dakshin

Navigating livelihood diversification for Small-scale Marine Fishworkers

Dakshin Foundation is a not-for-profit, non-governmental organisation committed to environmental sustainability and social justice. It works for sustainable resource use and community development for small-scale fishworkers across India, including Lakshadweep, the Andaman and Nicobar Islands, Odisha, Maharashtra and Tamil Nadu.

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I. Introduction

Research and policy tools on small-scale fisheries (SSF) have shifted their focus from its contribution to fish production to its contribution to rural and urban livelihoods, poverty-reduction, health, local nutritional security, and resource conservation. (Smith, 2019, World Bank, 2012, FAO, 2015, IHH, 2022)[1] From a marginal status in fisheries agendas, SSF have come to be recognized as a solution to the issue of long-term sustainability and a safeguard against an narrow and industrialised vision of the sector. (Kurien, 1996, Jadhav, 2018).

Increasing mechanisation and commercialisation of the coast, adverse weather events and declines in marine fish stock have accompanied a reduction in the role of SSF in sustainable fisheries management in India. While the latest sixth draft of the National Fisheries Policy 2020 acknowledges 'the predominance of small-scale fisheries in marine and inland waters' as well as in aquaculture 'where a majority of fish farmers have very small holdings' and calls for 'ensuring the full participation and engagement of the SSF in the socio-economic developmental negotiations', government expenditure and large investments in blue-economy models seem to indicate a turn towards more top-down, capital-intensive forms of production. As Jentoft and Cheunpagdee (2018) note, for several fisheries managers and academics, small-scale fisheries represent an obstacle to transforming fisheries into a more modern 'Blue Economy'-oriented means of resource exploitation. This report argues for the centrality of small-scale fisheries as a solution for issues of sustainability and equitability.

Within support for small-scale fisheries, towards increasing the resilience of households and coastal communities, '**livelihood diversification**' is advocated as a developmental strategy to bring together approaches that aim to increase activities and social support capabilities for withstanding market or climatic shocks. This process may be encouraged 'exogenously' through state or non-state interventions or regulation, or 'endogenously' through emerging opportunities or as a reaction to local social-ecological changes (Roscher et. al, 2022). The aimed outcomes of exogenous diversification programmes are primarily twofold – to reduce poverty and vulnerability and alleviate pressure on fish stocks. In published evaluations of these interventions however, there are critical questions raised about who benefits from the changes and the impact of the change on the immediate needs of participants and the resource (Roscher et. al, 2022, Brugère et. al., 2008).

[1] Smith, H. and Basurto, X. (2019) Defining small-scale fisheries and examining the role of science in shaping perceptions of who and what counts: A systematic review, Frontiers. https://www.frontiersin.org/articles/10.3389/fmars.2019.00236/full (Accessed: 04 March 2024).

In keeping with Dakshin's on-ground engagement, this report is aimed at exploring pathways for a more sustainable and equitable transition in fisheries income and asset diversification, one that places traditional small-scale resource users at the centre of development programmes and one that acknowledges the importance of the values associated with fishing and fishing-allied activities. The report brings together information about key diversification activities for small scale fishworkers promoted by the State Department of Fisheries and by Marine Research Institutes based in Kochi, Kerala. Additionally, engagements with micro entrepreneurs and practitioners have helped gather first hand accounts of challenges, successes and failures in the adoption of these technologies and practices.

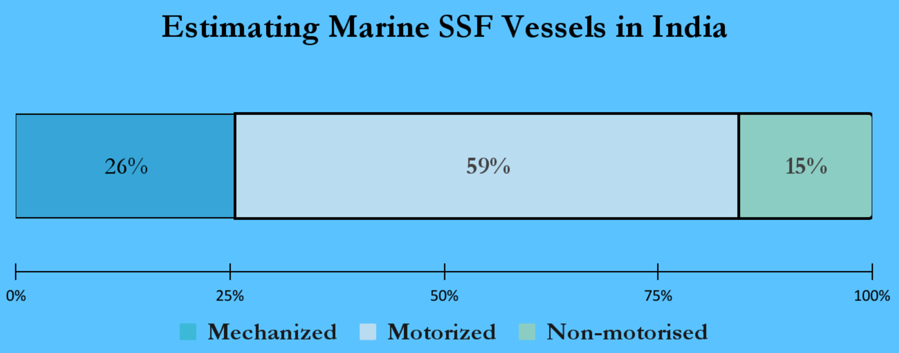
Which livelihoods count as small-scale?

Demarcating large-scale fisheries from small-scale has key policy and intervention-related implications. Given the diversity of small-scale fishing and fishing-allied operations across countries, the FAO has recently proposed using a matrix of technical and socio-cultural attributes (IHH, 2022).

> The definition of small-scale fisheries varies considerably in different countries, but generally includes low-technology, low-capital, labour-intensive fishing practices. Often, the term artisanal is used to refer to small-scale fisheries. In the context of this report, the term small-scale fisheries refers to the whole value chain of pre-harvest, harvesting and post-harvest activities, including subsistence fisheries and excluding recreational fisheries.
>
> IHH, FAO (2023)

In fisheries literature in India, working definitions to characterise local marine SSF focus on socio-cultural attributes including – use of small craft and simple gear of relatively low capital intensity for skill-intensive operations, traditionally passed down knowledge, employment as share-workers or owner-operators of their fishing units in a household enterprise, fishing close to their home communities in relatively near-shore waters in single day/night operations, considerable financial dependence on middlemen and those who buy their harvest, relative social and economic disadvantage with low employment mobility out of fishing, among others. (Kurien, 1996). Supplementary and ancillary actors in the small-scale fisheries value-chain however are left out in this definition.

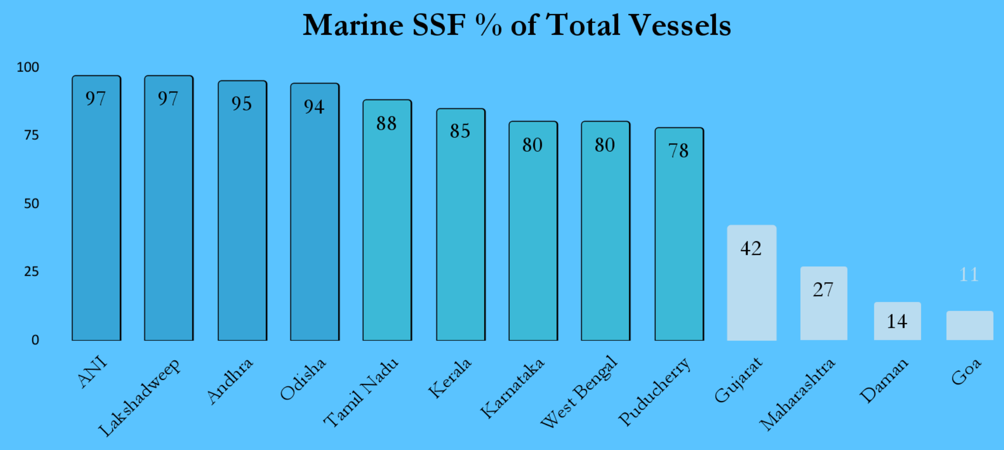
Motorised and non-motorised vessels as SSF



In publicly accessible government data, policy documents, and data released by marine research institutes, data is not aggregated by scale of operations, the number of fishers involved in SSF fleet and their economic contributions remain unknown and can only be estimated from existing categories. In the national and subnational datasets, the data is disaggregated into three broad categories – mechanised, motorised and non-motorised. In the datasets, additionally, there is no official definition of who counts as a fish-worker, and actors involved in pre- and post-harvest value-chains are often not included.

Motorised and non-motorised vessels are **around 75%** of the total vessels (CMFRI, 2016)

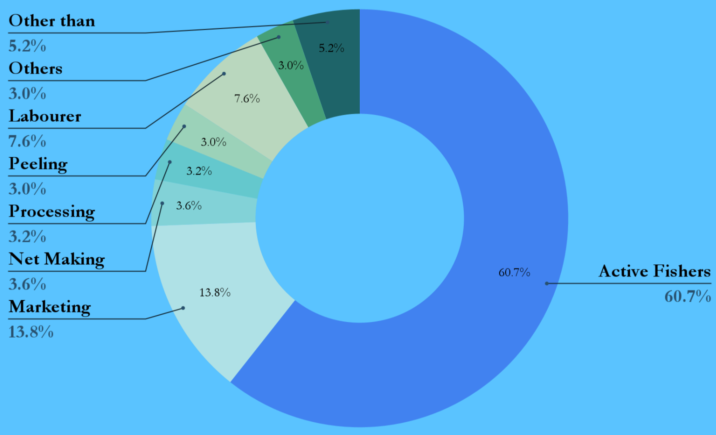
Compared to the global north standards of boat length and horsepower, however, boats belonging to **all three categories can be considered to be small-scale.** Towards a more conservative estimate of marine SSF vessels in India however, this report considers only motorised and non-motorized vessels under the category of the SSF.



Vessels in **nine out of thirteen** coastal states and U.T.s are **predominantly (> 78%) motorised and non-motorised** (DoF, 2018)

Characterising small-scale value chains

Among the key shifts in approaches with regards to characterising a fishery, has been to broaden the scope from focusing only on the act of harvesting towards considering the scale and sustainability of the entire value chain. As per the Illuminating Hidden Harvests report, **90 percent** of the people employed along capture fisheries value chains operate in small-scale fisheries. (IHH, 2022). The value chains include both pre-harvest and post-harvest actors, including net-menders, boat and engine repairers, ice suppliers, fish processors and fish vendors. Similar to SSF vessel operators, livelihoods along small-scale value chains are characterised by low capital, labour-intensive practices carried out by individuals or groups who are relatively socially and economically disadvantaged. Activities that are a part of this may include fish vendors, dry fish processors, boat builders and repairers, net menders, among others.



Fishworkers in India (CMFRI, 2016)

67% active fishers are employed by the motorised and non-motorised sector (CMFRI, 2010). An additional ~**34% fishworkers** belong to small-scale value chains (CMFRI, 2016). In total, well **over 70% marine fishworkers** are employed in small-scale fisheries in India.

Early stages of small-scale mariculture

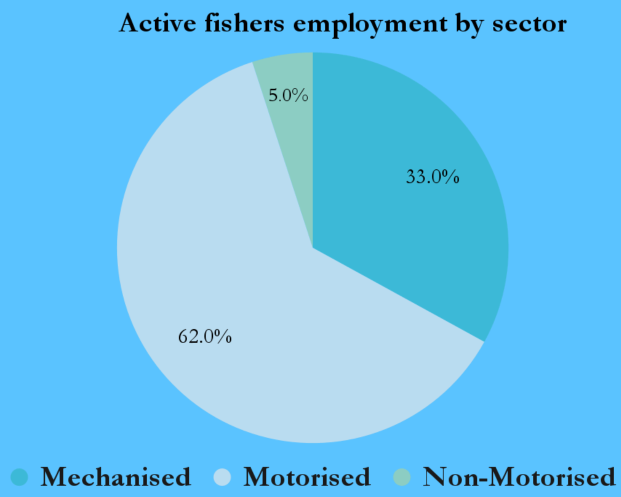
While traditional forms of coastal culture dependent on tidal water flows are carried out in Pokkali fields in Kerala as well as Bheri cultures in West Bengal, small-scale and large-scale non-traditional mariculture activities are still in their nascent stages in India. Seaweed, crab, molluscan culture and ornamental fisheries are considered to be activities that largely benefit small scale micro entrepreneurs.

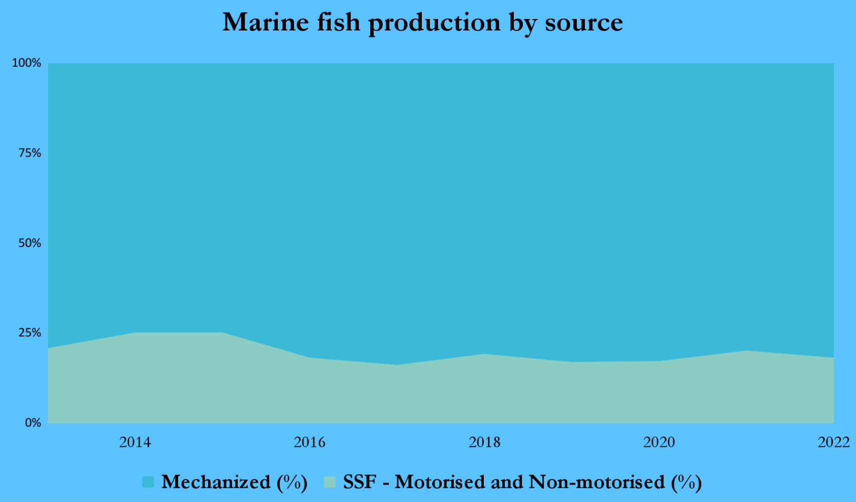
While still in its early stages, the number of livelihoods dependent on mariculture is set to increase. In government documents and policy papers, the potential economic benefits of large-scale mariculture is compared to that of aquaculture, particularly shrimp farming. However, just as in the case of shrimp, the threats of unregulated expansion are being overlooked. All non-traditional mariculture comes with the threat of degradation of coastal environments through introduction of exotic species, release of effluents from these systems and enclosing of the commons (Belton et al., 2020). While new farming-based systems have contributed significantly to fish production (at present, aquaculture is considered to be the fastest food producing sector, growing at an annual rate of 7% in India.[2]), large scale or industrial aquaculture was noted to produce less employment per unit of capital invested with the harvest being predominantly channelled to the export market. Additionally, the mariculture industry has also close dependencies on the bottom trawling dependent FMFO sector to supply its fish feed, with overall negative ecological consequences.

Thus, while ensuring sustainability and intergenerational equity within a context of large-scale commercially-driven mariculture production is a major challenge, at smaller-scales, mariculture activities have a potential to support low-income livelihoods.

Two ways of looking at marine SSF fish production

Employment (CMFRI, 2010) and fish landings (DoF, 2022)





~67% small-scale fishers land ~20% of the total catch

[2] Options for small-scale Aquaculture Development (overview paper). https://www.fao.org/3/x5821e/x5821e07.htm (Accessed: 04 March 2024).

Government Support Networks for SSF livelihood diversification in India

SSF Institutions and Policy

Support for SSF comes from State and Union governments particularly the Department of Fisheries and the Ministry of Agriculture, as well as specialised agencies such as the National Fisheries Development Board (NFDB) and to a lesser extent, the Marine Products Export Development Authority (MPEDA). Besides these organisations there are marine research institutes, funded by the Indian Council for Agricultural Research and State governments, who also have fisheries-related training and extension programs.

The government's Pradhan Mantri Matsya Sampada Yojana (PMMSY) carries forward many of the Blue Revolution (2015-2020) schemes and provides budgetary support to most developmental programs in this sector. Key programs funded under PMMSY are the Savings-cum-relief Schemes, the Group Accident Insurance Scheme (GAIS), Motorization of boats, among others. Distribution of fuel (kerosene and diesel), which form the largest share of overall support, comes from state mandates. The relief and welfare schemes are channelled through the state co-operative societies as well as through the government agencies such as the NFDB.

A closer look at the budgetary outlays of NFDB, show that increasingly there have been a number of schemes for large scale and industrial fisheries that have emerged over the past decade. These include introduction of deep-sea vessels, construction of raceways and recirculatory aquaculture systems, installation of cages and pens, among others.

At the policy level, a draft National Mariculture Policy was formulated in 2019 by an expert committee established by NFDB. The policy highlighted priority areas for development and policy imperatives. This draft policy was later integrated into the "Draft National Fisheries Policy 2020," which is expected to supersede all existing policy documents in fisheries and allied sectors once it is officially notified by the Government of India. Several maritime state governments, including the Government of Goa, are also actively working on their separate state-level policies, specifically for mariculture. (Parappurathu et.al, 2023)

Research Institutions

In India, mariculture's research and development activities are primarily led by public institutions and agencies operating under the State and Union governments. Notable institutions involved in research on culture technologies and related fields include ICAR-CMFRI (Kerala), ICAR-CIBA, NCSCM, and NIOT (Tamil Nadu), CSIR-CSMCRI (Gujarat) and State Universities. (Parappurathu et.al,

2023) For fishing technologies, post-harvest processing and extension related research and training, the state provides its support through ICAR-CIFT, ICAR-CIFE, NIFPHATT and CIFNET.

Top State Fisheries Expenditures and NFDB Expenditures (2015-20)

Red - Support for Large Scale Fisheries
Yellow - Support for Large & Small Scale Fisheries
Green - Support for Small Scale Fishers

State Fisheries and NFDB expenditure data shows an increase in spending towards schemes that support large-scale fisheries

II. Creating an income-support and diversification roadmap for small-scale fishworkers

1. Designing strategies that foreground the welfare functions of small scale fisheries in low-income contexts

Two dominant approaches guide vulnerability-reduction and income diversification in the sector– one, which focuses on maximising production and economic rent **for the government** from fisheries and the other that seeks to maximising nutritional security and economic rent **for small-scale fishworkers**, by focusing on fair support, fair access and fair price at the cost of increased government revenue from potential closed-access arrangements. In the former, government institutions are tasked with creating local public goods for marginalised fishing communities while the latter focuses on existing public goods that are generated by small-scale fisheries, including **employment, resource conservation, food security and equity.**

In the global south, in the absence of secure tenure rights, good political and economic governance, enforcement capacities, effective pro-poor policies, and a resource-rich government capable of reinvesting sufficient resources for poverty reduction, foregrounding welfare models that recognise the existing contributions of small-scale fisheries to food security, health, identity, autonomy and equity is key.

2. Using participatory approaches towards promoting social inclusion and aligning with local aspirations

Fisheries management and livelihood diversification goals are often decided non-locally. As these decisions can involve changes to existing arrangements of access and use of natural resources and commons, political considerations of collectivised interest groups (across scales), power, preferences and values play a decisive role in local outcomes. The key questions guiding income support interventions for fishers thus are **who gets to decide on the changes that are being introduced, how they are introduced, who benefits and who loses from the new arrangements**. While not uncritically equating processes of localization to de-centralization, justice or sustainability, interventions that prioritise the aspirations of those marginalised within the local community, provide an opportunity of generating a larger share of 'local public goods' for coastal communities. A commitment to participatory approaches thus helps reduce conflict and undercut imbalances of power and differing values about the nature of development at the local and non-local scales.

3. Prioritising complementary activities to existing livelihoods and 'supplementary' over 'alternate' income streams

In India, fishing as a practice is predominantly embedded in castes, cultures and traditions and initiation to the profession typically happens within fishing families, using familial social networks, and intergenerationally passed cultural and geographic knowledge. Given the role of cultural and social capital in fishing communities, diversification strategies should support opportunities that align with the community's values, traditional skill sets and way of life. Coastal communities rely on a wide set of both marine and non-marine resources for their livelihoods, and though diversification within fisheries need not be the only avenue for generating incomes (Brugère et. al, 2008), complementary activities that **build on existing skills and capacities**, improve standards of living and generate supplementary incomes have a greater tendency to sustain themselves.

4. Strengthening support systems focusing on credit and market linkages in the diversification roadmap

Access to subsidies, institutional credit and support for inputs, technological support from research institutes are crucial factors that determine the feasibility of the diversification roadmap. These support systems must be **aligned to national and state level anti-poverty programmes**. Discussions with micro entrepreneurs supported by Society for Assistance of Fisherwomen (SAF) and MATSYAFED indicated that most participants who successfully diversified incomes and benefited from the adopted technologies, were already involved in an allied traditional activity and had access to existing markets as well as subsidies and credit-related support systems.

5. Improving risk-mitigation measures by strengthening safety nets

The capacity to absorb risk in new ventures is central to designing diversification strategies. Microentrepreneurs reported **a lack of risk mitigation measures as a crucial impediment** in taking up new activities. Particularly riskier activities with under-developed supply chains such as mariculture required a greater number of **insurance and safety net measures** in case of unforeseen consequences such as bad weather and poor harvest. Before supporting a new venture, it is important to help fishworkers understand and manage risks associated with diversification. This may involve creating insurance mechanisms or safety nets to protect against unforeseen challenges.

6. Strengthening governance and co-management pathways for management of fishing commons

Economic strategies that do not take into account broader issues of coastal and resource governance and **the local politics of claim-making** are bound to have limited on-ground impacts. While there is no single framework which can be replicated across contexts, depending on the existing institutions of local governance, the role of fisheries experts and the state in a particular site, the economic engagement may be supported by an engagement in governance structures.

Co-management is a **collaborative power-sharing** arrangement in which a diverse set of stakeholders collectively assume the responsibility for overseeing the sustainable management of a local fishery. These stakeholders typically include the community of local resource users, such as fishers, along with government entities, such as departments and ministries, as well as research institutions, village organisations, and various other relevant parties like boat owners, fish traders, boat builders, business individuals, and so forth. Additionally, external actors like non-governmental organisations (NGOs), local civil society organisations (CSOs), trade unions, and cooperatives also play a key role in the joint effort to ensure the responsible stewardship of the fishery resources.

In recent years, states such as Kerala, Tamil Nadu, and Puducherry have endorsed co-management initiatives by either enacting changes in their respective state fisheries legislations or via government orders. Specifically, Kerala revised its Kerala Marine Fisheries Regulation Act in 2017, putting forth a proposal for the establishment of three-tiered, multi-stakeholder fisheries '**co-management councils**'. While the concept of fisheries co-management has been incorporated into the state's fisheries laws, its practical implementation of co-management is still far from institutionalised.

Besides the State of Kerala, the Governments of Tamil Nadu and Puducherry along with the Food and Agriculture Organization of the United Nations (FAO) implemented a project under Coastal Disaster Risk Reduction Project (CDRRP) called Fisheries Management for Sustainable Livelihoods (FIMSUL). Through multi-stakeholder consultations, the FIMSUL project attempted to advocate for policy changes towards designing effective fisheries management strategies which share some characteristics of participatory fisheries management. Taking heed of these recommendations, a government order was passed by the Department of Fisheries Tamil Nadu on March, 2019. The order requested the setting up of 'Village level Marine Fisheries Co-management Committees', 'District Level Marine Fisheries Co-management Council', 'Zonal Level Marine Fisheries Co-management Forum', and 'State Level Marine Fisheries Co-management Forum'. The four zones in the order were Coromandel coast (357.2 kms), Palk Bay Coast (293.9 kms), Gulf of Mannar (364.9) and Kanyakumari west coast (60 kms).

However, on-ground engagements with fisher leaders and oor-panchayat heads revealed that the **committees largely exist on paper and there has been no functional devolving of power at the village-level** in Tamil Nadu yet.

III. Dry Fish Processing and Trade

Introduction

Dry fish remains a crucial source of livelihoods and nutrition in South and Southeast Asia and has been acknowledged to be particularly important to low-income households in the region (Belton et al., 2022, Hossain et al., 2013, Ghosh et.al, 2023, Salagarama, 2014). India's production of processed fish including dried, salted, smoked and fermented fish is reported to be around 2.64 lakh tons with the largest share being produced in the states of Gujarat, Kerala, Maharashtra, Telangana, and Karnataka (Ghosh et.al, 2023). Prior to the introduction of refrigeration and cold chains, traditionally processed dried fish was more widely traded and consumed as the fresh fish consumptive trade was inadequate to dispose of the landed catch, especially during peak fishing seasons and glut landings. Today, the consumers of dry fish include agricultural labourers, landless poor and tribes living in coastal and interior areas (Salagrama, 2014). The gendered nature of the traditional processing work, has also meant that the occupation is dominated by women, with skills passed traditionally within the household. Additionally, the dry fish trade is characterised by **trade in small pelagics (sardines, mackerel, anchovies) and shrimps**, with little competition to existing markets of bigger high value

Fish salting in Ramnad, Tamil Nadu

fish. However, the overall decrease in fish landings, along with the development of the fishmeal industry, has led to a diminishment of fish supplied to the dry fish industry (Gupta et. al., 2020, Jyothishi et. al., 2024). This section looks at some of the continuations and transitions in the Dry Fish sector, focusing on processors in Dakshin's field sites in Tamil Nadu, Odisha and Kerala.

Traditional practices for traditional markets

There are no systematic national estimates of the number of people employed in the dry fish sector. In the existing literature however, there is agreement that a majority of the processors continue to rely on intergenerationally passed on skills and practices and operate largely within traditional low-income markets.

Sun drying of fish in coastal commons, including beaches, roads, sun drying yards or open grounds over jute mats is the most dominant form of processing. Fish is headed, gutted, and washed before drying for 8 - 16 hours, depending on the size of the fish being dried. Each fish is manually turned over to ensure even dehumidification. Along with sun drying, processors may hasten the process of dehumidification by dry salting bigger fish such as mackerels, sardines, croakers, ribbonfish, jewfish and horse mackerels (Salagrama, 2014). Lastly, wet salting may be carried out in salting vats filled with brine for 3-4 days, where the fish is not sun dried at all but is immediately packed in palmyra, coconut leaf or bamboo baskets in order to prevent oxidation.

a. Fisherwomen drying fish at Soliyakudi beach, Tamil Nadu and b. Vats for brining fish in Nuagaon, Odisha

Processors access their fish individually or in groups, by participating in auctions, purchasing from boat owners at landing centres, obtaining fish harvested by family members, through commission agents or through buybacks from traders at a fixed price.[3] In Odisha, women processors may individually or in groups purchase fish by either paying a 'booking amount' in advance (amounting to INR 30,000 – 50,000 annually) and purchase fish from the 'booked' fisherman at market rates or they may directly participate in fish auctions at the landing site. Additionally, smaller-scale local processors may repurchase processed dry fish from larger dry fish processors (a practice called '*Dandi Tuliba*' in Odisha) for local door-to-door selling.

Challenges for designing income-support interventions for the sector

Constraints for dry fish processing are faced during its stages of procuring of fish, processing of fish and trading of fish. Procurement constraints include **competition with fishmeal and fish oil plants, decrease in fish landings, and individualised purchase of small quantities** of fresh fish. Processing related constraints include **losses during monsoons, poor processing and storage conditions, loss of coastal space, infestation losses, transportations costs** and risks. Trading related constraints include dependence on **risky forms of credit, hand-to-mouth operations and presence of exploitative intermediaries**. (Salagrama, 2014)

Socio-economics of dry fish trade

Fishworkers involved in the fish drying trade operate at different scales. Large-scale processors employ waged processing assistants, have assured sources of fish supply, credit and capital and are not involved in the actual processing. Small-scale processors however directly obtain their fish, process them and sell them in nearby markets.

Dry Fish Traders in Pamban

[3] Jyotishi, Amalendu, Bhatta, Ramachandra and Surathkal Prasann. The Dried Fish Processors of Karnataka, Dried Fish Matters. Available at: https://driedfishmatters.org/dfm/wp-content/uploads/2024/01/KNT_DF_processors_2.pdf (Accessed: 08 March 2024)

In Odisha, large-scale processors invest up to Rs. 20 - 40,000/month in the trade (Salagrama, 2014), whereas in Kerala, large fish drying units (processing 20 tonnes/month) may require an investment of up to 6,00,000/month for 8 months, with **98% of total cost being operating costs of purchase of raw fish and salt, wages of labour employed for gutting, cleaning, and spreading the fish** (Salim et al, 2016). As an enterprise, profit margins (net profit/net sales) of these enterprises are reported to be low at around 22% - 27% for larger dry fish units in Kozhikode, Kerala, Ramanathapuram, Tamil Nadu and Digha, West Bengal (Salim et. al, 2016, Vipinkumar, et. al, 2022, Sahu et. al, 2018).

Fish	Cost Price (Rs./kg)	Selling Price (Rs./kg)	Drying Duration (days)
Anchovy	20	120	1.5-3
Sardine	25	100	3-5
Sole	20	100	3-5

Source: Salim et. al, 2016

Small, household-level processors may use between Rs. 500 - 3000 as working capital (Salagrama, 2014). Earnings in southern Odisha may range from 6000 - 10,000 per month, for six months of operations for larger traders and Rs. 800 - 1500 per month for smaller processors.

Dry Fish Value Chains in Ramanathapuram

A rapid dry fish mapping in Ramanathapuram revealed that Pamban and Soliyakudi were key nodes in the dry fish value chain. In Pamban, it was observed that mostly small-sale fisherwomen were involved in dry fish making, whereas in Soliyakudi large commercial companies produce large quantities of dry fish. **Pamban has the largest demand for dry fish, primarily due to the high flow of tourists towards Rameshwaram.**

Production centre	Types of fish	Source	Monthly Production (Kgs.)	Peak Season	Consumers
Pamban bridge	Anchovy, Sardines, Squid, Stingray Emperor, Parrot, Small shrimps, Milk shark, Ponyfish, Goat fish	Pamban landing centre	500	Summer (Jan - June)	Local markets in Pamban

	Croakers, Barracuda and Sole fish				
Pamban landing centre	Sardines, Anchovy, Goatfish, Croaker, Rainbow Ponyfish, Barracuda	Pamban landing centre	4500	Summer (Jan - June)	Wholesale and Retail markets in Ramnad
Soliyakudi	Pony fish, Anchovy and Lesser Sardine	Soliyakudi Landing centre (self-owned boats)	40,000	Summer (Jan - June)	Transport to Dry Fish companies
Thondi	Anchovy, Silver belly fish, Rainbow sardine, Red snapper, Swordfish, Croaker and Emperor	Thondi landing centre	250-350	Summer (Jan - June)	Retail

Markets	Types of fish	Source	Monthly Sales (Kgs.)	Peak Season	Consumers
Pamban (Wholesale and Retail market)	Mackerel, anchovies, kingfish, barracuda, cod, squid	Pamban bridge	1500-1800	Summer (Jan - May)	Across Tamil Nadu
Pamban (Wholesale and Retail market)	Rays, emperor, anchovy, small shrimps, red snapper, Barracuda	Pamban bridge	9000	Summer (Jan - May)	Chennai, Coimbatore, Tirupur, among other places in Tamil Nadu
Mandapam	Emperor, mackerel, anchovy, snappers	Repurchase from Pamban Markets	180	Summer (Feb - May)	Local consumers in Mandapam
Ramnad (10 retail dry fish shops)	Barracuda, Cod fish, Emperor, Anchovy and Indian goat fish	Pamban	15000	Summer (Jan - June)	Local consumers in Ramnad

Fisherwomen washing fish prior to preparing dry fish

Unpacking state-led techno-economic transitions

Given the dominant subsistence-based orientation, the dependence on low capital investments, poor support systems and largely low-income, informal and rural markets, the incentive to adopt new technologies to improve the overall quality of dry fish and reduce losses has been low. Additionally, capital-intensive interventions to 'modernise' the sector have seen mixed results. In Odisha, for example, the Scheme of Fund for Regeneration of Traditional Industries (SFURTI) under Ministry of MSME, seeks to organise traditional artisanal and 'village industries' into clusters of enterprises through a set of 'soft' (counselling, exposure visits, etc), 'hard' (common facility centres, raw material banks, technologies, and value-addition) and enterprise-independent 'thematic interventions' (brand building, institutional linkages, etc.).[4] This has led to setting up the **Humma Dry Fish Cluster in Gokharkuda, Ganjam for a total project cost of INR 4.5 crores** with the signatures of **728 Scheduled Caste fisherfolk** from Gokharakuda, Purunabandha and Nuagaon.[5] However, on-ground interviews with dry fish producers and SHGs from the locality and visits to the site have shown that the only successful venture at the site has been the ice production and distribution facility used by local traders to preserve fresh fish. This intervention unfortunately seems to be heading in the direction of the previous govt.-led projects in the region to support the sector such as installation of large solar dryers for dry fish in Purunabandha and NoliaNuagon set-up under ICZMP that are now in ruins (reportedly as the plan had not accounted for long-term electricity supply and maintenance of the site).

State interventions at the Humma Dry Fish Cluster, Gokharkuda

Among more promising developments in Odisha however, has been the **modern *sukua kendra*** (modern dry fish centre) at Humma market in Ganjam, a **INR 5 crore project** aimed to improve the working conditions of dry fish vendors. Additionally, in Kerala, relatively low-cost drying technologies

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[4] Revised guidelines for scheme of fund for regeneration of traditional Industries, MSME, https://msme.gov.in/sites/default/files/SFURTI_GUIDELINES_REVISED_0.pdf (Accessed: 08 March 2024).

[5] Brief profile of Humma Dry Fish Cluster. Available at: https://mrfoundation.org.in/pdf/Project Brief On Humma Dry Fish Cluster(1).pdf (Accessed: 08 March 2024)

have been introduced by the Central Institute of Fisheries Technologies (CIFT), among others. The following is a case study of one group that has successfully transitioned to a more capital-intensive drying technique.

WSHG-run Dried Fish Units

WSHG run dry fish units in Kochi, Kerala

Anandu Group, a dried fish processing SHG consisting of 3 women from Kochi, Kerala have purchased a hybrid fish processor through the support of the Society for the Assistance of Fisherwomen (SAF). While the drier can be run on gas and electricity, they've reported the use of woodfire to be most profitable, on account of reduced input costs. Among their products, they are involved in processing and selling dried shrimps in all seasons. The group also purchases salted fish from Kottapuram and re-processes it. The dried fish is also roasted and packaged.

SAF has been supporting the group for a year. Previously, they have been practising sun drying over sheets, without the use of a dryer for close to 5 years. They became aware of the opportunity through an outreach programme conducted by SAF.

As compared to sun drying, the group reported fewer losses on account of fish decay. Additionally, during monsoon, as fresh fish is difficult to come by, their trade has become primarily dependent on shrimp. They also reported that drying fish in the dryer was difficult as the fish often got powdered which made it inedible. They operated their dryers for three days a week.

Markets were mostly wholesale shops, to which they took the dried fish once a week. If the fish didn't sell at the market, they stored it at home, selling it the week after. Demand was reported as being highest during festival seasons. Occasionally, when sales are low, profits could also be low, but the products are never wasted, once dried, they can be sold off in the coming weeks. The credit for building the shed and setting up the unit was procured from Kerala bank for a period of 3 years. While the loan was still being repaid, they reported the business to be profitable on the whole.

Previously, they used to stock their produce in larger quantities, but because of an increase in processing units in the neighbourhood, competition has increased, and they reported trade having reduced as compared to before. Among technical improvements, they felt that the packaging could be improved. Overall, they indicated that the dryer technology has led to an improvement in their incomes and working conditions.

Technical support to the sector by Research Institutes including ICAR-CIFT

Another low-cost intervention advocated by fish processing scientists has been the use of elevated racks. With better airflow then at ground-level, raised racks help hasten the process of drying fish from both the upper and lower surfaces and provides protection from dust, insects, rodents, birds and unfavourable climatic conditions. Hygienic drying conditions are also noted to prevent fungus growth ensuring better food safety and quality control measures. (Salim et. al, 2016). Use of polythene sheets as solar tents have also been used as low-cost mechanisms for bulk drying. However, given the huge variability in quantities (particularly in glut seasons), added to the fact that temperatures in these tents cannot be controlled and may increase above desired levels, adoption of this has been limited.

Besides solar tent driers, other technologies developed and transferred to fishers and SHGs by the Central Institute for Fisheries Technologies (CIFT, Kochi) in 2023 are as follows. [6]

[6] Advanced drying techniques for fish - krishi icar. Available at: https://krishi.icar.gov.in/jspui/bitstream/123456789/32293/1/5_Advanced drying techniques for fish.pdf (Accessed: 08 March 2024).

Equipment	Capacity/batch	Equipment Cost
Solar Tent Dryer	NA	67,000
Solar-Electric-Wood Fuel Dryers	60-70 Kgs	2,50,000
Solar-LPG Dryers	200 Kgs	2,50,000

There are variances in sensory properties including colour, odour, flavour and texture in fish dried by means of these equipment which have implications for consumer behaviour and sales. Equipment of varying capacities are available with trays ranging from 6 to 110 m^2 capable of drying 10 kg to 500 kg of fish. Reported drying time for the units was 6 to 7 hours for around 10 kg of fish/batch. Among the solar-hybrid dry fish units, **operations costs were lowest for wood-fuel**, **followed by LPG gas and lastly electricity-run driers**. Fixed costs included construction of a shed to house the unit. Subsidies for equipment and free training on hygienic fish drying is available for microenterprises under Scheduled Caste Sub-Plan.

Expenses (First Year)	Amount
Fixed Costs (Shed, Platform drier, Sealing machine and weighing machine)	1,31,450
Operational Costs (Raw material 30,000 kgs/year, Labour, Electricity, Rent)	15,50,500
First Year Total Costs	16,81,950
Gross Returns (18000 Kgs @ 120Rs/kg)	21,60,000
Average Profit	4,78,050
Return on Investment (Profit/Total Costs)%	28.42%

Source: CMFRI (2022)

IV. Small-scale Mariculture - An Overview

Mariculture, characterised as being a subset of aquaculture 'involving the cultivation of marine organisms for food and other products in an enclosed section of the sea (cages/pens), or in tanks, ponds or raceways filled with saline water.' [7] In India, commercial aquaculture activities and supply chains are most well developed for coastal brackish water aquaculture, chiefly shrimp farming. Besides shrimp farming, other coastal aquaculture activities are primarily undertaken in small-scale contexts, prominent among which are green mussel farming, confined to Malabar Coast in Kerala and seaweed farming along the coast of Tamil Nadu.

Species	States (Commercial Production and Pilots)	Production Estimates
Bivalves	Kerala	**98,000 Tonnes** (2021)
Clams	Kerala and Karnataka	**64,105 Tonnes** (2016)[8]
Oysters	Kerala, Maharashtra and Goa	**2,500 Tonnes** (2016)[9]
Mussel	Kerala[10] and Goa	**20,000 Tonnes** (2020)[11]
Pearl	Tamil Nadu, Gujarat, Andaman and Nicobar Islands	
Seaweed	Gujarat, Diu, Maharashtra, Kerala, Tamil Nadu, Andhra Pradesh, Odisha[12]	**34,000 Tonnes** (2021)[13] (~5000 Tonnes Farmed and 25000 Tonnes Wild collected)

[7] Course manual Winter School on Technological Advances in Mariculture for Production Enhancement and Sustainability- CMFRI repository. 2016 Available at: http://eprints.cmfri.org.in/10600/1/PDF-Manual.pdf (Accessed: 04 March 2024)

[8] Gopal, N. et.al., Black Clam is all set to go places. Available at: https://krishi.icar.gov.in/jspui/bitstream/123456789/20894/1/Black%20clam.pdf (Accessed: 08 March 2024).

[9] Mohamed, K.S. (2016) Bivalve mariculture in India – progress in research and development. Available at: https://core.ac.uk/download/pdf/33019819.pdf.

[10] Kasakode, Ernakulam, Kozhikode and Malappuram Districts

[11] P.S, Aloysius, et.al., (2020) *Mussel Culture*, *http://eprints.cmfri.org.in/14223/1/Blue%20Bonanza_2020_Alloycious%20P.S.pdf*. (Accessed: 08 March 2024).

[12] Mantri et. al, (2017) An appraisal on commercial farming of Kappaphycus alvarezii in India: success in diversification of livelihood and prospects

[13] CMFRI (2022). *India Produces Record 34000 MT of seaweeds in 2021*. http://eprints.cmfri.org.in/16278/3/Aquaculture%20Spectrum%20July%202022_69.pdf

V. Mariculture - Seaweed

Introduction

Seaweed cultivation in India was first introduced experimentally in Mandapam, Tamil Nadu, between 1995 and 1997 (Eswaran et al. in 2002). Commercial operations were taken up by PepsiCo in 2002, and subsequently taken over by Aqua Agri in 2008 (Narayanakumar and Krishnan, 2011). After its initial introduction in 2002, it has gone through a few boom-and-bust cycles in the backdrop of **ecological concerns about Kappaphycus alvarezii's bio-invasive impacts on coral reefs** in Krusadai island (Chandrashekar et. al, 2008), **impacts on the abundance and diversity of native species** (Rajaram et. al, 2021), and **issues related to its productivity** in nearshore waters on account of temperature and disease (Johnson B., 2017).

However, seaweeds serve as the source for industrially significant thickening agents and gels like agar, carrageenan, and alginates, all of which are commercially important for a huge number of sectors including pharmaceutics, paper, cosmetics, fertilisers and industrial gum.

The red algae (Gelidiella, Gracilaria spp. and Kappaphycus alvarezii) are used for agar production and brown algae (Sargassum spp., Turbinaria spp.) are used for the production of alginates and liquid seaweed fertiliser. Red algae are of higher value and there are now attempts to culture and extract agar from the native Gelidiella and Gracilaria species.

Munikadu, Mandapam (T Nagar), Vedalai, Pamban, Olaikuda, Sambai, Vadakaddu and Mangadu are the major areas of Kappaphycus cultivated in the Ramanathapuram district.

Challenges and constraints to seaweed production

Among the challenges reported by seaweed farmers and practitioners include **substantial crop losses caused by high temperatures (above 36 degree Celsius) and diseases (ice-ice resulting from stress to the crop on account of changes in salinity, ocean temperature and light intensity, among other factors)**, as well as **damage to bamboo rafts during adverse weather conditions**. To address the issue of high temperatures in the cultivation of Kappaphycus alvarezii, slightly deeper waters with more favourable temperatures for optimal growth has been suggested. Additionally, as a newly emerging sector, while supply chains are still being developed, it is crucial to establish insurance coverage and risk-support mechanisms to provide compensation for crop losses resulting from natural disasters.

Wild Collection of Seaweed - Socio-economics

Alongside the farming of seaweed, the wild collection of seaweed is undertaken by around 2,000 women in 21 fishing villages in Tamil Nadu. Wild collection has close linkages to the seaweed culture supply chain and with reported declines in the availability of wild seaweed, there are plans to encourage collectors to become cultivators. [14]

Species	Season	Avg Price/Kg (2011-2015)
Turbinaria	January to July	9.8

[14] Senthalir. S., These Tamil Nadu women have been diving deep for seaweed – but now they are deeply worried.2019. Available at: https://scroll.in/article/913591/these-tamil-nadu-women-seaweed-divers-fear-the-loss-of-their-only-source-of-livelihood (Accessed: 08 March 2024).

Gelidiella	February to September	58
Gracilaria	February to March & September to December	17.6
Sargassum	September to May	8.2

Source: Johnson B. (2017)

Expenses / Trip / Group of 5 Members	Avg. Amt (2012-15)*
Average Cost/Trip	1710
Average Gross revenue/Trip	6200
Average Profit/Trip	4530
Average Trips/month	12 trips
Average Monthly Income	10,866

Source: Johnson B. (2017)

Voices from the waters - First-hand report of Seaweed Farming in Thaneer Ootru, Tamil Nadu

“

In February, around 250 seaweed rafts of the Kappaphycus are about to be cultivated, divided into 125 each among the two of us. It costs around 2000 for us to make a single raft, which includes the costs of bamboo nets and seed. It's highly volatile as the cultivation of it depends on the climatic conditions as there have been plenty of instances even in the past where the seaweed plants have become rotten due to high temperature. When the weather is moderate we can have the rafts in the seashore, but **when the temperature is high we have to anchor these rafts in deep waters for which we**

require a *vallam*. While there are provisions for loans to promote seaweed cultivation, the high volatility of the practice is the reason why there is a lot of uncertainty among us about undertaking this activity frequently. It gets really difficult to repay the loans when the weed gets rotten.

As we are among the traditional fishers in this region, we have not been able to invest in better fibre boats and hence have to explore alternative practices like seaweed. Winds also play an important role in the seaweed cultivation as **heavy winds can destroy the plantation and wash the rafts to the seashore**. The most significant barrier which has resulted in this dire financial situation for the village is the lack of capital investments despite the fact that we have really skilled fishers. **The ownership of these rafts are not with us** – we were approached by an individual from Chennai who was willing to invest in seaweed and wanted us to supervise and work through this process for a nominal salary. In the past we were able to secure loans to do seaweed farming but the weather conditions back then weren't conducive which resulted in a huge loss for us.

Co-operative societies haven't been so functional either so we are unable to get many schemes and subsidies which we are entitled to. [...] **In an ideal situation 100 gms seed would yield 3 kgs of seaweed.**

Without capital to invest in boats it's impossible to scale up the seaweed production as the reduced mobility means reduced space for seaweed farming. Availability of boats can also lead to partnerships between multiple fishers towards seaweed farming as an alternative activity which can be a steady source of income. Although there are multiple schemes, the government asks for a one time payment which is a little difficult in our financial circumstances. **A fund to help with the one time payment and a system where monthly payments are allowed in instalments** would be really helpful for us in the long run. SHGs are also getting stringent with their rules and repayment and even then **the maximum amount which can be availed is INR 30,000 which doesn't even cover the costs of our fishing nets**. Currently most fishers in the village earn their livelihood by net mending which is also a less remunerative work, involves a lot of labour and dire working conditions. [...].

"

Report of Seaweed Farming in Thoniturai, Tamil Nadu

"

I (Jaya) have been doing seaweed farming for the last 20 years. Initially, Pepsico introduced the contract farming method, distributing 200 rafts for 5 women, with a buyback system in Thonithurai. Pepsico handed over seaweed cultivation to AquaAgri from 2008 onwards. AquaAgri helped to form a five member self help group in the Thonithurai village and linked with the bank to get the loan. A rupees of three lakh was sanctioned and AquaAgri themselves took the responsibility of providing all necessary inputs using the bank loan. Self help groups never received any money in the form of cash; they only received it as inputs for seaweed farming. Earlier there had been restrictions from forest officials for cultivating Kappaphycus in the Gulf of Mannar regions but now all villages have begun farming.[...] **Seaweed farming was successful up to 2011-2012, but later there were many issues with productivity in the Palk Bay region because of poor water quality and high temperature. This year though the seaweed harvest is in a relatively good condition.** People who have started the culture earlier this year were able to get a good harvest. Seeing the success of the adjoining villages, now several people have started cultivating seaweed as well.

”

Government support and promotion of Seaweed Farming

Despite the challenges and the recent boom-and-bust cycles, the government has been heavily promoting seaweed culture and its associated value chains based on the large unmet industrial demand. The most ambitious of the attempts is the establishment of a '**Multipurpose Seaweed Park**', at Valamavur, Thondi, Ramanathapuram which aims to engage over 8000 people in 6 coastal districts of Tamil Nadu towards supporting entrepreneurs, processors and access to technologies and information. Towards encouraging the sector, Central and State governments provide support for training and demonstration, for initiating culture as well as setting up seaweed processing units for specific high value products like carrageenan.

For low-income fishers and WSHGs, the Tamil Nadu Department of Fisheries offers two schemes supporting seaweed culture. This scheme '**Start Seaweed Farming**' offers the applicant a thousand rupees/raft (with a maximum cap of 15000 for an SHG for setting up 15 rafts) that can be availed by anyone from Tamil Nadu including Fishermen Cooperative Societies, SC/ST Cooperative Societies, Women Self Help Groups, and Registered Companies of Private Entrepreneurs. The unit cost aims to cover capital, operational and maintenance costs on a one time basis. Additionally, seaweed farmers may procure further subsidies from NFDB with the maximum cap of 48000 per SHG. The second scheme '**Seaweed culture training for Fisherwomen in Ramanthapuram'** aims to facilitate training programmes on Seaweed culture for fisherwomen in the Ramanthapuram district. The training programme is conducted by the Additional Director of Fisheries on a need basis in collaboration with Women Fisheries Cooperative Societies. The applications are received by the concerned Districts ADF office around the year.

Procurement of Seeds

At present, seeds are procured either from existing farmers who save a small portion of the harvest for re-cropping or from private companies. At present the government is not involved in the supply of seaweed seeds, however there are plans to establish a seaweed bank in the 'Multipurpose Seaweed Park' to be established in Thondi, Ramanathapuram.

Domestic Markets

The seaweed market is fairly well developed in the private sector owing to its demand and the presence of large corporations that directly procure from farmers at the site of the harvest. Besides being used as raw materials for the production of agar and alginate, a small portion of the seaweed is also diverted towards producing liquid seaweed fertiliser. As per NFDB, there are about **20 agar industries, 10 algin industries and a few Liquid Seaweed Fertiliser (LSF) industries** situated at different places in the maritime states of Tamil Nadu, Karnataka, Andhra Pradesh and Gujarat. [15]

At present, the harvest is purchased from the producers either directly at prices determined by the market or at predetermined prices with investments subsidised by the private organisations themselves. Direct purchase involves price volatility owing to the seasonality of seaweeds and the periodic boom and bust cycles, which can lead to a potential loss for the farmer. The main marketers as identified by Johnson et. al. (2017) were AquAgri Processing Pvt. Ltd., Manamadurai; SNAP Alginate Processing Ltd., Ranipet, Vellore; Linn Plantae Pvt. Ltd., Ramanathapuram; PrasmoAgri, Kumbakonam and Sea6 Energy, Tuticorin with AquAgri Processing Pvt. Ltd., Manamadurai being the largest procurer of seaweed. While at once there were 37 agar industries in Madurai at one time, at present there are only seven companies that are processing seaweed at reduced capacities.

The corporations also help set up all-women self help groups (SHGs) and farmer cooperatives through which capital required for farming is provided with a promise of buyback of the harvest at a predetermined price. Alternatively, capital in the form of loans are extended through local banks as the intermediary, with the guarantee that the harvest will be purchased by the company itself.

Socio-Economics of Seaweed Farming

The low capital costs and short cycles of cultivation and harvest make the activity conducive to support low-income households. Most often than not, fishers take this activity up as a supplementary secondary source of income and there are only a few households that depend exclusively on seaweed harvest.

[15] Guidelines for seaweed cultivation. NFDB. Available at: https://www.nfdb.gov.in/PDF/ACTIVITIES/5.Guidelines for Seaweed Cultivation.pdf (Accessed: 09 March 2024).

Seaweed Farming (Sp. Kappaphycus)	Details[16]
Crop Duration	45 - 60 days
No. of Rafts/Beneficiary	45 nos
Seed Material Required Per Raft	50 – 65 kg/ raft
Seaweed Harvested Per Raft	250 kg/ raft
No. of cycles / year	4-6
Expenses (Per raft)	**Amount**
Fixed Costs (Bamboo, anchors, rope, nets)	3000
Operational Costs (Seed @ 20Rs/kgs, Labour, Maintenance)	1500
Total Costs	4500
Gross Returns (@ 20 Rs./kg)	5000
Average Profit	500
Return on Investment (Profit/Total Costs)%	11.11%

[16] Information compiled from seaweed farmers in Thaneer Ootru and Thonithurai, Tamil Nadu. Also from B. Johnson. Economic analysis of farming and wild collection of seaweeds in Ramanathapuram District, Tamil Nadu. Available at: http://eprints.cmfri.org.in/12458/1/IJF_64.4_Johnson B_Economic analysis of farming and wild collection of seaweeds.pdf (Accessed: 08 March 2024).

V. Mariculture - Mussel Farming

Introduction

Natural resources of bivalves (mussel, oyster and clam) are an inexpensive source of animal protein to coastal communities and a means of subsistence. In India, traditionally, bivalves are consumed by low-income communities with limited markets, however, **consumption is high and some bivalves are served in commercial establishments in pockets in Malabar and Goa**. Among mussels, **two species of edible mussel, *Perna viridis* and *P. indica,* majorly contribute to the fishery in the Indian coastline**. At present, approximately three fourth of the farmed mussel production of India is from Kasaragod district of Kerala.

Though mussel fisheries have traditionally existed, farming technologies of *P. viridis* were first standardised by the Central Marine Fisheries Research Institute, Kochi (CMFRI) and has been commercially adopted by fishers as a supplementary source of income. The availability of quality seed from the wild, the sedentary nature of the mussel, fast growth rate and tolerance to varying environmental conditions together have helped the culturing process. While the technology for *P. viridis* was developed in the 1970s, commercial farming practice began in 1996 in Padanna backwaters of North Kerala. **Self-help groups were key community institutions that helped proliferate the technology widely.** Since the 90s, culture based green mussel production in India has experienced growth to approximately 18,000 tonnes in 2009, mainly driven by the Padanna backwater system of northern Kerala (Mohamed *et al*. 2019)[17]. While production is still concentrated in the northern districts of Kerala, it has been successful since its introduction in the late 90s and commercial farming of mussels has subsequently expanded to Karnataka, Goa and Maharashtra along the west coast. (Kripa, 2008)[18]

Community Institutions - the Role of Self-Help Groups (SHGs)

Three forms of farm ownership have been identified among mussel cultivators in Kerala- individual owners or individual families, combined ownership of two or three families, and SHG owned farms which included individuals from over fifteen households forming an SHG. (Kripa, 2008). Initially, CMFRI had engaged 5 SHGs of 15 – 21 members in Kasaragod for the transfer of culture technologies and even today a substantial share of mussel farming activities is managed by women-led SHGs (Appukuttan et al., 2003)[19]. As in the case of seaweed farming in Tamil Nadu, low-cost interventions, done closer to the shoreline provide additional opportunities for low-income women fishworkers to organise and participate in supplementary income generating activities. At present, over 150 SHGs and nearly 1000 individual farmers practise mussel farming in the Padanna backwaters of Kasaragod (Shinoj et al 2021)[20]. There is also a strong demand for mussels in northern Kerala, and this **year-round domestic market** has significantly contributed to the thriving mussel farming industry in the region.

Technical and financial support systems for mussel culture

Along with the unique hydrological and climatic conditions and domestic demand, the success of Mussel culture has been attributed to the development of a **key technical, financial and institutional support systems,** these include **research institutes** such as Central institute of Marine Fisheries Technologies (CMFRI), financial support from **cooperative banks** and **development agencies** (including Agency for the Development of Aquaculture (ADAK), Brackish Water Fish Farmers Development Agency (BFFDA), MATSYAFED). Additionally, support by the National Bank for Agriculture and Rural Development (NABARD) for bank refinancing, has further enabled local cooperative banks such as the North Malabar Gramin Bank (NMGB) and **village panchayats** to offer loans to SHGs for increasing technology adoption. The relative success of mussel culture shows how technological transfers cannot be a shortcut to commercial viability, but needs a supportive ecosystem of community and administrative institutions that can sustain the activity.

Boom-and-bust - Challenges and risks to culturing technologies

Mussel farming faced a significant setback in Kerala from 2009 to 2015, with **production plummeting to 533 tonnes in 2016 from an all-time peak 18,400 tonnes in 2008.** This decline in production was primarily attributed to the widespread presence of the protozoan parasite *Perkinsus olseni*, which caused extensive mass mortality of mussels. The major contributing factor to the decline was identified to be the excessive concentration of farms within a limited area. This dense clustering resulted in inadequate flushing of waste within the farms, ultimately leading to eutrophication and a subsequent waning in water quality. This deteriorating environment further exacerbated mortality rates.

Overall, among the challenges identified in this period included the **overabundance of farms per unit area**, hindered water circulation, scarcity of good quality mussel seed, elevated temperatures and salinity levels, prevalence of parasitic infestations and to a lesser extent, presence of predators like crabs and lobsters, damage/loss of farm or crop in unexpected bad weather and ultimately, social issues over intersectoral conflict with fishers, credit and insurance. In close consultations with the mussel farmers, broad guidelines have now been developed towards promoting sustainable mussel farming methods through adopting better co-management practices. [17]

Farming guidelines for Mussels

[17](Mohamed *et al*. 2019) Guidance for Good Mussel Farming Practices in India based on a Case study from Kerala http://eprints.cmfri.org.in/13950/

Ideal site: Calm coastal sea waters and sheltered bays free from strong waves, or estuarine systems with moderate water current and free from pollution.

Water quality: Clear water with high primary production, free of silt and pollutants, salinity 25 - 35 ppt, temperature 26 - 32°C.

Seed: Wild caught seeds of 1.5 – 2.5 cm size are ideal for farming. Mussel seeds are wrapped around 1m long ropes with biodegradable cloth.

Rack culture: Suitable for shallow areas of protected bay, lagoon and estuaries with good flow rate. Seeded ropes are suspended on racks made of bamboo and casuarina poles. Horizontal ropes are tied on the racks where water depth is low (1m).

Longline culture: Used in unprotected open seas, seeded ropes are suspended on a long line stretched across a certain distance and anchored at either end.

Raft culture: Suited for calm open seas where seeded ropes can be suspended from a raft in nearshore waters.

Culture period: Post-monsoon period of November to May is the culture period in SW coast of India. Mussel attains a marketable size of 6-8 cm in six to seven months and are harvested prior to the onset of monsoon.

Domestic Markets

Mussel has a strong domestic market in northern Kerala. However, challenges arise when **extensive harvesting is necessary before the monsoon**, potentially leading to marketing issues. These can be potentially addressed by assessing demand in neighbouring states, creating value-added products and exploring the demand as nutraceuticals. Cultivating them in clean water and thorough post-harvest depuration to eliminate harmful particles can enhance export potential.

Despite the presence of natural mussel beds along the east coast, the consumption of mussels in this region remains relatively low and is largely subsistence based. To enhance the popularity of mussel culture, there is a need to promote consumption of both fresh and value-added products derived from mussels in the eastern coastal areas.

Socio-Economics of Mussel Farming

Cost Description	Kasargod (per ha)	Kozhikode (per ha)	Mallapuram (per ha)
Fixed Costs (Bamboo, rope, shed. etc)	12,60,000	5,85,000	5,08,500

Operating Costs (Labour, seed, implements)	19,89,000	8,23,500	8,37,000
Total Costs	32,49,000	14,08,500	13,45,500
Annual yield (tonnes/ha)	620	260	290
Sales price (per tonne)	8000	9450	9900
Gross Income	49,60,000	24,57,000	28,71,000
Annual Profit	17,11,000	10,48,500	15,25,500
Return on Investment (Profit/Total Cost)%	52%	74%	113%

Source: Kripa, et.al, (2008)[18]

Pearl Oyster Farming in India

The Indian natural pearl fishery of *Pinctada fucata*, **known to exist from 1663** under the trade name **'Oriental pearls'**, had superior quality and high value in international markets (Silas, 2003). Six species of pearl oysters occur in the Indian waters of which (*P. fucata*) alone has contributed to the pearl fisheries in the Gulf of Mannar and Gulf of Kutch. The black-lip pearl oyster (*P. margaritifera*) is confined mostly to Andaman waters. From Lakshadweep, settlements of spat of *P. fucata* and *P. margaritifera* have been found on the ridges of rocks and corals. (Alagarswami et al, 1987) **Declining natural pearl stocks however led to the closure of pearl fishery in the Gulf of Mannar (GoM) and Gulf of Kutch (GoK) in 1963 and 1967**, respectively.

Subsequently, CMFRI initiated its efforts to develop cultured pearls. It succeeded in producing cultured pearls in-vivo in 1973 (Alagarswami, 1974) and pioneered the development of commercially viable pearl culture technologies from 1973 to 1978 (Silas, 2003). Following this,

[18] Kripa, V. and Mohamed, K.S. (2008) 'Green mussel, perna viridis, farming in Kerala, India – technology diffusion process and socioeconomic impacts', Journal of the World Aquaculture Society, 39(5), pp. 612–624. doi:10.1111/j.1749-7345.2008.00191.x.

CMFRI also developed hatchery technologies for large scale seed production of *P. fucata* in 1981 (CMFRI Bulletin 39; Silas 2003; Jagadis, 2015). Additionally, training courses were developed for wider adoption of pearl oyster farming.

Government, private, and joint ventures in Tamil Nadu and Andhra Pradesh participated in technology transfer programmes, although sustained pearl production faced challenges. Fisherfolk in Veppalodai, Thoothukudi district, and Mundalmunai, Mandapam, engaged in pearl culture with CMFRI's guidance and were reported to produce commercial-grade pearls (Victor and Jagadis, 2007). Between 1997 and 2003, CMFRI reaffirmed the effectiveness of the pearl culture technology at its Mandapam Regional Centre. By the project's conclusion, the institute had managed to reimburse 45.5% of the project expenses through the sales of pearls and mother oysters (Jagadis, 2015). Subsequently, from 2009 to 2011, the institute conducted another round of training programmes in marine pearl culture among fishers at Sippikulam Village in Thoothukudi (Tamil Nadu), Kollam (Kerala), and Kalpeni (Lakshadweep Islands) (Jagadis et al., 2018).

Many of these training initiatives yielded significant pearl production. However, due to the **lack of sustained funding for Self-Help Groups (SHGs) and farmers, and challenges in sourcing and maintaining regular stocks of oysters, these programs could not be continued beyond their respective project periods.** That said, the availability of oysters, viable technologies for spat production, cultivation of mother oysters, and pearl production from *P. fucata*, along with reasonable success rates in producing commercial-grade pearls (ranging from 4.3% to 7.7%) by trained fishers (Jagadis et al, 2015), are encouraging factors that might be supported with greater institutional resources and support.

VI. Mariculture - Cage culture of finfish

Introduction

Cage culture was first initiated in India with the rearing of Asian sea bass in cages in the mid-2000s. Since then, CIBA and CMFRI have been the key institutions standardising breeding techniques for various species. While at present, CMFRI has identified close to 76 species for mariculture, few breeding technologies have moved beyond the farm-level demonstrations stage. At present, both open sea cage culture and coastal cage farming have been demonstrated to be economically viable with **close to 1500 cages installed in inshore and brackish areas**, producing around 1500 tonnes of fish (NFDB, 2018)[19]. Species including the Asian sea bass, Silver pompano, Indian pompano, mullets, milkfish, pearl spot, and Genetically Improved Farmed Tilapia (GIFT) have been cultured in near shore cages. For finfish cage culture, CMFRI has developed two different kinds of fabrications – cages made from Galvanised Iron (GI) and High Density Polyethylene (HDPE) cages. While HDPE cages are preferred for rough sea conditions, GI cages are preferred for coastal waters.

While the size of a cage can vary, farms are usually set up with several cage units and placed next to each other to ensure uninterrupted flow of water between the cages. The standard size of a cage is 6m (length) x 4m (width) x 4m (height) and a farm comprises 6, 12 or 24 such cages. These cages are generally set up in deep waters as fishing is easier in shallow waters and do not require cages or external feed inputs. As per government's guidelines "The reservoir should have at least 10 metres of mean depth and the cage site needs a water depth of at least 10 metres round the year. A clearance of 6 metres will always be needed from the cage bottom to the floor of the water body".

a. GI cages in brackish water and **b. HDPE cages in the Open Sea**

[19] Guidelines for sea cage farming in India. Available at: https://nfdb.gov.in/PDF/DOWNLOADS/Guidelines%20for%20Sea%20Cage%20Farming%20in%20India%20-%20January%202018.pdf (Accessed: 09 March 2024).

The main benefits of GI cage aquaculture is the low initial investment and low requirement of labour, making it a viable source of additional income in coastal households. Moreover, it can be done in many other water bodies such as rivers, estuaries and lakes, which are often present in coastal areas. This kind of aquaculture also yields good profits especially vis a vis the investment put into it. It also causes no pollution to the water source and keeps the waters ecologically healthy and safe.

Challenges and constraints to cage culture

Among the constraints facing the sector at present are the **insufficiently developed supply chains, particularly for seeds, high costs of high quality feed, poaching and outbreaks of diseases**. At present, seeds are sourced from select state-run hatcheries and commercial scale hatchery operations are available only for sea bass and cobia, with a limited number of seeds per year. The lack of adequate insurance programmes will also affect the amount of risk that can be taken by small scale fish farmers. Cages can also be affected by turbulent waters and extreme weather events such as cyclones. Additionally, improper use of fish feed is another cause for concern as it might lead to pollution and might cause imbalances to the local ecology.

Voices from the waters - Cage culture in Thaneer Ootru

“

[...] CMFRI introduced cage culture in Thanneer Ootru among all the islands here and I was given the opportunity to be incharge of monitoring the growth of those fishes. They asked me to provide the feed once a day which wasn't sufficient as they seemed to require feed at least thrice a day. Feed comprises trash fish and sardines. is the species in those cages and I was paid a salary of five thousand to undertake this activity. Due to this lack of feed, the fish started to die gradually. I informed the director of this program in CMFRI of the same. **When he came to look at the situation he blamed me for harvesting and selling the fish!** The allegation was baseless as those fish were juvenile and did not have any significant economic value. Others in the team that I had a longer relationship with vouched for my credibility. Eventually, they took back the fish that were left in the cage. Koduva (Seabass) and Kadal viraal (Cobia) are the major species that were put in the cage.

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Government support for cage culture

Recognising the relative stagnation of marine fish catch, relative to the increase in catch per unit effort (CPUE), both the central government through its PMMSY scheme as well as the state governments support cage culture as a viable alternative. However, compared to marine culture systems, inland culture has been more successful and has received the larger share of the state's support. The **Mission Cage Culture (2022)**[20] action plan for example identifies only small-scale inland water culture of species such as pangasius, GIFT tilapia to be economically viable and does not mention sea cage or brackish water cage culture even once.

However, the central scheme **Start Open Sea Cage Culture** provides Fishermen Cooperative Societies, SC/ST Cooperative Societies, Women Self Help Groups as well as Registered Companies of Private Entrepreneurs central assistance for 4 batteries of 5 cages each (20 cages) at a subsidy of up to INR 5,00,000. 40% of the total cost is subsidised for general category fishers and 60% of the total cost is subsidised for SC/ST or Women Cooperative Fishers. Other cage culture schemes supported by state and central governments are for inland or reservoir fishing. In addition to support provided by the state governments, fishers in Tamil Nadu and Kerala have reported **technical and financial support provided by CMFRI**. As per reports from the fishers, once the initial support was withdrawn, most operations were discontinued beyond the pilot and demonstration cycle.

Socio-economics of cage culture

The cage production system consists of a floating structure, net materials and mooring system with round or square shaped net cage to hold and grow fishes. The capital cost component includes investment in cage frame, nets, accessories, mooring, and installation charges. The major operational cost components include costs of feed (which account for 50-75% of total operational costs), seed (ranging from Rs 20-50 per seed depending on the species), labour charges for feeding and harvesting and maintenance costs for cage frame and accessories.

Cost Description (per cage)	Amt.
Fixed Costs (Cage, nets)	8,00,000
Operating Costs (Labour, Asian sea bass seed, feed,implements)	20,38,000
Total Costs	28,38,000

[20] Mission Cage Culture. NFDB Available at: https://nfdb.gov.in/PDF/E%20Publications/7%20Mission%20Cage%20Culture%202017.pdf (Accessed: 09 March 2024).

Gross Income	33,44,000
Annual Profit	5,06,000
Return on Investment (Profit/TotalCosts)%	17.83%

Source: CMFRI (2022)

VII. Fish Waste–based microenterprises

Introduction

Fish waste from households and fish markets and shellfish waste from crab and prawn processing units provide significant opportunities for producing fertilisers, feeds and high-value products such as chitin-chitosan. The aim of these enterprises is both mitigating waste and instituting better solid waste management as well as ensuring a shift towards circular economies where all components of the seafood industry, including waste, finds adequate value and utilisation. **Fish amino acids and Fish fertilisers** are two relatively successful income-generating activities that have been supported by the existing ecosystem of research and extension institutes.

We interviewed micro-entrepreneurs supported by KVKs and CMFRI who are now running their operations independently and inquired about some of their successes and challenges.

Crab waste being dried and packed into bags to be used as poultry feed, Ramnad

Kerala SHG Fish Amino Acid

Initially, the enterprise was started by a group of women who called themselves the **KVKS group.** However, after the group has disbanded due to a loss of interest, the activity is carried out individually as a micro-enterprise. Mary has been engaged in producing Fish Amino Acid for around four to five years, of which the initial two years were as a part of the group. Production can be done together, however, the other group members were not interested to continue group operations.

In the initial years, when the group was involved in the production, Oil Sardines were bought from the market, cut into small pieces, mixed with jaggery in sequential layers in an airtight container. With intermittent stirring, it has to be left for 40 days. If the sardines are fresh, it takes less time. As the sales were good initially, they increased production from 5 kilos to 30 kilos.

The group received their initial training from the local **Krishi Vigyan Kendra (KVK), CMFRI and additional trainings were facilitated by the NGO Atma**. In all these trainings, the group received only technical support, **financial support and marketing support was not provided**. Given the expenses, the group didn't initiate production after the first training, but **only after three training sessions, they felt confident enough to purchase the required amount of jaggery and sardines.** After the success of a small pilot, they felt confident to process larger quantities, close to 30 kilos of fish waste and jaggery. The 10 members of the group added a thousand Rs. each and the profits were equally divided.

Once the group became dormant however, the quantities processed were also reduced. Rather than purchasing oil sardine waste, she now preferred to use household fish waste and waste Fish waste was procured from nearby hotels, (approximately 1 kg fish waste added to 1 kg jaggery, yielding around 1.5 litres amino acid) sold in 100 ml or 50 ml bottles.

For selling her goods, she relies on **door to door sales, SHG exhibitions, as well as 'Farm Schools' organised by Krishi Bhavan**. The farm schools act as a point of sales for organic agricultural products including fish amino, panchadravyam, among others. The sales would be facilitated by Krishi Bhavan. Additionally, the NGO Atma would put Fish Amino Acid SHGs in touch with new farmers. Each 100ml bottle sells for around Rs. 80. Earlier, they used to engage in processing once a month but after the number of units producing amino acid has increased, competition has increased and sales have decreased. **Plus as the shelf life of the product is long, there is limited scope for wastage.**

At present, she produces close to 50 bottles per month, which are sold at exhibitions as well as individual households engaged in gardening. As her caregiving duties in the house have increased she had to further reduce the scale of operations and venture into the sale of handmade pillow covers and other small textile commodities as well.

According to her, even prior to financial or technical support, what was most needed was marketing related linkages and support. As her family owns an autorickshaw, her transport costs are low. However, **she reports that the transport costs cannot be offset solely by the sales of Fish Amino acid and sales from other small commodities were also needed to make profits**. She also reported the rising input cost as a significant challenge. A kilo sardines which sold for 100 Rs. when they began operations, now costs close to 200 Rs.

However she prefers the activity as she's able to work from home, and can do it along with her other household tasks. Even if 50 bottles are sold per month, it is a good income stream. Additionally, as the produce doesn't get spoilt, there are no losses as such. In terms of advice to other micro-entrepreneurs, she hopes that she would have started selling her goods at the same place in the local market so that she could have help develop a steady

customer base over time.

Fish meal pellets produced from fish waste at CIFT, Kochi

Ivy's Agrohub Munambam - Fish Fertiliser Micro-enterprise

Ivy Jose is an individual micro entrepreneur and produces Fish Fertiliser under the name 'Ivy's Agrohub, Munambam'. Prior to initiating fish fertiliser production, she has participated in several projects relating to fish farming as well as fish vending. On Fish Fertiliser production, she participated in several training programs covered by the SC/ST funds. Initially, the training at the local **Krishi Vigyan Kendra** was given to a group of four SC/ST women from Munambam. The group disbanded prior to taking up any activities.

She reported that **subsidies for trainings as well as financial support was given initially**. The support was not monetary, but assets needed for the production of fish fertiliser, including buckets and covers, scoops, nets, etc. were distributed. After having acquired the training as well as the production assets, she began production in a shed adjoining the house and has now been successfully doing it for 2 years.

No support was given to make the shed, which came up to around INR 20,000. For the production, fish waste is mixed with coco peat purchased at 14 Rs/kg. Fish waste is purchased at around 10-12 Rs./kg. While fish waste from the market can be occasionally free when the quantities are less, she has to purchase small fish as raw material. Other variable costs include transportation and labour charges for packing the fertiliser into bags. Plastic covers used for packaging are also bought from Coimbatore. Packaging materials were purchased from Tamil Nadu via KVK as purchasing packaging material from Kerala was expensive. She employs migrant workers who are paid around 1000-1500 Rs. for a day's work. Overall production costs including packing takes the cost price up to around 40 Rs/kg. She sells the fertiliser for 50 Rs/Kg locally and online sales are for 60 Rs/kg with additional courier charges.

This is a time bound process as blow flies might lay eggs and the waste might start stinking. If well preserved the fertiliser can last for up to a year. Packing is done exactly 60 days after the mixing of waste and coco peat. She produces around 10 kgs fertiliser at a time. Around 300 kg fish waste and 100 kg coco peat is needed as inputs for this quantity. For certain larger orders, she has taken loans using gold as collateral.

For promoting sales, KVK and CMFRI advertise products in newspapers and increasingly, she sells them online as well in bigger cities. CMFRI also purchases some of the produce.

Among the main challenges for the enterprise were **blow flies, the stink and marketing of the fertilisers.** Another issue was that the **fertiliser produced only with fish waste did not have sufficient amount of NPK**, so goat urine, or cow dung, had to be added. She had to test it in a lab individually as **KVKs do not issue certificates for the NPK content of the fertiliser**. In terms of technical assistance, she feels **her enterprise would benefit from identifying means by which NPK levels can be made appropriate.**

She feels that her fertiliser are optimal for terrace gardening and for fruiting plants, including bananas, papaya, and vegetables, but given the lower levels of NPK, they might not be suitable for large farms. Overall she reported her business to be profitable and her customers growing.

Value chain analysis of finfish/shellfish waste generated from domestic fish markets and commercial export companies in Ramanathapuram

A rapid assessment of fish waste management practices in fish markets and commercial exporting companies was undertaken in Ramanathapuram district to scope the feasibility of interventions based on improved waste utilisation. The assessment also aimed to identify if any of the study sites, especially in exporting companies or fish waste processing units, have existing value chains producing Chitin-Chitosan. Many fish markets practise dumping of fish waste, leading to issues related to solid waste management. Eight different areas of Ramanathapuram district were selected for the study which are Rameshwaram, Pamban, Mandapam, Ramnad, Devipattinam, Thiruppalaikudi, Soliyakudi and Thondi. The study was based on exploratory field visits to different fish markets, and seafood export companies. The data was collected from fishers and key informants using a checklist.

It was found that fish-waste management practices in most large markets around Ramanathapuram were similar, as a large share of the fish waste is diverted either towards **poultry feed, pet feed, or for use as fertiliser for plantations.** Some markets such as Mandapam fish market, Ramnad fish market, and Thondi market, also practise **dumping waste in bins**. Among these three fish markets, **Thondi generates over 100 kg of fish waste, while the other two markets generate around 20-30 kg of waste**. The purpose of the assessment is to determine whether interventions can help improve fish waste management practices. Successful modes such as those facilitated by ICAR- CIBA in collaboration with the Nambikkai SHGs in Chennai are also referred to. The waste management unit in Chennai is now producing two relatively successful value-added products (called Planktonplus and Hortiplus) from around 160 kg of fish waste. These products are used in the aquaculture and horticulture sectors.

Fish waste generated and its management in Ramnad

Fish market	No.of retail shops	Daily seafood inflow (kgs.)	Shellfish waste (kgs.)	Finfish waste (kgs.)	Total Waste (kgs.)	Fish Waste management
Rameshwaram	28	400	10-20	80-100	**~90 - 120**	Collected for Fish waste fertilisers

Mandapam	10	200	0-5	30	**~35**	Dumped in the bin-. Disposed by the municipality
Devipattinam	19	1000	60	10	**~70**	Collected for Fish waste fertilisers
Thiruppalaikudi	5	20	0	0	**~0**	-
Ramnad town	40	500	80-85	15-20	**~95 - 115**	Dumped in the bin-. Disposed by the municipality
Ramnad small fish market	7	200	15-20	0	**~20**	Dumped in the bin-. Disposed by the municipality
Thondi	30	1000	90	10	**~100**	Dumped in the bin-. Disposed by the municipality

Fish retail shops in Thondi and Rameshwaram

Conclusion

This document is a compilation of the primary and secondary research and interactions of the livelihoods team with small-scale fishworkers, micro-entrepreneurs and SHGs in Tamil Nadu, Kerala and Odisha. While the information is far from complete, this report attempts to bring together socio-economic research and diversification strategies particularly for dry fish, mariculture and fish waste based microenterprises aimed at supporting marginalised fishworkers and at inclusive economic development. We hope this report will be of use to students, researchers and practitioners working within the sector. We thank all researchers, practitioners, micro-entrepreneurs and fishworkers who participated and contributed their time to this project.