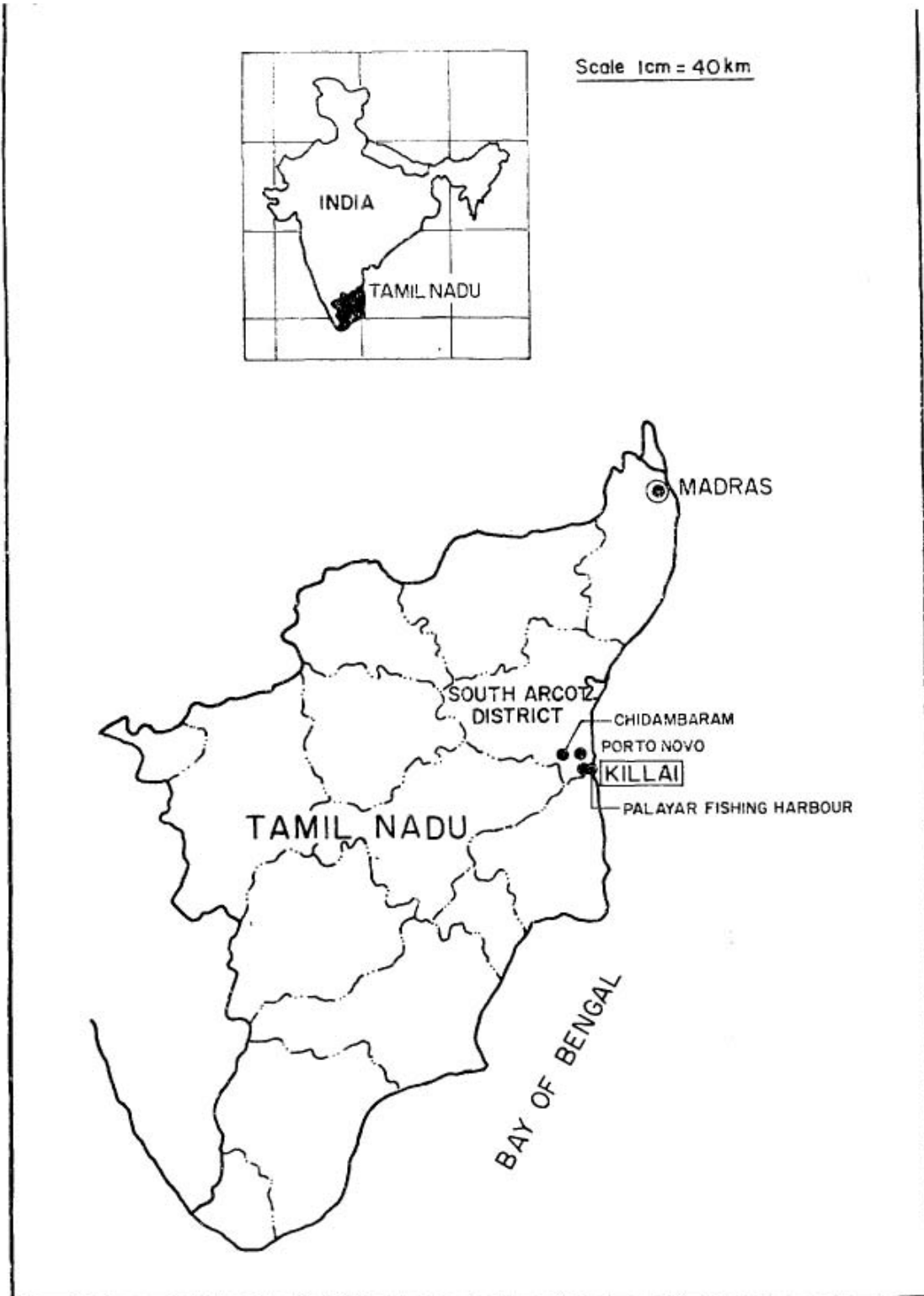
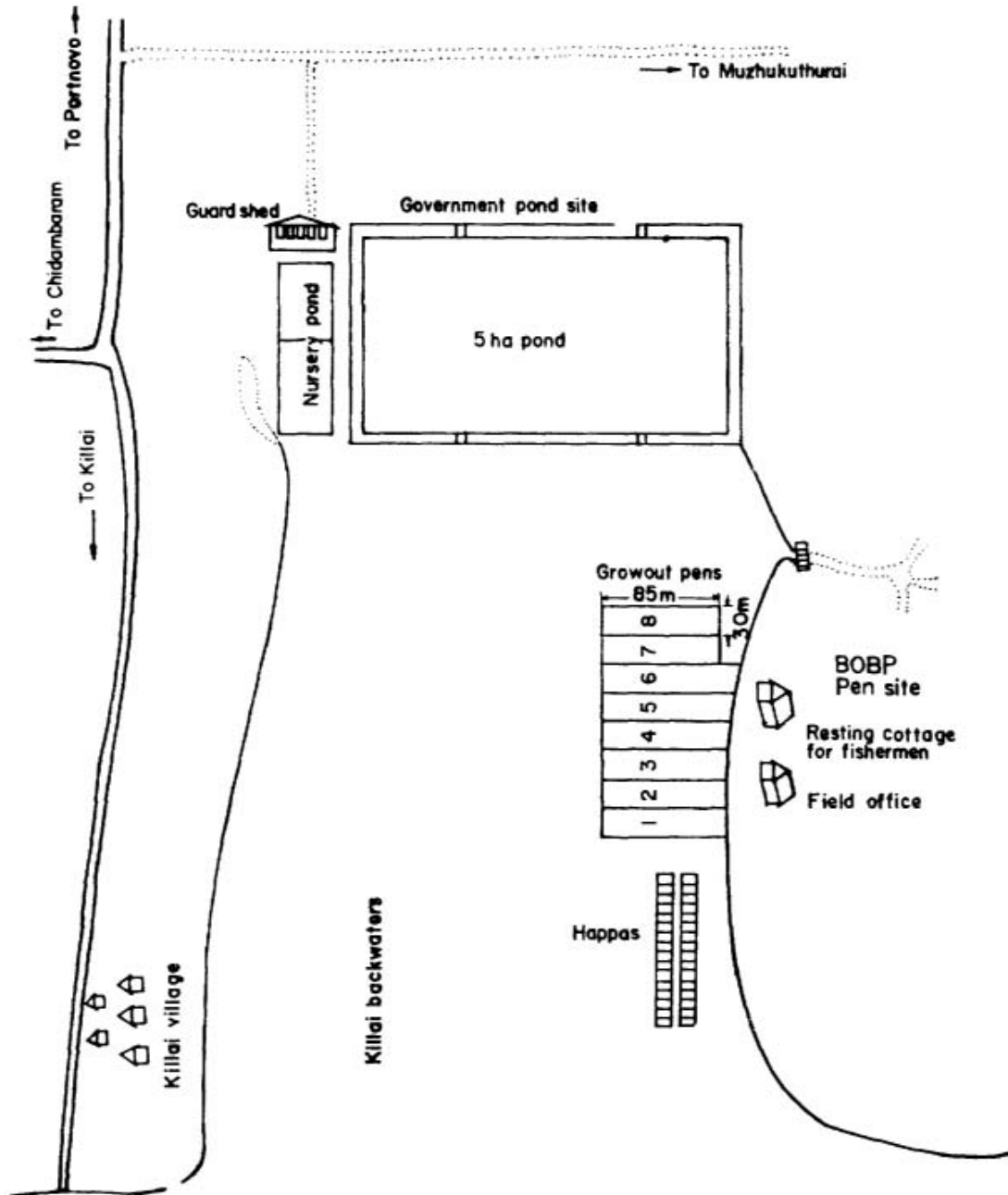


LOCATION OF PROJECT SITE

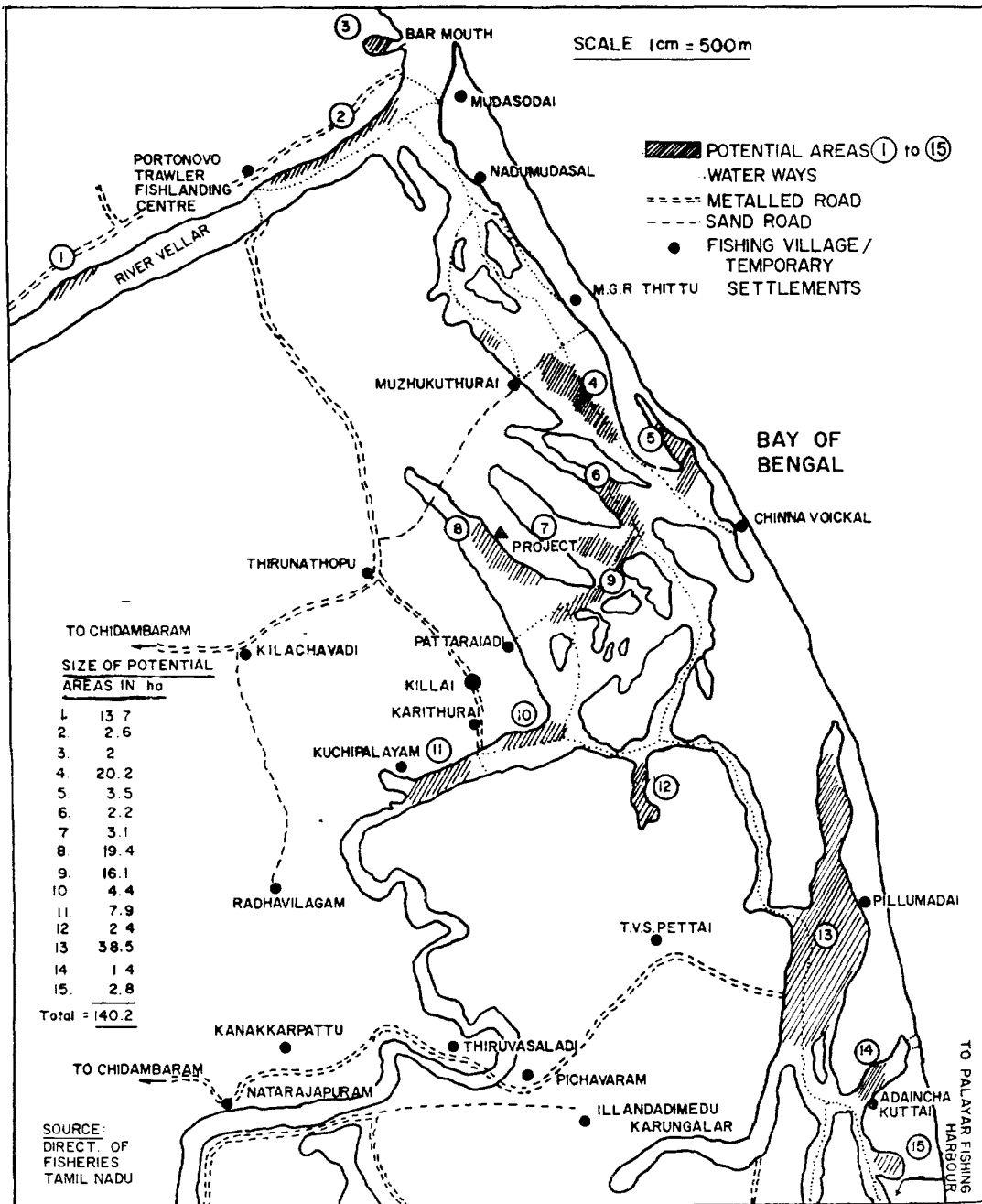


LAYOUT OF PENS AND HAPPAS

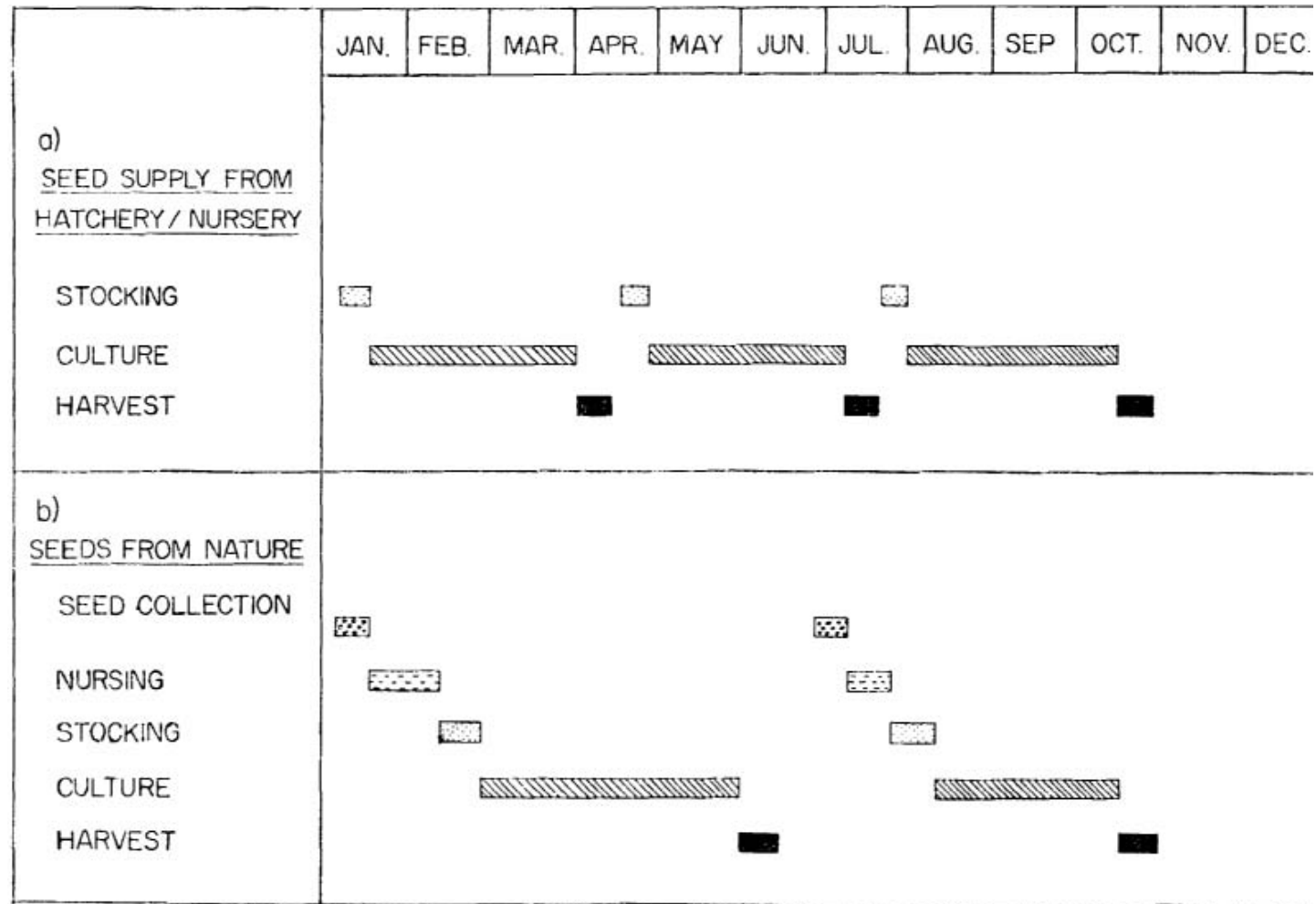


Appendix 3

Killai backwaters: areas hydrologically suitable for pen culture
(Total: 140ha)



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

[25] 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 $\frac{\text{wet feed}}{\text{dry feed}}$
during grow-out of
Date of harvest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	Rate	Total amount	Qty	Rate	Total amount	Qty	Rate	Total amount	Qty	Rate	Total amount	Qty	Rate	Total amount	Qty	Rate	Total amount
	kg	Rs/kg	Rs	kg	As/kg	Rs	kg	As/kg	As	kg	As/kg	Rs	kg	Rs/kg	As	kg	Rs/kg	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/ crab	12.2	57	1.0	6	0.9	5	1.8	11	5.5	33	11.5	58
		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

[30]

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	—	—	—	—

[31]

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	
	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/ crab	35.7 7.8	178 36	29.1 16.4	273 50	14.7 22.9	74 60	21.6 18.0	108 49	19.6 5.3	98 11	43.5 9.1	331 37	6.1 23.4	48 44	5.2 18.5	34 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

[32]

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, 15 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 x 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. Pest removal and harvest gear		
– Gillnets, 3 types, 280 Rs/piece mesh size 30 mm, 1 piece	4	1,120
.. 40 mm, 1 piece		
.. 55 mm, 2 pieces		
—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 (<i>P. indicus</i> of 0.25 g)		2,800
50,000 × 2 crops		
200 m-days × As. 14		

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

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

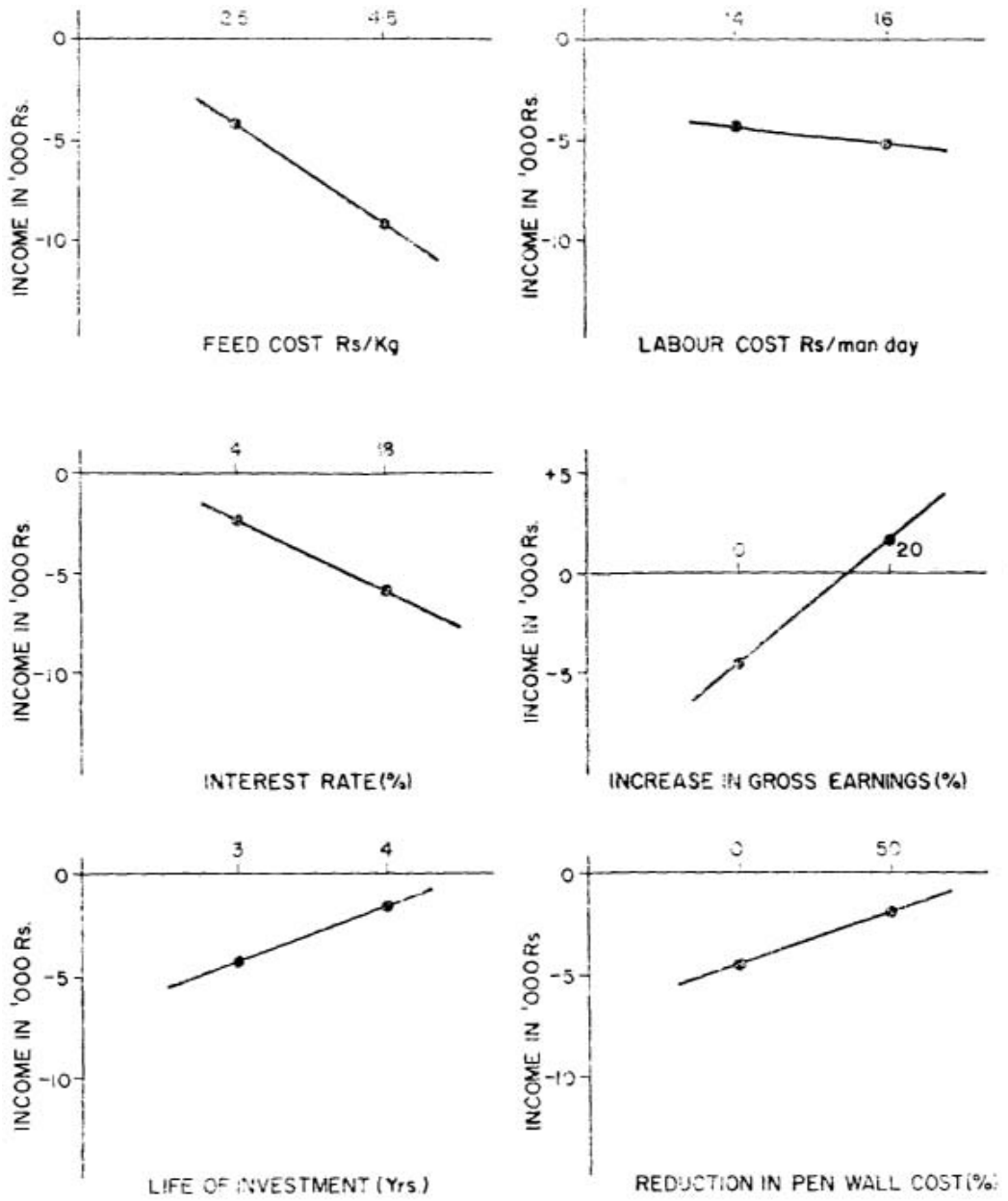
² 4 ha, one during the day and the other at night.

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 ¹	—4,793
from 2.50 Rs/kg to 3.50 Rs/kg ¹	—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. 14 to 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 further subsidized, e.g. 12.5 to 4%	—1,341 ±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 Rs. 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				Feed Costs in Rs. for			Gross Earnings in Rs.	Feed Costs as % of gross
			Nursing Dry	Nursing Wet	Grow-out Dry	Grow-out Wet	Nursing	Grow-out	Total		
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*, *Gracilaria* 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*, *Gracilaria* 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 *Gracilaria* 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.
- *Vellar 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 deployed 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 collected 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/ophila ova/is*, *Halodule uninervis* (rooted vegetation), *Gracilaria* 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 x 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.
- *Pushnet*: Designed by BOBP, 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. merguensis*, *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. Merguensis* 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 x 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. merguensis*) 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 m² 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 ==4,000x0.25 g		1.000 kg
200% of the body weight	==	2.000 kg
100%	=	1.000 kg
50%	=	0.500 kg

Feed requirement

Days x weight of feed		total
10x2 kg		20 kg
10x1 kg	=	10 kg
10 x0.5 kg	=	5 kg
		35 kg

Maintenance of nursery cages

Important points to be noted ~~and~~ ~~outlined~~ 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 sulphide 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 been developed in the Killai 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 and 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 and methods: 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 pre-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 pre-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 net was dragged during pre-stock removal. The bigger pelagic predatory fish (Johnius, tachysurus, epinephelus, 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, crabs can be caught with this.
- *Set gill/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: Removing seed 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 transferred 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 wall 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 body 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 week. 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 Sembonarkoil. 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 specific 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.

- *Castnetting:* 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 anything is left in the pens.