



## Adoption of sea cage farming of cobia (*Rachycentron canadum*) by fishermen self-help groups as a diversified livelihood option: A success story from Ramanathapuram District, Tamil Nadu, India

B. JOHNSON, A. K. ABDUL NAZAR, R. JAYAKUMAR, G. TAMILMANI, M. SAKTHIVEL,  
P. RAMESHKUMAR, G. GOPAKUMAR AND P. U. ZACHARIA\*

Mandapam Regional Centre of ICAR-Central Marine Fisheries Research Institute, Mandapam - 623 520, Ramanathapuram  
Tamil Nadu, India

\*ICAR Central Marine Fisheries Research Institute, Kochi - 682 018, Kerala, India

e-mail: jsfaith@gmail.com

### ABSTRACT

The ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI) is the pioneer in developing the technology for cage fish farming in India. Cobia (*Rachycentron canadum*) grows relatively fast in cages and is very much suited for small scale mariculture to meet the alternate livelihood needs of fisherfolk. Mandapam Regional Centre of ICAR-CMFRI has developed the technology for breeding, seed production and farming of cobia in cages and organised training, and frontline/participatory demonstration programmes which have aided in creating awareness about the techno economic viability of cage farming among the fisherfolk in Ramanathapuram District, Tamil Nadu. A survey was taken up among a sample of 75 members of fisher self help groups (SHGs) who had adopted cage farming of cobia, in order to assess their perception and attributes about the technology as well as the constraints faced by them. The study found that fast growth rate of cobia, shorter culture period, good farm gate price, high market demand, ease of farming near the seashore and seed availability were the important attributes which attracted the fishermen groups to take up the farming. The innovations introduced by the fishers in cage farming technology were also documented. Majority of the fishers stated, non-availability of seed during peak stocking season, high cost of pellet feed, fluctuating cost of low value fishes which are used as feed for cobia and poaching as major constraints in cage farming.

Keywords: Adoption, Cage farming, Cobia, Demonstration, Innovation

### Introduction

Global aquaculture production during 2014 was 73.8 million t, out of which, 36% (26.7 million t) was contributed by mariculture. The share of finfish in mariculture production was 23.6% (6.3 million ts) (FAO, 2016a). In recent years, seed production and farming of cobia (*Rachycentron canadum*) is rapidly gaining momentum in many Asian countries (Liao and Leano, 2007). In early 1990s Taiwan introduced the cage culture of cobia (Liao *et al.*, 2004) and at present nearly 23 countries have initiated seed production and farming of cobia (Nhu *et al.*, 2011). The global aquaculture production of cobia during 2014 was 40,000 t (FAO, 2016b) which is almost double the production in comparison to the year 2005. Cobia production is also reported in the United States, Puerto Rico, Bahamas, Martinique, Belize, Brazil and Panama (Bennetti *et al.*, 2008). India is a late starter in cobia research and the Mandapam Regional Centre (MRC) of the ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI) has developed the technology for

breeding, seed production and farming of cobia in cages to meet the need of fisherfolk for carrying out small scale mariculture. Cage farming of cobia was experimented for the first time in India at the MRC of ICAR-CMFRI with hatchery produced fingerlings during 2011-12. The results of several demonstrations revealed that cobia is a lucrative species for sea cage farming and it can reach an average weight of 2 to 3 kg in 6 months and 4 to 8 kg in one year of culture period (Gopakumar *et al.*, 2014). In America and the Caribbean, they could successfully grow cobia upto 6 kg in approximately 12 months in snapper farm (Benetti *et al.*, 2010). Therefore cage farming of cobia fish is a comparatively better alternate livelihood option to sustain the income of the marine fishers' household.

The fish catch or harvest from marine capture fisheries in Palk Bay and Gulf of Mannar region of Tamil Nadu is in a stagnation phase over the last few years (Johnson *et al.*, 2016). In order to address the issue of declining capture fisheries, the major management strategy followed worldwide is the adoption of fishing holidays. Another

option is to ban trawling in a phased manner after making alternative livelihood options to the fisherfolk. Under this situation, the MRC of ICAR-CMFRI developed the technology for mariculture of cobia (*R. canadum*) in cages as a viable livelihood option for the fisherfolk. As a result of the initiatives taken by the Research Centre, cage farming of cobia is being adopted in the Ramanathapuram District with the support of developmental agencies. In this context it has become necessary to know the socio-economic impact of cage farming. Hence, a study was conducted to assess the economic viability and technological perception about sea cage farming of cobia from all the fishermen groups who are presently involved in farming in Ramanathapuram District, south India.

**Materials and methods**

The study adopted ex-post-facto research design and primary data were collected from 75 members of the fisher self-help groups (SHGs) from six villages who had adopted cobia farming in Ramanathapuram District of Tamil Nadu. Data collection was done through interview method using a structured questionnaire and focus group discussions. The data obtained from respondents were systematically tabulated for the purpose of analysis and to arrive at meaningful conclusions.

*Tools for analysis*

The economic performance of cage farming of cobia was assessed by working out the annual fixed cost,

operating cost, gross revenue, net profit and net operating income.

$$\text{Net profit} = \text{Gross revenue} - \text{Total cost of production} \dots\dots\dots (1)$$

$$\text{Net operating income} = (\text{Gross revenue} - \text{Total operating cost}) \dots\dots\dots (2)$$

$$\text{Operating ratio} = (\text{Total operating costs} / \text{Gross revenue}) \dots\dots (3)$$

Operating ratio relates variable costs to gross income and is an indicator of economic efficiency.

The list of attributes which attracted the fishermen groups to take up sea cage farming was ranked using Garrett's Ranking Technique. It provides the change of orders into numerical scores.

Garrett's formula (conversion of ranks into %)

$$\text{Percent position} = 100 * (R_{ij} - 0.5) / N_j \dots\dots\dots (4)$$

where,  $R_{ij}$  = Rank given for  $i^{th}$  factor by  $j^{th}$  individual;  $N_j$  = No. of factors ranked by  $j^{th}$  individual.

The percent position of each rank was converted into scores by referring to the table (Garrett and Woodworth, 1969). The scores of each respondent were added together against respective factor. It was then divided by the total number of respondents for whom scores were added. In descending order, the mean scores for all the factors were arranged, ranks were given and the most important attributes were identified.



Fig. 1. Map showing the sites of cage farming of cobia in Ramanathapuram District

## Results and discussion

The techno-economic viability of open sea cage farming of cobia has been successfully demonstrated by the MRC of ICAR-CMFRI through Public Private Partnership (PPP) programmes during 2012-13. Realising the profits in sea cage farming, a fishermen SHG namely, Cobia Fisherman Welfare Association, from Rameswaram, took up sea cage farming with the technical support of MRC of ICAR-CMFRI. This was the first sea cage farming venture by a fishermen SHG, incurring all the expenditures involved. Their success motivated many fishermen groups to seek financial assistance from Ramanathapuram District Administration, to take up sea cage farming of cobia. Based on the requests received, the Government of Tamil Nadu mooted a new scheme under State Balanced Growth Fund to assist 10 SHGs to take up sea cage farming with 90 % subsidy for two cages per group. As a result of the initiation taken by the MRC of ICAR-CMFRI, about 25 groups adopted the technology in this region (Fig. 2).

It is evident from the results presented in Fig. 3, that 71 % of the fishers involved in cage farming belonged to the young age group (20-40 years), whereas only 29% of the fishers belonged to the middle age group (40-50 years). Hence it is very clear that the farming is mainly taken up by young and middle age group which is a good trend for the future.

### Sources of information on cage farming of cobia

The information about the technology has spread to different parts of the District through individuals, groups and mass contact (Table 1). The major communication channel was training programmes and demonstrations organised by the research institute (ICAR-CMFRI) (65%), followed by State Fisheries Department, Ramanathapuram (20%); mass media (10%) and individual contacts (5%) (farmer to farmer approach).

### Fishermen perception on sea cage farming of cobia

The fishermen groups expressed that the farming ideally could be carried out in the Gulf of Mannar and Palk Bay region during November-April and May-October,

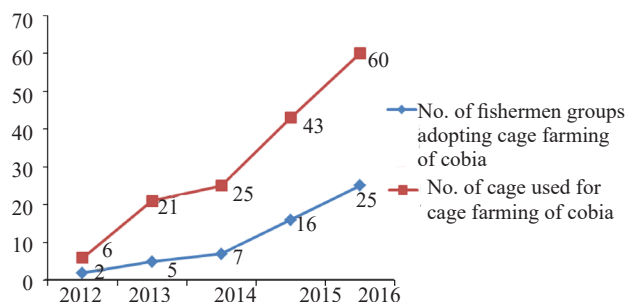


Fig. 2. No. of fishermen groups adopted sea cage farming of cobia in Ramanathapuram District with the technology support of ICAR-CMFRI

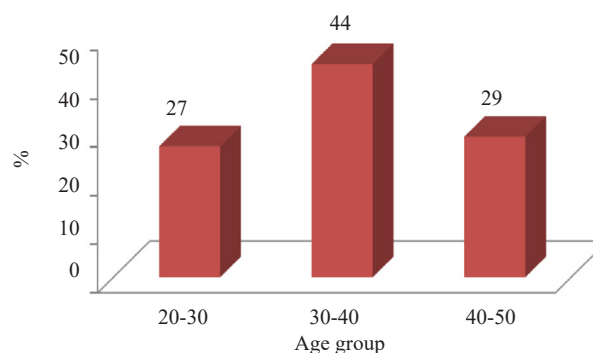


Fig. 3. Percentage of fishermen involved in cage farming based on age

Table 1. Source of communication to know about cage farming of cobia

Source	(N=75)	
	Percent	
Research Institute (ICAR-CMFRI)	65	
Tamil Nadu State Fisheries Department	20	
Mass media (Radio/Internet/Regional TV channels)	10	
Friends and neighbours	5	

### Adoption of sea cage farming of cobia

Garrett's Ranking Technique was used to identify and rank the attributes which attracted the fishermen groups to take up cage farming of cobia (Table 2). Relative advantage in the form of fast growth rate of cobia, easy farming methods and better economic returns, good farm gate price, availability of stockable size fingerlings, shorter culture period and high market demand were the important attributes ranked by the fishers, which motivated them to take up sea cage farming of cobia. The yield and economic returns from the farming was one of the major factors which contributed to the spread of this technology. Various agencies like research institutes (ICAR-CMFRI), Tamil Nadu State Fisheries Department and the Ramanathapuram District Administration played significant roles in successful adoption of this technology by the SHGs (Fig. 4, 5, 6, 7).

Table 2. Important attributes which attracted the fishermen groups to take up cage farming of cobia

Attributes	(N=75)	
	Garrett Rank	
Fast growth rate	I	
Shorter culture period	V	
Good farm gate price	III	
High market demand	VI	
Farming near the seashore	VII	
Availability of stockable size fingerlings	IV	
Easy farming methods and better economic returns	II	

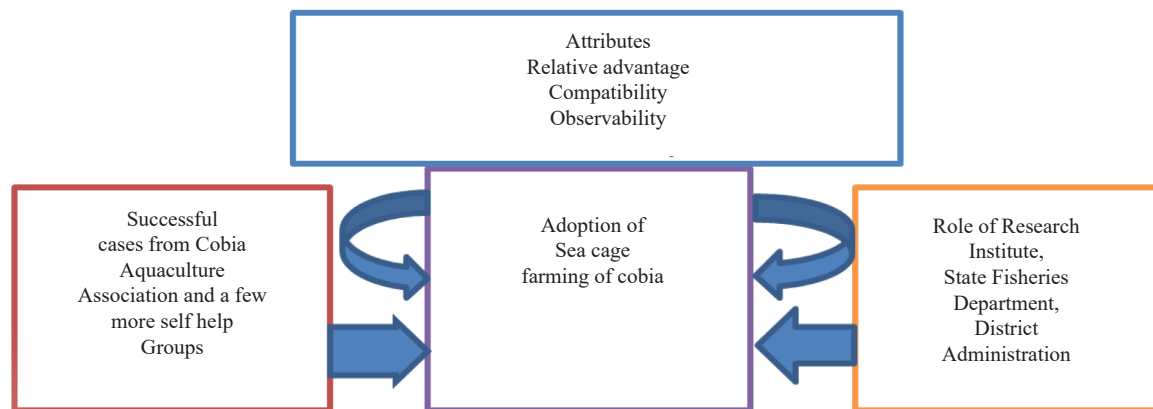


Fig. 4. Attributes and agencies that played a significant role in adoption of cage farming of cobia



Fig. 5. Cage farming by a fishermen SHG, Thangachimadam



Fig. 6. Cage farming by Cobia Aquaculture fishermen Association



Fig. 7. View of harvested cobia

respectively. They also strongly agreed that sea cage farming can increase the marine fish production and can supplement the capture fisheries in future and provide additional income to their households. They agreed that it serves as a fish aggregating device and could observe fishes like Terapon, Carangids, Silverbellies, Rabbitfish and Mulletts, near the cage site. The MRC of ICAR-CMFRI has successfully conducted the demonstration of Integrated Multi Trophic Aquaculture (IMTA) under participatory mode with a fishermen group at Munaikadu (Palk Bay), Tamil Nadu by integrating seaweed *Kappaphycus alvarezii* with cage farming of cobia. By witnessing and

adopting IMTA, majority of fishers agreed that integrating the seaweed with cage farming of cobia could serve as bio-mitigation along with increased biomass production (Table 3).

#### *Innovations introduced by fisherfolk in cage farming*

The innovative modifications made by the fishers in cage farming technology were also documented during the study. In order to protect the barrels tied to the cage frame from the scorching sun, fishers placed gunny bags over the barrel (Fig. 8) which helped to enhance the economic life of the barrels. Farmers applied their idea of fibre moulding

Table 3. Fishermen perception on sea cage farming of cobia (N=75)

Statements	%
Sea cage farming will contribute additional income to the household	100
Sea cage farming will supplement the capture fisheries	40
Sea cage farming may pave a way to reduce the fishing pressure	70
Sea cage farming may reduce the conflict among different sectors in fishery	60
Sea cage farming will address the problem of depletion of fishery resources	55
Sea cage farming serve as a fish aggregating device	100
Integrating the seaweed with cage farming of cobia will serve as bio-mitigation along with increased biomass production	80

at the weld joints in the cage frame (Fig. 9) which also helped to increase the life of the cage. Instead of epoxy coating over the cage frame, farmers applied rubber paint/tar which prevented rusting of GI pipes (Fig. 10) and reduced cost incurred for coating by 20 times. In cage farming, poaching is one of the major issues and to prevent this, farmers kept battery operated lights in each cage (Fig. 11). These lights automatically go off during day time and glows during night time.

#### *Economics of sea cage farming of cobia (for one cage and one crop)*

The cost for making one 6 m dia GI (Galvanized Iron) cage is ₹1,25,000/-. It includes cost of 'C' class GI pipe (1.5 inch dia), mooring materials and nets (2 inner



Fig. 8. Gunny bags placed over the barrels

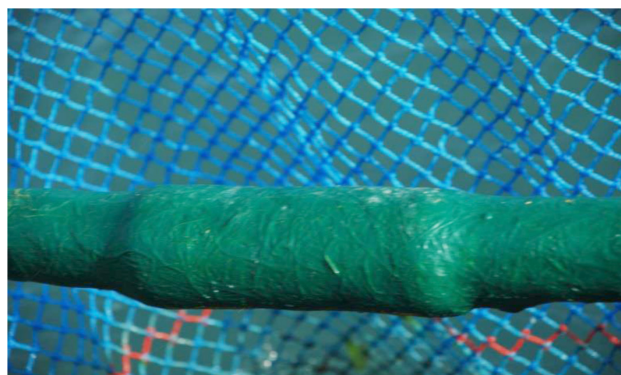


Fig. 9. Fibre molding at the weld joints



Fig. 10. Tar coating over the GI Pipes



Fig. 11. Provision of battery operated lights in the cage

net and one outer net with ballast pipe). The variable costs of production was 185 kg<sup>-1</sup> and sale price realised was ₹300 kg<sup>-1</sup> (Table 4). An yield of 1,950 kg was obtained in seven months and gross revenue of ₹5.85 lakhs was obtained. The income over operating cost was ₹2.25 lakhs (Table 4). The average operating ratio for sea cage farming of cobia was 0.62, which implied that 38 % profit was realised in cage farming.

#### *Constraints in sea cage farming of cobia as perceived by the fishermen*

Most of the fishers stated that non-availability of seed during peak stocking season (90%), high cost of formulated

Table 4. Economics of sea cage farming of cobia during 2016-17 (for one cage and one crop)

S. No.	Particulars	750 cobia seeds were stocked in a 6 m dia and 3.5 m depth GI cage	(₹)
1	Fixed cost (one cage)		1,25,000
	• Cost of 6 m dia cage made of 'C' class GI pipe of 1.5 inch diameter	- ₹50,000/-	
	• Mooring materials	- ₹15,000/-	
	• Nets (2 Inner net and one outer net with ballast pipe)	- ₹60,000/-	
	• Annual fixed cost [Depreciation (20%) and Interest on fixed capital (12%)]		40,000
2	Total operating cost		3,60,000
	• Cost of 750 nos. of cobia seeds @ ₹ 15 per seed	- ₹11,250/-	
	• Transportation cost	- ₹5,000/-	
	• Cost of 11.70 t of low value fishes @ ₹25,000 per ton (Feed conversion ratio = 1 : 6)	- ₹2,92,500/-	
	• Labour charges @ ₹1,000/- per person per month for 2 persons x 7 months	- ₹14,000/-	
	• Boat hiring and fuel charges	- ₹20,000/-	
	• Harvesting charges	- ₹5,000/-	
	• Miscellaneous expenses	- ₹12,250/-	
3	Total cost of production		4,00,000
4	Yield of farmed fish (kg) (average weight 3 kg, 86.6 % survival)		1,950
5	Gross revenue (@ ₹ 300 per kg)		5,85,000
6	Net profit from first crop		1,85,000
7	Net operating income		2,25,000
8	Average price realised (₹ per kg)		300.00
9	Variable cost of production		185
10	Operating ratio		0.62

pellet feed (90%), fluctuating cost of low value fishes used for feeding fishes (90%) and poaching (80%) as the major constraints (Table 5). Two-fifth of the fishers expressed that farm gate price of harvested cobia was comparatively less during the months of October-December (₹210- 230 per kg) as non-vegetarian consumption is less during these months owing to many traditional festivals.

Adoption of sea cage farming of cobia is in take off stage and may pave a way to reduce the fishing pressure and contribute additional income to the fisher household. Research institutes, developmental agencies, private hatcheries and feed mills should address the issue of seed and feed. Integrated Multi Trophic Aquaculture (IMTA) as a bio-mitigation can be adopted wherever possible. It was found that this practice was an eco-friendly option with sustainable income to the coastal fishers.

Table 5. Constraints on sea cage farming of cobia as perceived by the fishermen (N=75)

Attributes	%
Non-availability of cobia seeds during peak stocking season	90
Non-availability of low value fishes during ban period	90
Fluctuating cost of low value fishes	90
Poaching	80
Farm gate price of harvested cobia is comparatively less during the months of October - December	40

## Acknowledgements

The authors are thankful to the Director, ICAR-CMFRI, Kochi for guidance and support. The study was conducted with financial support from the ICAR-NICRA project (2020600006).

## References

- Bennetti, D. D., Mehmet, R., Bruno, S., Brian, O. H., Aaron, W., Ronald, H., Ian, Z., Jose, A. R., Bristol, D., Donald, B., Kevin, P. and Fernando, C. 2008. Advances in hatchery and grow-out technology of cobia, *Rachycentron canadum* (Linnaeus). *Aquac. Res.*, 39: 701-711. <https://doi.org/10.1111/j.1365-2109.2008.01922.x>.
- Benetti, D. D., Brian, O. H., Jose, A. R., Aaron, W. W., Christopher, M. and Refik, O. M. 2010. Growth rates of cobia (*Rachycentron canadum*) cultured in open ocean submerged cages in the Caribbean. *Aquaculture*, 302: 195-201.
- FAO 2016a. *FishStat J version 3.01: Universal software for fishery statistical time series: Aquaculture production 1950-2014; Capture production 1950-2014*. Fisheries and Aquaculture Department, Fishery Information, Data and Statistics Unit, Food and Agriculture Organisation, Rome, Italy.
- FAO 2016b. *The state of world fisheries and aquaculture 2016, Contributing to food security and nutrition for all*. Food and Agriculture Organisation, Rome, Italy, 200 pp. <http://www.fao.org/3/a-i5555e.pdf>.
- Garret, H. E. and Woodworth, R. S. 1969. *Statistics in psychology and education*. Vakils, Feffer and Simons Pvt. Ltd., Mumbai, 329 pp.

- Gopakumar, G., Abdul Nazar, A. K., Jayakumar, R., Tamilmani, G. and Sakthivel, M. 2014. Strategies and way forward to augment seafood production through finfish mariculture. *Mar. Fish. Infor. Serv., T & E Ser.*, 219: 3-7.
- Johnson, B., Nazar, A. K. A. and Jayakumar, R. 2016. Analysis of training effectiveness of marine ornamental fish culture training programmes. *Mar. Fish. Infor. Serv., T and E Ser.*, 229: 3-7.
- Liao, I. C. and Leano, E. M. 2007. *Cobia aquaculture: Research, development and commercial production*. Asian Fisheries Society, Manila, Philippines; World Aquaculture Society, Louisiana, USA; The Fisheries Society of Taiwan and National Taiwan Ocean University. Keelung, Taiwan, 178 pp.
- Liao, I. C., Huang, T. S., Tsai, W. S., Hsueh, C. M., Chang, S. L. and Leano, E. M. 2004. Cobia culture in Taiwan: current status and problems. *Aquaculture*, 237: 155-165. DOI: 10.1016/j.aquaculture.2004.03.007.
- Nhu, V. C., Nguyen, H. Q., Le, T. L., Tran, M. T., Sorgeloos, P., Dierkens, K., Reinertsen, H., Kjorsvik, E. and Svennevig, N. 2011. Cobia, *Rachycentron canadum* aquaculture in Vietnam: Recent development and prospects. *Aquaculture*, 315: 20-25.

Date of Receipt : 07.02.2017

Date of Acceptance : 18.06.2019