Brief communication

Technology for farming of Orange spotted grouper in marine cage culture systems

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Introduction

Aquaculture of groupers is carried out in tropical and subtropical areas throughout the world, with registered total production of 155 000 t during 2017 (FAO, 2017). Approximately 95% of this production was registered from Asia with major contribution from China (65%), Taiwan Province of China (17%), Indonesia (11%) and Middle East (0.1%). Grouper aquaculture is notable for its high level of diversity, including 47 grouper species and 15 hybrids. Orange spotted grouper, *Epinephelus coioides* valued for its excellent texture and flavour and has good demand in international live reef fish trade, especially in South East Asian countries. Aquaculture of groupers in India using hatchery produced seed was initiated during 2016 – 2017 by Visakhapatnam Regional Centre of ICAR-Central Marine Fisheries Research Institute (CMFRI), following the success in continuous seed production of the species. Initial trials of in sea cages were conducted in different states such as Andhra Pradesh, Tamil Nadu, Kerala, Karnataka and Gujarat. Thereafter, the cage culture technology was demonstrated to different groups including, fishermen, fisheries societies and small entrepreneurs with financial support from the National Fisheries Development Board

Marine fish cage farm at Visakhapatnam

(NFDB), Government of India. Various steps involved in cage culture of the species have been standardised and are explained below.

Cage site selection

As one of the most important factors for cage culture, the selected site should meet the following criteria: Water temperature: 26–30°C, water depth 6-10 m, and away from polluted or industry run offs. Continuous and free water movement, to maintain good dissolved oxygen content of more than 3.5 ppm always which also helps to avoid parasites, is required. Easy accessibility and free from social disturbances should be considered.

Construction

Circular shaped HDPE cages of 6 m diameter inner collar pipe and 8 m diameter outer collar pipe are supported by 8 base supports, 8 vertical supports and 8 diagonal supports. HDPE braided nets are suitable with specification for outer nets of 63 ply, 40 mm mesh size and with net dimensions of 7 m diameter and 4 m depth. Inner HDPE nets are of 63 ply, 25 mm mesh size and with dimensions of 6 m diameter and 4 m depth. The mesh size for inner net varies with the growth of the fishes stocked in the cages, and a mesh size of 10 mm is used till the stocked fish reaches 100g. Bird's net of 80 mm nylon mesh are preferred for fish culture. The cage structure is stabilised in the sea with the help of mooring systems supported by 1.5-2.0 tonne capacity cement blocks/gabion boxes/ anchor systems, with the help of mooring chain (long link alloy steel chain of 13 mm diameter with 22 tonne shearing strength), D-shackles (6.5 tonnes) and swivel (32 mm). Ballast pipes help to maintain the cage structure intact in proper shape against the water movement. To provide sufficient space for fish movement, the inner net has to be tied with two ballast pipes; one at the bottom and the other at the middle of the inner net for avoiding closure of the net due to the water movement.

Nursery rearing

This is an intermediate step after juvenile groupers (2-3 cm) from the hatchery are reared until they reach an optimum size to be stocked in sea cages (20-25g). Generally, this is done in onshore tank facilities established near the grow-out culture for ease of fish transfer. Two types of nursery systems: 1) Indoor system: Flow-through based FRP or concrete tank culture 2) Outdoor culture: Hapa based nursery rearing in earthen ponds or in sea cages are available. Among these, indoor culture system is better as less size variation, higher survival and better ease of operation.

In both nursery systems, feed with high nutrient content (crude protein 45% and crude fat 10%) is suggested, but chopped or minced trash fish is the most preferred by the grouper. In indoor based nursery system, the fingerlings showed good response to both artificial and pelleted feeds, but pellet feed prepared as the use of minced meat deteriorates the water quality quickly. However, in outdoor based nursery culture, a mix of artificial and pelleted feed for efficient feeding is recommended. The feeding rate in nursery is 8 to 7% and 15 to 13% for pelleted feed and trash fish, respectively. The stocked fish fry of 2 to 3 g usually takes 75 days to reach about 20 to 25 g in size. Feeding frequency of 4-5 times per day at 10-7% of body weight is recommended during the initial nursery phase. The commonly available nursery feeds are: Skretting (Norway), Lucky star (Singapore), Uni-President Enterprises Corporation (Taiwan), Growel Feeds Pvt Ltd (India) and Ananda Feed Pvt Ltd (India). Growth rate is slow during the initial growth phase till it reaches 250g, and thereafter increases. Hence, nursery culture of Orange spotted grouper is an important factor in cage culture operation for reducing the culture duration. Due to size variation during nursery rearing cannibalism is observed. To avoid cannibalism, it is suggested to maintain uniform size of the fish by fortnightly grading of the fishes. Survival rate during nursery phase varies from 90-95% in indoor systems and 70-85% for outdoor systems. Proper feeding and fortnight grading helps to improve the survival rate during nursery phase

Nursery rearing of orange spotted grouper fingerlings in hapa in cage

Grow-out culture

Grow out culture is the period following nursery rearing till marketing of the fish. The nursery reared fish seeds are transported to cages either in oxygen filled polythene bags or in containers supported with oxygen where they are slowly released for acclimatising to the cage water environment. The optimum stocking density suggested for the fish is 20 kg of final production per cubic meter area. Therefore, net with 6 m diameter and 4 m depth will occupy an approximately 110 cubic meter area which can produce 2.0 tonnes of fishes. To achieve the estimated production total 2500 seeds should be stocked with an expected survival of 80% and final body weight of around 1.0 kg. Groupers are demersal and always remains at the bottom. Hence net with low depth will help for higher visibility of feed. Therefore, at the beginning of the culture, the net depth of 2.0 m should be preferred. Once the fish size exceeds 250g, then the net depth can be maintained as usual. Artificial floating pelleted feed with high protein is recommended for grow out systems. It requires bigger sized pelleted feed during grow-out since the mouth size is bigger compared to other fishes of same size group. Feed size is most important for efficient feeding. In cages, fish fed with only artificial feed showed good growth response, but size variations were observed. However, feeding with chopped low value fishes not only reduced this size variation but also exhibited good growth. When pellet feeds are applied, feed mesh of 1.0 meter depth should be attached in the inner net to avoid feed wastage. For better feed digestion and assimilation, a minimum time gap of 3 hours should be given between two feeding schedules and the feeding frequency decided accordingly. Feeding is required at least twice a day to maintain good health of the fishes. Fish growth should be monitored fortnightly and feeding rate adjusted based on the weight gain after every sampling. Based on several demonstrations, it is observed that if the fish fingerlings of 20 to 25g are stocked at 20 numbers per m^3, then it takes nearly 12 months for it to reach the size range of 650 to 800 g and approximately 1.5 kg is reached in 15 to 16 months. The fish growth and optimum feeding rate is given in the Table.1.

Cage structure management

A minimum of one year to obtain marketable size fish is involved in the cage culture of orange spotted grouper. Hence, the cage structure should be sturdy and well designed. Some of the activities involved in cage management are net exchange, cage frame cleaning and checking of mooring. The cage net is prone to infestation with barnacles, algae and silt accumulation and adds extra weight to the nets. Hence, the net has to be changed periodically depending on their accumulation, varying with the seasons and locations. Based on the experiences from north Andhra coast, net exchange is required at least once in two months. If this is not done promptly, the net may tear off due to the load and it also impacts the buoyance of the cage frame. Cage frames which also act as a walkway are prone to the accumulation of barnacles that leads to tearing of the net ropes through rubbing and also reduces the durability of the frame. Hence it requires monthly cleaning. Cage mooring which keeps the entire cage structure in position, requires monitoring of the mooring chain, at least once in a month. The mooring system specified for the cages last for a minimum period of two years, and then needs to be changed based on the conditions of the chain.

Table 1. Feeding Schedule in grow-out system.

Days of Culture (DOC)	Size (g)	Feed Size (mm)	Feeding Rate (@ %body weight)		Feeding Frequency (per day)
			Artificial feed (A.F)	A.F + Low value fish	
0-60	20-75	1.8 to 3.0	8%	4% + 5%	4
60-120	75-150	3.0 to 5.0	6-5%	3% + 5%	4
120-180	150-275	5.0 to 6.0	5-4%	2% + 5%	2
180-240	275-450	6.0 to 1.0	4%	2% + 5%	2
240-300	450-650	1.0 to 1.5	3-2.5%	1% + 5%	2
300-360	650-800	1.5 to 1.8	2%	1% + 5%	2
360-450	800-1500	1.5 to 1.8	1.5%	0.5%+5%	2

Cage maintenance – Process of net exchange

Cage maintenance – Cleaning of cage frame

Fish health management

The cage cultured fish should be periodically checked for its feeding and health status, and should be sampled fortnightly. Apart from critical monitoring while sampling, daily observation of their feeding behaviour, which is a good indicator for the health status of the fish, is required. Three major disease-causing agents (parasites, bacteria and virus) that are mostly responsible for the diseases in orange spotted grouper culture systems and their controlling measures are given in Table 2. All diseases are associated with stress and the stressed fish are easily affected by the pathogens. Therefore, stress during culture should be minimised by maintaining good water quality, optimum feeding and stocking density. Among all, the virus infection can occur from hatchery produced larvae itself, so selecting an active and disease free larvae is an important measure to control the infection.

Fish harvest

Cage cultured fish being in a small confined environment, harvesting is easier than any other culture methods. Mostly the fish remains at the bottom and hence, during the harvest, the inner cage net should be lifted from all four sides and hung from hand rails of the cage frame. The fishes in the inner net are the harvested with the help of

Table 2. Important disease and their control in cage culture

Disease causing agents	Major groups	Symptoms	Control measures
Parasites	Protozoa, Monogena and Digenea	Skin irritation and rubbing against the hard surface and skin ulceration	Freshwater dip treatment
Bacteria	*Vibrio parahaemolyticus*, *V..alginolyticus, Streptococcus* and *Flexibacteria*	Haemorrhage, weakness, surface swimming and fin rot	Use of probiotics
Virus	Nidovirus and Iridovirus	Dark colouration, loss of equilibrium and mass mortality	Selection of disease-free juvenile fish

Harvest of orange spotted grouper from sea cages and transportation to shore in boats

Harvested orange spotted grouper with ice packing

a hand scoop net. Immediately after harvest, washing in clean water and chill killing is suggested to maintain the freshness, colour and quality of the harvested fish. These are packed in plastic trays or thermocol boxes by adding layers of ice in equal quantities at the bottom and top of the fish. Harvest of the fish in the early morning hours helps to maintain their freshness.

Fish marketing

The fish is highly popular in international trade in live and chilled conditions with Southeast Asian countries and United Arab Emirates (UAE) being the major markets. For live fish trade in Southeast Asian countries, premium price that is 3-4 time higher than the price of dead fish

can be got. Chilled fish is another major mode of export of bigger sized fish each 1.5 – 2.0 kg, especially UAE. Colour of the fish plays an important role in marketing with pale white with clear orange spot fetching higher price than the black coloured fish with orange spots. Therefore, during harvest, minimum stress and services of a fish cold chain should be ensured.

Table 3. Economics of farming orange spotted grouper in marine cages

Expenditure item	Cost in ₹ (in lakhs)
Depreciation value on cage and accessories with an average life of 10 years for cage frame and five years for cage mooring and nets	4.3 (Cost of cage and accessories including installation: ₹300,000 per unit and depreciation is ₹43,000 per unit per year)
Operational expenditure	
Cost of 25000 numbers of grouper seeds of 20 g in size	5.0 @ ₹20 per seed (including nursery rearing expenses)
Artificial feed: Cost for 35.0 tonnes of extruded pelleted feed (Survival 80%; Average Body Weight 1 kg at harvest) at FCR 1:1.75 at ₹100 per kg of feed	35.00
Low value fish feed: Cost for 100 t of low cost fish feeds (Tilapia/trash fish) (Survival 80%; Average Body Weight 1000 g at harvest) at FCR 1:5.0 at ₹30.0 per kg of fish feed : total cost ₹30.0 lakhs per annum Additional expenditure towards preserving and processing the low value fish feed (Freezer, electricity and cutting machine) at ₹2.0 lakhs per annum (Cost for feed and feed maintenance)	32.0
Labour Charges at ₹36000 per month for 12 months (@ ₹10,000 per person for three person)	3.60
Boat hiring and Fuel charges at ₹6000 per month for 12 months	0.72
Charges for net exchange at ₹500 per person for 3 persons, five times in the production cycle for each cage	0.75
Miscellaneous expenditure feed medicines and probiotics	0.5
Expenditure (SI No: 1-7)	49.87 (with Artificial feed) & 46.87 (with low cost fish feed)
Total income: Production: 20 tonnes at 80% survival with harvest size of 1.0 kg @ average selling price at ₹300 per kg	60.00
Net profit : (8-7) (lakh₹)	10.13-13.13

Economics

The total operational expenditure and profit for culture of the fish in a battery of 10 cages is given in the Table 3. Culturing the fish for 12 months at the stocking of 20 per m^3 will support the farmer with minimum net profit of approximately ₹10 lakhs with price realization of ₹300 per kg of fish. An additional ₹3 lakh could be earned by using low cost fishes as feed instead of artificial fish feed. However, the profit may vary depending on the market price of the low value fishes. Also, use of the low value fish feed is laborious as it requires fish storage and fish cutting before feeding. Continuous availability of the low value fish feed is uncertain due to increasing demand and frequent changes in availability.

The Best Management Practices (BMP) for grow out culture of orange spotted grouper can be summarised as below:

1. Periodical fortnight grading during nursery rearing is essential to reduce cannibalism.
2. Cages should be installed where water movement ensures optimum concentration of dissolved oxygen
3. Fish fingerlings of > 20g should be stocked for maximum survival
4. Cage net depth of 2.0 m should be maintained till the fish reach 250g
5. Inner cage net should be additionally supported with a middle ballast pipe for maintaining the round shape and avoiding folding of the net.
6. Low value fish feed should be given along with artificial pelleted feed for better growth and to avoid size variations
7. Periodical monitoring of fish, cage net and other cage system
8. Stress should be avoided while harvesting and the harvested fish should be maintained in ice till packing.