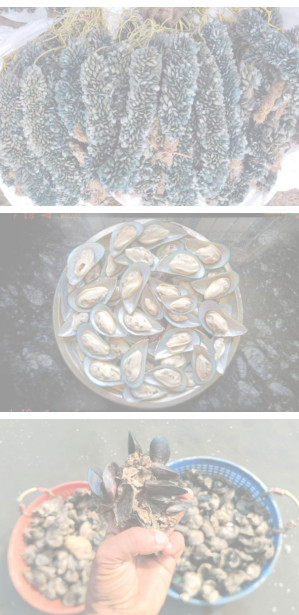




A Case for Green Mussels (*Perna viridis*) Cultivation as a High-Value Crop for Economic Upliftment of Marginal Fisherwomen

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1. Introduction

Fisheries and aquaculture provide food for billions of people, thereby playing a key role in global food security. This sector plays a significant role in the local economy and cultural life of coastal communities across the globe. Fish and fishery products are among the most widely traded food items. In 2021, they provided 15 per cent of total animal protein and six per cent of all protein consumed globally and accounted for at least 20 per cent of the protein per person on an average intake from all animal sources for 3.2 billion people (or 40% of the global population) (FAO, 2022). In developing countries, fisheries are a particularly important source of food, thanks to their relative affordability, availability, and accessibility for poor communities, and the same is true in the case of India.

India is the third largest fish-producing country and also the second largest aquaculture fish producer globally. About seven per cent of the global fish production is contributed by Indian fisheries. Fisheries, in the rural coastal economy, form an important component by generating income, employment, livelihoods, and food security for an estimated 3.52 million people all along the 8,118 km of Indian coastline spread across eight coastal states and two UTs of the country. From the income perspective, the fishery sector has significant importance in India, as it supports the livelihoods of about 28 million fishers, directly or indirectly. Fisheries play a significant role in generating farmers' income, particularly among the landless, small, marginal farmers, and women, besides providing cheap and nutritious food to millions of people. In India's agricultural export basket, fish and fish products have emerged as the largest group, with 1.377 million tonnes in terms of quantity and ₹ 45,107 crore in value. This accounts for about ten per cent of the total exports and about twenty per cent of the agricultural exports, and contributes to about 0.91 per cent of the GDP and 5.23 per cent to the Agricultural Gross Value Added (GVA) of the country. For India, the Blue Economy of Oceans provides a livelihood support base for about one million active fishermen. Hence, it is imperative to ensure that the ocean remains healthy

and experiences no deterioration; however, enormous challenges - pollution, climate change, loss of habitat and biodiversity, and resource exploitation - threaten this delicate ecosystem (Allison et al., 2020).

One of the basic requirements to ensure healthy coastal waters is to protect them from pollution. Data from a program on Coastal Ocean Monitoring and Prediction Systems (COMAPS) has been operated since 1991 by the Department of Ocean Development in tandem with the Ministry of Environment and Forests, indicating that effluents from municipal and industrial sources, aquaculture effluent, ports & harbours, fisheries harbours, fish processing units, salt pans, tourist hotels/resorts / beaches, and municipal solid waste dumping are some of the major sources of coastal pollution. However, municipal sewage is the main single source of pollution from land-based activities to the coastal water. There are about 120 Class I cities and Class II towns in the coastal area, and they generate about 6835 Million Litres per day (MLD) of wastewater, out of which only 1492 MLD receives various levels of treatment. The remaining quantity is being discharged into coastal waters without any kind of treatment (CPCB 2018). Moreover, on the west coast of India, the size of the coastal plains is significantly smaller than on the east coast, which presents another challenge in developing infrastructure for treating municipal sewage. With the increasing population in Tier I and II towns, the untreated sewage appears to have become a major concern affecting coastal water quality, and it is imperative to explore and encourage Nature-based Solutions (NbS) to ensure coastal water quality for sustainable coastal fisheries.

Green mussels are a popular seafood delicacy enjoyed by people around the world and an important global commodity. Mussels are important as a human food source, can be turned into a valuable omega-3 extract or an ingredient in fish feed, and are also used in animal feed. The green mussel is an excellent source of protein, fat, and carbohydrates (Chakraborty et al., 2016), making it a popular source of food for local communities, requires no supplemental food input, grows to harvestable size in about six months,

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and is particularly promising as a sustainable seafood product on erosion-sensitive mangrove coasts as well (Litasari, 2002). Furthermore, mussel cultivation, unlike shrimp cultivation, does not require highly sophisticated techniques, knowledge, or equipment, which makes it particularly suitable for use in small-scale artisanal settings (bin Sallih, 2005, Lymer et al., 2010, Lovatelli, 1988, Noor et al., 2019). Beyond its function as a food source, green mussels act as natural filters and reduce eutrophication – the excessive richness of nutrients that leads to algal blooms and oxygen depletion. Additionally, mussel shells are made of calcium carbonate, a form of stored carbon. While they do not match forests in carbon capture, large-scale mollusk farming can play a minor role in absorbing atmospheric carbon dioxide. In addition, mussel farms become microhabitats for juvenile fish, crabs, and other invertebrates, thus enhancing biodiversity in coastal areas, which are alarmingly degraded by human activities.

On the other hand, the Government of India has extended the Kisan Credit Card scheme (KCC) to fisheries to encourage the industry. Under the KCC scheme, fishers can receive loans at a subsidized rate of interest of seven per cent. To encourage this, an up-front interest subvention (IS) of two per cent is provided to the financial institutions. Additionally, farmers who pay back loans on time receive a three per cent additional Prompt Repayment Incentive (PRI), thus effectively bringing the interest rate to four per cent only. Collateral free loan limit for KCC fisheries is ₹ 1.60 lakh.

1.1 Objectives: These interrelated aspects centered around green mussels have encouraged this policy brief with three major objectives, viz., i) Explore the viability of green mussel farming as nature-based solutions, ii) its contribution to the economic upliftment of the marginalized fishing community, and iii) impact and extending the benefits of the Kisan Credit Card Scheme (KCC) to green mussel farmers.

1.2 Methodology: Udupi district has the highest number of green mussel farmers, and therefore, this district was selected for detailed study. To study the impact of the KCC, 25 beneficiaries and 5 non-beneficiaries were randomly selected for detailed interaction with a structured questionnaire.

2. Findings

2.1 Demographic Profile of Respondents: All the respondents are females belonging to the age group of 30 to 50 years and are married. They are all rural-based and belong to the Other Backward Caste (OBC). Regarding educational qualifications, about 35 per cent were illiterate, about 55 per cent had attended up to primary education, and only ten per cent had gone up to high school level. Referring to the nature of family, nuclear families were in the majority at 55 per cent in the beneficiary group, while it was about 70 per cent in the non-beneficiary group. Joint families constituted about 45 per cent in the beneficiary group and 30 per cent in the non-beneficiary group, respectively. Regarding the size of the family, the maximum households in the beneficiary group belonged to a medium size (4 to 6 members), contributing to about 77 per cent, while they constituted about 55 per cent in the non-beneficiary category. There were no large families with seven members or more. All respondent families were categorized as Below Poverty Line (BPL) households.

2.2 Household Practices: Liquefied Petroleum Gas (LPG) was found to be used by the maximum number of respondents. It was about 98 and 85 per cent in the beneficiary and non-beneficiary groups, respectively. However, firewood was also used for cooking in the non-beneficiary group to the extent of 15 per cent. Regarding the sanitary system, open defecation was totally absent among the respondents. A proper sanitary system was installed in about 87 per cent of the beneficiaries' houses. Regarding medical services, the government hospital was commonly used by both the beneficiary and non-beneficiary groups. The tube well was the primary source for drinking water. Being a high rainfall region, open wells were also used for potable water collection. 13 and 20 per cent of beneficiary and non-beneficiary members used this source, respectively. The two-wheeler mode of transportation was predominant, with about 79 and 60 per cent in the beneficiary and non-beneficiary groups, respectively. After two-wheelers, public transportation was found to cater to the transportation requirements at about 35 and 60 per cent in the beneficiary and non-beneficiary groups, respectively. It was found that about 88 and 80 per cent of beneficiary and non-beneficiary group members used smartphones to cater to their communication needs. Only about 12 to 15 per cent members of the beneficiary and non-beneficiary groups were using basic phones. None of the respondents owned agricultural land.

2.3 Household Income: Primary respondents for the survey were green mussel cultivators, and for them, involvement in cultivation was a part-time job from about Nov- Dec to April-May. During this period, for a few days, specifically during the erection of the pole-rope structure and seeding, it was full-time. Again, during the harvest, a few days were spent. For the rest of the year, these women had other occupations, ranging from work at the fishing harbour or as wage labourers in agricultural fields. Thus, the household income response includes the total income at the household level from all working members (Table 1).

Table 1: Household Income (In ₹)

	Beneficiary	Non-Beneficiary
Income from Main Occupation		
Small Families (0-3 members)	4,34,374	3,84,285
Income for Subsidiary Occupation		
Small Families (0-3 members)	1,07,500	1,12,000
Medium Families (4-6 members)	1,34,545	20,56,000
Large Families (7 & above)	1,38,000	-
Overall Income	1,26,681	10,84,000

Source: Primary Data.

3. Impact of Kisan Credit Card Scheme (KCC)

Most of the green mussel cultivators are marginal fisherwomen. To procure seeds, poles, ropes, and to meet other working capital requirements, they used to take loans from societies at 18 per cent interest. With the KCC extension to fisheries and with an easy loan process at just seven per cent interest, these farmers have greatly benefited.

3.1 Utilisation Pattern of the Loan: It was found during the primary survey that about 82 per cent loan amount sanctioned was used primarily for green mussel cultivation, and only 18 per cent had been used for other purposes (Table 2).

Table 2: Loan Utilisation Pattern

Amount Utilized for the purpose for which it was sanctioned		Utilized for a purpose not related to the trade		Total amount of Loan sanctioned	
Amount (in ₹)	%	Amount (in ₹)	%	Amount (in ₹)	%
1,30,000	82	30,000	18	1,60,000	100

Source: Primary Data.

3.2 Costs of Cultivation: To estimate the overall cost of mussel cultivation, details of expenses were collected from both beneficiary and non-beneficiary growers and shown in Table 2. For both categories, the maximum expenses were incurred for the procurement of seeds from Kerala. The seeds cost about ₹1,18,800/- on average for beneficiary farmers. It also included the transportation of seeds from Kerala to the place of cultivation. For non-beneficiary farmers, the cost of seeds was about ₹1,50,000/-. The variation in the cost of seeds depended on the time of purchase, the distance from the place of cultivation, and the demand for the seeds on that particular day of purchase. Labor costs (both own and hired) were another item that had a high cost for mussel growers. For the beneficiary growers, it was ₹ 76,333/- while it was ₹1,00,000/ for the others. All other costs were lower in comparison. There was no significant difference between the costs of cultivating mussels between beneficiary and non-beneficiary groups (Table 3).

3.3 Cost Benefit Ratio: Various details, for instance, the total mussels harvested, rate per unit realized, etc., are given in Table 4 and there were a lot of variations in every aspect. For instance, the total cost of rearing mussels was ₹ 2,15,934 for the beneficiary farmer, while it was higher by about forty thousand for the non-beneficiary farmer at ₹ 2,52,000/-. Similarly, the harvest of mussels was higher for the beneficiary at 26.37 quintals compared to 20.5 quintals of the non-beneficiary cultivator. The beneficiary cultivator produced 26.37 quintals, compared to 20.5 quintals by the non-beneficiary cultivator. On the other hand, the price realized by the beneficiary was only ₹ 11,990/-, much lower than the price realized by the non-beneficiary (₹ 15,750/-). Benefit Cost Ratio of green mussel cultivation indicates that for the beneficiary it was 1.46 while

for the non-beneficiary it was only 1.28. This clearly indicates the positive impact of KCC on these marginal fishermen.

4. Key Findings

Potential for green mussel cultivation: According to the Food and Agriculture Organisation of the United Nations (FAO), in 2018, global production was 2.1 Million Metric Tons (MT), up from 1.8 million MT in 2015. Total value in 2018 reached \$4.5 billion, up from \$3.2 billion in 2015. With the technical support from the Central Marine Fisheries Research Institute (CMFRI) Mangalore, fisherwomen can be encouraged to take up green mussel cultivation in the states of Karnataka and Kerala.

Table 3: Cost of cultivating green mussels for Both Beneficiaries and Non-Beneficiaries

Particulars	Fisheries	
	Beneficiary	Non-beneficiary
	(in ₹)	(in ₹)
Inputs		
A. Current Expenditure		
Labour Cost (own & hired)	76,333	1,00,000
Cost of Fish Seed/Fingerlings	1,18,800	1,50,000
Fish Feed Cost		
Rope	12,476	
Pole	1,875	2,000
Harvesting Charges		
Marketing Cost		
Interest Payment	6,400	
Total Paid Out Cost	2,15,934	2,52,000

Source: Primary Data.

Table 4: Positive Impact of KCC

Details	Beneficiary	Non-beneficiary
Quantity of Fish Harvested (in Quintals)	26.37	20.5
Rate per Unit (Rs/Quintal)	11,990	15,750
Gross Returns	3,16,176.30	3,22,875
Total Cost of Rearing Fish	2,15,934	2,52,000
Net Returns	1,00,242.30	48,475
BCR	1.46	1.28

Source: Primary Data.

Green Mussel as a High-Value Crop: Green mussel culture in backwaters is a low-investment activity and opens up immense potential for resource and employment generation among coastal



Plate 1: Mussels Ready for Harvest



Plate 2: Mussels Ready for Cooking

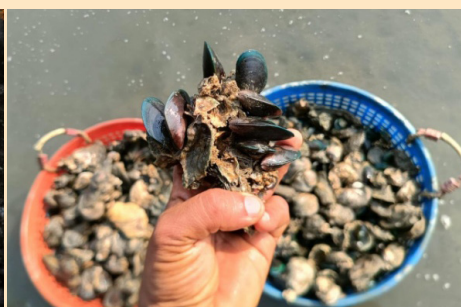


Plate 3: Mussels Damaged Due to High Temperature

communities, especially women and youth. It has the potential for stimulating a healthy socio-economic development. Better post-harvest technologies can develop attractive value-added products. Since there are very good export markets available for mussels, there is further scope for extending green mussel farming to other suitable areas. Significant backwater areas across the states have immense potential for resource and employment generation among coastal communities, especially women living below the poverty line, with proper incentives.

KCC Scheme: Getting timely loans at subsidized interest rates has helped many respondents, and it has a very positive impact on household income. Respondents said that the loan amount could be enhanced. On the other hand, non-beneficiaries said that there should be more awareness campaigns about the scheme.

Lack of Post-Harvest Management: Respondents felt that due to natural conditions, all of them harvest within a few days and thus fail to get remunerative prices in the local market. Green mussels being perishable, they were forced to sell at cheap prices. It was felt that either cold storage facilities or post-harvest processing would enhance their returns.

5. Policy Suggestions

- The major cost incurred by the farmers was for procuring seeds from Kerala and their transportation. The second major cost was for the construction of the pole platform. After the seeds were attached to hanging ropes, the farmers incurred no further expenses. If hatcheries were established locally/regionally by the Central Marine Fisheries Institutes to make seeds available, it would drastically bring down the costs for seed procurement. As a spinoff, this would encourage other fishing families to undertake green mussel cultivation as no other major costs are involved.
- Climatic conditions play a vital role in mussel cultivation, and at times, either due to high temperature or freshwater influx into the backwater system, mass harvests take place, resulting in a consequent glut in the market. Therefore, there is an imperative need for cold storage facilities for this perishable item.
- To safeguard the welfare of these marginal fishers from climatic factors, there is a need for a risk transfer mechanism, such as insurance. For green mussels, parametric insurance is ideal as it offers fishers an insurance plan based on predefined parameters and triggers like salinity and temperature. Such a model is already in implementation in the Restructured Weather-based Crop Insurance Scheme (RWBCIS) promoted by the Central Government for plantation crops, and a similar model can be extended to green mussel cultivation as well. However, for implementing such a model, one limitation could be the monitoring of the predefined parameters and the unwillingness of private insurers.
- Establishing a network of Internet of Things (IoT) connected simple probes in backwaters with mussel cultivation for online

monitoring and an Early Warning System would not only assist fishers in early harvests to avert complete death but also help in insurance claims. The Central Pollution Control Board is mandated to monitor water quality and has already established a network of 4484 monitoring stations, out of which 102 stations are monitoring creeks/seawater. With the latest developments in automatic water quality monitoring technologies, selecting and establishing a few more stations through Fuzzy Modeling is very economical.

- For the initial years, government-owned insurance companies (e.g., General Insurance Company) can provide insurance support until it reaches adequate penetration among green mussel cultivators to attract private insurers.

Implementation of these measures would not only protect the marginal fisherwomen but also enhance their income and contribute to overall rural development.

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