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PROSPECTS OF PRAWN CULTURE IN SALT PAN AREAS

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Introduction

The Central Marine Fisheries Research Institute has been undertaking several investigations in recent years to improve the existing aquaculture practices in the country, and has evolved new indigenous techniques for farming prawn on modern scientific lines. One of the major objectives of the Institute is to disseminate the findings at different levels through extension services. The present work is one such contribution. An awareness has recently been created along the southeast coast of Tamil Nadu for the utilisation of saline fallow coastal lands including salt pan areas for culture practices. The land and water in the low lying areas adjacent to salt pan areas along the coast of Gulf of Mannar between Pinnakayal in the south and Valinokkam in the north, have been assessed for their suitability for prawn farming.

Based on the resource potentials, Nair *et al.* (1974) have observed the possibilities of marine fish and prawn culture in salt pan areas at Tuticorin. Suseelan (1975) reported on the prawn culture practices in salt pan reservoirs of Cape Comorin region. A number of published accounts of seed resources and culture of prawns in salt pan areas are available now (Rao and Narasimham, 1978; Mohamed *et al.*, 1980; Marichamy and Rajapackiyam, 1982; Victor and Venkatesan, 1982). Information on the preliminary experiments in semi-intensive culture of prawns in salt pan areas at Veppalodai has been presented elsewhere (Marichamy, 1986). Several improvements have been made subsequently to enhance the production potential under intensive culture system and the present account describes the various aspects including the strategies evolved and economics of this profitable venture, highlighting the prospects of prawn culture in high saline waters.

Location, construction and preparation of ponds

About 800 hectares of land on the northern side of Kallar river are used as salt pans by M/s Veppalodai Salt Corporation at Veppalodai, north of Tuticorin in Chidambaranar District, Tamil Nadu. The salt pan reservoirs support a variety of fish and prawn resources. Water and soil characteristics are suitable for culture practices within the factory area but the major constraint is predation by migratory birds as the depth of water in the ponds is very low. In addition to this, predatory crabs and snakes present in the surrounding water logged area enter the reservoirs. Another factor for not considering the existing ponds for culture is that the addition of inorganic or organic fertilizers for raising plankton bloom in intensive culture practices, may affect the quality of salt produced. Considering all these factors a new site adjacent to the salt industry was developed exclusively for prawn farming. Soon after completing the preliminary experimental culture in a limited area, 3.3 ha of derelict land on the southern side of the river was converted into ponds for intensive prawn farming. Full advantage of the existing natural conditions was taken while preparing the lay-out for the farm. The ponds are located 50 m away from the main river. The mud excavated from the draining trenches and catching pit of the rearing ponds was used for raising bunds without scraping the top fertile soil too much. The bottom of the ponds was levelled by a tractor. Gradient slope was given towards the catching pit and draining sluices. The ponds were ploughed well for making the soil soft to promote algal development. Ponds are rectangular in size and provided with three inlets and three outlets of PVC pipe of 30 cm diameter in the bunds of opposite sides. At the western end, one 5 HP motor with a specially designed Vedaranyam type of pump set (with the motor kept at a higher level than the pump and a delivery pipe of 25 cm diameter),

having a high rate of pumping efficiency was fitted and this was sufficient to meet the water requirements for three ponds of the area of 2 ha. On the eastern side, a separate 5 HP oil engine was used to feed water for two ponds of the area of 1.3 ha. Since the ponds are constructed at an elevated place, water is lifted from the creek to a height of 2.5 m. This arrangement helps to drain the ponds perfectly at the time of harvesting. The system further helps for sun drying/baking the ponds so that all organic matter is completely oxidized. The sea water was properly screened and the entry of major organisms was prevented by fitting fine meshed velon screens at the inlets and outlets of the pumps. An average water depth of 0.4–0.7 m, was maintained in the rearing ponds. Lime treatment was not made since the soil pH was optimal at 7.5. After completing the tilling works, organic manure (dried poultry dung or cow dung) was spread in the ponds at the rate of 750 kg/ha. Water level was gradually increased and the development of bloom of phytoplankters or 'green water' was noticed on the fourth day after fertilization. The common nanoplankters were, *Synechocystis, Nanochloris* and *Chlorella* spp. The phytoflagellates were *Chlamydomonas* spp. and *Platymonas*. The benthic diatoms such as *Pleurosigma, Navicula, Mastogloia, Amphora* and *Oscillatoria salinarum* were also seen.

Culture experiments and stocking operation

The culture experiments were designed according to the availability of natural seed. February-May and August–October are the best periods for maximum collection of seed of *Penaeus indicus* from this region. The first set of culture experiments was carried out in one hectare area during August, 1985-January, 1986 and the second set during February, 1986-August/October 1986. The second crop normally covers longer period due to high salinity and slow rate of growth. A short interval of 20–25 days are available in between the culture experiments for preparing the ponds for subsequent stocking.

Table 1. *The results of culture experiments for* P. indicus

Particulars	Ponds			
	1	2	3	4
Size of ponds (m)	116.2 x 44.8	151.8 x 62.4	143.7 x 63.6	128.1 x 28.5
Area of ponds (ha)	0.5205	0.9472	0.9139	0.3677
Average water depth (m)	0.7	0.5	0.4	0.4
Date of stocking	1–3–1986	20–2–1986	25–3–1986	1–4–1986
Date of harvest	10–10–1986	10–10–1986	13–9–1986	13–9–1986
Days of culture	224	232	172	166
Size at stocking (mm)	22	15	25	25
Size at harvest (mm/g)	123.5/13.2	116/11	106/8	108/8.2
Rate of growth (mm/g/month)	13.6/1.7	14.4/1.4	14.1/1.4	15/1.5
No. of prawn seed stocked	66,500	1,15,000	1,35,000	55,000
Rate of stocking (per ha)	1,27,762	1,21,410	1,47,718	1,49,578
No. of prawn harvested	63,460	1,06,380	1,00,625	40,260
Percentage of survival	95.4	92.5	74.5	73.2
Total production (kg)	835	1,169	805	330
Rate of production(kg/ha/crop)	1,604	1,234	881	897
Total food supplied (kg)	5,945	7,592	4,347	2,372

The salt industry maintains continuous pumping of sea water from the adjoining creek and about 32 ha of salt pan reservoirs available within the Salt Corporation area formed the resourceful bed for the collection of required seed of *P. indicus* for farming. Wild seed were also collected from tidal pools and inlets of Tuticorin Bay and transported to the site by employing simple methods as described by Unnithan (1985). Collection and stocking operations of prawn seed were carried out in the morning hours since the rate of mortality increased with increase in water temperature. The particulars of stocking operations are given in Table 1.

Table 2. *Hydrology of prawn culture ponds*

Ponds / Period	Water temp. at 0800 hrs (°C)		Salinity (‰)		Dissolved oxygen (ml/l)		pH		Productivity mg C/m³/day	
	Range	Mean	Range	Mean	Range	Mean	Range	Mean	Range	Mean
1. Feb.–Oct. '86	27.1–32.2	28.4	38.00–49.30	43.28	2.69–4.48	3.60	7.72–8.36	8.04	390–2,213	986
2. –do–	26.8–32.5	28.5	38.74–48.65	42.53	2.08–5.01	3.63	7.70–8.20	8.03	325–2,045	858
3. Mar.–Sep. '86	27.0–32.5	28.7	37.27–49.00	43.98	2.55–4.85	3.77	7.60–8.25	7.94	244–1,055	702
4. April–Sep. '86	27.0–32.5	28.9	39.20–50.03	45.37	2.66–5.09	3.59	7.60–8.43	7.86	266–835	564

Table 3. *The trend of growth in* P. indicus *cultured in salt pan area*

No. of days after stocking	Pond 1				Pond 2				Pond 3				Pond 4			
	Average size		Growth rate		Average size		Growth rate		Average size		Growth rate		Average size		Growth rate	
	mm	g	mm	g	mm	g	mm	g	mm	g	mm	g	mm	g	mm	g
0	22.0	0.3	...	...	15.0	0.2	...	...	25.0	0.3	...	...	25.0	0.3	...	...
15	37.0	0.8	30.0	1.0	30.0	0.5	30.0	0.6	40.0	0.8	30.0	0.1	44.0	1.2	38.0	1.7
30	54.5	1.5	32.5	1.2	41.5	0.9	26.5	0.7	56.0	1.3	31.0	1.0	58.0	2.0	33.0	1.6
45	66.0	2.1	29.3	1.2	54.5	1.3	26.3	0.7	60.5	1.7	23.7	0.9	66.0	2.7	27.3	1.6
60	77.0	3.2	27.5	1.4	63.5	1.5	24.3	0.6	65.0	2.1	20.0	0.9	71.0	2.8	23.0	1.2
75	77.0	3.4	22.0	1.2	67.0	1.9	20.8	0.7	67.0	2.3	16.8	0.8	74.5	2.9	19.8	1.9
90	79.0	3.5	19.0	1.1	70.5	2.3	18.5	0.7	75.0	2.6	16.7	85.0	3.4	6.8	20.0	1.0
105	81.0	3.6	16.9	0.9	73.0	2.5	16.6	0.7	81.0	3.4	16.0	0.9	92.0	3.6	19.1	0.9
120	86.0	5.0	16.0	1.2	80.5	3.1	16.4	0.7	93.0	5.2	17.0	1.2	99.0	6.2	18.5	1.5
135	98.0	6.8	16.9	1.4	90.0	4.8	16.2	1.0	97.0	5.6	16.0	1.2	103.0	6.5	17.3	1.4
150	103.0	8.2	16.2	1.6	95.0	5.7	16.0	1.1	100.0	6.2	15.0	1.2	106.0	7.2	16.2	1.4
165	106.0	8.7	15.3	1.5	98.0	6.2	15.1	1.1	104.0	7.4	14.4	1.3	108.0	7.8	15.1	1.4
180	110.0	9.2	14.7	1.5	101.5	6.5	14.4	1.0	...	...	...	...	...	...	...	...
195	114.0	10.8	14.2	1.6	104.5	7.6	13.8	1.1	...	...	...	...	...	...	...	...
210	117.0	12.0	13.6	1.7	110.0	9.0	13.6	1.3	...	...	...	...	...	...	...	...
225	124.0	13.2	13.6	1.7	114.0	10.4	13.2	1.4	...	...	...	...	...	...	...	...

Intensive stocking was made in ponds 1 – 4. The size of the ponds varies from 0.37 ha to 0.95 ha. The average size of seed at stocking measured 15–25 mm and the rate of stocking varied between 1.2–1.5 lakhs/ha. Stocking operations were completed in four ponds during February–March, 1986. A maximum of 55,000 seed were released in the 0.37 ha pond on 1–4–1986. Stocking at high rate was purposely designed to see its effect on survival, growth and production when compared to low stocking density experiments completed earlier in the same environment. The seed were released directly into the rearing ponds and there was no need to acclimatize them because of the identical water characteristics at the collection centre and grow-out ponds.

Farm management

Water samples from culture ponds were analysed at weekly intervals. About one fifth of the volume of water was flushed daily for maintaining the quality of water and the rate of exchange was increased gradually during later phases of culture. As far as possible draining and pumping were arranged in the cool hours of the day. Water depth was 0.7 m in pond 1 and the average depth in rest of the ponds was 0.4–0.5 m only. Velon screen tied to water inlets and outlets were kept clean. The observations on essential water qualities are presented in Table 2.

Water temperature at the surface was 26.8–32.5°C with a monthly mean value of 28.4–28.9°C around 0800 hours. The salinity in the rearing ponds was always well above 38 ppt and reached maximum values of around 45–50 ppt on most of the days during April–June, 1986 due to increased evaporation as well as the closure of bar mouth frequently. The dissolved oxygen content varied from 3.59 to 3.79 ml/l and the pH measured around 8.00. The productivity of the ponds (measured by light and dark bottle method) was recorded in the range 244–2,213 mg C/m³/day and a minimum level of 500 mgC/m³/day was maintained on most of the days; under such conditions the colour of water was light green or blue green. Whenever there was a change in colour (transparent or pale brown) a fall in productivity values was noticed and quick arrangements were made to add organic manure at the rate of 20 kg/ha and inorganic fertilizers like urea and superphosphate, each at 5 kg/ha along the water edge of pond instead of spraying all over the pond. This was necessary for the development of the bloom. Excessive growth of algae was controlled by flushing as much

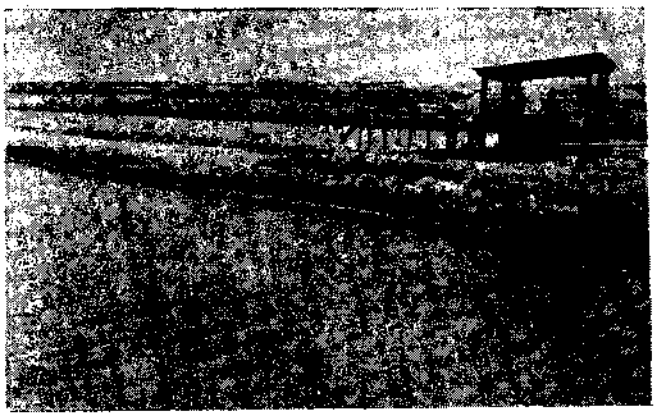

Fig. 1. Sea water being lifted from the creek.

quantity of water as possible. The presence of natural food in the form of microalgae and zooplankters in the ponds meet the food requirements of young prawns during the first three weeks after stocking. Thereafter, the pelletized feed obtained from TOMCO (through arrangements made by Marine Products Export Development Authority at subsidised rates) was given twice a day, at dawn and dusk at the rate of 7–10% of body weight. The food requirement was determined by assessing the percentage of stock surviving, by random sampling method and the progress of growth in weight of the prawns. The food was kept in trays at intervals of every 10 m at the bottom of the pond a little away from the bunds. Broadcasting the feed was avoided in order to avoid wastage. Because of the delay in getting the pelletized food from the company, supplementary feed consisting of fish meal, shrimp head, rice bran, ground nut oil cake, tapioca and minerals was given during June–July, 1986. Predatory birds were kept away by firing crackers and by keeping 'scare-crow.'

Growth assessment

The progress of growth of prawns was assessed by taking fortnightly random samples with castnet at different points of the pond and the results are presented in Table 3. Based on the actual observations made, an estimated average growth rate of the stock from all four ponds are tabulated for comparison. During the first month the rate of growth was more or less the same in all ponds. The overall growth rate varied from 13.6 mm (1.4 g) to 15 mm (1.7 g) depending upon the period of culture in different ponds (Table 1). The

maximum gain in weight was seen with prawn stocked in pond 1. Prawn seed of average 22 mm released on 1-3-1986 have grown to 123.5 mm (13.2 g) in the course of 224 days, whereas the stock in pond 2 attained a size of only 116 mm (11 g), and it had taken more number of days. The rate of growth was affected during May-June, 1986 when the supply of pelleted feed was interrupted. In ponds 3 and 4, the stock reached a size of 106-108 mm with an average weight of 8 g in the course of 5 1/2 months. The rate of growth was generally poor when compared to earlier experiments carried out in the same environment with lower stocking density. It may be mentioned that the earlier crop during August, 1985 - January, 1986, took only five months to attain the size of 138 mm (19.8 g) because of the conducive hydrological factors and optimum stocking density at 44,000/ha (Marichamy, 1986).

Harvest and production

Harvest arrangements were made after ascertaining the quotations of competitive price from buyers on the basis of samples given. The slope of the pond bottom and trenches facilitated quick draining through outlets during night hours. Harvesting was made easy by spreading a net exactly on the floor of the catching pit (area 15 m x 15 m) before draining commenced. As the water receded, bulk of the prawns assembled in this limited water area and were harvested by lifting the net from four sides. The rest of the stock was collected by using a cast net and finally by hand picking after expelling the remaining water with a small pump. Harvesting operations were over before 1000 hours and the time factor was considered important to avoid spoilage of the prawns as water temperature increased towards noon.

In ponds 3 and 4, prawns started swimming near the surface in distress due to oxygen deficiency, particularly in the early morning hours and instances of stray mortality were noticed in September, 1986. Prawns were harvested from these ponds on 13-9-1986. The production details are given in Table 1. 805 kg of prawns with an average size of 106 mm (8 g)at survival rate of 74.5% were harvested from pond 3 and 330 kg from pond 4. The rate of production was more or less the same, being 881 kg/ha/172 days in pond 3 and 897 kg/ha/166 days in pond 4. The actual production in pond 2 (0.95 ha) was 1,169 kg and the rate of production amounted to 1,234 kg/ha/232 days. Better production was attained from pond 1 as the rate of growth was comparatively good with high rate of survival (95.4%). The rate of production was 1,604 kg/ha/224 days. No predators were noticed in ponds 3 and 4 and the low survival cannot be ascribed to this problem. Two or three fish, *Lates calcarifer* and *Elops* were noticed in the catches made from pond 2. *Nematalosa nasus* occurred in large numbers (40 kg) in this pond; though it is not a predator, it was a competitor for food and space.

Fig. 2. Part of the harvested prawns.

Marketing and economic aspects

The Century Cold Storage Ltd., Palayakayal a leading shrimp exporter offered the best price for the cultured prawns. The catches were disposed off on the spot. Prawns from pond 1 fetched better price of Rs. 46.25/kg (head-on count 76/kg). The rate for prawns from pond 2 was Rs. 36.75/kg since the head-on count was 91/kg. The catches from the last two ponds were sold at Rs. 22.00/kg as the count was 123/kg. The total yield of 2,930 kg of prawns produced from four ponds of 2.75 ha was sold for Rs. 1,00,537. This works

Fig. 3. The catch being weighed for disposal.

out to the average income of Rs. 36,558 per ha/7 months. The cost of fixing of sluice pipes, and the recurring expenditure such as wages for watchman, cost of supplementary food, fertilizers, fuel and energy, preparation of pond by tilling, harvesting and marketing and miscellaneous expenditure came approximately to 50–60% of the income. The capital expenditure involved in the construction works and installation of pump sets can be recovered in four crops at the rate of 25% of the profit. The income can be substantially increased by proper management, particularly by curtailing the expenditure on excess feeding which has happened in the present experiment.

General remarks

The occurrence of seed of *P. indicus* in two seasons in a year during February–May and August–December facilitates designing the culture programme accordingly. Out of the two crops raised in a year, the summer crop from February/March onwards was continued upto August/September covering a maximum of six to seven months and the next crop started from September onwards could be limited to four to five months, because of the prevalence of conducive environmental factors. Maintenance of phytoplankton bloom in the rearing ponds by manuring the water, forms an important aspect in prawn culture. Culturists in Japan endeavour to grow phytoplankton in ponds particularly in summer when the prawns grow at a fast rate (Shigueno, 1972). Since the growth and production of prawns in the pond vary according to the level of primary production, the productivity was maintained at moderate levels of 500–1,000 mg C/m^3 / day in culture ponds.

Suseelan (1975) estimated the average growth attainment upto 135 mm (24.7 mm/month in the summer crop and 19–21 mm in the later monsoon) for crops raised in salt pan area of Manakkudy, where the salinity varied from 10.55 to 28.10 ppt only. Sultan *et al.* (1973) indicated an average growth rate of 25.8 mm/month eventhough the culture area was brackishwater. In the preliminary experiments carried out in the present environment, Marichamy (1986) observed a better rate of growth of 21.6 mm (3.8 g) / month in the monsoon crop raised during August, 1985–January, 1986 when the salinity was recorded around 35 ppt during most of the days. The growth rate in the present summer crop was in the range of 13.6 mm (1.7 g) to 15 mm (1.5 g) / month, because of the prevalence of high salinity around 45 ppt in most of the days. Muthu (1980) observed the ideal salinity range for the culture of *P. indicus* as 10–35 ppt.

High stocking density may be another factor affecting the growth rate as seen in the present experiment. The growth rate in ponds 3 and 4 was extremely low because of the maximum stocking rate of 1.5 lakh/ha whereas the earlier experiment made in the same season with the stocking density of 80,000/ha revealed better growth rate. The influence of the stocking density on the growth rate has been studied earlier. Mohamed *et al.* (1980) recorded a high growth rate of 1.0–1.1 mm/day till the size of 125 mm in *P. indicus* in a similar environment with low stocking rate of 27,000/ha. Venkatesan *et al.* (1982) reported the maximum growth and production of *P. monodon* at a stocking density of 25,000/ha even in brackishwater ponds and considerably low values when the density was increased to 40,000/ha. Sriraman and Ananthanarayanan (1986) opined that the ideal stocking density was 30,000 to 45,000/ha for good production of *P. indicus*. Based on the two sets of experiments covered so far in the salt pan areas of Veppalodai, it may be stated that 50,000–70,000/ha would be the optimum stocking density as per the productivity of the ponds. The depth of water as well as the rate of exchange in rearing ponds play a key role in the ecological conditions to promote the growth and survival rates. The poor results observed in the last two ponds may be attributed also to the low depth of water and inadequate water exchange. The rate of production in the present experiment was comparatively better than the results published from different areas. The recent experiments on *P. monodon* carried out in Pulicat Lake gave maximum production of 1,157 kg/ha/crop (Sanjeeva Raj, Keynote address in Nat. Symp. Estuarine Biology, Parangipettai, October, 1986). Suseelan (1975) recorded a maximum production of 1,134 kg/ha/year. The maximum production of 1,200–1,600 kg/ha/crop obtained in the present work appears to be the best so far reported under such conditions. The present efforts in the salt pan area have shown that the project is a profitable venture.

Eventhough the hydrological conditions are not so conducive in the present experiments, the results have shown that farming can be organised for still better yields by resorting to management practices particularly

by limiting the stocking density to about 70,000/ha. Improvements in flushing system, increase in the water depth, steady supply of nutritive food, provision of 'water blender' to avoid oxygen depletion are some of the suggestions for more effective implementation and higher production. The peak summer period may be avoided for stocking and the duration of culture can also be reduced to realise a better economic return from the yield.

In Japan 70 percent of the prawn ponds are converted salt pans. About 1,20,000 ha of brackishwaters in the form of disused salt pans and low lying coastal areas are available for culture purposes in Tamil Nadu. The Government of India has already cleared a project for the development of 150 ha of brackishwater area for farming in Thondikadu in Tanjore District, Valinokkam in Ramanathapuram District and Pinnakayal in Tirunelveli District or in Pulicat Lake (Dixitulu, 1986). Realising their commercial value, a number of private farmers have just started prawn culture practices in salt pan areas in Palayakayal, Pinnakayal, Vaipar and Vembar. With the available technology in prawn farming, the salt pan areas can be profitably utilised for prawn culture in the near future.

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