indicator for the health status of the fish. Three major disease-causing agents (parasites, bacteria and virus) are mostly responsible for the disease in orange-spotted grouper culture. Freshwater dip treatment and use of praziquantel in feed are good controlling measures for parasitic infestation. Medicated feed and use of probiotic are suggested for controlling bacterial infection. Viral infection can occur from hatchery phase itself, selecting active and virus free seed is an important measure to control the viral disease. Moreover, all the diseases are associated with stress and thus stress during culture should be minimized by maintaining good water quality, optimum feeding and stocking density.

Fish harvest and marketing

Cage cultured fish remains in a small confined environment, so harvesting cage cultured fish is easier than any other culture methods. Immediately after harvest, washing in clean water and chill killing is suggested to maintain the freshness and quality of the harvested fish. Harvested fishes are packed in plastic trays or thermocole boxes by adding layers of ice in equal quantities at the bottom and top of the fish. 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, fetches premium price of 3-4 times higher than the price of dead fish. Apart from live fish trade, chill fish is another major mode of export to UAE countries.

Economics

The total operational expenditure and profit for culture of the fish in a battery of 10 cages is given in the Table 2. Culturing the fish for 10 months at the stocking of 20-25 nos/m^3 will support the farmer with net profit of approximately Rs. 13.5 lakhs.

Sl.No	Head of expense	Cost (lakh)
1	Depreciation value on cage and accessories with an average life of 10 years for cage frame and five years for cage mooring and nets (Cost of cage is INR 300,000/unit) and depreciation is INR 43,000/unit/year)	4.3
2	Cost of 25000 numbers of grouper seeds @ INR 20/seed	5.0
3	Cost of 32.0 tonne of pelleted feed (Survival 80%; Average Body Weight 1000 g at harvest) @ FCR 1:1.6 @ INR 100/kg of feed	32.00
4	Labour charges @ INR 30,000 month for 10 months	3.00
5	Boat hiring and fuel charges @ INR 6,000 month for 10 months	0.60
6	Charges for net exchange; Rs. 500/person for 3 persons, five times in the production cycle for each cage	0.75
7	Miscellaneous expenditure, feed medicines and probiotics	0.5
	Expenditure: (Sl no: 1-7)	46.15
8	**Total income:** Production: 20 tonnes @ 80% survival with harvest size of 1.0 kg at selling price of Rs 300/kg	60.00
9	**Net profit**: (8-7)	13.85

Best Management Practices (BMP) for grow out culture

- Cage should be installed in the location with the adequate water movement.
- Fish fingerlings of > 25g should be stocked for maximum survival.
- Grading should be done till fish reaches 100g for better survival.
- Cage net depth of 2.0 m should be maintained till the fish reaches 250g.
- Low value fish feed should be given along with artificial pelleted feed for better growth and to avoid size variations.
- Periodical monitoring of fish, cage net and other cage system is essential.

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Introduction

Aquaculture of groupers is carried out in tropical and subtropical areas throughout the world, but approximately 90% of the production is from Asia with major contribution from China, Taiwan province of China and Indonesia. Grouper aquaculture is notable for its high level of diversity; the orange-spotted grouper *(Epinephelus coioides)* is one of the important species and has been successfully cultured in cage based culture systems. Grouper culture in India using hatchery produced seeds is a recent initiative. At Visakhapatnam Regional Centre, Central Marine Fisheries Research Institute (CMFRI), under Indian Council of Agriculture Research (ICAR), researchers have succeeded in breeding and consistent seed production for the species. Cage culture technology for the species was standardized and demonstrated in different parts of Andhra Pradesh under Blue Revolution Scheme with financial support from National Fisheries Development Board (NFDB), Government of India. Various steps involved in cage culture of the species are explained below.

Cage site selection

Site selection is one of the most important factors for cage culture of the fish. The important selection factors are: water temperature: 26-30°C, depth: 6-10 m, continuous water movement for good dissolved oxygen content, away from polluted waters and industry run offs and easy accessibility for reaching cage site.

Cage Structure

Circular shaped HDPE cages of 6 meter dia inner collar and 8 meter dia outer collar pipes are supported by 8 base, 8 vertical and 8 diagonal supports. HDPE braided nets are suitable with following specification: outer nets of 7 m dia and 4 m depth, 40 mm mesh, 63 ply, 3 mm twine thickness; inner nets of 6 m dia and 4.5 m depth, 25 mm mesh; bird net of 80 mm nylon mesh are preferred. The cage structure is stabilized in the sea with the help of mooring systems supported by 2-3 tonne capacity cement blocks/gabion boxes/anchor systems with the help of mooring chain (long link alloy steel chain of 14 mm dia with 22 tonne shearing strength), D-shackles and swivel. Ballast pipes help to maintain the cage structure intact in proper shape against the water movement. In order to provide sufficient space for fish movement, the inner net has to be tied with two ballast pipes at bottom and middle.

Nursery rearing

Nursing is an intermediate stage undertaken after juvenile groupers (20-30 mm) leave the hatchery until they reach optimum size to be stocked in sea cages (20-25g). In general, the nursing is done in onshore tank facilities. Two types of nursery systems are suitable for the species with respect to cage culture:

1) Flow-through based FRP or concrete tank culture.
2) Hapa based nursery rearing in earthen ponds.

Feed with high nutrient content (crude protein - 45% and crude fat -10%) is suggested, and chopped or minced trash fish is also preferred. The recommended feeding rate is 10 to 8% for pellet feed and 15 to 13% for trash fish with a 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 in size.

The commonly available supplier for nursery feeds are: Skretting (Norway), Lucky star (Singapore), Uni-President Enterprises Corporation (Taiwan), Growel Feeds Pvt Ltd (India).

Grow-out culture

The nursery reared fish seeds are transported to cages either in oxygen filled polythene bags or in containers supported with oxygen. The suggested optimum stocking density is 20-25 nos/m^3, and thus, a 6 meter cage with 4 meter net depth will have to be stocked with 2500 numbers of fish seed. Grouper is a demersal fish, which remains always at the bottom, and therefore, less net depth is preferred for better feed acceptance based on visibility. Thus, the net depth of 2.0 m is recommended till the fish reaches 250g, thereafter the net depth is maintained as usual. Artificial floating pelleted feed with high nutrient (40% CP & 10% CF) is recommended for in grow out systems. In cages, fish fed with only artificial feed showed good growth response, but feeding with chopped low value fishes helped for further improving the growth rate and reducing size variations. When pellet feeds are applied, feed mesh net of 1 meter depth should be attached in the inner cage net to avoid feed wastage. In grow out culture, fish growth should be monitored fortnightly and feeding rate to be adjusted based on the weight gain after every fortnight sampling. The fish growth and optimum feeding rate is given in the Table 1.

DOC	Fish Size (g)	Feed Size (mm)	Feeding Rate	F.F (times/ day)
0-60	20-75	1.8-3.0	8%	4
60-120	75-150	3.0-5.0	6%	4
120-180	150-275	5.0-6.0	4%	3
180-240	275-450	6.0-10	3%	3
240-300	450-650	10-15	2%	2
300-360	650-900	10-18	1.5%	2

Note: F.F – Feeding frequency

Note: When mixed feeding of artificial pellet feed and low value fish is given together, then the low value fish should be given at 5-7% of fish body weight and artificial feed should be reduced by 50% of the original feeding rate.

Cage management

Cage culture of orange-spotted grouper requires minimum of one year, thus the cage structure should be managed well with timely net exchange, cage frame cleaning and mooring checking. The cage net is prone to barnacles, algal and silt accumulation and the rate of accumulation is depending on the season and the locations. However, the net should be exchanged at least once in two months. Cage frame is prone to barnacle's accumulation. Thus, this structure requires monthly cleaning. Cage mooring helps to keep the entire cage structure in position, thus the mooring chain requires continuous monitoring, at least once in a month. The mooring system specified for the cages will remain without much of a problem for a minimum of two years, and then slowly the chain starts eroding and then, based on the conditions, the chain needs to be changed.

Fish management

The cage cultured fish should be periodically checked for its feeding and health status by fortnight sampling. Apart from critical monitoring, daily observation while feeding is essential for understanding their feeding behavior, which is a good