

Table 2.

Group	Major group	Symptoms	Control measure
Parasites	Protozoa, Monogenea and Digenea	Skin irritation and rubbing against the hard surface and skin ulceration	Freshwater dip treatment
Bacteria	<i>Vibrio parahaemolyticus</i> , <i>V. alginolyticus</i> , <i>Streptococcus</i> and <i>Flexibacteria</i>	Haemorrhage, weakness, surface swimming and fin rot	Use of probiotics
Virus	Nodavirus & Iridovirus	Dark colouration, loss of equilibrium and mass mortality	Selection of disease-free juvenile fish

market demand. However, as size variation in the fish is more, phased mannered fish harvest would be an ideal. If entire pond is planned for harvest, then the majority are harvested by help of drag net and the remaining fish by draining out the entire pond. For phased harvest, hide outs made of PVC pipes or small branches are used. The hide outs are placed usually where feed is given, and the fish congregates in the hide out, then, through the use of cast net or lift net, the fish is harvested. Bigger fishes are collected and smaller fishes are released back for further growth. A type of production net cage of 6 x 3 x 1.5 m size can be installed in the pond, and the bigger fishes collected through cast net can be stocked in the net cage and fed till marketing. To maintain the freshness and quality of harvested fish, washing in clean water and chill killing is suggested. Harvested fishes are packed in plastic trays or thermocole boxes by adding layers of ice in equal quantities, both below and above the fish. It is suggested to harvest in the morning hours to maintain the freshness.



The fish is highly popular for international trade in live and chilled conditions. South East Asian countries and United Arab Emirates (UAE) countries are the major buyers for the fish. Groupers with their popularity for live fish trade in South East

Asian countries, the live fish fetches premium price of 3-4 time higher than the price of dead fish. Apart from live fish trade, chill fish is another major mode of export to other UAE countries.



Economics

The total operational expenditure and profit for culture of the fish in 1 acre water spread area is given in Table.3. Culturing the fish for one year at the stocking density of 3500 nos/acre will support the farmer with net profit of approximately Rs. 1.5 lakhs.

Sl. No	Particulars	Cost (Rs)
1	Pond preparation and water treatment	40,000.00
2	Seed cost - 3500 nos @ Rs 15/seed	52,500.00
3	Nursery rearing (hapa)	25,000.00
4	Live tilapia culture	25,000.00
5	Feed @ FCR 1:1 (for 2.4 tonnes of fish, approx. 2.5 tonnes of feed @ Rs 110/kg is required)	2,75,000.00
6	Electricity	50,000.00
7	Miscellaneous expenditure (labour for grading)	50,000.00
8	Expenditure (Sl no: 1-8)	517,500.00
9	Total income: Production of 2400 kg @ 80% survival with harvest size of 850 g and selling price of Rs 280/kg	6,72,000.00
10	Net profit : (9-8)	1,54,500.00

Best Management Practices (BMP) for coastal aquaculture

- ↳ Transportation of fingerlings of 10-15g size in polythene bags should be avoided.
- ↳ Seed stocking during winter season should be avoided.
- ↳ Grading in nursery is essential for reducing cannibalism.
- ↳ Hide-out should be used in grow-out culture pond.
- ↳ Mixed feeding (artificial and low value fish) helps for better growth.

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Coastal Farming of Orange-spotted grouper



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Introduction

Groupers are popular carnivorous fish in the global Live Reef Food Fish (LRFF) trade. Culture of some grouper species is being carried out around the world, and they have the potential to become an important aquaculture species because of high market price, consumer demand, good taste, fast growth, efficient feed conversion and hardiness. Coastal farming of the fish is mostly developed in South East Asian countries, mainly because of high commercial value in the live markets particularly in Hong Kong, Singapore and Taiwan. Among the groupers, around 20 species are cultured world-wide, and the dominating species vary depending upon the country of origin. Orange-spotted grouper, *Epinephelus cooides* is one of the important farmed grouper species. In India, hatchery seed production technology was standardized for the species by ICAR-CMFRI, Visakhapatnam Regional Centre. This was followed by pond culture demonstrations at different places of Andhra Pradesh with financial support from National Fisheries Development Board (NFDB) under Blue Revolution Scheme. The package of practices on coastal farming of the fish species has been developed as an outcome of the project and the details are presented.

Pond Preparation and Water Quality

Groupers can be cultured in earthen ponds of 500 m² to 1 ha water area. Usually, rectangular shape with 1-2 m depth and uniform pond bottom is suggested for easy harvesting. The pond site should have enough water sources with salinity ranging from 15 to 35 ppt. Pond site selected near to areas with sufficient source of live tilapia will have added advantage for the fish culture. During pond preparation, the pond should be drained and completely dried for a week or two or until the soil crack appears.

Water filling should be done with filter net bags of less than 100µ mesh. After filling water, the predators are killed either, by chlorination (10 ppm) or by liming or by other environmentally friendly organic fertilisers. General pond preparation and water treatment followed is more or less similar to the shrimp culture. Water fertilization is to be done by applying either organic or inorganic fertilizers for enhancing the growth of natural food in the pond. Organic fertilizers like cow dung or chicken manure are applied at the rate of 1 ton / ha. Inorganic fertilizers like urea and di-ammonium phosphate are applied at the rate of 50 Kg/ha. However, the dose may be increased or decreased depending on the pond fertility. Stocking of adult tilapia at 2500 to 5000 nos./Acre is recommended in grouper culture pond, as once this stocked tilapia starts reproducing; they will serve as natural food or prey for the grouper.



Nursery Culture

The optimum stocking size of grouper in grow out culture is 25 to 30 g, and if the available size is small (1-2 inch), then nursing of the fry should be done before stocking in the grow-out pond. Pond based nursery culture in hapa/cage is recommended in the same grow-out pond or in separate nursery culture pond. Rectangular cages/hapas are installed in the pond and are supported with bamboo or casuarina poles. The hapa dimension can vary from 4 x 2 x 1.5 m to 6 x 3 x 1.5 m with mesh sizes of 0.5 cm. The stocking density varies from 200 to 250 nos/m³. Immediately on stocking in the hapa/cage, the newly stocked fry do not respond to the pelleted feed, therefore, for a week, they have to be fed with chopped trash fish or moist feed. After acclimatisation to the pelleted feed, grouper fingerlings come to the surface for feeding. Grading of stocked fry based on size is to be followed on a weekly basis, to minimise the cannibalism. Extra net cage is needed to accommodate the fry graded based on the size.

Feed with higher nutrient content (45% Crude Protein & 10% Crude Fat) is suggested, although chopped or minced trash fish is the most preferred by the fish. While using minced trash fish, adequate care should be taken to maintain water quality. The recommended feeding rate in nursery is 8 to 10% and 15 to 13% for pelleted feed and trash fish, respectively with an optimum feeding frequency of 4-5 times/day. The fish fry stocked at 2 to 3 g usually takes 60 days to reach 25 to 30 g. The commonly available supplier for nursery feeds are: Skretting (Norway), Lucky star (Singapore), Uni-President Enterprises Corporation (Taiwan), Growel Feeds Pvt Ltd (India). Maintaining good water quality is paramount in nursery rearing. Adequate aeration should be provided in the nursery pond as the fish fry are stocked at high densities in the hapa. Maintaining dissolved oxygen level of 4 to 6 ppm is recommended through use of paddle wheel aerators. The recommended salinity for good growth is 15-35 ppt. Water pH can vary from 7.5 to 8.5, but high fluctuations in daily pH

due to algae in the pond increases the toxicity of ammonia, ultimately impacting the stocked fry, and therefore, has to be avoided.



Grow-out Culture

The grow-out culture phase involves rearing of grouper juveniles from 25-30 g to marketable size (>1000 g). Nursery reared grouper fingerlings are transferred, a month after tilapia brooders have been stocked in the grow-out pond. This ensures abundant availability of tilapia seeds when grouper fingerlings are stocked. The ideal stocking density for juvenile is 3500 nos/Acre. Apart from the live tilapia available in the pond, the fingerlings should also be fed with either dead chopped fish @ 5% of biomass or pelleted feed at 1-2% of biomass.

The total feed should be divided and given at the feeding frequency of 2-3 times per day and feeding should be done at the same place to acclimatize the fish for feeding. When chopped fish are provided as feed, adequate care should be taken to avoid the deterioration of water quality parameters. Determining the feeding rate depends on the fortnight growth. Grouper, during sampling, can be collected by a cast net. Based on the weight gain, subsequent feeding should be determined.

DOC	Fish Size (g)	Feed Size (mm)	Feeding Rate	Feeding Frequency (times/day)
0-60	25-75	1.8 to 3.0	8%	4
60-120	75-150	3.0 to 5.0	6-5%	4
120-180	150-275	5.0 to 6.0	5-4%	3
180-240	275-450	6.0 to 10.0	4%	3
240-300	450-650	10.0 to 10.5	3-2.5%	2
300-360	650-850	10.0 to 10.5	2%	2

(Note: When live tilapia is available in the pond, the feeding could be reduced by 50%)



Though the fish accepts artificial pelleted feed well, but it needs bigger pellet since the fish is having bigger mouth size. The fish being demersal in nature, use of aggregating substratum is recommended during grow-out culture, where the fish can hide and can also be fed at the particular location. However, use of hide-out may lead to increase in cannibalism if size difference exists. The fish growth, feeding frequency and feed used is given below (Table.1).



Disease Management

Three major disease-causing agents; parasites, bacteria and virus are mostly responsible for disease in orange spotted grouper culture. The details of the causative agent, symptoms and controlling measures are given in Table. 2. All diseases were associated with stress and the stressed fish are easily affected by the pathogens. Therefore, stress during culture should be minimized by maintaining good water quality, optimum feeding and stocking density. Among all, the virus infection can occur from hatchery produced larvae itself, so selecting active seed is an important measure to control the infection.

Fish Harvest and Marketing

Orange spotted grouper, being demersal, mostly remains in the bottom. Our observations indicated that the bigger fishes make pits in the pond bottom and remains in the pit. Few methods are employed for harvesting the fish based on the