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EDITORIAL ANALYSIS

Blue Economy Frontier — India's Open-Sea Mariculture and the Untapped EEZ Opportunity

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Blue Economy Frontier — India's Open-Sea Mariculture and the Untapped EEZ Opportunity

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INTERVIEW ANGLE

"India's EEZ is among the world's largest yet its mariculture output is negligible compared to peers. What governance, technology, and regulatory reforms are needed to realise the Blue Economy potential without repeating the ecological mistakes of coastal aquaculture?"

WHY IN NEWS

India launched its first open-sea marine fish farming project in the Andaman Sea near Sri Vijaya Puram (formerly Port Blair), Andaman and Nicobar Islands — a joint initiative of the Ministry of Earth Sciences (MoES), the National Institute of Ocean Technology (NIOT), and the UT Administration. The project marks India's entry into offshore mariculture, a sector that generates hundreds of billions of dollars globally but has been largely untapped by India despite its vast Exclusive Economic Zone.

THE SCALE OF THE OPPORTUNITY

India's Exclusive Economic Zone (EEZ) extends across approximately 2.37 million square kilometres — the seventh largest in the world. This vast maritime space, stretching from the Arabian Sea to the Bay of Bengal to the Andaman and Nicobar Islands, contains some of the world's most productive fishing grounds, extensive coral reef ecosystems, and deep-water zones with significant aquaculture potential.

Yet India's mariculture (marine aquaculture) sector remains embryonic. The country's aquaculture output — predominantly inland freshwater fish and coastal shrimp farming — stood at approximately 9.64 million metric tonnes in 2023-24. Open-sea mariculture, which involves cultivating fish, molluscs, seaweed, and other species in offshore cage or longline systems beyond the intertidal zone, contributes a negligible fraction.

The contrast with global leaders is stark. Norway produces over 1.4 million tonnes of Atlantic salmon annually through offshore cage farming. China is the world's largest aquaculture producer (about 80 million tonnes/year) with significant offshore components. Chile, Japan, and New Zealand have built substantial

offshore mariculture industries. India, despite its coastline of 8,118 kilometres and its vast EEZ, has remained a bystander.

WHY OPEN-SEA MARICULTURE MATTERS

THE CASE FOR MOVING OFFSHORE

Coastal aquaculture — particularly intensive shrimp farming — has generated significant employment and export revenue in India but has also left a difficult legacy. In states like Andhra Pradesh, Tamil Nadu, and Odisha, unregulated coastal shrimp farms have destroyed mangrove ecosystems, contaminated coastal groundwater with saline intrusion, generated antibiotic-resistant bacterial strains through overuse of antibiotics, and created social conflicts with traditional fishing communities.

Open-sea mariculture offers a fundamentally different proposition. By moving operations offshore — beyond the coastal zone — it reduces pressure on sensitive coastal ecosystems, disperses nutrient waste loading over larger water volumes, and operates in more predictable open-ocean current regimes that naturally dilute effluents. The Andaman Sea, with its deep, oligotrophic (nutrient-poor, clear) waters, is a particularly suitable environment for high-value marine species.

HIGH-VALUE SPECIES AND EXPORT POTENTIAL

Open-sea mariculture can support production of high-value species — Cobia, Pompano, Snapper, Grouper, and marine finfish that command premium prices in domestic and export markets. India's seafood exports stood at approximately USD 7.38 billion in 2023-24, with shrimp dominating the basket. Diversification into marine finfish could expand the export basket and reduce vulnerability to shrimp disease cycles that periodically devastate coastal farmers.

Seaweed cultivation — also being explored in the Andaman project — has additional dimensions: seaweed absorbs CO_2 (a form of blue carbon sequestration), provides raw material for food, pharmaceuticals, biofuel, and fertiliser industries, and requires no freshwater, land, or feed inputs.

THE TECHNOLOGY ARCHITECTURE: NIOT'S ROLE

The National Institute of Ocean Technology (NIOT), headquartered in Chennai under the Ministry of Earth Sciences, has been the key technology developer for this initiative. NIOT has designed submersible cage systems that can withstand monsoon swells and cyclone-season waves — a critical engineering challenge for open-sea aquaculture in the Bay of Bengal and Andaman Sea, which experience severe weather systems.

Specifically, the technology involves:

- **Submersible sea cages:** Cage systems that can be submerged during extreme weather events to avoid storm damage — unlike fixed surface cages
- **Automatic feeding systems:** Remotely operated feed dispensers reducing operational diver time

Real-time monitoring: Sensors for water temperature, dissolved oxygen, salinity, and current speed

Mooring systems: Anchoring solutions for deep-water deployment (30-50 metre depths) that must withstand Indian Ocean monsoon conditions

NIOT has also been developing seaweed cultivation technologies on longlines for species like Kappaphycus alvarezii and Gracilaria — commercially valuable species for carrageenan (food additive) and agar (laboratory media) production.

GOVERNANCE CHALLENGES: THE MISSING FRAMEWORK

India's open-sea mariculture ambitions face a significant governance gap. Unlike Norway, which has a clear licensing and zoning framework for offshore aquaculture, or Australia, which manages offshore cage sites through Commonwealth Marine Reserve and EPBC Act frameworks, India lacks a dedicated offshore mariculture regulatory system.

Key gaps include:

Spatial planning: There is no systematic Marine Spatial Planning (MSP) process that allocates EEZ zones for mariculture while avoiding conflicts with navigation channels, military restricted zones, fishing grounds, and ecological sensitive areas like coral reefs and seagrass beds.

Licensing authority ambiguity: The EEZ is under central jurisdiction (Ministry of Earth Sciences, Ministry of Fisheries, and the Coast Guard all have overlapping mandates). Island UTs like Andaman and Nicobar have additional layers of environmental protection (Andaman and Nicobar Protection of Aboriginal Tribes Regulations, Coastal Regulation Zone notifications, and forest clearance requirements for island projects).

Finance and insurance: Traditional bank finance is reluctant to fund offshore aquaculture given weather risk, disease risk, and the absence of insurance products designed for open-ocean operations. The Pradhan Mantri Matsya Sampada Yojana (PMMSY) — India's flagship fisheries development scheme — has begun to address this, but offshore mariculture remains underfunded.

Technology transfer to private sector: The NIOT pilot project uses government-funded technology. Scaling to a commercial industry requires knowledge transfer to private operators, trained workforce development, and a supply chain for cage equipment and feed.

THE ANDAMAN AND NICOBAR CONTEXT

The Andaman and Nicobar Islands sit at a strategic maritime crossroads — astride the international shipping lanes connecting the Indian Ocean to the South China Sea. Their EEZ extends India's maritime presence deep into the eastern Indian Ocean. The islands' waters are among the cleanest and most biologically rich in the Indian Ocean basin.

However, the islands also face unique conservation constraints. The Andaman and Nicobar Islands are home to tribal communities (Jarawa, Sentinelese, Onge, Great Andamanese, and Shompen) protected under the Protection of Aboriginal Tribes Regulations. Large portions of island territory and surrounding seas are under Protected Area or Reserve Forest status. Any mariculture expansion must navigate these protections carefully — respecting tribal exclusion zones and conducting rigorous ecological impact assessments before scaling.

THE BLUE ECONOMY POLICY ARCHITECTURE

India's Blue Economy Policy framework (released in draft in 2021 and being finalised) identifies mariculture as a priority sector. The Deep Ocean Mission, launched in 2021 with a budget of approximately Rs 4,077 crore over five years, funds ocean technology development including deep-sea aquaculture research. The Pradhan Mantri Matsya Sampada Yojana (PMMSY), launched in 2020 with an outlay of Rs 20,050 crore, provides investment support for aquaculture infrastructure.

The first open-sea mariculture project is therefore a proof-of-concept for a larger ambition — testing whether the technology, regulatory framework, and community acceptance conditions can be assembled to build a scalable offshore mariculture industry.

UPSC RELEVANCE

India's EEZ (2.37 million sq km; 7th largest globally); NIOT (National Institute of Ocean Technology; under MoES; HQ Chennai); India seafood exports (USD 7.38 billion, 2023-24); Sri Vijaya Puram (formerly Port Blair); Deep Ocean Mission (Rs 4,077 crore; launched 2021); PMMSY (Pradhan Mantri Matsya Sampada Yojana; Rs 20,050 crore; 2020); India coastline (8,118 km); Kappaphycus alvarezii (seaweed; carrageenan)

MAINS GS-3:

"India's Exclusive Economic Zone offers enormous untapped potential for mariculture. Analyse the opportunities, technological challenges, and governance reforms needed to realise India's Blue Economy potential." | "Compare coastal aquaculture and open-sea mariculture — what ecological and economic trade-offs does the shift offshore involve?"

ESSAY:

"The ocean is India's last and largest untapped frontier — but blue growth must not repeat the mistakes of the green revolution's ecological overreach."

INTERVIEW:

"What is the significance of the Andaman and Nicobar Islands for India's Blue Economy strategy? How should India balance development ambitions with tribal protection obligations?"

📌 FACTS CORNER — KNOWLEDGEPEDIA

INDIA'S MARITIME SPACE:

EEZ: ~2.37 million sq km (7th largest globally)

Coastline: 8,118 km (9 coastal states, 4 UTs)

Territorial sea: 12 nautical miles from baseline

Continental shelf: up to 350 nautical miles (UNCLOS Article 76)

OPEN-SEA MARICULTURE PROJECT:

Location: Andaman Sea, near Sri Vijaya Puram (formerly Port Blair)

Partners: Ministry of Earth Sciences (MoES) + NIOT + Andaman and Nicobar UT Administration

Focus: Marine finfish cultivation + seaweed farming

Technology: Submersible sea cages, automatic feeding, real-time monitoring

NIOT (NATIONAL INSTITUTE OF OCEAN TECHNOLOGY):

Type: Autonomous institute under Ministry of Earth Sciences

Headquarters: Chennai, Tamil Nadu

Key functions: Deep-sea technology, ocean thermal energy conversion (OTEC), desalination, ocean observation systems, mariculture technology

INDIA FISHERIES AND SEAFOOD:

Seafood exports (2023-24): ~USD 7.38 billion

Aquaculture production (2023-24): ~9.64 million metric tonnes

Dominant export: Shrimp (Litopenaeus vannamei, Black Tiger Shrimp)

PMMSY: Pradhan Mantri Matsya Sampada Yojana — Rs 20,050 crore (2020-25); flagship scheme

BLUE ECONOMY POLICY ARCHITECTURE:

Deep Ocean Mission: Rs 4,077 crore (2021-2026); 6 pillars including deep-sea mining, desalination, biodiversity conservation

Blue Economy Policy: Draft 2021; mariculture identified as priority

Sagarmala Programme: Port-led development; 10 Blue Economy sectors

SEAWEED FACTS:

Kappaphycus alvarezii: Commercially important seaweed; source of carrageenan (food stabiliser)

Gracilaria: Seaweed source of agar (laboratory culture media; food industry)

Seaweed benefits: CO_2 absorption (blue carbon), no freshwater or land inputs, pharmaceutical raw material

India seaweed potential: Gulf of Mannar, Palk Bay, Andaman Islands are prime cultivation zones

ANDAMAN AND NICOBAR ISLANDS:

Status: Union Territory

Capital: Sri Vijaya Puram (renamed from Port Blair, 2024)

Key tribes (protected): Jarawa, Sentinelese, Onge, Great Andamanese, Shompen

Protection law: Andaman and Nicobar Protection of Aboriginal Tribes Regulations

Biodiversity: Coral reefs, mangroves, tropical rainforests; part of Sundaland biodiversity hotspot

OTHER RELEVANT FACTS:

Norway Atlantic salmon production: ~1.4 million tonnes/year (offshore cage farming)

World aquaculture leader: China (~80 million tonnes/year)

Marine Spatial Planning (MSP): International best practice for zoning ocean areas — India lacks comprehensive MSP

UNCLOS: UN Convention on the Law of the Sea (1982) — defines EEZ, continental shelf, territorial sea

Ocean thermal energy conversion (OTEC): NIOT has developed 1 MW demonstration OTEC plant

Coral Bleaching: Rising sea temperatures threaten Andaman coral reefs — an ecological constraint on mariculture siting

Sources: The Hindu, PIB, Ministry of Earth Sciences

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