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ECONOMIC ANALYSIS ON THE HATCHERY TECHNOLOGY AND GROWOUT OF PEARL SPOT (*Etroplus suratensis*)

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ABSTRACT

"Karimeen", which is also known as 'Pearl spot fish', is one of the most important fish species in Kerala. Even though it was officially announced as the 'State Fish of Kerala' in only the year 2010, karimeen is the most influential fish in the lifestyle of Kerala. Karimeen is highly nutritive as food. Pearl spots have the special ability to live equally in both pure and saline waters. They are mainly found in rivers, ponds, farm fields, canals and estuaries. Karnataka and Orissa are the other major states in India, where karimeen is found. Due to the favouring geographical conditions of the coastlines in Kerala, almost 10 per cent of the local freshwater fish found in Kerala are karimeen. With its increasing demand, the price of the fish variety is also soaring. Apart from the growing demand from local market and domestic tourism sector, the fish is also exported in large quantity to foreign markets as well. Though, Kerala produces 2000 tonnes of Karimeen annually, it is not sufficient to meet the rising demand for 'Kerala Karimeen' inside and outside the state. This paper presents the different package of practices of karimeen farming and analyses the economics of the pearl spot hatchery technology and farming in cages and farms involving monoculture and polyculture. The analysis indicates the economic viability of pearl spot as a candidate species for farming in Kerala, which could provide alternate vocation and good remuneration to the fishers.

Keywords: Pearl spot, "Karimeen", hatchery technology, growout culture, economics

I. INTRODUCTION

Pearl Spot (*Etroplus suratensis*) is a euryhaline fish adaptable to wide range of salinities. The 'green chromide' is a species of cichlid fish from freshwater and brackish water in southern India and Sri Lanka (Fryer and Iles, 1972). The Pearl spot, *Etroplus suratensis* commonly known as "Karimeen" in Kerala, is an indigenous fish extensively found along the east and south-west coasts of Peninsular India (Padmakumar *et al.*, 2004). It is an important candidate species for aquaculture in ponds, in both brackish water and freshwater (Vijayaraghavan *et al.*, 1981). It feeds on algae, plant material and insects. This fish is fairly expensive and is available throughout the year. It is caught mainly using gill nets. It commonly reaches 20 centimetres (7.9 in) in length. The Kerala government has declared

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pearl spot fish, known as "karimeen" in local parlance, as the State Fish of 'Gods Own Country'. The decision was taken to protect the costly fish, considering its food and economic value. With its unique taste and tender flesh, the fish variety had already been known as the unofficial brand ambassador of the Gods Own Country's intrinsic taste. Karimeen justifies the economical and tourism importance in Kerala state. It is cultured in traditional ponds in Kerala, where it is considered a delicacy fetching a high price up to Rs. 400-500/kg. Though, growth is slow, at a high stocking density, table-size fish can be harvested in culture period of 9-12 months.

The most astonishing features of Karimeen, which makes it a candidate species, includes the following:

1. Ability to live in varying genre of water resources.
2. Ability to make their living together with a wide variety of fishes.
3. Lively growth rate and high survival rate of young ones.
4. Delicious taste and flavour of karimeen.
5. High survival rate of eggs, due to its ability of parental care.
6. Consistent and stable market price.

II. OBSERVATIONS

Nutritive Value of Karimeen: Karimeen is a highly nutritive food. In addition to a good amount of meat, Karimeen also includes fat, phosphorus, calcium, ash, iron and water. Percentage of these contents in karimeen includes fat: 17.5 percent, phosphorus: 1.65 percent, calcium: 0.50 percent, ash: 1.08 percent, iron: 4.90 percent and water: 79.70 percent (Mukundan and James, 1978).

Biology: Karimeen have an elliptical black body with shiny white diamond like spots all over the body. It is this physical appearance, which gave the fish the name 'pearl spot' or 'Karimeen'. Even though the word '*kari*' points to a dark black colour, the fish has a mixed combination of green and black on its body. Dark black stripes (usually 8 in number) are found from head to tail (Panikkar, 1920; Thampy, 1980; Vijayaraghavan *et al.*, 1981; Raju *et al.*, 1987; Keshava *et al.*, 1988; Jayaprakash *et al.*, 1990). Apart from the vegetative diet, they also feed on plankton, small worms and small prawns. Spirogyra is the most favourite food for pearl spot fish. *Fragilleria, Coscinodiscus* are the other major foods of karimeen. Fishes like catla and various carp species can be used for composite cultivation along with Karimeen.

Seed Production: Seed of pearl spot is available throughout the year, along the east and south-west coasts of India (Jhingran, 1991). The peak season of abundance is during the months of May-July and November-February. It is collected from both the brackish water and freshwater tanks and ponds. A simple method of seed collection is adopted, taking advantage of the tendency of the fish to congregate in large numbers for feeding on epiphytic growth. In this method, twigs or branches are kept submerged in the water, a week ahead of day of collection. The juveniles congregating for feeding purpose are trapped using an encircling net or trap. Fecundity of pearl spot is low and has been estimated to be around 3000-6000, hence a successful hatchery production of seed is difficult

(Bhaskaran, 1946). However, Central Institute of Brackishwater Aquaculture (CIBA), Chennai; using the technique of environmental management, has successfully demonstrated the hatchery seed production of pearl spot.

Pond Preparation: The ponds are drained followed by removing all the materials that may be detrimental to the growth and productivity of fish farming. Application of the agricultural lime is essential to pond bottom which is acidic (pH below 7). Consequent to pond draining, 10-12 random samples of the upper 5 cm layer combined with equal volume of soil samples are collected from several places from the pond bottom to prepare a composite sample. The application of agricultural lime may be based on the following pH scale (see Table.1).

Tabie 1. Lime requirement based on the pH

Sl. No.	Soil pH	Liming (kg/ha)
1	Above 7.0	0
2	6.9 - 6.5	500
3	6.4 - 6.0	1000
4	5.9 - 5.5	2000
5	5.4 - 5.0	3000

Drying: Drying accelerates the decomposition of organic matter accumulated in the pond bottom with a provision of a better oxygen supply to bacteria. Better aeration of the soil oxidises reduced inorganic and organic compounds in the soil to improve the soil condition. Drying also kills disease organisms and their carriers that may exist in the soil. A drying period of two weeks is normally adequate (Mathew, 2012).

Acclimatization and Stocking of Breeders: Adult Etroplus in the weight range of 50-125 g procured from the wild or culture ponds are stocked @ 5000/ha, after one week of fertilization of the pond. Breeders collected from the wild are to be disinfected by dipping in 1 per cent commercial formalin and acclimatised before introducing into the pond. Since, the fish is monomorphic, sex differentiation is difficult and it has to be assumed that the sex ratio of the stocked breeders is approximately 1:1. Additional breeders have to be added to the existing stock from the second year onwards to compensate the natural mortality of breeders. Breeders once stocked will normally be viable for three years (Bindu, 2013).

Provision of Spawning Surfaces: In the natural environment, the fish attaches its eggs to submerged substrata like stones (Sultana *et al.*, 1995). As a prepared pond may not have such natural spawning surfaces, materials like palmyra leaves tied in bunches to fixed poles, coconut leaf petioles, coconut husks, bricks, pieces of asbestos sheets etc., have to be provided in the ponds (Samarakoon, 1985).

Water quality monitoring and management: Water level is maintained at a height of 1.2 metre. Water exchange has traditionally been used in ponds at a rate of 20 % to 30 % of pond volume per day through sluice gate operation where the tidal flow is prominent. Exchange of pond water through sluice gate by putting a

filter net of 1-2 mm mesh size is a common and successful practice and will not lead to escape of hatchlings and fry. Due to the water exchange through sluice gate, a prominent water circulation takes place in the pond. As the fish grows, by increasing the mesh size of the filter net, the volume of water exchange and circulation in the pond increase, resulting in the maintenance of a uniform water quality.

Mechanical aeration: Maintaining appropriate oxygen level is very essential for respiration, digestion and assimilation of food. Pond water contains plenty of oxygen during day light hours due to photosynthesis. But during night, dissolved oxygen concentration declines to a low level. Aeration can be used late afternoon and pre-dawn to stabilise dissolved oxygen concentration within safe ranges. Oxygenation and induced water circulation are the basic function of aerators. Different types of aerators are available. Diffused air aerators employ an air blower and tubing to deliver air to diffusers mounted at many places at the pond bottom. Small air bubbles released by the diffusers rise through water and oxygen in the air within bubbles diffuse into water.

Feeding: Feeding of the breeders has to be initiated within 3-4 days after stocking. Artificial feed prepared with groundnut oil cake 40 per cent, rice bran 45 per cent and fish meal 15 per cent, fortified with vitamin and mineral mix @ 2.5 kg per 100 kg feed, is to be supplied daily @ 3-5 per cent of the fish biomass, either in pelleted or in dough form. Feed can be supplied in feeding trays kept at the bottom of the pond. The feeding trays should be examined daily and cleaned outside the pond (Alikunhi, 1957). The quantity of the feed can be reduced whenever left-over feed is present in the trays, to avoid wastage and water pollution (Gopalakrishnan, 1968). The presence of hatchlings indicates that the pond is to be manured with cow dung @ 500 kg/ha for the production of plankton, which forms the food for the hatchlings (Khen and Chien, 2006). Small quantities of the artificial feed (250-300 g/pond of 1000 m^2) also can be broadcast in powder form during early morning (Sobhana and Nair, 1980).

Fry Production and Harvesting: The experiment conducted in a pond of 100 m^2 area, gave an actual production of 3500 fry from five sets of spawning in a year (projected production rate is 3.5 lakhs/ha/yr), when the breeders were stocked at the rate of 6800/ha. Fry production from a pond of 300 m^2 area from 3 sets of spawning over a period of 5 months was 9600 and this works out to more than 5 lakhs/ha/year from five sets of spawning, when the breeders were stocked at the rate of 5400/ha. This probably indicates that the rate of fry production may be enhanced from a bigger pond even at a low stocking density of breeders (Mathew, 2012).

Larval Rearing: The eggs are oblong in shape, about 1 to 2 mm in diameter, attached at one end by means of a short stalk to the nesting object (Panikkar, 1920). The newly laid eggs are yellowish in colour and as the embryo develops, the colour becomes brownish and the yolk sac becomes pigmented. The incubation period lasts from 82 to 100 hours. During hatching, the egg membrane bursts first over the head of the larvae, which is at the free end, and this continues along the

upper side by the waving of the tail (Noakes, 1991). The early larval stage lasts for 7 days during when the larvae develop into free-swimming individuals. During late larval stage, the larvae, though free swimming, are quite different from the adult. The tail remains long and the caudal fin is continuous with dorsal and anal. After a fortnight, the primary chromatophores on the back disappear and permanent colour bands begin to appear (Endler, 1995). The larvae assume adult form within a month after hatching and measure about 18 mm (Bindu, 2013).

The young ones feed almost exclusively on zooplankton, the advanced fry on aquatic insect larvae, filamentous algae and other vegetable matter; while the adult fish subsist mainly on filamentous algae, aquatic macrovegetation and planktonic organisms (Sundararaj and Krishnamurthy, 1975). Worms, shrimps and insect larvae also form part of its food. Adult pearl spot can be fed with pelleted fish feed.

Growout Culture: The pearl spot is suitable for culture in confined, fresh and brackish waters. The fish is cultured on a small scale, mainly in the state of Kerala. It is cultured in the traditional manner, in the '*Pokkali*' fields (paddy fields). An annual yield of 3 to 5 tonnes is obtained from these fields, of which, prawns constitute 80 per cent, while the mullets and pearl spot form 20 per cent. In mixed-culture operations, along with prawns and other fishes ranged from 768.2 kg/ha/3 months at a stocking density of 25,200/ha (24000 prawns + 1200 fish) to 845.4 kg/ha/110 days at a stocking density of 20,300/ha (20,000 prawns + 300 fish) have been reported. The culture of pearl spot is more economical under polyculture system, especially with milkfish and mullets, than under monoculture (Mathew, 2012).

The fish can attain a marketable size of 200-250 g over a period of 7-8 months. Though, growth rate is relatively slow, high stocking density with low input management can yield optimum production. Under monoculture at stocking densities ranging from 10,000 to 12,000 /ha, an average production of 1,000 kg/ha/year can be obtained in brackish water ponds (Samarakoon, 1985). The fish can also be reared in backyard ponds and tanks in the rural areas. Being a herbivorous fish, it is suitable for polyculture. Pearl spot farming could be adopted to any scale integrating with other occupations like poultry farming. The poultry droppings form good manure for natural food production in the culture ponds.

Adult fish in the weight range of 50-125 g are stocked in ponds @ 5,000 nos./ha. The fish are fed with supplementary feed @ 3.5 per cent of the body weight (prepared with groundnut oil cake 40 per cent, rice bran 45 per cent and fish meal 15 per cent fortified with vitamin and mineral mix @ 2.5 kg per 100 kg of feed). The feed is supplied in pellet or dough form. The hydrographical parameters desirable for the breeding and seed production of pearl spot are: water temperature 24-32°C, salinity 15-30 ppt, dissolved oxygen >3.5 ppm, pH 7.0 to 8.0 and transparency >50 cm (Mathew, 2012).

Diseases: Pearl spot diseases are mainly caused by wide fluctuations in environmental parameters. The most common disease causing agents are bacteria including *Pseudomonas, Alcaligenes, Flavobacteria, Moraxella, Vibrio*

and gram-positive *Micrococci, Athrobacter and Bacillus* spp (Brightsingh *et al.*, 1981).

The calendar of different operations is given in Table 2.

Table 2. Calendar of operations

Operation	Month	Details
Stocking	January - March	Stocking of Seed (2-5 cm long)
Feeding	Day to day	Indigenous feed with high FCR (2:1) can be used for the purpose. Vegetable pieces and algae is also allowed
Harvesting	Phased (based on demand)	Within 7-8 months fish will come to around a weight of 200-250 grams
Collection of seed	December - February	Leaving few matured and productive fishes in the pond itself, will make the way for laying eggs during the period of culture

Seed Requirement:

Production aimed at 1 ha stocking (10000 seed)

Stage	Period	Number	Hatching/ Survival rate	Length/Weight
Egg		225000	80	0.5 -1cm
Fry	2 -3 weeks	18000	70	1-1.5 cm
Nursery	3-4 weeks	12500	80	1.5-2 cm
Advanced FL	8-12 weeks	10000	80	3 cm /5-8 gm
Table size	Till 8 months	8000	80	200gms

III. RESULTS & DISCUSSION

The economic analysis was done at four stages

a. Grow-out of Pearl Spot in cages
b. Hatchery technology
c. Grow-out of Pearl Spot (monoculture)
d. Grow-out of Pearl Spot (Two species)
e. Grow-out of Pearl Spot (Three Species)

[I] ECONOMICS OF GROW-OUT OF PEARL SPOT IN CAGES

Assumptions:

- Stocking: 1/m^2
- 30 kg fish per m^3 harvest
- Area available: 3.14X12X2 = 6.28 m^3
- Maximum harvestable size 200 gm
- 942 fishes to be harvested
- Stocking rate: 1256 no.s - 75 per cent survival)

A. Capital Cost:

Sl. No.	Particulars	Details	Cost
(a)	Installation of cages (battery of 5 cages)	(Circular Dimension of 2 m diameter X 2 depth Stocking of (3.14 X 1 X 2 = 6.28 cu m) @	1,00,000
(b)	Cage nets	ADD	50,000
(c)	Mooring accessories	Anchor, Sinkers and Floaters	25,000
(d)	Miscellaneous	Ropes, Nets	25,000
(e)	**Total**		**2,00,000**

B. Operating Cost:

Sl. No.	Particulars	Details	Cost
(a)	Fingerlings	6250 @ Rs 7 per fingerlings	43,750
(b)	Feeding*	2 tonnes of Rice bran oilcake for fingerlings weighing 200gm @ 5 per cent of the body weight for 10 months @ Rs. 15000 per tonne	30,000
(c)	Labour	Salary for 1 labour and watch ward for 10 months @Rs. 6000 per month	1,20,000
(d)	Others	Contingencies if any – Net, Equipment/Hapa and other contingent expenditure	20,000
(e)	Interest on working capital	10 per cent of Item 1-5	21,375
(f)	Interest on fixed cost	5 per cent of Capital Cost	10,000
(g)	**Total**		**2,45,125**

C. Income Details:

Sl. No.	Particulars	Details
1	Production (ha)	1000 kg
2	Price per unit	Rs. 400
3	Total Revenue	Rs. 4,00,000

D. Economics:

Revenue (Rs.)	Production of 1000 kg	4,00,000
Total cost (Rs.)	(Fixed cost + Operating cost)	4,45,125
Fixed cost (Rs.)	Includes all capital cost	2,00,000
Operating cost (Variable cost) (Rs.)	Includes variable cost and interest on working capital and fixed cost	2,45,125
Net profit	Revenue - Variable cost	1,54,875
Rate of return	Net profit /Total cost	0.35
Profitability ratio	Net Profit/Operating cost	0.63
Net profit ratio	Net Profit/Revenue	0.39
Cost of production per unit (Rs.)	Variable cost/Output	245.13

[ii] ECONOMICS OF HATCHERY TECHNOLOGY

Assumptions:

- The hatchery is to cater to the seed requirement for 10 hectare farming
- Production for 4 cycles
- Production capacity is 2,00,000 seed per year (James, 2000; Bensam, 2000)

A. Capital Cost:

Sl. No.	Particulars	Details	Cost
1.	Hatchery complex	Land with adequate construction	10,00,000
2.	Earthern pond	Construction of a 650 m^3 earthern pond @ Rs 150 per m^3	97,500
3.	Larval rearing tank	24 one m^3 larval rearing tank made of fibrocement / FRP/ earthern @ Rs 7000 per m^3	1,68,000

4.	Overhead tank	A 10 m^3 FRP tank @ Rs 6000 per m^3	60,000
5.	Pump set	A 5HP pump set	50,000
6.	Water lining charges /Platform		40,000
7.	Electrical	Accessories	10,000
8.	Aerators		60,000
9.	Miscellaneous	Net, Equipment/Hapa and other contingent expenditure	14,500
	Total		**15,00,000**

B. Operating Cost:

Sl. No.	Particulars	Details	Cost
1.	Brooders	650 brooders (325 pairs of male and female with 70 per cent brooding success @ Rs. 100 per brooder	65,000
2.	Feeding of brood stock	2.34 tonnes of Rice bran oilcake for brooder weighing 200 gm @ 2.5 per cent of the body weight for 12 months @ Rs. 15000 per tonnes	35,100
3.	Feeding of larval rearing		20,000
4.	Electricity charges	For operations related to farming operations and aerators @ Rs. 500 per month for 12 months	6,000
5.	Labour	Salary for 2 labour and watch ward for 12 months @Rs. 6000 per month	2,16,000
6.	Others	Contingencies if any – Net, equipment's / hapa and other contingent expenditure	10,000
7.	Interest on working capital	10 per cent of Item 1-6	35,210
8.	Interest on fixed cost	5 per cent of Capital Cost	75,000
9.	**Total**		**4,62,310**

C. Income Details:

Sl. No.	Particulars	Details
1.	Production	200,000 fry
2.	Price per unit	Rs 7.00
3.	Total Revenue	Rs. 1400,000

D. Economics:

Revenue (Rs.)	Production of 200000 fry @ Rs 7.00	14,00,000
Total cost (Rs.)	(Fixed Cost + Operating cost)	19,62,310
Fixed cost (Rs.)	Includes all capital cost	15,00,000
Operating cost (Variable Cost) (Rs.)	Includes variable cost and interest on working capital and fixed cost	4,62,310
Net profit	Revenue - Cost	9,37,690
Rate of return	Net profit/Total cost	0.48
Profitability ratio	Net profit/Operating cost	2.03
Net profit ratio	Net profit/Revenue	0.67
Cost of production per unit (Rs.)	Variable cost/Output	2.31

E. Cost-Benefit Analysis: (Rupees in lakhs)

Year	Cost	Benefit	DF	Discounted Cost	Discounted benefit
0	15		1.00	15.00	0.00
1.	4.62	14.00	0.89	4.11	12.46
2.	4.62	14.00	0.80	3.70	11.20
3.	4.62	14.00	0.71	3.28	9.94
4.	4.62	14.00	0.64	2.96	8.96
5.	4.62	14.00	0.57	2.63	7.98
6.	4.62	14.00	0.51	2.36	7.14
7.	4.62	14.00	0.45	2.08	6.30
8.	4.62	14.00	0.40	1.85	5.60
9.	4.62	14.00	0.36	1.66	5.04
10.	4.62	14.00	0.32	1.48	4.48
				41.10	79.1

Pay back period PBP - 3.5 years
Net present value NPV - 37.997 lakhs
Benefit Cost ratio BCR - 1.92
Internal Rate of return IRR - 62 per cent

[iii] ECONOMICS OF GROWOUT OF PEARL SPOT IN MONOCULTURE

- Stocking : 1/m^2 (10000 per ha)

A. Capital Cost:

Sl. No.	Particulars	Details	Cost
1	Earthern pond	Construction of a 5 earthern pond of 2000 m^2 area @ Rs 100 per m^2	10,00,000
2	Pump set	A 5HP pump set	50,000
3	Provision of sluice gate / Water exchange		20,000
4	Electrical		10,000
5	Aerators		60,000
5	Miscellaneous	Net, Equipment/Hapa and other contingent expenditure	25,000
7	**Total**		**11,65,000**

B. Operating Cost:

Sl. No.	Particulars	Details	Cost
1.	Fingerlings	10000 @ Rs. 7 per fingerling	70,000
2.	Feeding*	4.165 tonnes of Rice bran oilcake for fingerlings weighing 200gm @ 5 per cent of the body weight for 12 months @ Rs. 1500 per tonne	62,475
3.	Electricity charges	For operations related to farming operations and aerators @ Rs. 500 per month for 12 months	6,000
4.	Labour	Salary for 2 labour and watch ward for 12 months @ Rs. 6000 per month	1,44,000
5.	Others	Contingencies if any – Net, Equipment/Hapa and other contingent expenditure	10,000
6.	Interest on working capital	10 per cent of Item 1-5	29,248
7.	Interest on fixed cost	5 per cent of Capital cost	58,250
8.	**Total**		**3,79,973**

C. Income Details:

Sl. No.	Particulars	Details
1	Production (ha)	8,000 no.s @ 0.20 kg = 1600 kg
2	Price per unit	**Rs. 400**
3	Total Revenue	**Rs. 640,000**

D. Economics:

Revenue (Rs.)	Production of 1600 kg	**6,40,000**
Total cost (Rs.)	(Fixed cost + Operating cost)	**1544973**
Fixed cost (Rs.)	Includes all capital cost	**11,65,000**
Operating cost (Variable Cost) (Rs.)	Includes variable cost and interest on working capital and fixed cost	**3,79,973**
Net profit	Revenue - Cost	**2,60,027**
Rate of return	Net profit / Total Cost	**0.17**
Profitability ratio	Net profit/Operating cost	**0.68**
Net profit ratio	Net profit/Revenue	**0.41**
Cost of production per unit (Rs.)	Variable cost/Output	237.48

[iv] ECONOMICS OF GROWOUT OF PEARL SPOT IN POLYCULTURE

- Stocking : 1/m^2 (8000 per ha)
- Species Mix: Mullet, Pearl Spot

A. Capital Cost:

Sl. No.	Particulars	Details	Cost
1	Earthern Pond	Construction of a 5 earthern pond of 2000 m^2 area @ Rs 100 per m^2	10,00,000
2	Pump set	A 5HP pump set	50,000
3	Provision of sluice gate/ Water exchange		20,000

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