नीतू प्रसाद, भा.प्र.से.
NEETU PRASAD, IAS

सत्यमेव जयते

आजादी का अमृत महोत्सव

संयुक्त सचिव
भारत सरकार
मत्स्यपालन, पशुपालन एवं डेयरी मंत्रालय
मत्स्यपालन विभाग
कृषि भवन, नई दिल्ली–110001

Joint Secretary
Government of India
Ministry of Fisheries, Animal Husbandry & Dairying
Department of Fisheries
Krishi Bhawan, New Delhi-110001

DO No. j-2103035/10/2025-Fy (E- 26241)

Dated 15th December, 2025

Dear Sir/Madam,

I am pleased to inform you that the Department of Fisheries, Government of India has released the Standard Operating Procedure (SOP) for Mariculture on the occasion of World Fisheries Day, 21st November, 2025. This SOP has been developed to provide a uniform, science-based framework for promoting sustainable and responsible mariculture activities along the Indian coastline. Copy of the same SoP enclosed herewith for further necessary action at State/UT level.

2. The SOP serves as an advisory, offering comprehensive guidance on site selection, species suitability, environmental safeguards, technical and operational standards, licensing procedures, monitoring mechanisms, and other regulatory requirements essential for responsible mariculture development. It is designed to support States/UTs in facilitating streamlined, uniform, and investor-friendly mariculture operations aligned with national priorities for coastal livelihood enhancement and Blue Economy growth.

3. Coastal States and UTs are requested to integrate the provisions of the SOP into their mariculture policies/action plans, or, where no such policy exists, to develop an overarching mariculture policy incorporating the SOP.

4. The Fisheries Departments of Coastal States/UTs are further requested to report actions taken and progress made in this regard to the Department for continued guidance and support.

With Warm Regards

Yours sincerely

(Neetu Prasad)

To,

The Addl. Chief Secretaries/ Principal Secretaries/ Secretaries of Department of Fisheries of all the Coastal States/ UTs.

Copy to:

The Commissioner/Directors of Fisheries of all the Coastal States/ UTs.

Tele.: 011-23383781, E-mail : jsfy@nic.in

सत्यमेव जयते

STANDARD OPERATING PROCEDURE FOR DEVELOPMENT OF MARICULTURE IN INDIA



Department of Fisheries
Ministry of Fisheries, Animal Husbandry and Dairying
Government of India

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Joint Secretary
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Ministry of Fisheries, Animal Husbandry & Dairying
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Krishi Bhawan, New Delhi-110001

PREFACE

India's maritime heritage, with its 11,098.81 km long coastline and 20.40 lakh square km vast Exclusive Economic Zone (EEZ), offers a phenomenal, yet largely untapped, reservoir for growth of Blue Economy. As global capture fisheries reach their ecological limits and the demand for sustainable, high-quality seafood continues its upward trajectory, driven by population growth and changing dietary preferences, Mariculture emerges as a critical, non-negotiable pillar for our nation's food security, nutritional needs, and economic prosperity.

The global landscape, as highlighted by the FAO's SOFIA 2024 report, underscores the increasing dominance of aquaculture, with marine and coastal aquaculture contributing a significant 71.1 million tonnes. For India, the development of a robust mariculture sector is not just an aspiration but an imperative to achieve sustainable growth in aquatic production, diversify livelihoods for our vulnerable coastal communities, and mitigate the impacts of climate change on traditional fishing.

Over the past decade, while marine fish production has risen, the time has come to systematically scale up mariculture activities, spanning finfish cage

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culture, marine mollusc farming, and especially seaweed cultivation to unlock the immense potential of our coastal and offshore waters.

This *Standard Operating Procedure (SoP) for the Development of Mariculture in India* is a landmark document formulated by the Department of Fisheries to provide a clear, action-oriented, and holistic guiding framework. It synthesizes global best practices and indigenous technological advancements developed by our pioneering research institutions.

The SoP addresses the persistent challenges, including the scarcity of quality seed and feed, the need for clear marine spatial planning, and gaps in supportive policy frameworks by outlining a comprehensive strategy focused on:

- Strengthening the entire value chain from hatcheries and feed production to processing and market linkages.
- Driving Technological Advancements and Innovation, including the judicious use of modern tools like AI and drones.
- Ensuring Sustainable and Equitable Development through the adoption of Good Aquaculture Practices (GAPs) and biosecurity measures.
- Enabling a Supporting Ecosystem that encourages private investment, robust financial access, and extensive capacity building for fishers and entrepreneurs.

This document is advisory in nature and is intended to serve as the core reference for all 9 coastal States and 4 Union Territories to formulate their localized mariculture policies and action plans.

I urge all stakeholders, State Fisheries Departments, Research Institutions, FFPOs, Cooperative Societies, SHGs, entrepreneurs, and the traditional fisher

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communities to embrace this SoP. By working together, we can cultivate a responsible, resilient, and thriving mariculture sector in the country that delivers enhanced incomes, empowers coastal livelihoods, and firmly establishes India as a global leader in sustainable seafood production.

(Neetu Prasad)



1. INTRODUCTION

1.1 According to the Food and Agriculture Organisation (FAO), State of World Fisheries and Aquaculture 2024 (SOFIA), global aquaculture production reached 130.9 million tonnes, with an estimated value of USD 312.8 billion contributing over 59% to the global fisheries production.

1.2 Global production of marine and coastal aquaculture reached 71.1 million tonnes[1], that includes 35.8 million tonnes of aquatic animals and 36.4 million tonnes of algae. The aquatic animals comprise of molluscs, finfish and crustaceans and are majorly produced in Asian countries (80.2%)[2].

1.3 Globally, seaweed farming and molluscs cultivation have dominated mariculture production. Since 2016, total production of aquatic animal species increased by 25% to reach ~25 million tonnes[3] through

[1] SOFIA 2024

[2] *ibid*

[3] SOFIA 2024 – Fig 11 Composition of world marine and coastal aquaculture by main species group, 2016-22

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mariculture. The increase in production of aquatic animal was led by finfish and molluscs that increased by 37.5% and 15% respectively. In addition, algae production under mariculture, including seaweed, increased by 16% from ~30 million tonnes to ~35 million tonnes.

1.4 Mariculture is expanding globally as a sustainable alternative to capture fisheries, which are nearing their ecological limits. Its growth is driven by rising seafood demand, supported by population growth, increasing incomes, and a shift toward healthier protein sources, alongside enabling economic, technological, and policy factors.

1.5 Technological advancements have played a crucial role, including innovations in hatchery management, disease control, feed efficiency, selective breeding, and farming systems making mariculture more productive and cost-effective.

1.6 Mariculture is being increasingly recognized for its climate resilience and resource efficiency, offering low-carbon, low-water food production solutions.

1.7 The cultivation of seaweeds and marine molluscs contributes to ocean health by absorbing excess nutrients and carbon dioxide. This sector also supports livelihood diversification and coastal economic development, particularly in regions with limited scope for land-based agriculture.

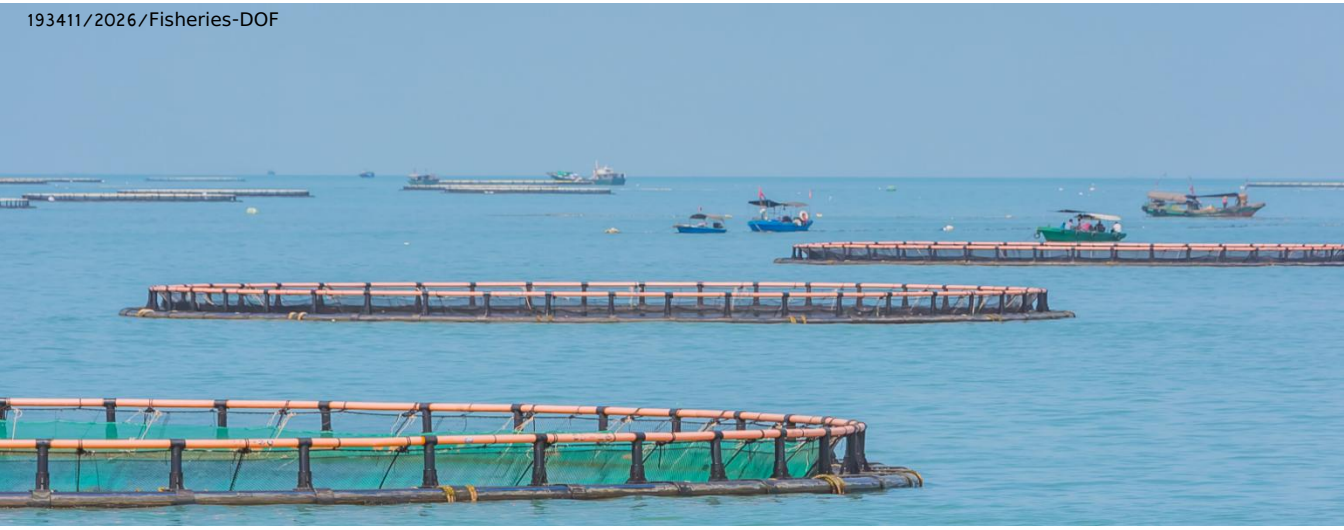
1.8 In addition, Government support through enabling policies, financial assistance, marine spatial planning, and investment in research and infrastructure has also accelerated growth, particularly in Asia and coastal regions of Europe and Latin America.

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1.9 With greater integration into global seafood markets and rising demand for traceable, sustainably farmed products, mariculture continues to expand as a key pillar of sustainable blue economies worldwide.

1.10 This Standard Operating Procedure (SoP) aims to provide an analytical overview of the mariculture sector in India, outlining its potential, challenges, and strategic importance. It offers actionable recommendations and policy implications to guide its sustainable development, aligned with national priorities and global best practices.

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2. MARICULTURE IN INDIA

2.1 India is bestowed with an extensive 11,098.81 km coastline, Exclusive Economic Zone (EEZ) of 20.40 lakh square kilometres and 5.30 lakh square kilometres continental shelf that offer abundant resources for marine fisheries and mariculture activities.

2.2 Coastal waters offer suitable environmental conditions such as salinity, depth, temperature, and tidal patterns for farming a wide range of marine species which include shellfish such as mussels, oysters, and clams, as well as seaweeds and ornamental species.

2.3 In addition to harnessing natural resources and practicing traditional methods of fish rearing, Fisheries Research Institutes have made significant progress by developing technologies for broodstock development, seed production, and farming of high-value finfish, shellfish, other invertebrates, and seaweed species, paving way for commercial-scale operations. Thus, technologies for captive breeding,

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seed production, and farming have been developed for more than 30 marine species of food and ornamental value4.

2.4 Standardized mariculture farming systems such as sea cages, rafts, monolines/ tube nets, recirculatory aquaculture systems (RAS), bioflocs and Integrated Multi-Trophic Aquaculture (IMTA) have been established across a range of environments, including coastal ponds, tanks, sea cages and pens.

2.5 Significant progress has also been made in refining larval rearing protocols, nursery systems, and mass cultivation techniques for microalgae and invertebrates used as live feed across the developmental stages of cultured species.

2.6 Mariculture is also considered as a powerful socio-economic tool, particularly for coastal communities across 3477 coastal villages as it provides an additional source of income for small-scale fishers during the lean fishing season or fishing bans and alternate means of income for women. It has also opened avenues for entrepreneurship among women, youth, and marginal farmers through activities like seaweed cultivation, pearl cultivation, ornamental fisheries, cage fabrication, hatchery operations, feed production, value-added seafood processing and other allied fisheries activities. Mariculture has increasingly become both a primary and supplementary source of income for various coastal stakeholders.

2.7 As a result, over the past decade, marine fish production in India has increased by approximately 25%, rising from 3.6 million tonnes in 2015 – 16 to around 4.5 million tonnes in 2023 – 24. While this increase is

[4] Central Marine Fisheries Research Institute | Home (cmfri.org.in)

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largely driven by marine capture fisheries, mariculture activities is steadily becoming popular means of fish and seafood production.

2.8 The need for development of mariculture is imperative to achieving sustainable growth in aquatic production and export, diversifying livelihoods opportunities amid climate change, and mitigating the depletion of conventional marine resources.

2.9 To unlock the full potential of mariculture by leveraging India's marine resources, technological advancements and human capital, the Department of Fisheries (DoF), Government of India, has formulated the Standard Operating Procedure (SoP) for Development of Mariculture.

2.10 In addition to outlining key mariculture activities and technologies, this SoP aims to provide framework(s) that are essential for addressing practical challenges in implementation and operations related to mariculture.

2.11 The SoP is advisory in nature and is intended to serve as a guiding framework for the formulation of mariculture policies, strategies and action plans by the 13 coastal States/UTs in accordance with locally available fisheries resources, investment potential and institutional capabilities

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3. DEVELOPMENT OF MARICULTURE IN INDIA

3.1 BACKGROUND

3.1.1 The Comprehensive Marine Fishing Policy was notified in November 2004 by Department of Animal Husbandry & Dairying, Ministry of Agriculture, Government of India, then housing the erstwhile Department of Fisheries (DoF), Government of India (GoI). It aimed to responsibly enhance marine fish production, boost seafood exports and domestic consumption, safeguard the socio-economic security for artisanal fishers whose livelihood solely depends on marine fisheries and advancing sustainable development with due regard to the ecological and biodiversity safeguards.

3.1.2 Further, the National Policy on Marine Fisheries (NPMF) was notified by Department of Fisheries (DoF), Government of India (GoI) in 2017 for "ensuring the health and ecological integrity of the marine living resources of India's Exclusive Economic Zone (EEZ) through sustainable

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harvests for the benefit of present and future generations of the nation". With this mission, NPMF framework aimed at sustainably managing marine fisheries including mariculture and holistic development of fishers and fish farmers.

3.1.3 NPMF recognises potential of mariculture, if carried out sustainably, to play an important role in increasing fish production from the coastal waters through Governmental schemes for setting up mariculture farms/parks, hatcheries for supply of seed; facilitating institutional and commercial needs like lease rights policies; spatial planning; technological inputs like seed, feed, health management; environmental and social impacts; capacity building of local fishers, farmers and local entrepreneurs; and development of local markets and value chains. It also focuses on inclusive participation of small fishing communities, fishermen groups, fishery cooperatives, Government organizations and the development of island fisheries.

3.1.4 The Department of Fisheries (DoF), Government of India, accorded high priority for the development of mariculture activities through its national schemes such as Blue Revolution Scheme (BR), Pradhan Mantri Matsya Sampada Yojana (PMMSY), Fisheries and Aquaculture Infrastructure Development Fund (FIDF), Pradhan Mantri Matsya Samridhi Sah-Yojana (PM-MKSSY) and Kisan Credit Card (KCC) through provisions of subsidies, institutional credit, performance-linked grants, capacity building and targeted outreach.

3.1.5 Recognizing the need to promote mariculture across coastal States and Union Territories in an ecologically sustainable manner, the provision under Section 13(8)(c) of the Coastal Aquaculture Authority (CAA) Act, 2005 (amended in 2023) permits seaweed, pen, raft, and

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cage culture activities in creeks, rivers, and backwaters within the Coastal Regulation Zone. The permitted activities include cage cultivation, bivalve farming (e.g., pearls and mussels), seaweed cultivation, and ornamental fisheries, supported by appropriate production technologies and systems tailored to coastal environments.

3.2 CHALLENGES IN MARICULTURE

3.2.1 Mariculture in India faces several significant challenges that impede its widespread development and long-term sustainability. Limited availability of quality and accredited hatchery-produced seed, cost-effective, healthy feed particularly for key marine species like cobia, seabass, and pompano have adversely impacted the expansion of mariculture as well as the productivity and profitability of farming operations.

3.2.2 Lack of clear mariculture zonation leads to spatial overlap with shrimp aquaculture and traditional fisheries, increasing the risks of disease transmission and operational conflicts. Effective spatial planning is essential to delineate areas for different culture systems and minimize disease transmission risks.

3.2.3 Lack of comprehensive regulatory and policy frameworks such as the uniform national mechanism for leasing coastal waters, streamlined environmental clearances, facilitative processes for ease of doing business etc. have deterred private investments in mariculture and also result into inequitable access / distribution of resources.

3.2.4 Infrastructure gaps across mariculture value chains such as inadequate marine hatcheries, feed mills, cold storage facilities, and

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processing units in several coastal regions continue to hinder mariculture expansion. Additionally, the absence of direct market linkages and reliance on multiple intermediaries near production sites increases transaction costs and reduces income, particularly for small-scale mariculture farmers.

3.2.5 Limited awareness of mariculture and related government schemes, inadequate access to institutional credit, and weak technology transfer from research institutions have hindered the adoption of best practices. Social and institutional barriers such as lack of insurance, financial access, and technical knowledge continue to restrict the effective participation of fisher communities in mariculture activities.

3.2.6 Significant opportunities such as offshore mariculture, species diversification, and climate-resilient practices remain largely underexplored. Strategic scaling these domains can unlock new livelihood opportunities, enhance income generation, foster innovation, and catalyse sustainable growth across the mariculture value chain.

3.2.7 Therefore, coordinated efforts encompassing policy reforms, capacity building, infrastructure development, and inclusive stakeholder engagement etc. are imperative to overcome the aforementioned challenges and unlock the full potential of mariculture in India.

3.3 VISION AND MISSION

3.3.1 The Government of India envisions mariculture as a key driver of sustained and inclusive growth in coastal regions. The Department of Fisheries (GoI) has outlined a clear vision and mission to guide the strategic expansion of mariculture across the country.

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3.3.1.1 **Vision:** To develop a sustainable and responsible mariculture sector that fosters holistic and inclusive development in coastal States/UTs leading to socio-economic upliftment, technology advancements and enhanced stakeholder collaboration.

3.3.1.2 **Mission:** To promote widespread adoption of mariculture as a primary source of livelihood for meeting the rising demand of quality seafood products in domestic and global markets by strengthening mariculture value chains through advancements in mariculture technologies, innovative solutions, adoption of good aquaculture practices, capacity and skill building and extensive outreach resulting into enhanced incomes and empowerment.

3.4 OBJECTIVES OF STANDARD OPERATING PROCEDURE (SOP) FOR DEVELOPMENT OF MARICULTURE

3.4.1 The SoP focuses on the following key elements:

i To facilitate an enabling environment for enhancing mariculture production and productivity through sustainable development of mariculture activities across the 9 coastal states and 4 UTs of India.

ii To provide guiding principles for formulation, adoption and compliance of required mariculture policies and action plans.

iii To ensure that mariculture practices are ecologically sustainable to the coastal environment in alignment with CAA and other such best practices including Code of Conduct for Responsible Fisheries (CCRF).

iv To promote additional livelihood activities for coastal communities including women.

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v To promote indigenous species and infusion of modern technologies such as Satellite, drones, AI etc. stakeholder co-operation and partnerships.

vi To identify and provide skill-based capacity building training for mariculture activities.

vii To promoter offshore mariculture activities such as sea cages, sea weeds, etc.

viii To promote Public – Private Partnerships (PPP) in mariculture for bringing investment and scale to the sector.

ix To meet the domestic needs and boost export of sea foods such as finfish, seaweeds, bivalves, ornamental fisheries and pearls.

x To establish necessary quality standards such as traceability, certifications, biosecurity measures and hygiene.

xi To develop entire value chain from "Source to Serve".

3.5 TYPES OF MARICULTURE ACTIVITIES AND PRODUCTION TECHNOLOGIES

3.5.1 Mariculture includes a wide range of activities such as farming of finfish, shellfish, seaweed, and other high-value marine resources, using systems like sea cages, pens, rafts, longlines, and land-based saline aquaculture units.

3.5.2 Mariculture production technologies have been adopted in India for fish farming in accordance with the local coastal water bodies, local species, demographics and prevailing economic conditions, with a focus on affordability and scalability. A few important production systems are outlined below.

3.5.3 Cage Culture

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3.5.3.1 As per FAO – SOFIA 2024, sea-based cage culture accounts for 65% of world's total finfish production that is farmed in both marine and coastal aquaculture. Recognising its efficiency and versatility in production of both high-volume and high-value species across diverse environments, especially in open water bodies, cage culture is being prioritized and promoted by DoF (GoI).

3.5.3.2 In India, open sea cage culture has emerged as a leading mariculture technology, particularly for finfish species like cobia, pompano, and seabass. The Central Marine Fisheries Research Institute (CMFRI) has developed cost-effective cage models suited for Indian coastal conditions, promoting their adoption across states such as Maharashtra, Andhra Pradesh, and Tamil Nadu. Small cage clusters have been promoted in states such as Maharashtra, Tamil Nadu under Government schemes such as PMMSY, however, cage culture has not been scaled across all coastal States/UTs due to operational knowledge gaps and its capital-intensive nature.

3.5.3.3 Coastal Aquaculture Authority Rules, 2024, has notified guidelines for regulating cage and pen culture of marine or brackish water aquaculture species which includes, finfish, shellfish, seaweed and other organisms. It lays down provisions for criteria for application for undertaking cage or pen culture, site selection, optimum range of water quality parameters, cage structure and installation, technical guidelines for cage or pen culture operations, feed

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management, prevention and treatment of fish diseases, harvesting, maintenance of farm management records etc.

3.5.3.4 Cage or pen culture of marine and brackish water fish species may be undertaken in ecologically suitable locations such as backwaters, lagoons, territorial waters, and areas within the Exclusive Economic Zone (EEZ), as identified by fisheries research institutes or other authorized government agencies. However, such activities may be avoided in creeks, estuaries, and backwaters where traditional fishery operations or coastal aquaculture farms already exist, as sharing water resources among different farming systems may lead to biosecurity risks and multi-user conflicts.

3.5.3.5 The respective states/UT Fisheries Department to allocate the suitable sites within the state territorial waters and the Department of Fisheries (Government of India) to allocate the suitable sites in the EEZ beyond territorial waters; with specific geo-coordinates or geo-fencing, to individuals/Self Help Groups (SHGs)/Joint Liability Groups (JLGs)/Fish Farmer Producer Organisations (FFPOs)/ Cooperative Societies/ farmers/ entrepreneurs/ technocrats etc., for taking up mariculture activities.

3.5.3.6 To minimize conflicts of interest along the coastline, cage or pen culture may be established in locations that are away from existing commercial shipping and navigational lanes, areas designated for fishing, ports and harbours, wastewater discharge points, restricted defence sensitive areas, wave or

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tidal energy projects, pipelines, recreational activities, ecologically sensitive areas, etc.

3.5.4 Cultivation of Marine molluscs

3.5.4.1 Marine molluscs cultivation is an important and eco-friendly segment of mariculture in India, that involves farming of species such as oysters, mussels, and clams. It is mainly practiced along the coasts of Kerala, Karnataka, Goa, Maharashtra, and Tamil Nadu.

3.5.4.2 Various bivalve farming systems are used for cultivation depending on site conditions and species' requirements. The rack culture system is used in shallow waters, typically between 2 to 5 meters deep. The raft culture system is practiced in sheltered bays with considerable depth and is anchored securely. The longline culture system is suitable for open waters with greater depth and is designed to withstand strong winds and wave action. Additionally, onshore culture systems involve cement tanks ranging from 250 to 500 square meters, primarily used for raising marine molluscs, especially pearl oyster seeds. Among these, the raft and rack systems are most commonly adopted in shallow coastal areas, particularly for the cultivation of mussels and oysters.

3.5.4.3 Coastal Aquaculture Authority Rules, 2024, has notified guidelines for regulating seed production and farming of bivalve in marine and brackish water. It outlines the provisions for bivalve cultivation such as the biosecurity facilities required and in-house quarantine, site selection criteria, sanitary requirements, water intake, water quality parameters,

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broodstock collection and management, seed production and sale, feed management, prevention and treatment of fish diseases, harvesting and maintenance of farm.

3.5.5 Seaweed cultivation

3.5.5.1 Seaweed mariculture in India is an emerging sector with significant ecological, socio-economic, and climate-related potential. India is home to over 850 seaweed species, especially along the Tamil Nadu, Gujarat, Maharashtra, Goa, Kerala, Andhra Pradesh, Lakshadweep and Andaman & Nicobar coasts.

3.5.5.2 Commercially farmed seaweed species include *Kappaphycus alvarezii*, a red seaweed cultivated for carrageenan production; *Gracilaria edulis*, used primarily for agar extraction; and species such as *Ulva spp., Sargassum spp., and Gelidiella acerosa,* which are valued for their applications in food, animal feed, and bioactive compounds. Other suitable species may also be considered based on ecological suitability and market demand.

3.5.5.3 While a significant portion of seaweed in India is still harvested from natural sources, an estimated 72,385 tonnes of seaweed were reportedly produced through farming in 2023. Recognizing its potential, the Department of Fisheries (GoI) and NITI Aayog are actively working to develop a robust seaweed value chain, positioning it as a key component of mariculture and a driver of economic growth of coastal areas.

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3.5.5.4 Main production methods include longline or rope culture with seedlings attached at intervals of 10 to 15 cm along the length of the rope. The exact spacing and seed material quantity may vary depending on seaweed species, growth conditions and farming location. Raft culture is another method that uses seaweed fastened onto ropes or monoline tube nets attached within floating rafts and tube net culture method uses cylindrical mesh tubes with a minimum mesh diameter of 25 mm and above, secured with polypropylene rope of appropriate thickness for growing seaweed.

3.5.5.5 While raft-based cultivation has traditionally been the preferred method for seaweed farming, alternative systems such as monoline and tube net setups have demonstrated greater effectiveness in several coastal states, particularly Tamil Nadu, Gujarat, and Maharashtra.

3.5.5.6 IMTA approach may be explored for integrating fish, shellfish, and seaweed for a diversified mariculture system and creating low environmental impact.

3.5.5.7 These technologies, backed by appropriate policies, schemes and investments are paving the way for a more resilient and sustainable mariculture sector.

3.5.5.8 The guidelines notified under the Coastal Aquaculture Authority Rules, 2024, are to be followed for registration of seedlings production units of marine and brackish water seaweed spores and seedlings, required bio-security facilities and in-house quarantine facility, sanitary requirements, site

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selection, potential species, water intake, and discharge of wastewater, harvesting and drying etc.

3.5.6 While existing production technologies have gained traction and shown success, Fisheries Research Institutes may continue to explore innovative aquaculture systems aimed at enhancing productivity in limited spaces, especially in the offshore areas.

3.6 MARICULTURE CANDIDATE SPECIES

3.6.1 In India, species specific mariculture and species' diversification both are gaining momentum as a sustainable approach for enhancing seafood production and coastal livelihoods.

3.6.2 Finfish mariculture has been successful with species such as cobia (*Rachycentron canadum*), Indian pompano (*Trachinotus mookalee*), silver pompano (*Trachinotus blochii*), and Asian seabass (*Lates calcarifer*), which are well-suited for cage farming in open sea waters. These species exhibit fast growth, high market demand, and adaptability to Indian coastal conditions.

3.6.3 Ornamental fisheries have gained prominence as a high-value component of mariculture in India, with several coastal states actively engaged in the breeding and rearing of marine ornamental species. States/UTs like Tamil Nadu, Andaman & Nicobar Islands are hubs of marine ornamental fisheries while Kerala, Maharashtra, and Goa are progressively advancing in this sector.

3.6.4 Shellfish farming is another key activity, particularly the culture of bivalves Marine Molluscs such as green mussels (*Perna viridis*), pearl oysters, edible oysters (*Crassostrea madrasensis*), clams

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and mud crab. These species are commonly farmed in brackish water areas. Green and brown mussels, along with edible oysters, are especially popular in shallow coastal waters, where they are cultivated using rack and raft systems, widely adopted in states like Kerala and Karnataka.

3.6.5 Seaweed species suitable for cultivation in marine and brackish water includes *Kappaphycus alvarezii*, *Gracilaria salicornia, Gracilaria crassa, Gracilaria verrucosa, Agarophyton tenuistipitatum, Gracilaria edulis, Gracilaria dura, Gracilaria debilis, Hypnea musciformis, Gelidiella acerosa, Ulva lactuca, Ulva intestinalis* and *Caulerpa sp.* or any other species permitted by the Central Government. Promotion of species may be guided by economic viability and location specificity, in accordance with recommendations from designated Government institutions. Additionally, seaweed may be cultivated in co-culture or Integrated Multi-Trophic Aquaculture (IMTA) systems alongside other compatible aquatic species.

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4. STRATEGIC FOCUS AREAS FOR SCALING MARICULTURE

The key areas identified to accelerate the growth of mariculture in India are as follows:

4.1 STRENGTHENING FISHERIES' VALUE CHAIN

i Enhancing the mariculture value chain is essential for realizing its full potential in driving coastal economic development, ensuring sustainable seafood production, and improving livelihoods. A robust value chain involving interventions at every stage from seed production and farming to harvesting, processing, marketing, and export need to be established.

ii A reliable and continuous supply of quality seed material is fundamental to the sustained expansion of mariculture. State - run facilities, including finfish and shellfish hatcheries, nursery units, Specific Pathogen Free (SPF) / Specific Pathogen Resistant (SPR)

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brood banks, and seaweed planting material centres need to be established with technical and financial support extended to FFPOs, SHGs, Joint Liability Groups, Cooperative Societies, technocrats and entrepreneurs.

iii Hatchery-based production of marine ornamental species and pearl oysters, having significant global trade, may be promoted. Additionally, R&D may also be supported for culture of indigenous ornamental fishes and pearls that have export value.

iv Sufficient number of brood banks, hatcheries and nursery units for different species need to be established for catering to small-scale fish farmers in coastal regions. This is also expected to prevent overexploitation of wild fish populations.

v For sea ranching, parent stocks may preferably be sourced from the wild populations and utilized for captive breeding to preserve the genetic variability and maintain the ecological integrity of wild stock. Mariculture efforts thus be adhered to these principles to safeguard the natural genetic diversity.

vi Species diversification of mariculture species is essential for maintaining an ecological balance and also diversifying the marine seafood export basket. To support this, State and UT fisheries departments need to actively promote awareness, outreach, and skill-building initiatives.

vii Existing aqua feed mills may be supported to expand production capacity, lower feed costs, and ensure supply of cost-effective feeds for small-scale farmers through targeted feed distribution schemes.

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viii For reinforcing the commitment towards minimizing ecological footprints, low-carbon feed production technologies, alternative protein sources and nutrient recycling technologies (utilization of organic waste from mariculture systems) may be adopted. Replacement of fish meal with sustainable protein alternatives need to be prioritised. Formulated feeds may be promoted and the use of low-value fish for feed discouraged.

ix A seed and feed certification system may be developed by State/UT fisheries departments for ensuring high quality and adoption of sustainable practices integrated with traceability mechanism.

x In the absence of breeding technologies for certain commercial marine species, wild seed collection may be allowed for aquaculture with due caution.

xi A certification framework for eco-friendly formulated feeds with low Fish In-Fish Out (FIFO) ratios may be implemented to reduce dependency on wild-caught fish.

4.1.1 Area expansion

4.1.1.1. Optimal utilisation and expansion of area under mariculture

4.1.1.1.1. Optimal utilisation and expansion of area under mariculture is crucial for increasing seafood production strengthening livelihoods security and promoting sustainable use of marine resources. While India has immense untapped potential for mariculture, the area currently under cultivation needs to be upgraded with required infrastructure ensuring compliance to necessary regulatory processes, and robust awareness and outreach initiatives to unlock its full potential.

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4.1.1.1.2. Therefore, strategically identifying suitable mariculture zones, promoting efficient farming practices, and encouraging public-private participation are expected to significantly boost marine fish and seaweed production.

4.1.1.2. Identification and Demarcation of mariculture zones

4.1.1.2.1. The State/UT fisheries departments need to identify and designate suitable sites as mariculture zones for activities such as cage farming, bivalve farming, pen culture, seaweed cultivation, hatcheries, and nurseries. Each coastal State/UT may develop a detailed operational framework to guide these activities.

4.1.1.2.2. The process of site identification needs to be carefully curated, planned, and implemented in consultation with the Department of Fisheries (GoI), research and development institutions, local planning authorities, mariculture farmers, Self Help Groups (SHGs), cooperatives, Fish Farmer Producer Organisations (FFPOs), coastal fishers, and other relevant stakeholders to ensure ecological suitability, stakeholder alignment, and long-term sustainability.

4.1.1.2.3. The demarcation of mariculture zones to be based on a comprehensive evaluation of environmental parameters, including the risk of Harmful Algal Blooms (HABs) and potential environmental impacts.

4.1.1.2.4. Carrying capacity and vulnerability assessments of identified zones are to be done in tune with CAA provisions and norms. Socio-cultural attributes, local area master plans, and logistical considerations may also be factored in for safeguarding the livelihoods of local fishing communities,

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ensuring permitted access to fishing grounds, and minimizing conflicts with other coastal activities.

4.1.1.2.5. Climate vulnerability assessments may be conducted for ensuring long-term sustainability and adaptability to changing oceanographic conditions.

4.1.1.2.6. Each coastal State/UT fisheries department need to prepare Marine Spatial Plans (MSPs) following guidelines by GoI, wherever available. These plans may integrate data management, analysis, modelling, and decision-making frameworks, adhering to CAA guidelines/ Coastal Regulation Zone (CRZ) rules.

4.1.1.2.7. The relevant research institutions such as CMFRI, CSMCRI, CIBA, NCCR, NCSCM, etc. may serve as technical partners to the States and Union Territories in identifying suitable areas and facilitating the development of Marine Spatial Plans and other mariculture related activities.

4.1.1.2.8. Mariculture zones in inshore and coastal areas need to explicitly exclude Marine Protected Areas (MPAs), ecologically sensitive regions such as coral reefs, mangroves, seagrass beds, turtle breeding and nesting grounds, navigational channels, port and harbour access points, major fishing grounds, and other areas of strategic importance.

4.1.1.2.9. Mapping of coastal zones, offshore areas, and tidal-influenced inland water bodies may be done using Geographic Information System (GIS) and Remote Sensing tools for identifying spatial availability for mariculture activities. This may demarcate potential areas for cage culture, pen culture, seaweed farming and mollusc culture.

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4.1.1.3. Leasing and licensing of identified mariculture zones

4.1.1.3.1. Each coastal State/UT fisheries department is empowered to manage and promote marine fisheries and allied activities which include mariculture within 12 nautical miles ahead of the Indian coastline under CAA jurisdiction. The State/UT fisheries department may lease out / license the areas demarcated for mariculture as per the MSP formulated by the State/UT in consultation with DoF (GoI), R&D Institutions, local bodies, the coastal fishermen, and other stakeholders.

4.1.1.3.2. These processes need to be followed by all individuals/ groups who wish to practice mariculture for commercial purposes and adhering to the regulatory frameworks of the central and State/UT governments. Small scale fishermen and cooperatives may be given priority for leasing mariculture sites to ensure equitable and inclusive development.

4.1.1.3.3. Panchayat Raj Institutions (PRI), municipal bodies and other local governing bodies may be engaged for promoting mariculture. In such leasing arrangements, priority may be given to local groups/ dwellers.

4.1.1.3.4. The leasing/ licensing mechanisms may incorporate a performance-based renewal system for encouraging compliance with environmental and production benchmarks. Activities under the issued licenses may be subject to periodic reviews assessing production efficiency, environmental compliance, and socio-economic contributions.

4.1.1.3.5. The State/UT fisheries department need to take into account the public trust doctrine, the interest of all stakeholders as well as principles of Ecosystem Approach to Aquaculture (EAA) in

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governance frameworks to ensure that the biological production remains within in the ecological carrying capacity and environmental sustainability.

4.1.1.3.6. The State/UT fisheries department may facilitate ease of doing mariculture ventures/ businesses through single window system wherever possible. In addition, mariculture activities shall also abide by the amended CAA guidelines, wherever applicable.

4.1.1.3.7. A monitoring framework needs to be defined for ensuring adherence to the terms and conditions of the leases. In addition to manual oversight, the framework may include use of digital tools, including geo-tagged farm data, Internet-of-Things (IoT) based sensors for tracking water quality and production metrics, use of drones and satellite surveillance.

4.1.1.3.8. License renewals need to be linked to performance-based benchmarks including production output, operational efficiency, environmental compliance, and socio-economic contributions. Leasing of areas for mariculture parks may also be reviewed before renewal.

4.1.2 Adoption of cluster-based approach

4.1.2.1 Strengthening the value chain and promoting cluster development are mutually reinforcing processes that play a critical role in the sustainable growth of mariculture. A robust value chain from input supply and farming to post-harvest processing and marketing ensures that each link functions efficiently, enhancing productivity, profitability, and resilience.

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4.1.2.2 When these value chain components are developed within geographically concentrated areas or clusters, they benefit from shared infrastructure, skilled workforce, market access, and coordinated services. This spatial concentration fosters economies of scale, reduces costs, and facilitates collective problem-solving among stakeholders.

4.1.2.3 This model enables efficient use of resources (sharing of common infrastructure such as hatcheries, nurseries, feed units, and post-harvest facilities), reduces individual costs, promotes economies of scale, reduces individual financial and economic risks and encourages collective marketing, training, and technology adoption. The cluster-based approach focuses on and enables better coordination amongst stakeholders.

4.1.2.4 By fostering cooperation and scale, clusters enhance productivity, improve traceability, and attract investment, making mariculture more inclusive, profitable, and sustainable for coastal communities in India.

4.1.2.5 Mariculture clusters may thus be developed through a coordinated, multi-stakeholder approach that brings together coastal communities, government agencies, research institutions, and private sector partners. The information on the identified designated mariculture zones across the coastal States/UTs along with the fisheries profile of respective States / UTs may be taken into account in identifying the location and activities for development or expansion of clusters.

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4.1.2.6 The clusters need to focus on development of end-to-end value chain(s) for commercially important mariculture activities such as production and processing activities as suitable and relevant for fisheries' development in the local region.

4.1.2.7 Once the type of cluster and location has been identified, gaps assessment may be conducted to access the financial, infrastructure, resource support required. This may entail in-depth study pertaining to pre-production (inputs supply, hatcheries, feed mills etc), production (availability of pond/sea area, technology, training) and post-production (cold chains, markets, processing facilities, market linkages etc.) aspects ensuring sustainable and inclusive development in the region.

4.1.2.8 Cluster development needs to focus on reducing operational costs and improving efficiency and effectiveness to enhance income for stakeholders. To support this, training and capacity-building programs for local communities may be conducted to ensure the adoption of best practices in species selection, disease management, and sustainable farming techniques.

4.1.2.9 The cluster development activities need to be carried out in accordance with the Department of Fisheries (GoI) Guidelines for 'Cluster Development'. Efforts need to be made to integrate mariculture clusters with existing government schemes such as PMMSY, PM-MKSSY, and KCC. Additionally, linkages through Self-Help Groups (SHGs), Fish Farmer Producer Organizations (FFPOs), and cooperative

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models may be explored wherever possible to achieve cluster development targets and ensure long-term growth of the sector.

4.1.2.10 Under the Cluster Development Plan, 34 specialized clusters have been notified for development of mariculture activities which include pearl farming, ornamental fisheries, seaweed farming, brackish water aquaculture, sea cage farming and pearl spot. In addition, 4 integrated aquaparks including multipurpose seaweed park at Tamil Nadu are being developed as hubs for seed and feed production, pre- and post-harvest infrastructure, logistics, marketing, export promotion, technology incubation, recreation, and innovation.

4.2 TECHNOLOGICAL ADVANCEMENTS, INNOVATION AND ITS ADOPTION

4.2.1 Mariculture production systems and technologies

4.2.1.1 Various types of mariculture production systems are currently employed for rearing aquatic animals as well as seaweed. The common production systems are sea cages, Recirculating Aquaculture Systems (RAS), bioflocs, longlines, racks, pens, IMTA and raceways. Rafts, monoline, tubenets and a combination of these methods are generally used for cultivation of seaweed.

4.2.1.2 Production systems need to be optimally utilized by establishing a Code of Good Aquaculture Practices (GAqP) tailored to the species and production systems in use. The State Fisheries Departments may conduct year-round outreach and awareness programs to educate fishermen

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on new technologies, methodologies, and environmental concerns. Additionally, States and Union Territories may also actively engage in capacity-building initiatives for fishermen and other stakeholders, with the involvement of R&D institutes, to promote best practices in species selection, disease management, and sustainable farming techniques.

4.2.1.3 The State fisheries department, in consultation with R&D institutions, need to assess the annual mariculture production potential periodically based on the site-specific carrying capacity, water quality parameters, and species suitability studies.

4.2.2 Enhancement of productivity for increasing mariculture production

4.2.2.1 DoF (GoI) along with NFDB, State/UT fisheries departments and fisheries research institutes may take considerable efforts for disseminating technological know-how for enhancing productivity across mariculture production systems and use of technologies as well as the information on resources and species appropriate for the respective regions.

4.2.2.2 Activities like hybrid offshore aquaculture systems can be integrated with AI-driven smart cages, automated feeding mechanisms, real-time environmental monitoring sensors etc. and may be introduced as pilot projects for testing scalability, enhancing production efficiency and ensuring minimal ecological disruption.

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4.2.3 Species selection in production system

4.2.3.1 Species diversification has been prioritized as a key strategy for development of mariculture in India as it reduces the ecological and economic risks associated with the over-reliance on few species.

4.2.3.2 Species suited for different salinity ranges, depths, and water qualities are expected to enhance resilience and productivity across India's diverse coastal ecosystems. Species diversification is expected to open new business avenues for catering to multiple domestic and export markets, minimize the threats of disease outbreaks and market saturation and allow farmers to adapt varying environmental conditions and market demands. It needs to be encouraged based on site suitability, technological feasibility, market demand, commercial viability, ecological impact, and overall economic benefits.

4.2.3.3 Thus, farming a wider variety of species such as cobia, seabass, groupers, shellfish, seaweeds, ornamental species and high-value species like lobsters and oysters that command premium prices in international markets may be actively promoted. Seaweed and mussels that support eco-friendly, low-input farming models are expected to be ideal for women and small-scale mariculture farmers.

4.2.3.4 IMTA production system may be adopted for enhancing resource utilization and operational efficiency and ecological balance within the marine ecosystem. Thus, species diversification is expected to not only support

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income stability for farmers but also aligns with India's goals of a balanced, inclusive, and climate-resilient blue economy.

4.2.3.5 In order to mitigate risks of escapees from culture systems, particularly during natural calamities such as cyclones or floods, the use of non-native species and/or Genetically Modified Organisms (GMOs) may not be allowed in an open mariculture system. Such species may however be considered and subject to rigorous Risk Assessment (RA) and compliance with national regulations governing quarantine, non-native species, and GMOs.

4.3 SUSTAINABLE AND EQUITABLE DEVELOPMENT

4.3.1 Climate resilience and sustainability

4.3.1.1 State-specific climate vulnerability assessments may be conducted to evaluate the exposure and sensitivity of coastal regions to risks such as cyclones, ocean warming, salinity intrusion, sea-level rise, and ocean acidification.

4.3.1.2 These assessments may develop into long-term mariculture planning under the State/UT development plan by identifying high-risk zones and proposing adaptive strategies. Wherever available, findings from baseline gap studies carried out for mariculture cluster development, spatial planning, and schematic impact assessments need to be leveraged to prepare comprehensive State/UT-specific action plans. These plans may guide the formulation of mariculture policies,

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protocols, and operational frameworks that promote both climate resilience and ecological sustainability.

4.3.1.3 Adaptive strategies and risk mitigation measures may be embedded in State/UT fisheries department's Annual Action Plans. This includes promoting the culture of climate-resilient species, infrastructure designed to withstand extreme weather events (e.g., submersible cages, cyclone-resistant mooring systems), and species diversification to reduce biological and economic risks. Risk transfer instruments such as weather-indexed and input-based insurance schemes may also be promoted to safeguard the livelihoods of mariculture farmers from climate-induced losses and disease outbreaks.

4.3.1.4 The guiding principles of the FAO's Ecosystem Approach to Aquaculture (EAA) may be mainstreamed into mariculture planning and implementation. EAA emphasizes holistic planning that ensures environmental integrity, social equity, and economic viability. This includes maintaining ecosystem services, integrating multi-use spatial planning, and ensuring equitable participation of local communities.

4.3.1.5 With regard to Environmental Impact Assessments (EIA) of mariculture projects, the relevant CAA guidelines shall be followed.

4.4 ENABLING A SUPPORTING ECOSYSTEM

4.4.1 Convergence, private partnerships and international co-operation

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4.4.1.1 Development of mariculture activities in each State/UT will seek convergence with existing activities of PMMSY, PM-MKSSY, FIDF schemes of the Department of Fisheries, Ministry of Fisheries, Animal Husbandry and Dairying, schemes run by allied Ministries such as Ministry of Food Processing Industries (MoFPI) for value addition and cold chain development; Ministry of Rural Development (MoRD) for livelihood and cluster development through NRLM; Ministry of Agriculture & Farmer Welfare (MoAFW) for integration with coastal agriculture and input services; Ministry of Environment, Forest and Climate Change (MoFECC) for clearances and sustainability frameworks as applicable; Ministry of Skill Development and Entrepreneurship (MSDE) for human resource development; Ministry of Micro, Small and Medium Enterprises (MSME) for entrepreneurship and credit facilitation; Ministry of Tribal Affairs for inclusive outreach in coastal tribal areas etc. Suitable linkages and convergence with allied ministries and departments are expected to create synergies for inclusive and holistic development. The states may strive for bringing convergence of mariculture activities with their existing state schemes / programs of its Fisheries and other relevant departments.

4.4.1.2 Coastal States/UTs fisheries departments may also explore convergence with international development agencies, blue economy-focused investment platforms, and CSR initiatives for mobilizing additional resources, technology

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transfer, and capacity-building support. A convergence roadmap with clearly defined roles, responsibilities, and timelines may be prepared by State/UT fisheries departments, in conjunction with DoF (GoI).

4.4.2 Training and Capacity Building

4.4.2.1 A comprehensive assessment of the availability and capacity of skilled and semi-skilled manpower within coastal communities may be undertaken to identify potential candidates for mariculture activities and plan targeted interventions.

4.4.2.2 Tailor-made capacity-building modules need to be developed in collaboration with academic and R&D institutions, aimed at imparting specialized knowledge on mariculture operations, governance, and value chain management to fishers and other stakeholders. These modules may include technical training, entrepreneurial development, and operational best practices applicable both within identified mariculture clusters and in related coastal areas.

4.4.2.3 Government bodies, fisheries research institutes, industry associations, and private enterprises need to collaborate to upgrade the skills of traditional fishers and other potential stakeholders, helping them transition from capture fisheries to economically viable and sustainable mariculture ventures. These efforts will broaden awareness and attract new entrants into the sector.

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4.4.2.4 Innovative e-learning platforms and augmented reality (AR)-based simulation tools may be developed to train mariculture practitioners in advanced farming practices, disease prevention and control, and value chain optimization. These technologies can enhance practical understanding and improve on-ground implementation of best practices in mariculture. Assessment of available skilled and semi-skilled manpower within coastal communities for mariculture activities may also be conducted.

4.4.2.5 Given the increasing vulnerabilities posed by climate change, it is imperative to develop and mainstream climate-resilient mariculture strategies. These strategies may be incorporated into a mission-mode action plan and may also include the development of high-temperature and low-salinity-tolerant species, robust offshore cage systems capable of withstanding extreme weather, and scenario-based climate vulnerability assessments. Such models can evaluate the impacts of ocean acidification, rising sea surface temperatures, and sea-level rise. Public-private partnerships (PPP) may be actively encouraged to attract investment and operationalize these innovative technologies at scale.

4.4.2.6 R&D initiatives may be spearheaded by national and state-level R&D institutions and universities, in close collaboration with the DoF (GoI) and the respective State/UT fisheries departments.

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4.4.2.7 Furthermore, government agencies may actively identify and evaluate established mariculture technologies from countries which are global leaders in mariculture.

4.4.3 Investment and market potential

4.4.3.1 The coastal State/UT fisheries departments may formulate a comprehensive investment roadmap that identifies key areas for financial support and private sector participation. The roadmap may inter alia outline potential for PPP, venture capital funding, and impact investments aligned with the principles of a circular blue economy. Special emphasis may be given on creating inclusive models that enable small-scale mariculture farmers to participate and benefit, through mechanisms such as concessional loans, interest subvention, and risk-mitigation tools like insurance and guarantees.

4.4.3.2 There is growing global and domestic demand for high-quality seafood, nutraceuticals, seaweed-based products, and ornamental species creating opportunities for expanding the domestic and international markets.

4.4.3.3 The State Fisheries Department may also capture the growing market needs and establish the necessary institutional and regulatory framework for smooth clearances and facilitating the trade. Efforts need to focus on enhancing the ease of doing business including adopting single-window clearances and streamlined licensing processes besides bringing in a suitable lease policy along with demarcation of mariculture zones.

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4.4.4 Food Safety and quality assurance

4.4.4.1 To ensure food safety and compliance with acceptable market standards, mariculture operations need to adhere to appropriate national and international regulations across pre-production, production, and post-harvest stages.

4.4.4.2 Good Aquaculture Practices (GAPs) and Best Management Practices (BMPs) may be developed with the help of Fisheries Research Institutions, Bureau of Indian Standards (BIS), Export Council of India (ECI), Department for Promotion of Industry and Internal Trade (DPIIT), Food Safety and Standards Authority of India (FSSAI), Good Handling Practices (GHP), and Hazard Analysis and Critical Control Points (HACCP) among others.

4.4.4.3 Mariculture operations need to incorporate robust aquatic animal health management programs that align with national legislation and draw from global best practices, including FAO's Code of Conduct for Responsible Fisheries (CCRF) Technical Guidelines and the World Organisation for Animal Health (WOAH) standards. Real-time monitoring systems, including AI-enabled diagnostic tools, may be employed to enable early detection and mitigation of disease outbreaks. The use of medicines and other inputs need to comply with national regulations and international agreements to ensure efficacy, public and animal safety, and environmental sustainability.

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4.4.4.4 Comprehensive traceability systems need to be established to maintain records of farming practices and all input sources including feed, seed, veterinary drugs, vaccines, antibiotics, additives, and chemicals. Accurate documentation of input types, concentrations, dosages, and administration methods will be essential for audit trails, quality assurance, and regulatory compliance. In parallel, preparedness strategies may also be developed to address emerging diseases and parasites, supported by AI-driven Aquatic Animal Disease Surveillance Systems (AADSS). These systems may integrate real-time data from IoT-enabled devices, diagnostic labs, and farmer reports to deliver early warnings and actionable insights

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5. IMPLEMENTATION FRAMEWORK OF STANDARD OPERATING PROCEDURES (SOP) FOR MARICULTURE

The implementation of SoPs is required to be guided by the following framework;

5.1 OPERATIONAL FRAMEWORK

5.1.1 Site selection: States & UTs may identify suitable sites for mariculture based on depth, current, salinity, dissolved oxygen, distance from sensitive habitats (coral reefs, mangroves), carrying capacity assessment and other relevant parameters as recommended by the research institutes.

5.1.2 Establishment of Nucleus Breeding Centre (NBC), Brood Bank, Hatchery for candidate species such as Finfish (cobia, pompano, seabass, groupers etc), Shellfish (mussels, oysters, clams), Crustaceans (lobster, mud crab), Seaweeds, and Ornamental

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fishes. Establishment of NBC, Brood Bank and Hatchery should be as per the guideline notified under CAA Act, 2023.

5.1.3 Seed production needs to follow established aquatic animal health management protocols to ensure biosecurity and high-quality stock, including disease screening and record-keeping.

5.1.4 Species/varieties that are fast-growing, high-yielding, and disease-resistant may be prioritised for mariculture. To ensure genetic quality and health standards, seeds need to be procured exclusively from hatcheries certified by the Coastal Aquaculture Authority (CAA).

5.1.5 Mariculture systems such as Cage culture (offshore & nearshore), longline & raft culture for mussels and seaweed, rack and bottom culture for oysters, pen culture in coastal lagoons/estuaries and integrated multi-trophic aquaculture (IMTA) may be established as per site suitability and species-specific requirements. The responsibility for managing and monitoring mariculture activities undertaken by fishers and farmers rests with the respective State and UT Governments.

5.1.6 Feed mills for marine species, water quality and disease diagnostic laboratories may be established, preferably in sites/areas close to the mariculture activities, to avoid extended transport of inputs thus reducing input cost. These facilities may preferably be developed using a cluster-based approach to support localized production, enhanced operational efficiency, and improved farmer access to essential services.

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5.1.7 Post-harvest handling including cleaning, grading, and sorting needs to be carried out promptly to maintain product quality, reduce waste, and enhance hygiene and marketability.

5.1.8 Cold chain infrastructure such as cold storages or dry storages as required, ice plants, insulated/refrigerated vehicles for transport of product and marketing infrastructure may be established within each mariculture cluster. These facilities may strategically be located to minimize logistics costs and enhance value chain integration.

5.1.9 Landing centres, processing units, and value addition facilities for mariculture products may be established, incorporating smart technologies and green components.

5.1.10 Effective marketing strategies need to be developed for harvested and value-added mariculture products. Local marketing networks may also be established to support product promotion, distribution, and access to domestic and export markets.

5.1.11 A unified digital Mariculture Governance Portal (MGP) may be developed by the coastal States/UTs to facilitate integrated tracking and monitoring of mariculture development plan implementation. The portal should enable real-time data entry, progress assessment against physical, financial, and performance targets, compliance tracking, and stakeholder feedback collection, thereby strengthening transparency, accountability, and adaptive management

5.1.12 The MGP may include modules for licensing, zone allotment, traceability, proposal approvals, standard certification status, and a

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dashboard displaying performance indicators. It may also integrate services for regulatory compliance, helpdesk support, grievance registration and tracking for redressal. Where feasible, advanced technologies such as IoT, satellite imagery, drones, and AI-based monitoring tools may also be embedded to enable real-time data collection, analysis, and decision-making.

5.1.13 Institutional mechanisms for contract farming, buyback agreements, public-private partnerships (PPP), and transparent fish pricing may be developed and implemented. These mechanisms may be designed in consultation with farmer groups, private sector stakeholders, and market actors to ensure fairness, profitability, and equitable value distribution across the mariculture value chain.

5.2 REGULATORY FRAMEWORK

5.2.1 The Coastal Aquaculture Authority will serve as the designated statutory body responsible for registration of mariculture projects within the CAA limits (12 nautical miles from the coastline and in the coastal waters).

5.2.2 All the mariculture units/activities shall be registered with the Coastal Aquaculture Authority as per the provisions contained under subsection (1) of the Section 13 of the CAA Act, 2005 (amended in 2023).

5.2.3 The officers authorised by the CAA as Authorised Officers in all coastal Districts under Section 13A (1) and designated agencies appointed by the CAA, State/UT Fisheries Department shall be responsible for verifying records, conducting site inspections, and carrying out audits to ensure compliance with applicable national

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and local regulatory frameworks, operational guidelines, and mariculture best practices.

5.2.4 Mariculture activities carried out in the identified feasible locations shall always be environmentally sustainable. The mariculture units that cause pollution shall be liable for penal action as per the provisions contained in the CAA Act, 2005, and the CAA Rules, 2024.

5.2.5 The CAA is empowered to order the removal or demolition of any coastal aquaculture unit which is causing pollution after hearing the occupier of such unit as provided under Section 11 (1)(d) of the CAA Act, 2005 (amended in 2023).

5.2.6 The operator or owner of such coastal aquaculture unit or activity shall be liable for payment of the assessed cost of the damage to the coastal environment including the cost of demolition of such unit, in to account of the CAA as prescribed under Rule 17 (2) of the CAA Rules, 2024 under "Manner of assessing cost of damage to environment".

5.2.7 The Guidelines notified under Rule 3 of the CAA Rules, 2024 on "Assessment of Cost for the Damage to Environment and Cost of Demolition and Utilisation of Environment Monitoring Fund Guidelines" shall be followed in case any unit causes the pollution to the coastal environment to recover the cost of damage to the environment from the concerned unit operator/owner of the unit.

5.3 INSTITUTIONAL FRAMEWORK

5.3.1 The overall responsibility of planning, execution, monitoring including capacity building and marketing within the territorial

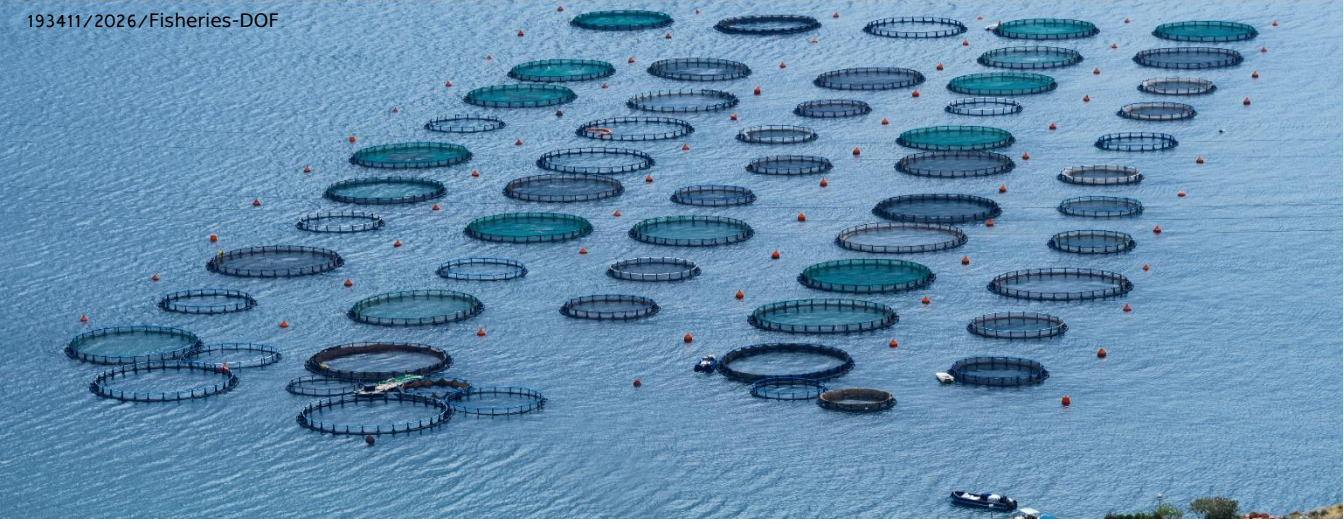
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waters lies with the fisheries department in the concerned coastal State / UT.

5.3.2 The overall compliances and regulations related to mariculture within the territorial waters shall be governed as per the CAA Act 2023 and its relevant rules and guidelines, as applicable.

5.3.3 The Offshore Mariculture activities beyond the territorial waters are to be governed by the DoF, GoI.

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6. OFFSHORE MARICULTURE INCLUDING SEAWEED AND CAGE CULTURE IN EEZ

6.1. Aquaculture currently accounts for approximately half of global seafood production, with the majority originating from Asia. Given the limited potential for significant growth in wild fish stocks, aquaculture has emerged as a vital strategy for ensuring global food security. Expanding aquaculture presents a significant investment opportunity, with an estimated capital requirement of $150 billion to $300 billion over the next decade to enhance production capacity.

6.2. The offshore mariculture activities including seaweed and cage culture systems may be promoted in the Exclusive Economic Zone (EEZ) of India. These practices are aimed at promoting sustainable offshore eco-friendly mariculture in India while protecting marine ecosystems, food and nutritional security, employment generation and providing an additional source of income to coastal and fisher communities, offering a comparatively low-carbon source of protein.

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6.3. In the Offshore Mariculture, the cultivation of marine species (finfish, shellfish, seaweed) in floating or submerged structures may be promoted under Cage Culture anchored in the open sea or the cultivation of macroalgae on ropes, rafts, or longlines in offshore waters including utilization of innovative platform technology based on a rig or semi-submersible system. All onshore and offshore systems may be encouraged to adopt green energy sources (such as solar, wind, wave) with hydrogen-based backup options and integrated with world-class technologies including IoT-enabled intelligent systems.

6.4. The industrial scale offshore cultivation may be promoted having secured investment by private partners supported by loans and grants including public private partnership (PPP) model and involving Financial & Insurance Partners such as NABARD, NCDC, Nationalized Banks, Insurance Partners, ADB, World Bank, etc.

6.5. Active involvement of the concerned coastal State Government, State Maritime Board and Port Authorities need to be ensured during stakeholder consultations. Logistical requirements and necessary MoUs may be formed for land allocation and local support for establishment of hatchery, nursery, and processing facilities.

6.6. SITE SELECTION AND REQUIREMENTS PERMIT

6.6.1 Proposed sites for Offshore Mariculture need to be located in pre-identified mariculture zones as designated by the Department of Fisheries, Ministry of Fisheries, Animal Husbandry & Dairying (MoFAHD), Government of India in consultation with the coastal States/UTs, R&D Institutions and concerned Ministries/ Departments including MoPSW, MoEFCC, MoES, MoPNG, MoD, etc. Sites should have good water exchange, sufficient depth (>10 m

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for cages, >5 m for seaweed), and not interfere with navigation, fishing, or sensitive habitats or offshore installations.

6.6.2 The MoFAHD, Government of India is the Competent Authority to grant Permit for allowing the Offshore Mariculture activities in the Exclusive Economic Zone (EEZ) of India beyond the territorial waters of 12 nautical miles. Applicants need to submit their proposal(s) online indicating the Farm Site Plan with coordinates, proposed species and method of cultivation to the Department of Fisheries, MoFAHD, GoI.

6.6.3 The applications for the Offshore Mariculture to be considered by the 'Inter-Ministerial Committee on Offshore Mariculture' constituted by the MoFAHD, Govt of India having members from the Concerned Ministries, State Governments and research institutes (such as MoPSW, MoEFCC, MoES, MoPNG, MoD, MEA, ICAR, etc.). The allocation of sites for offshore mariculture and periodic review of the sites may be considered by the said Committee considering the ecological or sectoral changes.

6.7. SPECIES SELECTION

A variety of finfish, shellfish and seaweed species may be identified as well-suited to the sea environment in the particular location. The target species for breeding, nursing, and cultivation may include high value species such as Cobia, Groupers, Snappers, Trevallys, Seriola (S. lalandi and S. rivoliana), Seabass and Seabream, Red Drum, Yellowfin Tuna, Oysters, and Crabs etc. The species may be selected based on their adaptability to the local marine conditions, commercial value, market demands, sustainability and their alignment with the overall objectives of the project. Research and development efforts will also focus on

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establishing and optimizing breeding and growth protocols for these species. The operators are encouraged to facilitate or enter into MOUs with Indian R&D institutions and renowned overseas Institutions/ Professional organizations in the areas of breeding and culture technologies, processing and value addition, use of advanced methodology designed to support commercial-scale mariculture operations and also the technology transfer intended to maximize operational efficiency and support the consistent production of high-quality seafood for domestic consumption and export.

The fish shall grow in the natural environment of the Indian Ocean in deep-sea conditions, without chemicals or antibiotics used, following the standards of traceability and certification so as to make them export compliant.

6.8. DESIGN AND CONSTRUCTION OF MARICULTURE SYSTEMS

Cage and mooring systems should withstand local offshore sea conditions (including monsoons and cyclones). The Seaweed rafts, longlines, or other cultivation systems may preferably use biodegradable or marine-grade materials. Mooring systems may include GPS-tagged anchors, tight rigging to prevent entanglement, and biannual inspections. Installation of both cages and seaweed structures need to be certified by a competent structural engineer or manufacturer.

6.9. OPERATIONAL PRACTICES

Stocking may be done under suitable weather conditions and under proper supervision. Species cultured may preferably be native or approved exotic species; Genetically Modified Species are prohibited

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unless explicitly approved by the MoFAHD. The biosecurity protocols should include quarantine (for fish), record-keeping of stock origin, and routine health checks (for fish and shellfish). The Seaweed operators need to monitor epiphytic load and keep the biofouling under control. A Loss-Control and Escape Recovery Plan (for cage systems) need to be submitted and implemented.

6.10. FEED AND WASTE MANAGEMENT FOR CAGE CULTURE

The Operator need to use nutritionally efficient and eco-friendly feed, maintain the detailed records of feed conversion ratio (FCR), and minimize the feed wastage. Effective feed management may be practiced to prevent accumulation of uneaten feed and faecal matter on the seafloor. On-site physical or biological (e.g., use of herbivores) net cleaning is required to avoid use of chemical antifoulants

6.11. HEALTH AND ENVIRONMENTAL MONITORING

The Operator need to ensure regular monitoring of water quality parameters: dissolved oxygen, pH, ammonia, salinity, etc. and record all health parameters: morbidity, mortality, treatments administered (for cage systems). The Operator is also required to undertake biosecurity and environmentally sustainable measures. Scientific institute authorised by the DoF, GoI need to conduct periodic inspections, as prescribed to ensure that the facility is being operated in environment friendly manner.

Seaweed operators are required to monitor macroalgal health, grazing pressure, and nutrient uptake effects. The Operator should also ensure submission of a Marine Entanglement Log if interactions with protected marine species occur.

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6.12. RECORD KEEPING AND REPORTING

The Operator need to maintain records of stocking, health checks, feed logs (if applicable), mortality, water quality, and harvests and provide records to the competent authority upon request. The Operator need to ensure submission of quarterly and annual compliance reports to MoFAHD, GoI, CAA or any other authority as designated by DoF, GoI.

6.13. VESSEL AND WASTE MANAGEMENT

Service vessels should follow maritime safety and sanitation norms (e.g., MSD). All solid waste (ropes, feed bags, netting, etc.) should be collected and disposed off ashore. Mortalities should be stored securely and disposed of as per DoF/State Pollution Control Board guidelines. Seaweed residue, ropes, or degraded lines to be removed and disposed off as per marine litter protocols.

6.14. COMPLIANCE AND ENFORCEMENT

The Permit for Offshore Mariculture including site(s) allocated to the operator shall be non-transferable, and sub-leasing is prohibited. Non-compliance including pollution, unreported escapes, or structural negligence may result in suspension or cancellation of the Offshore Mariculture Permit. Annual audits need to be conducted by the designated Authority appointed by the MoFAHD. All operators need to comply with relevant international conventions ratified by India and national environmental legislation. Any escape incidents must be reported to the competent authority/ MoFAHD/ CAA/ concerned state/UT government within 24 hours.

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7. FRAMING MARICULTURE POLICY BY COASTAL STATES/UTS

7.1 The State/UT fisheries department are advised to design suitable, comprehensive mariculture policy for all mariculture activities practiced in the State/UT as per local fisheries resources, culture technologies used, standards and certifications, stakeholder roles & responsibilities, including implementation and monitoring of such activities.

7.2 The State/UT fisheries department may ensure that the baseline data/updated data is always available as a reference point for identifying key location(s) and the focus activity(ies) for development of mariculture. This may be done in consultation with key stakeholders such as DoF (GoI), NFDB, Fisheries Research Institutes, Fishers' Associations, intended beneficiaries and other stakeholders as deemed necessary for technical and on-ground inputs.

7.3 Key aspects, operational frameworks and parameters of all identified mariculture activities may be exhaustively and holistically defined in

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the State / UT policy and be in consonance with the relevant national and global instruments and other guidelines wherever available. The policy may clearly outline the overarching aims and objectives for mariculture development, along with defined targets, expected outputs and outcomes, zonation and spatial planning mechanisms, leasing, regulatory and compliance frameworks, and wherever applicable legal provisions for buyback arrangements and contract farming. It should also address the promotion of cooperatives, convergence with other schemes, public-private partnerships (PPP), and mechanisms for marketing and price discovery.

7.4 Currently, mariculture is being carried out within the 12 nautical miles from the coastline towards the sea. The State/UT fisheries department may make necessary amendments to the extant rules to permit mariculture with adequate safeguards for conservation efforts.

7.5 All relevant information on mariculture area development needs to be made publicly accessible and policy parameters may further be laid out into strategies and developmental plans for development of mariculture activities to boost their economies. The States/UTs may dovetail these mariculture activities in their Annual Action Plans.

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8. WAY FORWARD

8.1 Mariculture presents significant and transformative opportunity for India to enhance seafood production, diversify coastal livelihoods, strengthen nutritional security, and advance the sustainable growth of the Blue Economy. As marine capture fisheries reach their peak, the expansion of mariculture presents a viable and timely alternative to meet rising domestic and global seafood demand. By leveraging India's vast and ecologically rich coastline, mariculture can become a transformative driver of coastal development, bringing in both economic and ecological benefits. This document outlines a structured, strategic roadmap to unlock this potential through a comprehensive, integrated and inclusive development framework.

8.2 The current mariculture scenario in India, although evolving, is still in a nascent stage characterised by limited species coverage, fragmented initiatives, and constrained infrastructure and investment. While there have been notable advancements in seaweed cultivation, bivalve farming and finfish cage culture, several systemic challenges persist,

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including regulatory bottlenecks, leasing issues, and disease management, shortage of trained manpower, absence of coordinated governance, and weak market integration. This SoP thus outlines clear objectives and a strategic framework to overcome these hurdles and foster scalable, sustainable, and science-based mariculture practices.

8.3 A major strength of this framework is its focus on the development of mariculture clusters and the strengthening of the entire value chain from pre-production (seed, feed, infrastructure) to post-harvest management (processing, cold chain, quality assurance). Species diversification, productivity enhancement, and adoption of climate-resilient technologies are given high priority, ensuring that production systems are not only economically viable but also environmentally sustainable. Provisions for food safety, certification, and traceability further aim to make Indian mariculture products globally competitive and compliant with international standards.

8.4 Institutional and operational frameworks detailed in the SoP emphasize on the roles and responsibilities of central and state governments. The digital governance and monitoring mechanisms, especially the proposed Mariculture Governance Portal (MGP), aim to improve transparency, accountability, and data-driven decision-making. Coupled with regular reviews and impact assessments, these mechanisms will ensure that implementation remains aligned with the dynamic needs of coastal communities and evolving ecological conditions.

8.5 The expected outcomes of this strategy include increased mariculture production, improved coastal livelihoods, better gender and youth inclusion, enhanced food security, and measurable contributions to

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the Gross State Domestic Product (GSDP) and India's Blue Economy. It will also generate employment, foster entrepreneurship, and support India's commitments to global frameworks such as the Sustainable Development Goals (SDGs) and climate action agendas.

8.6 Going forward, the success of mariculture in India will depend on consistent policy support, financial investments, robust scientific inputs, and active stakeholder participation. Coastal States and UTs are advised to expedite the implementation of their mariculture policies, promote convergence across sectors, and incentivize innovation and private sector engagement. With coordinated efforts and adaptive governance, India is well-positioned to become a leading global player in sustainable mariculture, ensuring prosperity for coastal communities and resilience for marine ecosystems.

8.7 The following guidelines notified under Rule (3) of the Coastal Aquaculture Authority Rules, 2024, shall be followed for registration of seedlings production units of marine and brackish water seaweed spores and seedlings, required bio-security facilities and in-house quarantine facility, sanitary requirements, site selection, potential species, water intake, water treatment and discharge of wastewater, harvesting and drying etc.

8.7.1 Guidelines for regulating hatcheries and farms for seed production and culture of crabs and specific pathogen free *L. vannamei*.

8.7.2 Guidelines for regulating Bio-floc, Re-circulatory Aquaculture Systems and Nursery based Aqua Farming Systems.

8.7.3 Guidelines for notifying the aqua zones and aqua mapping.

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8.7.4 Guidelines for regulating hatcheries and rearing units for seed production and culture of marine and brackish water ornamental organisms.

8.7.5 Guidelines for regulating seaweed seedling production and farming in marine and brackish water

8.7.6 Guidelines for regulating cage and pen culture of marine/brackish water aquaculture species

8.7.7 Guidelines for regulating seed production and farming of bivalves in marine and brackish water

8.7.8 Guidelines for regulating Live Feed Culture Units and Management in coastal aquaculture.

8.7.9 Guidelines for Safeguards and regulations for operation of marine finfish hatcheries

8.7.10 Guidelines for indigenous shrimp which includes both *Penaeus indicus, P. monodon, P. semisulcatus, P. mergueinsis, P. japonicus* and any other indigenous species.

8.7.11 Guidelines for Import of Live Seaweeds into India.

8.7.12 Guidelines for Regulating Coastal Aquaculture.

8.7.13 Guidelines for the health monitoring, disease surveillance and specific pathogen free certification of coastal aquaculture units and stocks in India.

8.7.14 Guidelines for Certificate of Compliance for Aquaculture Inputs.

8.7.15 Guidelines for establishment and operation of NBC and BMC in India.

8.7.16 Guidelines for solid waste management in Coastal Aquaculture Units or Activities.

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ABBREVIATIONS

BR	Blue Revolution Scheme
CAA	Coastal Aquaculture Authority
CCRF	Code of Conduct for Responsible Fisheries
DoF	Department of Fisheries
EEZ	Exclusive Economic Zone
FAO	Food and Agriculture Organization
FFPO	Fish Farmer Producer Organisation
FIDF	Fisheries and Aquaculture Infrastructure Development Fund
GoI	Government of India
IMTA	Integrated Multi-Trophic Aquaculture
JLG	Joint Liability Group
KCC	Kisan Credit Card
MoFAHD	Ministry of Fisheries, Animal Husbandry and Dairying

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NPMF	National Policy on Marine Fisheries
PM-MKSSY	Pradhan Mantri Matsya Samridhi Sah-Yojana
PMMSY	Pradhan Mantri Matsya Sampada Yojana
RAS	Recirculatory Aquaculture System
SHG	Self Help Group
SOFIA	State of World Fisheries and Aquaculture

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Department of Fisheries
Ministry of Fisheries, Animal Husbandry and Dairying
Government of India

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