Brief Communication

Marine finfish culture technology demonstration and dissemination towards food security and livelihood empowerment in Andhra Pradesh

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Introduction

Marine aquaculture is still in its infancy when compared to freshwater and brackish water aquaculture sectors, and commercial-scale farming in this sector is yet to take off despite its huge potential to enhance seafood production in the country. Based on the resources available in the maritime states, union territories and islands, the projected mariculture potential of the country is 8-16 million tonnes. In comparison, the current mariculture production is less than 0.1 million tonnes (Gopalakrishnan *et al.*, 2022). However, the mariculture sector will have to play a pivotal role in achieving the maximum fish production to meet marine food fish demand in the near future, as the marine finfish production from wild catch is stagnating. Therefore, towards the development of the mariculture sector in the country, several efforts in the research and development sector has been initiated by ICAR-Central Marine Fisheries Research Institute (ICAR-CMFRI) and other fisheries research and development organizations such as ICAR-Central Institute of Brackish-water Aquaculture (CIBA) and Rajiv Gandhi Centre for Aquaculture (RGCA). With a focus on mariculture for increasing national fish production, and with the need for species diversification; package of practices on breeding and seed production and culture for three economically valued marine finfish species viz., Orange-spotted grouper, Indian pompano and John's snapper (Sekar *et al.,* 2021; Ritesh *et al.,* 2015) was developed at Visakhapatnam Regional Centre of ICAR-CMFRI with major focus in the eastern coastal states, especially in Andhra Pradesh. Realizing the importance of skill development and technology dissemination for achieving the true potential of mariculture, multiple training programmes, technological demonstrations and harvest melas were organised on different culture methodologies by the Visakhapatnam Regional Centre of ICAR-CMFRI, under different institutional programmes and National Fisheries Development Board (NFDB) sponsored projects. These include marine cage farming of Indian pompano and Orange-spotted grouper, coastal cage farming of Indian pompano and Asian seabass and coastal pond farming of Indian pompano and Orange-spotted grouper.

Skill development

Capacity building, by virtue of hands-on training was organised for different stakeholders on important mariculture technologies such as cage culture of marine finfishes in marine cages, cage culture of finfishes in backwaters, coastal pond farming for high-value marine finfishes (Indian pompano and Orange-spotted grouper), cage culture of Indian pompano in backwaters, live feed production technologies for marine finfish and shellfish and breeding technologies, etc. During the training programmes, skills in different aspects were imparted to the participants in various activities including cage fabrication and installation, fish seed stocking, fish feeding, cage net exchange and cleaning, fish husbandry, fish harvest, live feed (phytoplankton and zooplankton) production, live feed harvesting and marketing of different fish produce from different systems. More than 20 skill development programmes were organised from 2014 to 2022 in different locations in Visakhapatnam district, West Godavari district and Krishna districts of Andhra Pradesh. All the programmes were attended by active participation from marine fishermen, aqua farmers, backwater fishermen and fisher youths, hatchery technicians, department officials,

researchers and students. A total of 1198 individuals were trained, and following capacity building to different individuals, marine and coastal cage culture and coastal pond farming technologies were adopted based on demonstrations.

Frontline demonstration & technology adoption

Different farming technologies for the marine finfish were developed to suit in diversified ecosystems: marine cage farming of Indian pompano and Orange-spotted grouper; coastal cage farming of Indian pompano and Asian seabass and coastal pond farming of Indian pompano and Orange-spotted grouper under different institutional programmes. The technologies were demonstrated and disseminated to different beneficiaries under All India Network Project on Mariculture (AINP-M), scheduled tribes component (STC) and schedules caste component (SC-SP) of the institute activities and National Fisheries Development Board (NFDB) sponsored projects. The outcome of the demonstrated technology was popularised among the respective stakeholders through organizations of 'farmer's mela' and 'harvest festival', and using media (local and national newspapers and visual communications). Different harvest and farmer's melas organised with technological support by Visakhapatnam Regional Centre of ICAR-CMFRI for culture of marine finfishes in different production systems are appended below in the Table 1.

Marine cage culture of Indian pompano and Orange-spotted grouper

Marine cage farming technology for Indian pompano and Orange-spotted grouper was developed and standardised

Table 1. Harvest Mela organised

Sl. No	Name of the events	Date	Organizers and venue	Participants attended (App. No)
	Harvest mela for marine cage cultured marine fishes			
1	Demonstration on Indian pompano and Orange-spotted grouper in sea cages	16th August, 2018	Visakhapatnam Regional Centre of ICAR – CMFRI; at Ramakrishna Beach sea cage farm, Visakhapatnam	100
2	Harvest of sea cage farmed Indian pompano	28th January, 2020	Individual (Mr. Karnam Anilkumar, Visakhapatnam District); at Ramakrishna Beach sea cage farm, Visakhapatnam	150
3	Harvest of sea cage farmed Indian pompano and Orange-spotted grouper	12th March 2021	Society (Traditional Fishermen's Co-operative Society, Jalaripettai, Visakhapatnam District); at Ramakrishna Beach sea cage farm, Visakhapatnam	150
	Harvest mela for coastal cage cultured marine fishes			
4	Harvest of coastal estuarine cage farmed Indian pompano	24th May, 2020	Yanadi tribal community under Antyodaya women mutually aided co-operative society; at Edurumondi, Peddapalem and Marripalem Village, Nagayalanka Mandal, Krishna District, Andhra Pradesh	150
5	Harvest of coastal estuarine cage farmed Indian pompano	5 to 15th June, 2021	Individual farmers and fisherman Co-operative societies; at Edurumondi, Peddapalem and Marripalem Village, Nagayalanka Mandal, Krishna District, Andhra Pradesh	200
6	Harvest of coastal estuarine cage farmed Indian pompano	17th June, 2021	Mala (Scheduled Castes) and Yanadi tribal community (Scheduled Tribes) under Antyodaya women mutually aided co-operative society; at Edurumondi, Peddapalem and Marripalem Village, Nagayalanka Mandal, Krishna District, Andhra Pradesh	75
7	Harvest of coastal estuarine cage farmed Asian seabass	17th June, 2021	Yandi community (Scheduled Tribes) under Antyodaya women mutually aided co-operative society; at Laximipuram village, Kruthivennu Mandal, Krishna District, Andhra Pradesh	50
	Farmer's mela for coastal pond cultured marine fishes			
8	Harvest of Indian pompano cultured in coastal earthen ponds	23rd December, 2018	Marginal Farmer (Mr. B. Sunil Kumar); at Bhavedevarapally, Nagayalanka Mandal, Krishna District, Andhra Pradesh	50
9	Harvest of Indian pompano cultured in coastal earthen ponds	4th January, 2020	Marginal Farmer (Mr. Subbarao); at Bhavedevarapally, Nagayalanka Mandal, Krishna District, Andhra Pradesh	150
10	Harvest of Orange-spotted grouper cultured in coastal earthen ponds	June, 2020	Marginal Farmer (Mr. B. Sunil Kumar); at Bhavedevarapally, Nagayalanka Mandal, Krishna District, Andhra Pradesh	50
11	Harvest of Indian pompano cultured in coastal earthen ponds	11th March, 2021	Marginal Farmer (Mr. Krishna Prasad); at Komaragiripatnam, East Godavari district, Andhra Pradesh	100

at Visakhapatnam Regional Centre of ICAR-CMFRI. Average net profit was standardized during different demonstrations at ₹1.50 to ₹1.70 lakhs per cage per annum (Sekar *et al.,* 2021). First harvest for both species was performed in August, 2018. After 12 months of grow-out, the fishes reached an average of 0.75 kg in weight, with survival of more than 90%, resulting in an average yield obtained per cage being 2.0 tonnes (Sekar *et al.*, 2021). Subsequent demonstrations were performed with comparable production, and the technology was disseminated to 460 marine fishermen and fish farmers. Marine cage culture technology for Orange-spotted grouper was adopted by 10 marine fishermen from the Traditional Fishermen's Co-operative Society, Visakhapatnam; and for Indian pompano by three educated entrepreneurs at Visakhapatnam, 6 marine fishermen from the Mangamaripeta Fishermen's Cooperative Society, Mangamaripeta, Visakhapatnam and 9 marine fishermen from the Indira Gandhi Marine Fishermen Co-operative Society, Danavaipeta, East Godavari. More than 18.23 tonnes of Orange-spotted grouper were harvested from ten cages at Visakhapatnam. For Indian pompano, the harvest was 7.02 tonnes from Visakhapatnam from five cages, 5.50 tonnes from Mangamaripeta from five cages and 3.02 tonnes from Danavaipeta from six cages. All the demonstration events were well accepted by the fishermen societies, and small scale entrepreneur and many of the trained individuals were approached for government funding for further continuing the culture operation under different government scheme.

Coastal cage culture of Indian pompano and Asian seabass

Farming of finfish in coastal backwater cage is considered apt for small-scale fishermen and fish farmers with low economic capacity. Coastal cage farming of Indian pompano and Asian seabass were demonstrated in Krishna and Godavari backwaters in Krishna and West Godavari district of Andhra Pradesh. From several demonstrations, it is evident that average net profit per culture ranged between ₹0.65 lakhs to ₹0.80 lakhs per cage. Maiden culture of Asian seabass was performed during 2013-2014, with average final body weight of 0.65 kg and survival of 86.0% after five months resulting in an average production of 0.8 ton/cage (Ghosh *et al.*, 2017). Indian pompano was first cultured during 2018-2019, and thereafter, with survival of >90% and an average body weight in excess of 0.65 kg after six months of rearing, an average production per cage of close to 0.6 to 0.8 ton has been consistently achieved (Sekar *et al.,* 2021). Culture technology was demonstrated and propagated among 598 fish farmers, of which 370 were from backward communities, Yenadi and Mala communities from scheduled tribes and scheduled caste, respectively. Following demonstrations, coastal cage farming of Indian pompano was adopted by 74 fishermen and fish farmers belonging to Yanadi Girijana Matsya Sakhara Sangam (backward community), Krishna district at multiple locations (Edurumondi, Nagayalanka and Peddapalem) and by two private entrepreneurs in Nagayalanka Mandal, Krishna District. Asian seabass culture in coastal cages was adopted by four small scale farmers from backward communities in Lakshmipuram, Peddapalem and Etipagaru Pallipalem of Krishna. Around 47.32 tonnes of Indian pompano and 5.34 tonnes of Asian seabass were harvested from 70 and 8 cages and sold with an average price ranged from ₹300 to ₹450/kg of fish.

Coastal pond farming of Indian pompano and Orange-spotted grouper

Coastal pond farming of Indian pompano and Orange-spotted grouper was developed in institutional research programme and demonstrated under NFDB funded demonstration projects. From two demonstrations at Bhavedevarapally, Nagayalanka Mandal, Krishna District and Komaragiripatanam, Konaseema District; annual profit was found to vary from ₹1.75 to ₹2.5 lakhs per acre. From Nagayalanka, the harvest was in 2020 and from Komaragiripatanam, the harvest was in 2021. Indian pompano attained an average body weight of 0.80-1.0 kg after one year, with survival >95% and feed conversion of 1:1.6 to 1:1.8. For Orange-spotted grouper, after fifteen months of rearing, body weight ranged from 0.8 kg to 1.6 kg and average survival was 80% (Sekar *et al,.* 2021). Technology was exhibited to 50 fish farmers, and out of which, six educated entrepreneurs in the districts of Visakhapatnam (Tuni), East Godavari (Amalapuram and Kakinada), West Godavari (Narsapuram) and Krishna (Nagayalanka) adopted the technology. From Krishna District, an average of 2.6 tonnes per acre was obtained from 13 acres of water area and from Konaseema District, an average of 3.0 tonnes per acre was harvested from 12 acres.

Innovative approaches in coastal farming

Cluster-farming and two-tier approach concept were introduced for demonstrations in coastal cage farming, for ensuring wide adoption among the farming community by

making the technology lucrative. Cluster-farming involves a battery of 5-10 numbers of cages managed by an individual from the community on rotation basis, either on alternate days or on weekly basis, depending on their convenience. This ensures equal participation and effective management of time and resources, encouraging diversified livelihood. Using two-tier approach, with separate nurseries for rearing fry to advanced fingerlings, two harvests can be performed in a year, adding to the income of the farmer (Sekar *et al.*, 2021).

Impact on mariculture technology dissemination for overall development

The fish requirement for domestic consumption in the country is estimated to touch 15.6 million metric tonnes by 2030. With the present annual fish production of 12.4 million metric tonnes, a gap of 3.2 million metric tonnes will need to be bridged to meet the projected domestic fish demand. Given the limitation of marine capture fisheries sector, and the modest enhancement that is likely to occur from deep sea resources along with the limited opportunities for expansion of land-based fisheries and aquaculture systems, the focus is towards expansion of mariculture. India, with 8129 km of coastline, 2.2 million km^2 of Exclusive Economic Zone, 0.5 million km^2 of continental shelf, 1.2 million ha of coastal salt affected land and 3.9 million ha of estuarine area possesses a high potential for marine finfish culture. Despite having vast potential to enhance the marine finfish production, the country is still at an early stage with respect to commercial scale marine finfish farming. However, in tune to the global scenario, there is anticipation that contribution from mariculture is poised to increase manifolds in the future. Primary problem associated with expansion of marine finfish culture in the country is the lack of established farming protocols. Farming technology for several commercially important finfishes has been developed and perfected by ICAR-CMFRI, among which Indian pompano (*Trachinotus mookalee*) and Orange-spotted grouper (*Epinephelus coioides*) exhibited considerable promise, with respect to growth and survival when cultured either in marine or coastal environments. Possessing superior market demand and higher prices (₹350-400/kg), these two species is currently viewed as alternatives to shrimp for farming by aqua farmers of the country. In fact, the progress and success achieved with respect to culture by Visakhapatnam Regional Centre of ICAR-CMFRI have created a sense of belief, confidence and interest among many aqua-entrepreneurs and many of them, has evinced keen interest in establishing cage farms and coastal farming facilities in the state of Andhra Pradesh. Also, presently, shrimp culture is in doldrums, due to the frequent failures of the crop. Adopting crop rotation using these finfishes, to some extent would solve the issue of diseases in shrimp industry and these fish species are suitable for crop rotation, since the shrimp pond could be used as such for the culture of these species without further modifications. These marine finfishes, particularly Orange-spotted grouper is highly priced (₹1250-1500/kg) for flesh quality in the global Live Reef Food Fish (LRFF) trade, and thus would be an alternative for shrimp in terms of export revenue generation. From the 1198 individuals imparted skill on mariculture especially from the Andhra Pradesh State; totally, 114 had adopted the technology with reasonable success till year 2022. It was heartening to observe that the adoption rate was significantly higher among the backward communities, with 78 individuals involved in coastal cage farming of Indian pompano and Asian seabass in Krishna and Godavari backwaters, and small creeks and Krishna districts. A perusal on the trained manpower available vis-a-vis the current production augurs well. It is expected that in the next couple of years, the entire trained manpower would turn into adopters. Also, the trained personnel would in future, in all probability acts as trainers for exponential growth in skill development on mariculture. Eleven memoranda of understanding (MOU) on culture demonstration and popularization were signed and executed with private enterprises/fish farmers related to hatchery and farming aspect of marine finfishes. Technological interventions made by Visakhapatnam Regional Centre of ICAR-CMFRI on various mariculture methodologies have resulted in significant improvement of farmer's income. The impact is more pronounced for sections of backward communities, which is evident from their higher rate of technology adoption. Being mostly landless, with very little capital, mariculture is a boon for the underprivileged. Livelihood improvement was observed, with earlier income generating no savings but with the present enhancement in income, considerable savings was generated for meeting their liabilities and as an investment for subsequent culture. As the government is marching towards with the aspirations to double the income of every Indian farm household, these success stories on mariculture are proof for the same, as these adopters of developed technology had already experienced in doubling their income through different culture practices of marine finfishes. The developed technologies have raised a ray of hope among the coastal communities for ensuring their economic sustainability. Innovations and gender mainstreaming were ensured for holistic and equitable socio-economic development.