Spiny Lobster Culture Using Sea Cage

The following article is a part of FIFP webinars on the topic "Entrepreneurship in fisheries-Part 4" held on 19th June, 2021.

Note from the Chief Editor:

The main theme of FIFP webinar conducted on 19th June, 2021was 'Entrepreneurship in fisheries'. Dr. K.N. Saleela shares her decades of experience in culture of high-value spiny lobsters through an elaborate presentation on 'Spiny lobster culture using sea cage'. The article covers various aspects of mariculture such as its history and development in India; Scope, prospects and advantages of spiny lobster cage culture; Classification of lobsters; Characteristics and trend of lobster fisheries in India; and biological traits of spiny lobsters. She explained various steps involved in sea cage culture, maintenance and husbandry practices. She presented the economics of spiny lobster cage culture and brought out various constraints and challenges faced by culturists. Sources of financial support available in the country for sea cage culture was listed. State wise and area wise cage culture modes were identified for furthering sea cage farming in India. She highlighted the scope of spiny lobster culture using sea cages as a viable option for entrepreneurship in fisheries.

Introduction

Mariculture is a branch of aquaculture involving the cultivation of marine plants and animals in the sea or any other natural water bodies having tidal influence such as onshore facilities like brood banks, hatcheries, nursery rearing and grow-out system using sea water. It is a fast-growing sector contributing to the global food basket and nutritional security. It also provides livelihood avenues and employment opportunities. Marine fish farming in cages began in the 1950s in Japan which was followed by Thailand, Malaysia, Korea, Philippines, China, Europe and other parts of the world in the decades that followed.

History of mariculture development in India

Year	Events & Setbacks
1960	Technology on farming marine mollusks such as different species of oysters, mussels, clams developed by CMFRI was popularized and adopted by rural farmers.
1970	Shrimp breeding, seed production, rearing technologies, and shrimp farming protocols for commercially high value and, suitable species standardized by CMFRI.
1980	Shrimp production through coastal mariculture was launched by establishing commercial shrimp hatcheries at Andhra Pradesh and Odisha by MPEDA
1990	Indian shrimp industry witnessed fast growth during 1990's.
1994	However due to the outbreak of White Spot disease among the farmed tiger shrimp, *Penaeus monodon,* industry witnessed a major setback.
2000	Focused on diversification of shrimp species for coastal farming.
2007	With the funding from Ministry of Agriculture & Farmers Welfare, the first large open sea cage developed and launched in Vishakapatanam, Andhra Pradesh by CMFRI.

2009	Exotic species *Litopenaeus vannamei* introduced in shrimp farming sector
2009	First large open sea cage for lobster culture was launched in Vizhinjam, Thiruvananthapuram district of Kerala and spiny lobster *Panulirus homarus* cultured successfully with funding from Ministry of Agriculture & Farmers Welfare.

Global status of fish production

According to the UN, 30% of fish stocks in the wild have already collapsed, meaning they yield less than 10 % of their former potential, while virtually all fisheries will run out of commercially viable catches by 2050. Several factors brought global fisheries to this declining scenario such as: uncertainty in stock assessment leading to improper management, over capitalization, open access, common pool fisheries, deterioration of coastal habitats and rapid expansion of unsustainable aquaculture enterprises. Due to the continuous impetus made mainly by the Asian countries during 1990's, global aquaculture production increased about 25 times in the last 30 years when compared to only 7 times increase in capture fisheries production during the same period. The global aquaculture production reached an all-time record high of 114.5 million tons in 2018 with an estimated value of 263.6 billion US dollars (Sofia,2020).

Present scenario of seafood production in India

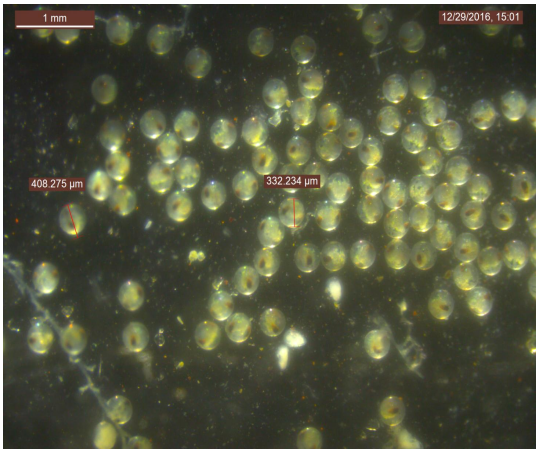
At present India ranks 2nd after China in aquaculture production and our seafood production is being exported to more than 100 countries around the globe. Farmed shrimp *Litopenaeus vannamei* contributes bulk of the production. As the sea food industry is over dependent on shrimps, its sustainability is unpredictable. India explored options for promoting mariculture through diversified culture systems, techniques and species promoting their culture in open seas. Series of cage designs were made and tested subsequently using HDPE, GI and wooden frames to meet the requirements of small-scale farmers. In this regard, front line demonstrations with locally available high-value species along the coastal states were made by CMFRI to bring awareness among stakeholders. This initiative gained wide popularity among the targeted stakeholders and has proven to be highly successful model for mariculture production in India.

Scope of spiny lobster cage culture

Spiny lobsters are a luxury seafood which are also nutrient-rich with vitamins, minerals and omega-3 fatty acid, and have a high value with prices ranging from Rs 700 to 4,000 Rs/kg for lobsters weighing above 100 g in the domestic market. They have high demand in national & international markets. Currently India exports lobsters to nearly 22 countries. The Juvenile lobsters below 150g body weight are banned from exporting as per minimum legal-size regulations which can be procured and used as seed for stocking in cages. Lobsters can grow on locally available suitable live/fresh feeds. Lobster culture ensures high predictable

economic return utilizing small area in shorter period of time. Lobsters have a very high fecundity ranging from 1,20,544 to 19,79,522 number of eggs per specimen. Hence, sea cage culture conducted along coastal states of India has revealed that a large number of larvae were released from the sea cages to the ecosystem due to the occurrence of egg-bearing females among the harvested lobsters. At present many Government agencies such as National Bank for Agriculture and Rural Development (NABARD), National Fisheries Development Board (NFDB), National Fishermen Welfare Fund Board, *etc*. provide loans with subsidies, and other financial support for mariculture and aquaculture activities.

Berried *Panulirus homarus*



Fertilized eggs

Prospects of cage culture

Cage culture of lobsters offers tremendous prospects due to increasing global and domestic demand, higher market value, and employment opportunity generation with an average return up to 68% on investment.

Cage culture: Advantages

Since no ownership is required for water bodies, even landless people can undertake cage culture using locally available high-value species. Monitoring of cage is easy and it also prevents loss of stock due to flood. As it is in natural water bodies, water exchange is not required. Optimum feed utilization is also an advantage in this system. Stakeholders are also benefitted from research support offered by Research and Development organizations under ICAR like CMFRI, CIFA, CIBA, CIFE, CIFRI *etc.*

Classification of lobsters

Order	Decapoda

Sub order	Macrura Reptantia
Class	Malacostraca
Phylum	Arthrpoda
Sub phylum	Crustacea
Species	260
Sub species	4
Family	6
Genera	54
Infraorder	4
Categories	Clawed lobster, Spiny lobster, Slipper lobster, Reef lobster & Blind lobster

Lobster fauna in India

Infraorder	**Family**
Astacidae	*Enoplometopidae, Nephropidae*
Achelata	*Palinuridae, Scyllaridae*
Polychelid	*Polychelidae*
Area of occurrence	Indian coast of Arabian Sea, Lakshadweep Island Indian coast of Bay of Bengal, Andaman & Nicobar Island
Known Species	38

Characteristics of lobster fisheries in India

Lobster fishery in India is highly distinct, compact and small-scale with less species diversity. It is available in shallow marine and mid-water to deep-sea zones. They are harvested through open access fishing mostly as by-catch by multi- day trawlers, out-board bottom set gill nets followed by single-day trawlers and traditional gears including traps.

Male lobster

Single pleopod

Female lobster

Merged pleopod

Berried Lobster

Cluster of eggs

Biological traits of Spiny lobsters

Spiny lobsters are purely marine and are named so due to the presence of spines over their body. The presence of carotene pigments or asetaxanthin found in their body just below their shell or exoskeleton makes them exhibit a blend of colors like brown, green, black, yellow etc. They have a tubular body and are heterosexual. Lobsters do not have rostrum and if present, it will be rudimentary. They are nocturnal in nature. They can differentiate odors and perceive visually as well as chemically. They navigate their surroundings through the sense of touch. Their well-developed antennules chemosensory system helps locate food, shelter and is also used for communication. Lobsters are able to regenerate their lost body parts through a process known as autotomy. They are primarily scavengers feeding on the remains of dead or decayed marine fauna usually found in plenty in the sea bed. They are occasionally opportunistic carnivores too. Their legs do not have true pincers and in most Indian species the first pair is not enlarged. They have long cylindrical antennae many times larger than their body. Their carapace or head is sub cylindrical, and their eyes are protected by a strong spiny frontal projection of the carapace (frontal horns). In males, dactylus of the 5^{th} leg is simple with presence of gonopore at the base whereas in females, dactylus of the 5^{th} leg is biramus due to the presence of a false pincer and gonopore is present on the base of the 3rd leg. Lobsters reproduce in inshore waters. Egg bearing female lobsters are known as berried and the fertilized eggs are hatched into transparent planktonic phyllosoma larvae. The Phyllosoma larvae metamorphose into pueruli larvae after one year that resembles miniature adult lobster. The Pueruli larvae migrates from offshore to inshore waters and attain maturity in 2 to 2.5 years and reproduces again and the life cycle goes on.

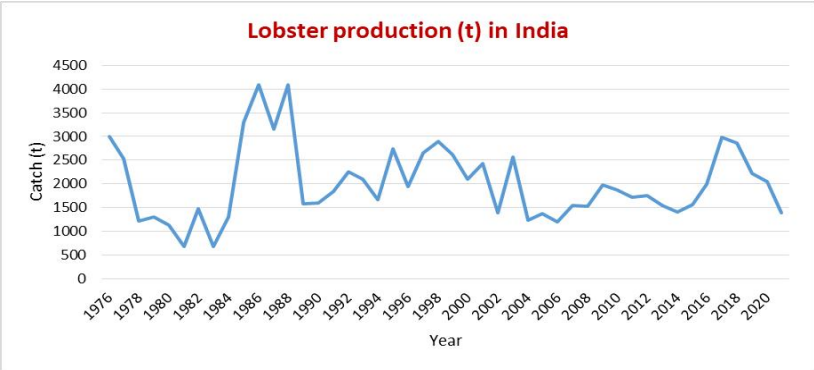
Palinuridae - Species available in Indian waters

Species	Maximum Length (mm)	Habitat & Ecology
Panulirus homarus	31	Rocky reefs
Panulirus ornatus	50	Rocky areas and coral reefs
Panulirus versicolor	40	Coral reefs
Panulirus penicillatus	40	Rocky areas and coral reefs
Panulirus polyphagus	31	Muddy and rocky substrates
Panulirus longipes longipes	30	Rocky areas and coral reefs
Puerulus sewelli	20	Coarse sand, hard mud and shell
Puerulus angulatus	21	Mud or sand
Linuparus somniosus	35	Soft bottom
Palinustus waguensis	10	Rocky areas

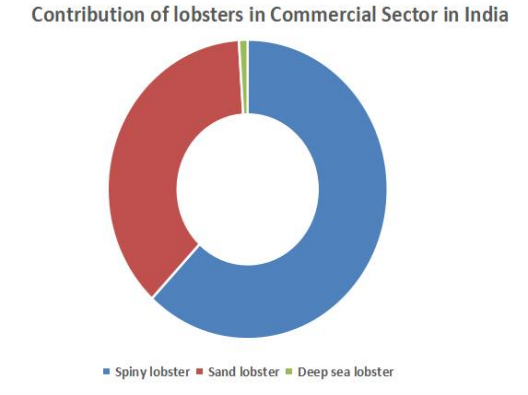
Spiny lobster: Dominant species

State	Species
Gujarat	*Panulirus polyphagus*
Maharashtra	*Panulirus polyphagus*
West Bengal	*Panulirus polyphagus*
Tamil Nadu	*Panulirus homarus*
Kerala	*Panulirus homarus*

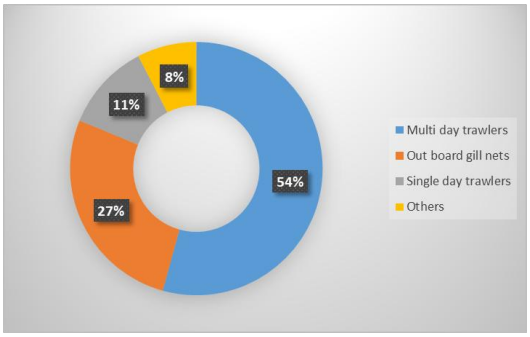
Lobster fishery trend



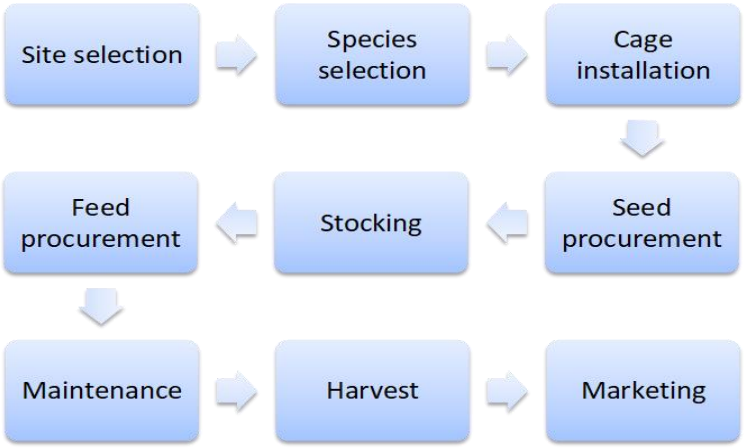
Spiny lobster - Gear wise contribution in India



Gear wise lobster contribution in India



Steps Involved in Sea Cage Culture



Site selection

The cage installation site should be free from navigation, fishing, tourism or any other developmental activities. The site also should have favorable environmental conditions such as good and steady water quality. The site should be free of pollution from industrial, agricultural and household sewage. Depth should be 6-10 m at low tide. The site should also be accessible by road.

Promising species for cage culture

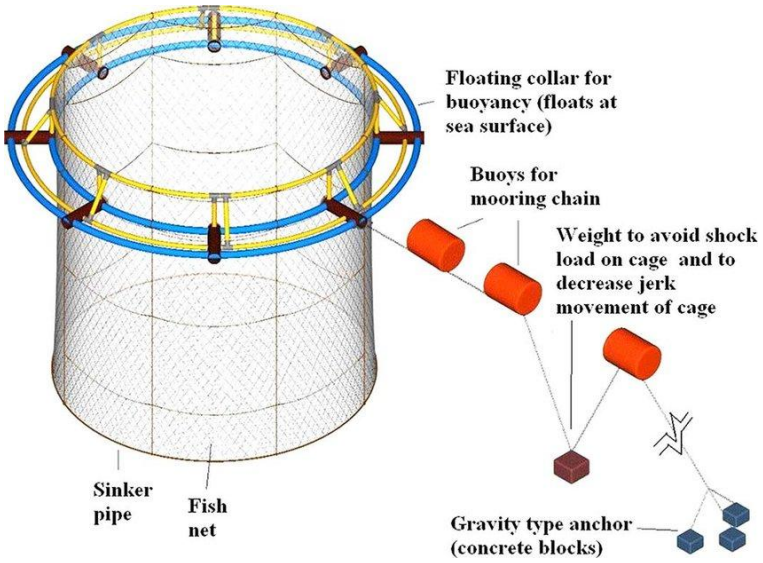
Panilurus ornatus

Panilurus homarus

Panilurus polyphagus

Sea Cage Culture: Cage installation

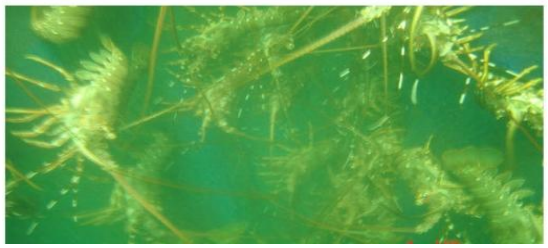
Sea cage structure



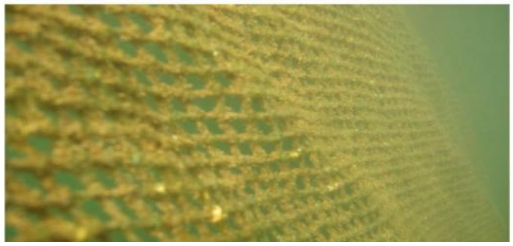
Sea cages can be of any size and shape suitable for installation and operation. It is designed to provide adequate safety of the cultured animals and can withstand waves, strong under-water currents, natural calamities *etc*. Cages made of galvanized iron (GI), high density polyethylene (HDPE), wood etc. can be used as per requirement and budget. The main parts of the cage include **c**age frame, buoyancy system, sinker system and mooring system.

Juvenile procurement and stocking

Lobster Seed Stocking in HDPE Sea Cages



View of Lobsters inside cage



Inner net

Outer net

Lobsters should be transported soon after harvest under moist condition to prevent excessive drying of their soft gills and resultant death due to respiratory blockage. They should be healthy with good color and intact exoskeleton or shell with all appendages. Lobsters can be stocked in floating/submerged sea cages. Bottom of the cage should be flat, wide & stretched for the free movement of the lobsters which only occupy cage bottom due to their sedentary nature. Top of the cage should be covered with a bird net of 80-100 mm mesh size to prevent entry of birds. Lobsters should be carefully transferred into the sea cage without disturbance. About 15 numbers of juveniles <100g can be stocked in $1m^3$ cage area. A crop of lobsters can be harvested after a period of 3-4 months and in a year up to 3 crops can be farmed and harvested.

Feeding- items

Brown mussel

Squid

Green mussel

Sardine

Clam

Acetes

Lobsters can be fed up to 10% of their weight with feeds such as low-cost fish, mussel, clam, non-penaeid shrimp acetes, squids *etc*. Fresh feed must be procured in bulk and stored in a freezer after cleaning and chopping into small pieces. Lobsters can be fed twice a day in the morning and evening or once in the evening. Live feeds such as clam and mussel can be fed directly without removing shell up-to about 16-20 % by weight of the lobster stock. Ensuring of proper nutrition by providing different live/fresh feeds is necessary for the healthy growth of lobsters. When fed with live mussels, left-over shells accumulated inside the cage bottom should be removed by diving in to the cages regularly to reduce weight of the cage and save space inside the cages.

Maintenance and Husbandry practices

Cleaning of the cage should be carried out depending on the extent of fouling by various organisms such as algae, mussels, barnacles, ascidians, crabs *etc*. Outer cage net should be replaced if fouling is excessive for enabling proper water exchange. Rough and frequent handling of lobsters should be avoided right from the stages of collecting, transportation and stocking in the cage to reduce stress for the lobsters. Stress, poor water quality, starvation and pathogens can lead to diseases among lobsters causing wounds, tail rot, redness, lethargy and non- acceptance of feed.

Prophylaxis (Treatment)

Protozoan infestation can be controlled by dipping the infected lobsters in 20-30 ppm formalin for one hour. Bacterial infections can be controlled by dipping lobsters in furazolidone at 10 ppm/hour. Lobsters affected with Gaffkemia- like diseases will display reddish color which can be controlled by stocking them at lower temperature i.e., 13^0C cooled sea water in indoor tanks till they recover from disease.

Harvest from sea cages

Marketing

Harvested lobsters can be sold at farm gate price to restaurants and hotels, or can be sold to sea food export firms.

Economics of spiny lobster cage culture

Particulars	Amount (Rs)
No of juvenile lobsters	2400
Average lobster weight at stocking	68g
Average lobster weight at harvest	173g
Cost of Sea cage (6 m dia)	6 Lakhs
Cost of production	2.0 Lakhs
Gross revenue per harvest	6.64Lakhs
Net income per harvest	4.64 Lakhs
Cost of production/kg lobster	602
Average price/kg of lobster	Rs 2000

Sea cage culture: Constraints and challenges

Poor seawater quality, damage to the cage structure due to the attachment of fouling organisms, poaching, non-availability of steady supply of juveniles and lack of artificial feed are a few of the constraints faced in sea cage culture. Poaching can be prevented to some extent by installing solar powered or battery-operated surveillance system. Natural disasters like, cyclones, tsunamis *etc.* can pose several challenges in sea cage culture.

Sea cage culture: Financial support

To address the critical gaps in fisheries sector and its welfare, the Government of India has introduced an umbrella scheme "Pradhan Mantri Matsya Sampada Yojana (PMMSY) backed up by an investment of Rs 20,050 crores. This scheme is implemented by the Department of Fisheries through the NFDB (National Fisheries Development Board, Hyderabad, Govt. of India). Financial support is available for setting up fish-brood banks and hatcheries, for construction of ponds and rearing ponds, for installation of cages in reservoirs, brackish water, inland water and open seas. Support is also available for fish-feed mills, development of post-harvest infrastructure like ice plants, cold storage, ice plants-cum cold storage, development of fish landing centers & harbors along coastal states.

Area wise Cage Culture Mode suitable in India based on fisheries status

STATES	District	Sea farming methods
Gujarat	Valsad	Small cages
	Amreli, Jamnagar, Junagadh, Navsari, Porbandar	Large single cage
	Dwaraka, Gir Somnath, Kutch	Large scale farming
Maharashtra	Sindhudurg, Ratnagiri	Large single cages
	Raigad, Thane, Palghar	Large single cages
	Mumbai	Large scale sea farming
West Bengal	Midnapur	Large single cages
	South 24 Parganas	Large scale sea farming
Odisha	Balasore, Bhadrak, Jagatsinghpur	Small cages
Andhra Pradesh	Srikakulam, Vizianagaram, Guntur, East Godavari	Small cages
	Visakhapatanam	Large single cages

Karnataka	North Kanara, Udupi, south Kanara	Small cages
Tamil Nadu	Thiruvalluvar	Small cages
	Ramanathapuram	Large single cages
	Chennai	Small cages
	Kancheepuram	Small cages
	Villupuram	Small cages
	Caddalure	Small cages
	Nagapattinam	Small cages
	Thrunelveli	Large single cages
	Tuticorin	Large single cages
	Kanyakumari	Large scale sea farming
Goa	North Goa	Small cages
Kerala	Kozhikode, Thiruvananthapuram	Small cages
	Kollam	Large single cages
	UNION TERRITORIES	
Pondicherry	Pondicherry, Karaikal	Small cages
Daman&Diu	Diu	Small cages

Conclusion

Spiny lobsters comprise one of the luxury seafood components having high demand in national & international markets. Currently India exports lobsters to nearly 22 countries. Sea farming of spiny lobsters is an effective fishery management technique that can be used for propagation and restoration of the fishery in India. Cage culture of lobsters offers tremendous prospects due to increasing global and domestic demand, higher market value, and employment opportunity generation with an average return up to 68% on investment. A crop of lobsters can be harvested after a period of 3-4 months and in a year up to 3 crops can be farmed and harvested. At present many Government agencies such NABARD, NFDB, National Fishermen Welfare Fund Board, *etc*. provide loans with subsidies, and other financial support for mariculture and aquaculture activities. To address the critical gaps in fisheries sector and its welfare, the Government of India has introduced an umbrella scheme “Pradhan Mantri Matsya Sampada Yojana (PMMSY)under which financial support is available for setting up fish-brood banks and hatcheries, for construction of ponds and rearing ponds, for

installation of cages in reservoirs, brackish water, inland water and open seas. The draft National Mariculture Policy (NMP-2019) particularly focuses on entrepreneurship opportunities utilizing the resources in a sustainable manner to ensure food and nutritional security of the country and enhance the quality of life of the population, the ultimate goal of India's blue economy. Thus, sea farming of spiny lobsters seems to have a promising future in the coming years.

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Dr. K.N.Saleela is currently working as Senior Scientist, Crustacean Fisheries Division, Vizhinjam Regional Centre of CMFRI (ICAR). She completed her post-graduate studies at School of Industrial Fisheries under Cochin University of Science and Technology and then joined the Central Marine Fisheries Research Institute Kochi, under the Indian Council of Agricultural Research as Scientist in 1992. In her 29 yearlong scientific career she worked on several research projects focusing on the commercial fisheries of marine crustaceans and biology of high-value shrimps, crabs and lobsters along the southeast and southwest coast of India. She has been actively involved in exploring the possibilities of mariculture of spiny lobsters. She is the principal investigator of ICAR funded sub project "Investigations on commercial lobster fishing and live lobster trade in India" during 2017-2021. Dr. Saleela organized many stakeholders' meetings at Vizhinjam Regional Centre on the theme "Best fishing practices". Also, she co-organized and participated in series of stakeholder awareness national workshops on lobster culture using sea cages and conducted training workshops in Kollam and Thiruvananthapuram districts of Kerala. She was associated with the successful culture of high-value spiny lobster *Panulirus homarus* in large floating sea cage for the first time in India, funded by the Ministry of Agriculture and Farmers Welfare. She has participated and presented papers in national and international symposiums/conferences. Dr. Saleela has authored in peer-reviewed publications and has also contributed technical reports, chapters in workshop manuals and bulletins besides co-authoring a chapter in an international book "Lobsters: Biology, Fisheries and Aquaculture 2019", Springer publication.

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