Boatbuilding Materials for Small-Scale Fisheries in India. Madras, India, October 1980.

10. Fishing Trials with High-Opening Bottom Trawls in Tamil Nadu, India, G. Pajot, John Crockett. Madras, India, October 1980.

11. The Possibilities for Technical Cooperation between Developing Countries (TCDC) in Fisheries. E. H. Nichols. Madras, India, August 1981.

12. Trials in Bangladesh of Large-Mesh Drfftnets of Light Construction. G. Pajot, T. K. Das. Madras, India, October 1981.

13. Trials of Two-Boat Bottom Trawling in Bangladesh. G. Pajot, J. Crockett. Madras, India, October 1982.

44. Three Fishing Villages in Tamil Nadu. Edeltraud Drewes. Madras, India, February 1982.

15. Pilot Survey of Driftnet Fisheries in Bangladesh. M. Bergstrom. Madras, India, May 1982.

&6. Further Trials with Bottom Longlines in Sri Lanka. Madras, India, July 1982.

<<

17. Exploration of the Possibilities of Coastal Aquaculture Development in Andhra Pradesh. Soleh Samsi, Sihas Sircgar and Martono. Madras, India, September 1982.

18. Review of Brackishwater Aquaculture Development in Tamil Nadu. Kasemsant Chalayondeja and Anant Saraya. Madras, India, August 1982.

19. Coastal Village Development in Four Fishing Communities of Adirampattinam, Tamil Nadu, India. F. W. Blase. Madras, India, December 1982.

20. Further Trials of Mechanized Trawling for Food Fish in Tami] Nadu. G. Pajot,J. Crockett, S. Pandurangan, P. V. Ramamoorthy. Madras, India. December 1982.

21. Improved Deck Machinery and Layout for Small Coastal Trawlers. G. Pajot, J. Crockett, S. Pandurangan and P. V. Ramamoorthy. Madras, India, June 1983.

22. The Impart of Management Training on the Performance of Marketing Officers in State Fisheries Corporatiofls. U. Tietze. Madras, India, June 1983.

23. Review of Experiences with and Present Knowledge about Fish Aggregating Devices, M. Bergstrom. Madras, India, November 1983.

24. Traditional Marine Fishing Craft and Gear of Orissa. P. Mohapatra. Madras, India, April 1986.

25. Fishing Craft Development in Kcrala: Evaluation Report. 0. Gulbrandseis. Madras, India, June 1984.

26. Commercial Evaluation of IND-13 Beachcraft at Uppada, India. R. Ravikumar. Madras, India, June 1984.

27. Reducing Fuel Costs of Small Fishing Boats- 0. Gulbrandscn. Madras, India, July 1986.

28. Fishing Trials with Small-Mesh Driftnets in Bangladesh. G. Pajot and T. K. Das. Madras, India, March 1984.

29. Artisanal Marine Fisheries of Orissa: a Techno-Demographic Study. M. H. Kalavathy and U Tietze. Madras, India, December 1984.

30. Mackerels in the Malacca Straits. Colombo, Sri Lanka, February 1985.

31. Tuna Fishery in the EEZs of India, Maldives and Sri Lanka. Colombo, Sri Lanka, February 1985.

32. Pen Culture of Shrimp in the Backwaters of Killai, Tami] Nadu: A Study of Techno-economic and Social Feasibility. Rathindra Nath Roy, Madras, India, January 1985,

33. Factors that Influence the Role and Status of Fisher-women. Karuna Anbarasan. Madras, India, April 1985.

34. Pilot Survey of Set Bagnet Fisheries of Bangladesh. Abul Kashens. Madras, India, August 1985.

35. Pen Culture of Shrimp in the Backwaters of Killai, Tamil Nadu. M. Karim and S. Victor Chandra Bose. Madras, India, May 1985.

36. Marine Fishery Resources of the Bay of Bengal. K. Sivasubramaniam. Colombo, Sri Lanka, October 1985.

37. A Review of the Biology and Fisheries of *Hilsa ilisha* in the Upper Bay of Bengal. B. T. Antony Raja. Colombo, Sri Lanka, October 1985.

38. Credit for Fisherfolk: The Experience in Adirampattinam, Tamil Nadu, India. R. S. Anbarasan and Ossie Fernandez. Madras, India, March 1986.

39. The Organization of Fish Marketing in Madras Fishing Harbour. M. H. Kalavathy. Madras, India, September 1985.

40. Promotion of Bottom Set Longlining in Sri Lanka. K. T. Weerasooriya, S. S. C. Pieris, M. Fonseka. Madras, India, August 1985.

41. The Demersa] Fisheries of Sri Lanka. K. Sivasubrarnaniam and R. Maldeniya. Madras, India, December 1985.

42. Fish Trap Trials in Sri Lanka. (Based on a report by T. 1Iarnmerman). Madras, India, January 1986.

43. Demonstration of Simple Hatchery Technology for Prawns in Sri Lanka. Madras, India, June 1986.

44. Pivoting Engine Installation for Bcachlanding Boats. A. Overa, R. Ravikunsar. Madras, India, June 1986.

45. Further Development of Beachianding Craft in India and Sri Lanka. A. Overa, R. Ravikumar, 0. Gulbrandsen, G. Gowing. Madras, India, July 1986.

46. Experimental Shrimp Farming in Ponds in Polekurru, Andhra Pradesh, India. J. A. J. Janssen, T. Radhakrishna Murthy, B. V. Raghavulu, V. Srcekrishna. Madras, India, July 1986.

47. Growth and Mortality of the Malaysian Cockle *(Anaa'ara Granosa)* under Commercial Culture: Analysis through Length-Frequency Data. Ng Fong Oon. Madras, India, July 1986.

48. Fishing Trials with High-Opening Bottom Trawls from Chandipur, Orissa, India. G. Pajot and B. B. Mohapatra. Madras, India, November 1986.

49, Pen Culture of Shrimp by Fisherfolk: The BOBP Experience in Killai, Tamil Nadu, India. Madras, India, April 1987.

<<

50. Experiences with a Manually Operated Net-Braiding Machine in Bangladesh. B-C. Gillgren. Madras, India, November 1986.

51. Hauling Devices for Beachlanding Craft. A. Overa, P. A. Hemminghyth. Madras, India, August 1986.

53. Atlas of Deep Water Demersal Fishery Resources in the Bay of Bengal. T. Nishida and K. Sivasubramaruam. Colombo, Sri Lanka, September 1936.

54. Experiences with Fish Aggregating Devices in Sri Lanka. K.T. Weerasooriya. Madras, India, January 1987.

Manuals and Guides (BOBP/MAG/. ...)

I. Towards Shared Learning: Non-formal Adult Education for Marine Fisherfolk. Trainers' Manual. Madras, India, June 1985.

2. Towards Shared Learning: Non-formal Adult Education for Marine Fisherfolk. Animators' Guide. Madras, India, June 1985.

3. Fishery Statistics on the Microcomputer: A BASIC Version of Hasselbiad's NORMSEP Program. D. Pauly, N. David, J. Hertel-Wuiff. Colombo, Sri Lanka, June 1986.

Miscellaneous Papers (BOBP/MIS/.. . -)

1. Fishermen's Cooperatives in Kerala: A Critique. John Kurien. Madras, India, October 1980.

2. Consultation on Social Feasibility of Coastal Aquaculture. Madras, India, 26 November—I December 1984. Madras, India, November 1985.

3. Studies on Mesh Selectivity and Performance: the New Fish-cum-Prawn Trawl at Pesalai, Sri Lanka, M.S.M. Siddeek. Madras, India, September 1986.

4. Motorization of Dinghy Boats in Kasafal, Orissa. S. Johansen and 0. Gulbrandsen Madras, India, November 1986.

Information Documents (BOBP/LVF/.. .

I. Women and Rural Development in the Bay of Bengal Region: Information Sources. Madras, India, February 1982.

2. Fish Aggregation Devices: Information Sources. Madras, India, February 1982.

3. Marine Small-Scale Fisheries of India: A General Description. Madras, India, March 1983.

4. Marine Small-Scale Fisheries of Andhra Pradesh: A General Description. Madras, India, June 1983.

5. Marine Small-Scale Fisheries of Tamil Nadu: A General Description. Madras, India, December 1983.

6. Marine Small-Scale Fisheries of Sri Lanka: A General Description. Madras, India, November 1984.

7. Marine Small-Scale Fisheries of Orissa: A General Description. Madras, India, December 1984.

8. Marine Small-Scale Fisheries of Bangladesh: A General Description. Madras, India, September 1985.

9. Food and Nutrition Status of Small-Scale Fisherfolk in India's East Coast States: A Desk Review and Resource Investigation. V. Bhavani. Madras, India, April 1986.

Newsletters (Bay of Bengal News):

25 issues quarterly from January 1981 to March 1987.

Published by the Bay of Bengal Programme, FAO, 91, St. Mary's Road, Abhiramapuram, Madras 600 018, India. Printed atAmra Press, Madras 600 041.

<<