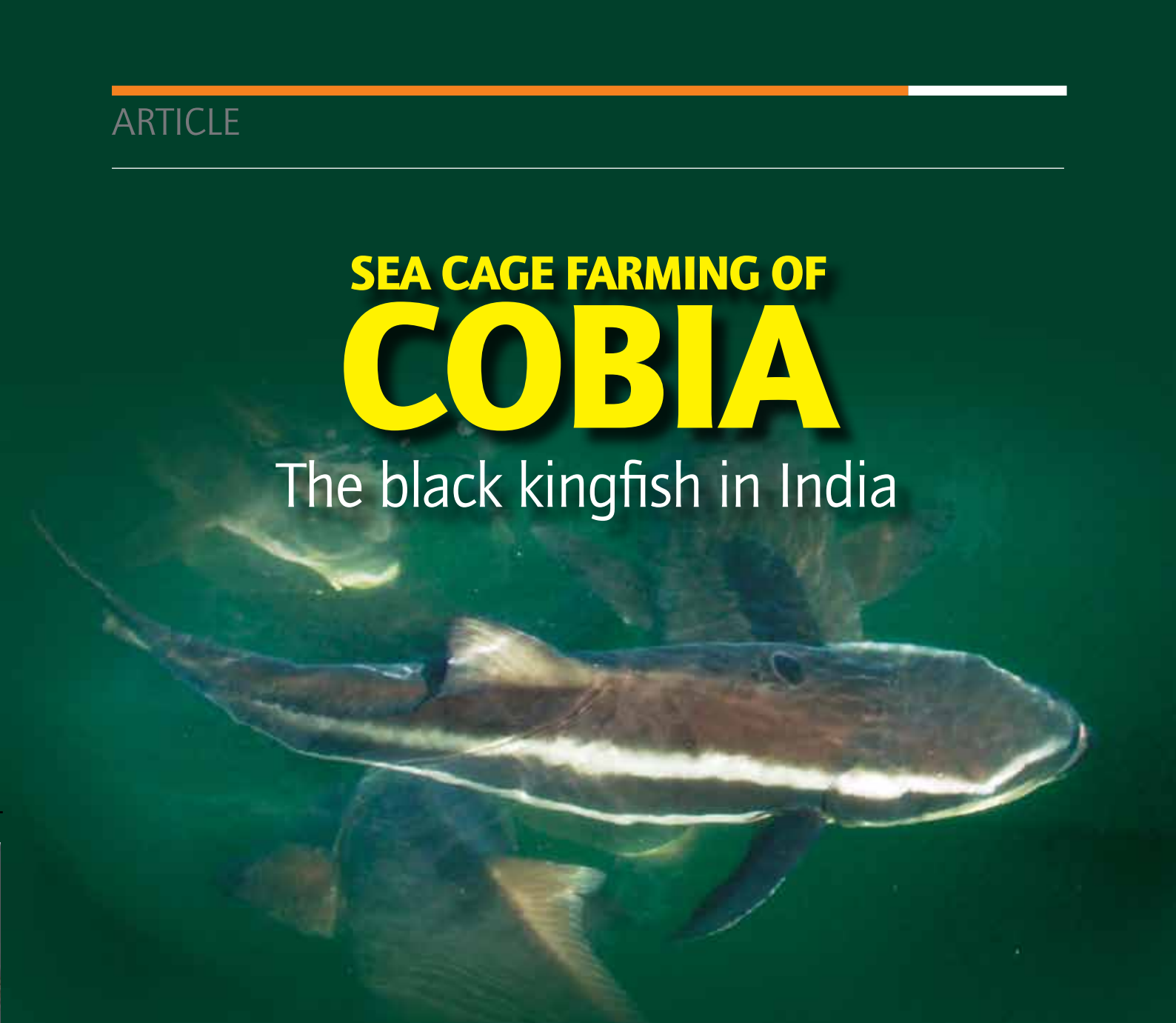
SEA CAGE FARMING OF COBIA

The black kingfish in India



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Introduction

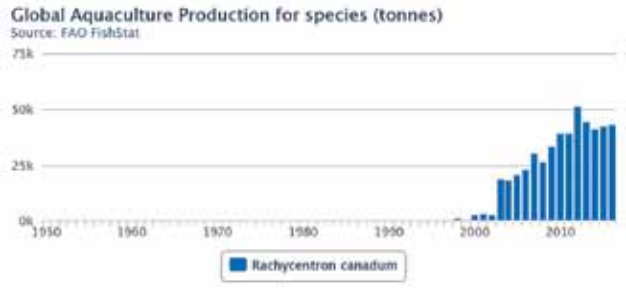
Cobia, *Rachycentron canadum*, commonly known as Black Kingfish, is a fast growing warm water marine fish with pinkish white flesh. It is considered as a promising candidate species for farming due to its fast growth rate, excellent meat attributes and easy adaptability to farming conditions. In the Indian scenario, it has the added advantage of being suitable for ecological aquaculture production linked to rural fishing villages along the long coast line. Envisaging the potential and prospects for cobia farming in India, captive broodstock development was first initiated during 2006 at the Mandapam Regional Centre of ICAR – Central Marine Fisheries Research Institute (CMFRI), Tamil Nadu, India. The first successful captive breeding and fingerling production of cobia was achieved in 2010 in India by the ICAR – CMFRI, Mandapam Regional Centre and since then, cobia fingerlings are being supplied to the entire coastal regions of the country for farming. Cobia fish is popularly known by the common names - Black kingfish, Black salmon, runner or sergeant fish, crab eater and Sea Murrel. On an average, a person consumes about 18 kilograms of fish products per year and with a growing global population and health awareness, the per capita consumption of fish

HDPE cage (Aerial view)

and fisheries products is expected to grow further. The farming of such fast growing and large fish can help meet the protein requirements of the expanding population, in addition to providing diversified livelihood opportunities for the fishers and aiding in uplifting their socio-economic status.

Cobia (*Rachycentron canadum*)

Being the only member of the family Rachycentridae, it is found in the warm, temperate to tropical waters of the West and East Atlantic, throughout the Caribbean and in the Indo-Pacific off India, Australia and Japan. To date, research and development of cobia aquaculture has been initiated in over 23 countries and territories, half of them in the Asian-Pacific region. FAO Stats (2018), shows that the global aquaculture production of cobia has been increasing rapidly from only 9 MT in 1997 to around 43,100 MT in 2016. Since the late 1990s, cobia aquaculture production has been steadily expanding in Asia, primarily in Taiwan, Vietnam and China and also in other Southeast and Indo-Pacific Asian countries including the Philippines, Indonesia, Iran and Reunion Island.



Global Aquaculture Production of Cobia

Although the majority of cobia aquaculture production currently comes from China, most of the detailed information about culture and grow-out methods is reported from Taiwan Province of China. Broodstock collection generally involves capturing and transporting juvenile or sub-adult wild-caught cobia (often during their natural spawning season) into the tank systems, where 2-3 year old fish will spawn either naturally or after being induced hormonally or with photoperiod and temperature manipulations. Cobia breeds throughout the year with peak spawning activity during October to February. In captivity, cobia gains a weight of around 2 kg in six months of culture period, from the initial stocking weight of around 38 g. Thereafter, it grows faster and reaches around 4 kg in eight months and about 7.3 kg in one year.

The fast growth rate, adaptability to captive breeding are the major attributes which makes cobia an excellent candidate species for mariculture. The meat of cobia is served raw, called as *Sashimi,* at the restaurants in the Southeast Asian countries. In India, this fish is known in various vernacular names in various parts of the country.

State	Vernacular name
Kerala	*Motha, Kadal varal*
Tamil Nadu	*Kadal Veral*
Maharashtra	*Modso*
Andhra Pradesh	*Peddah-mottah*

Cobia farming methods developed by ICAR-CMFRI

India is a late starter in cobia research. Following the success achieved in breeding and fingerling production of cobia at CMFRI. Mandapam, the centre subsequently standardized cobia farming protocols in the High Density Polyethylene (HDPE) and Galvanized Iron (GI) cages at different stocking densities and feeding strategies were developed, tested and validated. Out of these farming trials an economically viable farming method has been evolved. Farming of Cobia in sea cages was successfully demonstrated by CMFRI at different areas along the entire coastline of India. Subsequently, the Rajiv Gandhi Centre of Aquaculture (RGCA) under the Marine Product Export Development Authority of India (MPEDA) also contributed to the cobia fingerling production and farming in India.

Nursery rearing

It is essential to carry out nursery rearing of cobia fingerling for a period of one month to achieve a size of 20 grams, which is ideal for stocking in cages. The nursery rearing of juveniles could either be carried out in tanks (minimum 10 tonnes capacity) or in sea cages (6 meter diameter) fitted with smaller mesh sized nets. If the nursery is carried out in cages, it is pertinent to clean or brush the nets daily to ensure free flow of water. If nursery is carried out in indoor systems, adequate water quality and optimum aeration should be maintained in the tanks.

Duration	Length (cm)	Weight (g)
Week – 0	7.1 ± 0.1	2.2 ± 0.1
Week – 1	10.0 ± 0.2	4.2 ± 0.1
Week – 2	12.0 ± 0.1	5.5 ± 0.2
Week – 3	13.5 ± 0.2	13.6 ± 0.6
Week – 4	15.2 ± 0.4	23.3 ± 0.6

Recommended stocking density in indoor nursery tanks is 1 number per 10 litres with 200% water exchange and for nursery cages it is 1.8-3.0 kg/ m^3. Suitable sized artificial feeds (800 – 1800 micron) should be provided during nursery rearing. Floating or slow sinking pellet feed with 50% crude protein and 10% crude fat composition would be suitable for successful nursery rearing. Such high protein and fat containing nursery feeds are available in India at reasonable prices. Storage of such feeds plays a vital role in maintaining the quality during their shelf life period. Storage in air-conditioned rooms would be ideal. The growth recorded during nursery rearing is detailed below for reference;

Technology of sea cage farming of cobia

The cobia can be farmed in sea cages made of High density Polyethylene (HDPE) or galvanized iron (GI) pipes. While the HDPE cages have a durability of 10 - 15 years, GI cages usually last only for a maximum of

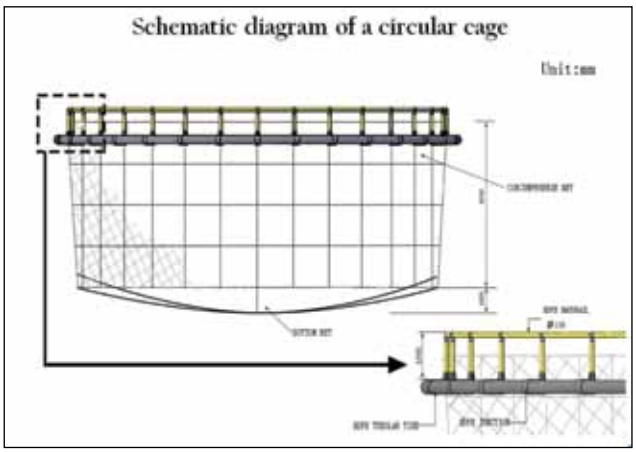
Sea cage farm at Mandapam

three years with good maintenance. However, the initial investment would be much lesser, if the GI cages are used.

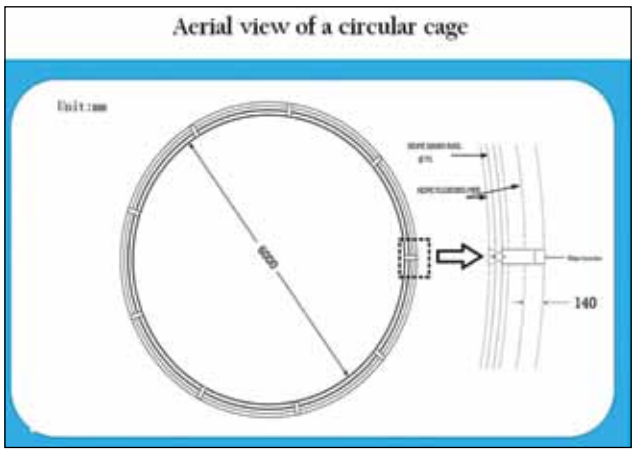
Design and structure of cages

The grow-out culture can be carried out in circular floating sea cages of 6 meter diameter. The cage frames can be made up of HDPE pipes or GI pipes. The handrail has to be fixed at one meter height from the base. The space between the inner and outer rings of the cage could be kept as one meter. The cage nets are fabricated with HDPE ropes of 2.5 mm thickness and the mesh size of 20 mm and 40 mm for inner net cage and 60 mm for outer net cage. The depths of the net cages are maintained at 3.5 - 4.0 meters from the base of the cage frame. The shape of the net cages is maintained with circular ballast. The schematic diagrams with measurements of HDPE and GI cages are given below.

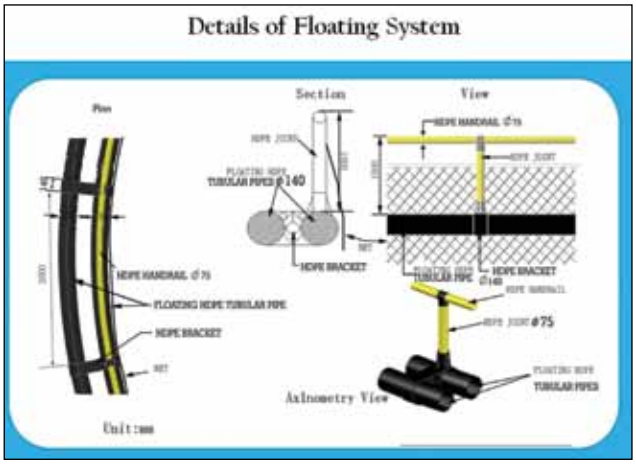
Selection of suitable site for sea cage farming is essential for smooth and easy farming operations. A healthy seabed having sandy soil is necessary in keeping satisfactory water quality. Cage farming produces organic wastes like residual fish feed, fish waste and fish carcasses. Under normal conditions, these waste materials are consumed by wild fishes, crabs, sand dwelling organisms or flushed through the water current. Cages have to be moored at appropriate depth having enough space between the net bottom and sea floor (minimum 2 – 3 meters), so as to allow the waste materials to move from the cage farming area through water currents. When a cage is moored in low depth area with poor planning such as over density, over feeding or improper disposal of dead fish will increase load of organic matter in the water body and will cause problems like turbidity, anoxia, death of benthic species and increase in bacterial growth. The cage farming site should have minimum depth of 6 meters depth during low tide, when a cage net depth



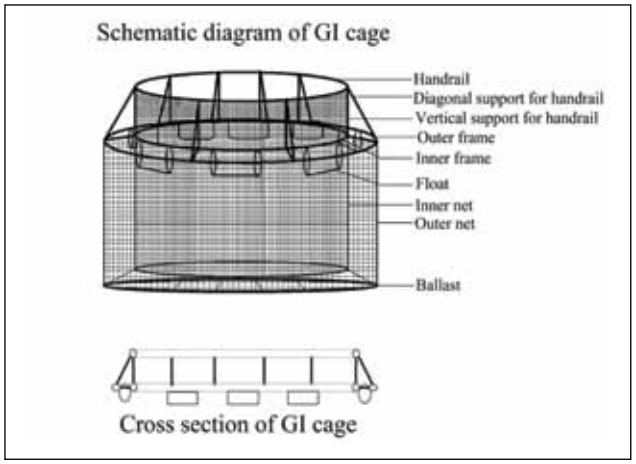
Schematic diagram of a circular cage



Top View of a Circular Cage



Measurements of HDPE cage frame structures



Schematic diagram of GI cage with nets and floats

is maintained at 3.5 meters. Dissolved oxygen level is comparatively lower at the sea floor and fishes cultured too close to the sea bed may suffer from anoxia.

Optimal Stocking density

As fishes grow, they need more space for movement. However, the space in net cage is limited. Therefore, it is necessary to stock an optimum number of fingerlings that would ensure maximum growth. Overstocking will weaken the fish resulting in higher risk of bacterial, viral or parasitic infection. Higher stocking densities may also lead to insufficient levels of dissolved oxygen to sustain the entire stock. During low tide and poor water current, non-availability of required level of dissolved oxygen leads to anoxia and death. A cage with 6 meter diameter having a net depth of 3.5 meters can be stocked with 900 numbers of cobia fingerlings (@ 9-10 fingerling/m^3).

Acclimatization and stocking of fish fingerlings

Cobia fingerlings procured from the hatchery needs to be acclimatized to the new environment to get better survival and growth. If any abnormal behaviour or symptoms of infection are noticed, such fingerlings have to be isolated and reared separately. To avoid spreading of diseases, fingerlings infected with pathogens could be given proper treatment. Approved disinfectants/antibiotics can be used judiciously for treating diseases in consultation with the fisheries experts/CMFRI scientists.

Management of Bio-fouling in net cages

Cage farming activities enrich the sea with nutrients, this coupled with warm water temperature, forms an ideal habitat for fouling organisms like barnacles, mussels, sea weeds and algae to grow on the net and cage surfaces. Proliferating fouling organisms not only consume a great deal of dissolved oxygen, but also block the meshes of nets and impede effective replenishment of dissolved oxygen in sea water inside the cage area. Fouling organisms may also add weight to the cage nets and cause damage to nets and sinking of the cages. To avoid this situation, cage nets have to be cleaned regularly to prevent the colonization of fouling organisms. The cage nets have to be inspected

Cobia fingerlings (45 days old)

regularly and repairing of torn or damage parts and exchange of nets having more fouling needs to be undertaken. Net cages can be changed based on the subjective assessment of fouling of the net in order to have sufficient water exchange. Normally net cages have to be changed once in 45 to 60 days depending on the intensity of bio-fouling. Nets having high level of fouling needs to be dried under sunlight through prolonged exposure and all the barnacles and algal attachments on the nets need to be cleaned. Repairing of any damage found in the cage unit including mooring system would help to maintain the buoyancy as well as healthy cage frame.

Feed Management

Fish feed forms a major part of the operational expenditure for cage farming of cobia. Proper feed management strategies would help to reduce overall production cost. Optimal use of feed also helps to improve the farming environment and ensures the health of fish stock. Fish feed management includes choosing the right feed, following correct feeding methods, feeding the optimum quantity and cost effectiveness. Feeding of cage farmed cobia fishes with appropriate quantity and quality feeds will prevent the presence of excessive organic matter and mitigate problems like low dissolved oxygen and bacterial growth. Use of extruded formulated pellet feed instead of low value fish/trash fish will help to reduce organic matters in water. If the formulated feeds are not readily available at affordable price, farming can be taken up by feeding with low valued fishes and by-catch. The juveniles of cobia have to be fed @ 5 to 10% of total biomass of fish with chopped low-value fishes (sardine, lesser sardine, rainbow sardine, etc.) twice daily up to two months of culture. As a thumb rule, the feed can be provided initially at the rate of 10 % of the biomass

Feeding of cobia fingerlings in sea cage

which can be slowly reduced to 8% and then to 5% as the fish grow. The timing of feeding should also be maintained, feed them at about the same time of the day, preferably early in the morning or late in the afternoon as the fishes will automatically get used to the timing and will also come near the surface when they hear the sound of the boat. Feed quantity has to be reduced when the fishes are under stress or during rough weather or during low water temperature. Feeding has to be done slowly to give enough opportunity to all the fishes to feed. In general, marine fish require high level of protein (35 to 40%) and fat (8 to 10%) for their metabolic activities and growth.

Monitoring of water quality

Water quality is the critical factor which determines the growth and survival of cobia reared in the cages. If the water quality parameters fall outside the optimal range it would create stress to the fishes leading to weakness and pave way for infection by opportunistic pathogens. Monitoring of water quality helps to detect disease at an early stage and will reveal the cause of stress/ mortality. Basic water quality parameters such as level of dissolved oxygen, pH, salinity, water temperature and turbidity can be measured at specific time intervals during every day. These parameters vary according to the seasons in the East and West coast of India. Unless in special conditions (Monsoon/winter), water quality parameters of cage farming areas should generally remain within the following ranges most of the time:

Sl. No.	Water Quality Parameter	Range
1	Dissolved Oxygen	5 – 8 mg/L
2	Water temperature	28 - 33°C
3	pH	7.9 – 8.3
4	Salinity	25 – 34 ppt
5.	Transparency	40 cm and above

Growth assessment

Random sampling can be carried out at the time of net exchange with the sample size of at least 30 cobia fishes per cage. The entire grow-out culture is carried out for a period of 6-8 months. The growth details of cobia as recorded in sea cages at a stocking density of 8 nos./m^3 are given below.

Duration	Length (cm)	Weight (g)
Month – 1	21.5 ± 0.3	70.8 ± 2.4
Month – 2	22.4 ± 0.6	94.1 ± 1.3
Month – 3	26.0 ± 0.8	125.3 ± 2.5
Month – 4	32.9 ± 1.1	468.5 ± 27.8
Month – 5	46.3 v 1.0	1109.3 ± 87.7
Month – 6	56.4 ± 1.1	1985.5 ± 92.3
Month – 7	73.5 ± 1.0	3316.2 ± 57.6
Month – 8	77.9 ± 1.1	4015.4 ± 74.0
Month – 9	85.7 ± 0.9	4851.1 ± 88.8
Month – 10	90.8 ± 1.2	5622.4 ± 146.5
Month – 11	96.6 ± 1.6	6291.8 ± 138.9
Month – 12	103.0 ± 1.7	7276.6 ± 148.6

Health management

Fish diseases affect the survival and growth of fish reared in the cages and outbreak of diseases invariably lead to lower harvest and higher production cost. Regular observation of fish is an effective way to identify altered behaviour, onset of diseases and to initiate appropriate treatments. Normal symptoms such as low intake of feed, sluggish movement of fish, altered swimming behaviour etc., can be noticed when the fishes are under stress or infected with pathogens. Routine examination of the body surface, fins and gills for the presence of parasites or disease symptoms would help to take therapeutic measures at the initial level of infection. Several bacterial, viral, and fungal pathogens as well as parasites exist in the natural environment and healthy fish have adequate resistance against them. When the pathogen loads in the water increases sharply due to various factors and if the natural immune resistance of the fish is weak, fish will become vulnerable to pathogenic infection and diseases. To prevent and control fish diseases, maintaining a good farming environment and use of hygienic and nutritious fish feed is essential.

Maintenance of farm records

Marine Fish farmers should maintain records on

Cobia harvested from cage

weather, water temperature, dissolved oxygen level, quantity of feed, length and weight of fishes sampled, fish behavioural changes, diseases and disinfection treatments, net exchange details etc.

Analysis of these records provides useful information in understanding the health status and growth pattern for future crops. A suitable management solution can thus be identified to enhance culture efficiency.

Better Management Practices in sea cage farming of cobia

Adoption of Better management practices (BMP) help fish farmers to achieve greater productivity and economic returns. BMP's are also need to be adopted to be able to produce quality aquaculture products that meet all food safety standards and satisfy consumer demands. Some of the key factors in BMP includes:-

- Proper acclimatization of cobia fingerlings prior to stocking.
- Avoiding over-stocking.
- Careful feeding of cobia fingerlings and usage of dry pellets to allow all the fishes to get equal ration of feed.
- Monitoring the growth rate, grading and sub-dividing cobia fingerlings/juveniles in different cages at

appropriate time intervals.

- Cleaning and regular exchange of cage nets for effective water exchange.
- Close observation of fish behaviour to assess the health status.
- Proper removal and disposal of dead fishes.
- Usage of approved feed supplements and additives as recommended by the fisheries officials and CMFRI experts.
- Regular prophylactic treatment of fishes with disinfectants and dipping in fresh water.
- Periodic monitoring of dissolved oxygen level, pH value, water temperature, etc.
- Observing the weather conditions, changes in seawater quality, and emergence of red tide etc.

Cage farming of Cobia

- *Stocking density: 7 - 8 nos/m^3 (15 cm; 23 g fingerlings)*
- *Culture period: 6-8 months*
- *Weight at harvest: 3 - 5 kg*
- *Production : 2.0 - 4.0 tonnes per cage of 6m diameter*

Marketing and Unit Economics for sea cage farming of cobia

Cobia is a popular table fish due to its high quality white meat. Cobia is mainly exported as frozen whole fish, frozen and IQF head on gutted fish, frozen and IQF steaks. In India, fish are sold as whole or as steaks in domestic market. It has very good demand in Kerala, Tamil Nadu, Maharashtra, West Bengal, Karnataka and Goa. Cobia is also an export seafood commodity from India. The present production level is not yet enough to meet the increasing demand both in domestic as well as in export market. The preferred marketable size for cobia is above 3.5 kg. As the culture practice of the cobia is picking up momentum, it will also have export potential in future. The unit economics for cage farming of cobia is detailed below:

Economics of sea cage farming in a 6 meter dia HDPE cage

Sl. No.	Head of expense	Cost in INR (in lakh)
Capital Expenditure		
Cage and Net		
1	Cost of Cage (6 meter dia.) made of HDPE material	1.50
2	Cost of netting (4 m depth) for one outer net, two inner nets, one bird net cages and mooring materials ballast hose, anchor and anchor rope	1.00
	Sub Total	**2.50**
Operational Expenditure		
1	Cost of 900 Numbers of cobia seeds @ 8 fingerlings / m3 @ INR 30/seed (Total volume of a cage: 113.04 m3)	0.27
2	Transportation	0.10
3	Cost of 5.10 tonnes of Extruded pellet feed @ FCR 1:1.8 @ INR 0.75 lakh per tonne, OR Cost of 15.3 tonnes of low value fish @ FCR 1:5.4 @ INR 25 lakhs per tonne	3.83
4	Labour Charges @ INR 8000/ Person/ month X 7 months	0.56
5	Boat Hire & Fuel Charges	0.50
6	Miscellaneous expenses	0.50
	Sub Total	**5.76**
Grand Total		**8.26**

Sl. No	Production Estimate and Economics
1	Survival 90% = 810 fishes
2	Feed Conversion Ratio = 1:1.8 (pellet feed) or 1:5.5
3	Average size of each fish at the time of harvest =3.5 kg
4	Total harvest = 2,835 kgs/cage (2.835 tonnes/cage)
5	Sale price of the produce @ INR 310/kg = INR 8.79 lakh
6	Gross Income from the harvest = INR 8.79 lakh
7	Gross income – Operational expenses = INR 3.03 lakh
8	Gross Profit = INR 3.03 lakh

Way Forward

Mariculture has got immense growth potential in India. The long coastline of the country provides several suitable locations for taking up various mariculture activities. Cobia has proved to be a suitable fish for mariculture and its production through farming has increased many folds at various parts of the globe. With development of cost effective and successful indigenous technologies for hatchery production and farming, cobia can play a pivotal role in the development of mariculture in India. The success story in cobia farming undertaken by various farming groups in the country has evoked much interest among farmers of the country. Best management practices should be implemented during the entire production process and include detailed monitoring of broodstock and fingerling production, use of high quality and nutritionally complete diets, frequent sampling and observation of stock for diseases and/or parasites. It is expected that production from cobia farming will contribute substantially to the seafood production of India in the near future.

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The first author of this article Dr. M. Sakthivel, Ph.D., is Senior Scientist at ICAR-CMFRI Mandapam Regional Centre. He is working on finfish breeding and seed production particularly cobia, silver pompano, red snapper and marine ornamental fishes. Genetic broodstock management and production of high-quality marine finfish seed are his major research areas.