Overview of Mariculture in India

Imelda Joseph and Anuraj A
Mariculture Division, ICAR-CMFRI, Kochi

Aquatic food systems play a vital role in ensuring healthy diets, sustaining livelihoods, enhancing global food security and nutrition, and conserving aquatic ecosystems and biodiversity. Global production of aquatic animals reached a record 195 million tonnes (live weight equivalent) in 2024, representing a 5.1% increase over 2022. Aquaculture production exceeded the landmark 100 million tonnes for the first time, reaching 102.7 million tonnes and accounting for 52.8 % of total aquatic animal production, further reinforcing its position as the primary source of aquatic food globally. Marine production contributed 118 million tonnes (61% of the total), with capture fisheries accounting for 67% and marine aquaculture for 33%. Inland waters produced 77 million tonnes (39% of the total), of which aquaculture contributed 84% and capture fisheries 16%. Additionally, global algae production reached 40 million tonnes in 2024, with 97% originating from aquaculture, reflecting a 5.8% increase compared to 2022.

Source: SOFIA, 2026

	1990s	2000s	2010s	2022	2023	2024
	Average per year					
	(million tonnes, live weight equivalent)					
Production						
Aquaculture						
Inland	12.6	25.6	44.9	59.2	61.6	64.3
Marine	9.4	18.0	26.8	35.5	37.2	38.3
Total aquaculture	**22.0**	**43.6**	**71.7**	**94.7**	**98.8**	**102.7**
Capture fisheries						
Inland	7.1	9.3	11.3	11.4	12.1	12.3
Marine	81.9	81.6	79.7	79.0	78.4	79.6
Total capture fisheries	**88.9**	**90.9**	**91.1**	**90.4**	**90.4**	**91.9**
Total world fisheries and aquaculture	**110.9**	**134.4**	**162.7**	**185.1**	**189.3**	**194.6**

Global aquaculture production (including seaweeds) has expanded steadily since the start of this millennium, more than tripling from 43.1 million tonnes in 2000 to 141.6 million tonnes in 2024 with estimated farm-gate value of USD 391.5 billion. About 770 aquatic species are cultured all over the world in a variety of farming systems and facilities of varying input intensities and technological sophistication. China, the world's largest aquaculture producer, derived 81.6 percent of its national aquatic animal production from aquaculture. In countries like India, Viet Nam and Bangladesh, as well

as in Egypt, Ecuador, Brazil, Türkiye, Colombia, Saudi Arabia and Uzbekistan, aquaculture shares represented 57 percent of total production or higher. This shows the important role of aquaculture in meeting the increasing demand for aquatic animal foods.

Mariculture is a specialized branch of aquaculture involving the cultivation of economically important marine plants and animals in the sea or any other natural water bodies having tidal influence and includes onshore facilities like brood banks, hatcheries, nursery rearing and grow-out systems using seawater. It is an important component of the blue economy, contributing to food security, nutritional security, employment generation, export earnings, and sustainable utilization of marine resources. With increasing pressure on capture fisheries, mariculture has emerged as a promising solution to meet the growing demand for seafood while supporting the livelihoods of coastal communities.

Mariculture plays an important role in:

- Increasing seafood production
- Meeting future protein requirements
- Reducing pressure on wild fish stocks
- Enhancing income of coastal communities
- Generating employment opportunities
- Promoting entrepreneurship
- Supporting export-oriented fisheries
- Strengthening climate-resilient food production systems

Mariculture activities other than for human consumption include live bait farming for fishing, live ornamental animal and plant species and ornamental products (pearls and shells), fishes cultured as feed for certain carnivorous farmed species, culture of live feed organisms such as plankton, Artemia and marine worms for use as feed in hatcheries and grow-out systems, aquaculture hatchery and nursery outputs for on-growing in captivity or stocking to the wild and capture based aquaculture. In 2024, global mariculture produced nearly 27 million tonnes of aquatic animals, with production dominated by molluscs (over 74%) followed by finfish, crustaceans and other aquatic animals. In addition to aquatic animals, 37 million tonnes of seaweed were also produced.

Mariculture in India

The beginning of mariculture research in India started during 1970s led by the initiatives of ICAR-Central Marine Fisheries Research Institute (CMFRI) at Mandapam with the culture of seaweeds followed by seaweed and bivalve cultivation during 1980s. Since then, ICAR- CMFRI is in the forefront towards development and disseminating mariculture technologies in India through standardising seed production technology and farming of marine finfishes/shellfishes, Integrated Multitrophic Aquaculture (IMTA), Recirculating Aquaculture System (RAS). Despite India's estimated mariculture production potential of 4–8 million tonnes annually, the current production remains only about 0.1 million tonnes, highlighting the vast untapped potential for expanding mariculture and driving blue economic growth. With a coastline of over 7,500 km and an extensive Exclusive Economic Zone (EEZ) of approximately 2.37 million km^2, India possesses immense potential for the expansion of mariculture.

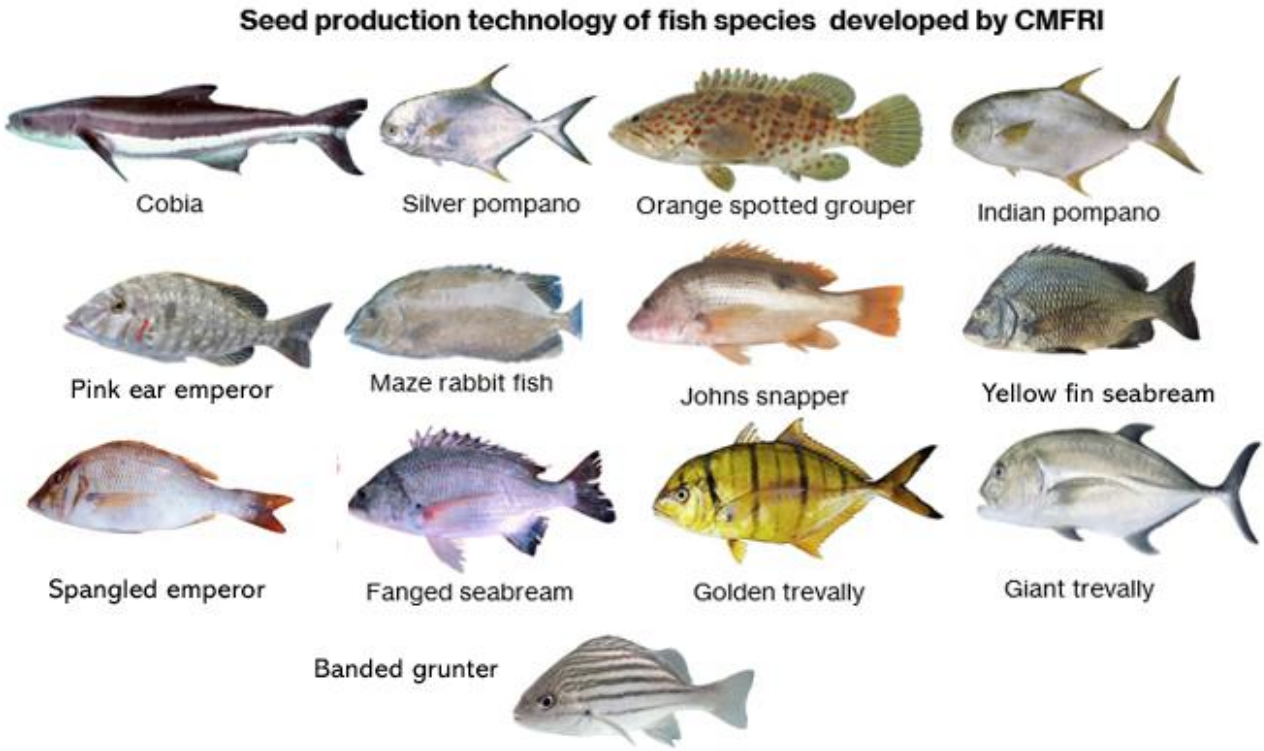
The country's diverse coastal ecosystems and favourable environmental conditions provide significant opportunities to boost sustainable marine aquaculture, enhance seafood production, create coastal livelihoods, and strengthen the blue economy. Central Marine Fisheries Research Institute has played a pioneering role in advancing mariculture in India through the development and standardization of hatchery-based seed production technologies for several high-value marine finfish, shellfish, seaweeds, and ornamental species. In addition, CMFRI has developed and demonstrated sustainable farming technologies, including cage culture, open-sea farming, seaweed cultivation, integrated multi-trophic aquaculture (IMTA), and molluscan farming, while facilitating their transfer to stakeholders through training, demonstrations, and capacity-building programmes to promote coastal livelihoods and the blue economy.

Understanding the importance of cage culture, the Central Marine Fisheries Research Institute initiated cage culture as a research and development activity to identify appropriate design and suitability of cages under Indian context as early as in the year 2005-06. The first open sea cage was launched in Bay of Bengal off Visakhapatnam coast during May 2007. After several modifications, a 15 m cage was launched in December 2007. This cage was stocked with sea bass and harvested after 6 months with 75% survival. This was the first successful harvest from open sea cage in lndia and this

success has given motivation and encouragement to the researcher and fish farmers. For ease of operation, later 6 m diameter cages were designed, installed and successfully demonstrated in several states of India with different commercially important finfishes and shell fishes. The indigenous 6-meter diameter cages of GI and HDPE for farming of different marine species have been demonstrated in Maharashtra, Tamil Nadu, Kerala, Karnataka, and Odisha.

The research towards the development of technology for seed production of marine species yielded commendable results within a few years and Mandapam Regional Centre of ICAR CMFRI succeeded in captive breeding of high value marine fishes, Cobia, *Rachycentron canadum* for the first time in the country. Broodstock development of cobia was initiated at the Mandapam Regional Centre of Central Marine Fisheries Research Institute in sea cages during 2008 and the first successful induced breeding and seed production was achieved in March 2010. Building upon this initial cobia success, CMFRI's dedicated mariculture research dramatically transformed India's marine aquaculture sector. Over the following 13 years, the institute's scientists expanded their pioneering work from the Mandapam Research Centre to its research centres in Visakhapatnam, Vizhinjam, and Karwar. By systematically addressing the complexities of broodstock development, induced spawning, and larviculture in captive

environments, CMFRI successfully standardized and developed hatchery production technologies of another 12 high-value marine finfish species. This rapid 13-year progression established a robust framework for steady supply of hatchery-produced seeds supporting commercial expansion of mariculture.



Species	Common name	Year	Technology developed at
Rachycentron canadum	Cobia	2010	CMFRI RC, Mandapam
Trachinotus blochii	Silver pompano	2011	CMFRI RC, Mandapam
Epinephelus coioides	Orange spotted grouper	2013	CMFRI RC, Vishakhapatnam
Trachinotus mookalee	Indian pompano	2016	CMFRI RC, Vishakhapatnam
Lethrinus lentjan	Pink ear emperor	2017	CMFRI RC, Vizhinjam
Siganus vermiculatus	Maze rabbit fish	2020	CMFRI RC, Karwar
Lutjanus Johnii	Johns snapper	2020	CMFRI RC, Vishakhapatnam
Acanthopagrus berda	Yellowfin seabream	2021	CMFRI RC, Karwar
Sparidentex jamalensis	Fanged seabream	2021	CMFRI RC, Karwar
Pomadasys furcatus	Banded grunter	2021	CMFRI RC, Vizhinjam
Lethrinus nebulosus	Spangled emperor	2022	CMFRI RC, Vizhinjam
Gnathanodon speciosus	Golden trevally	2024	CMFRI RC, Vishakhapatnam
Caranx ignobilis	Giant trevally	2024	CMFRI RC, Vizhinjam

Mariculture systems available for expansion in India

Sea cage farming

The cage culture which initiated in Norway during 70s got developed into a high-tech industry in many countries all over the world for high value fishes. The major advantage in countries where cage culture has been commercialized is that they have large, calm and protected bays to accommodate the cages safely against any unfavourable weather conditions. Recent technological advance is in cage design and with new species. In the past, the industry had typically used steel-framed rectangular support structures for the net cages, with walkways around them as work platforms. After that HDPE cages came into existence. Of recent submersible cages which can overcome rough oceanic conditions are being designed and used. Farming was mostly in the inshore waters and since the commercial aquaculture of marine finfish will continue to expand in future, it will take place more in offshore locations than have traditionally been used. By integrating the cage culture system into the marine aquatic ecosystem, the carrying capacity per unit area is optimized because the free flow of current brings in instantaneous exchange of water and removes metabolic waste and excess feed. Thus economically speaking, cage culture is a low impact farming practice with high economic returns and with least carbon emission activity. In view of the high production attainable in cage culture system and the presence of large sheltered coastal waters in many countries, marine cage farming can play a significant role in increasing fish production.

Recirculating Aquaculture Systems (RAS)

A notable technology-based development in the farming sector has been a significant expansion in fish production using closed-recirculation systems. Recirculation aquaculture systems (RAS) are systems in which water is (partially) reused after undergoing treatment. Each treatment step reduces the system water exchange to the needs of the next limiting waste component. RAS have been developed to respond to the increasing environmental restrictions in countries with limited access to land and water. RAS offer advantages in terms of reduced water consumption, improved opportunities for waste management and nutrient recycling and for a better hygiene and disease management, biological pollution control (no escapees), and reduction of visual impact of the farm. These systems are sometimes referred to as 'indoor' or 'urban' aquaculture reflecting its independency of surface water to produce aquatic organisms. In addition, the application of RAS technology enables the production of a diverse range of (also exotic) seafood products in close proximity to markets, thereby reducing carbon dioxide (CO2) emissions associated with food transport.

Bivalve farming

Bivalve culture in India is primarily focused on green mussels (*Perna viridis*) and Indian backwater oysters (*Crassostrea madrasensis*). It is a sustainable, low-investment mariculture practice. Predominately centered along the estuaries and backwaters of Kerala, Karnataka, Maharashtra and Goa, this farming method

provides vital supplementary income and affordable protein for coastal fishing communities. Methods of farming like long-line culture, raft culture and rack culture can be employed.

Integrated Multi-Trophic Aquaculture

Integrated multi-trophic aquaculture (IMTA) refers to the explicit incorporation of species from different trophic positions or nutritional levels in the same system. IMTA has been defined based on studies in marine habitats involving joint aquaculture of fed species, usually fish, together with extractive species such as bivalves and/or macroalgae. IMTA can also allow an increase in production capacity for harvesting of a particular site when regular options have established limitations.

Seaweed farming

Marine macroalgae (seaweed) cultivation offers substantial economic and ecological advantages, driven primarily by minimal capital requirements and low external resource dependency. For the past decade, Self-Help Groups (SHGs) in Palk Bay, Tamil Nadu, have operated economically viable farms using 12 ft x 12 ft raft systems with a 45-day cycle across 270 operational days per year. While this eco-friendly practice offers clear pathways to boost coastal livelihoods and generate carbon credits, industrial demand still eclipses the combined output of wild-harvested and farmed supplies.

The National Mariculture Policy 2019 has been framed to ensure a structured growth of mariculture for meeting the growing demand of fish in the country as well as to enhance nutritional security, wealth creation and employment while adhering to the principles of ecological wellbeing and environmental sustainability. Along with dedicated areas for mariculture activities, there is also need for establishment of fish brood banks and private hatcheries. Transitioning from wild-caught seeds to hatchery-produced, disease-resistant, and genetically improved seeds ensures predictable stocking, higher survival rates, and consistent growth cycles for farmers. The availability of standardized feeds for different species at affordable costs are also necessary. By establishing a synchronized supply chain that guarantees ready access to high-health seeds and standardized feeds, India's mariculture development can transition from a vision into a thriving reality.