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Mariculture: A sustainable and lucrative alternative for open access fishery

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Abstract

The sustainability of open-access fisheries has been severely impacted by advancements in modern fishing technologies and the violation of institutional regulations. Overexploitation has led to immense pressure on fish stocks and the extinction of numerous species. As a vital source of livelihood for fishermen, open-access fisheries have become unsustainable. Consequently, fishermen need to explore alternative options within the fishing industry to sustain their livelihoods. One such promising alternative is mariculture, specifically the cage culture of fish species. In the Udupi region of Karnataka, the practice of cage culture typically involves two small cages and one large cage. This study evaluates the sustainability and economic feasibility of mariculture. Findings reveal that cultivating sea bass and wild-caught red snappers through mariculture is economically viable. This practice not only supports the livelihoods of fishermen but also alleviates pressure on open-access fishery resources.

Keywords: Mariculture, sustainable fisheries, open-access fishery, cage culture

Introduction

In India, open-access fisheries are the primary source of fish supply, but the growing gap between demand and supply has become a serious concern. To meet the increasing demand, fishermen have adopted indiscriminate fishing practices, often disregarding fish breeding and biological replenishment cycles. The introduction of mechanized fishing boats has further aggravated the overexploitation of natural fish stocks, leading to the extinction of several species. This unsustainable approach threatens the long-term viability of fisheries and the livelihoods of fishing communities. To address these challenges, fishermen must adopt alternative practices that reduce the strain on natural fish stocks while providing economic benefits. Cage culture, also known as mariculture, has emerged as a viable alternative. This study focuses on assessing the profitability and sustainability of mariculture in the Udupi district of Karnataka.

Methodology

Karnataka's coastal regions, particularly the districts of Uttara Kannada, Dakshina Kannada, and Udupi, play a significant role in fisheries. Among these, Uttara Kannada boasts the largest estuarine area with 13 estuaries spanning 4,200 hectares, followed by Udupi with eight estuaries covering 1,885 hectares, and Dakshina Kannada with five estuaries over 1,140 hectares. Cage culture is predominantly practiced in Udupi district, particularly by the young fishermen of the Uppunda region. This community has

pioneered mariculture by forming an informal cooperative group, named after the Sea bass species they rear. The group primarily cultures sea bass and red snapper fish species. Sea bass fingerlings are procured commercially from the Rajiv Gandhi Centre for Aquaculture in Tamil Nadu, while red snapper fingerlings are caught from local estuaries. Fishermen use various cage sizes, with the common setup involving two small and one large cage. This study gathered data from six fishermen practicing mariculture in this system (2S+L). Information was collected on aspects such as initial investment, the number of fingerlings reared, labor required for feeding, harvesting, and cage maintenance, the type and quantity of fish feed, and the use of medicines to address fish diseases.

Results

The 2S+L system allowed fishermen to simultaneously culture both sea bass and red snapper species. Sea bass were initially raised in small cages for six months. After this period, to facilitate further growth and achieve the desired body weight, half of the sea bass population remained in one small cage, while the other half was transferred to the large cage. The second small cage, now vacant, was utilized for red snapper cultivation. Red snappers were reared for a period of 18 months to reach the target body weight. The total capital investment for the two small cages amounted to ₹71,100 (Table 1). Among the components, the cage bag accounted for the largest share of the cost at ₹35,900, followed by the cage frame at ₹19,200. Additional

expenses included ₹8,000 for the floating system, ₹6,000 for labor, and ₹2,000 for the service system. For the large cage, the total investment was ₹54,330, with component-wise costs as follows: ₹14,400 for the cage frame, ₹25,930 for the cage bag, ₹6,000 for the floating system, ₹1,000 for the

service system, and ₹7,000 for labor.

In addition, the common infrastructure required for the 2S+L system, including the mooring system and anchoring system, cost ₹2,500 and ₹3,250, respectively. Overall, the total investment for the entire 2S+L system was ₹1,34,380.

Table 1: Capital investment made on cages

Particulars	Qty	Rate	Value
I. Component wise investment made on two Small cages			
1. Cage frame	16	1200	19200 (14.29)
2. Cage bag			
a) HDP outer mesh			15000 (11.16)
b) Inner mesh (Kg)	20	450	9000(6.70)
c) Hapa cage			10000 (7.44)
d) Nylon ropes (3mm) (Kg)	6	250	1500 (1.12)
e) Rod with plastic (8 mm) (Piece)	24		400 (0.30)
Sub total			35900 (26.72)
3.Floating system			
a) PVC pipes (Length)	6	1000	6000 (4.46)
b) Cans (No.)	8	250	2000 (1.49)
Sub total			8000 (5.95)
4. Service system	2	1000	2000 (1.49)
5. Labour	12	500	6000 (4.46)
Investment on two small cages			71100 (52.91)
II. Large cage			
1. Cage frame	12	1200	14400 (10.72)
2. Cage bag			
a) Outer HDP mesh			11830 (8.80)
b) Inner mesh (Kg)	16	450	7200 (5.36)
c) Hapa cage			5000 (3.72)
d) Nylon ropes (3mm) (Kg)	6	250	1500 (1.12)
e) Rod with plastic (8 mm) (Piece)	24		400 (0.30)
Sub total			25930(19.30)
3. Floating system			
a) PVC pipes (Length)	4	1000	4000 (2.98)
b) Cans (No.)	8	250	2000 (1.49)
Sub total			6000(4.47)
4. Service system	1	1000	1000 (0.74)
5. Labour to prepare cage			7000 (5.21)
Investment made on large cage			54330 (40.43)
III. Common investment made on both the cages			
1. Anchoring arrangements			
a) Rope nets (Kg)	5	250	1250 (0.93)
b) Labour for anchoring arrangement with sand	4	500	2000 (1.49)
2.Mooring system			
a) 14 mm ropes (Kg)	10	250	2500 (1.86)
3. Nylon fishing net or dip net for harvesting (Kg)	4	500	2000 (1.49)
4. Round Scale for weighment	1	1200	1200 (0.89)
Sub total			8950 (6.66)
Total investment			134380

Economics of Mariculture of Sea Bass

The economic analysis of mariculture of sea bass using two small cages and one large cage is summarized in Table 2. The total variable cost for sea bass production was ₹4,86,918.60, accounting for 87.34% of the overall cost. Among variable costs, feed expenses were the highest, amounting to ₹2,80,890 (50.37%). Moist or semi-moist feed, primarily consisting of fish trashes, was utilized, with approximately 18,726 kg of trash fish consumed over 18 months.

Labor was the second-largest expense, costing ₹77,968.75 (13.97%). Mariculture is labor-intensive, requiring 155.9375 mandays to manage tasks such as feeding, cage cleaning, supervision, and harvesting. Feeding, in particular, demands

significant labor, as fish trash needs to be cleaned and chopped before use. The cost of fingerlings was another major component, amounting to ₹75,000 (13.45%).

The interest on working capital, calculated at an annual rate of 12%, totalled ₹52,169.85 (9.35%). Regarding fixed costs, depreciation of cages was the largest expense at ₹55,676.25 (9.98%), followed by the interest on fixed capital at ₹14,850.90 (2.66%).

In total, the cost of producing sea bass was ₹5,57,445.75. After accounting for a 56% mortality rate, the yield was 2,835 kg, with each fish averaging 2.7 kg. Gross returns, based on a market price of ₹430 per kg, totaled ₹12,19,050. The cost per kilogram of fish produced was ₹196.63, while the net return per kilogram was ₹233.37.

Table 2: Economics of mariculture of sea bass

I. Variable cost			
Particulars	Qty	Rate	Value
1) Seed	1875	40	75000(13.45)
2) Feed			
Upto 2 months	1125	15	16875(3.02)
2-6 months	3037.5	15	45562.5(8.17)
6-18 months	14563.5	15	218452.5(39.18)
Sub total			280890
3) Labour			
a) Feeding	135.9375	500	67968.75(12.19)
b) Cleaning of cage		500	6000(1.07)
c) Harvesting	12 8	500	4000(0.71)
Sub total			77968.75
4) Medicine			890(0.16)
5) Interest on working capital @12%			52169.85(9.35)
Total variable cost			486918.6(87.34)
II. Fixed cost			
1) Interest on fixed capital @ 12% for 18 months			14850.90(2.66)
2) Depreciation			55676.25(9.98)
Total fixed cost			70527.15(12.66)
III. Total cost (I+II)			557445.75
IV. Returns			
1) Yield 56% survival& 2.7 Kg/ fish			2835
2) Price per Kg			430
3) Gross returns			1219050
4) Net returns			661604.25
5) Cost per Kg			196.63
6) Net returns per Kg			233.37

Economics of Mariculture of Red Snappers

After six months of culturing sea bass, the unused small cage was repurposed to rear wild-caught red snapper fingerlings. Variable costs accounted for 77.84% of the total expenditure. Among these, feed emerged as the most significant expense, amounting to ₹1,24,541.25 (48.93%), followed by labor costs at ₹52,331.25 (20.57%). Labor activities included catching fingerlings, feeding, supervision, and harvesting.

The interest on working capital was calculated at ₹21,224.70 (8.34%). Fixed costs were primarily driven by

depreciation of the cage, which amounted to ₹47,058.75 (18.49%), and interest on fixed capital, which stood at ₹9,337.50 (3.67%). Overall, the total cost of producing red snappers came to ₹2,54,493.45.

Red snappers exhibited a low mortality rate of 4.35%. After accounting for mortality, the yield was 990 kg, with an average weight of 1.8 kg per fish. Gross returns were estimated at ₹3,76,200, based on a market price of ₹380 per kg. The production cost per kilogram of red snapper was ₹257.06, while the net return per kilogram was ₹122.94 (Table 3) (Ashwathy and Joseph, 2018)^[1].

Table 3: Economics of mariculture of red snappers

I. Variable cost			
Particulars	Qty	Rate	Value
1) Feed			
Upto 2 months	345	15	5175(2.03)
2-6 months	931.5	15	13972.5(5.49)
6-18 months	7026.25	15	105393.75(41.41)
Sub total			124541.25
2) Labour			
a) To catch fingerlings	15	500	7500(2.95)
b) Feeding	87.1875	500	43593.75(17.13)
c) Harvesting	2.475	500	1237.5(0.49)
Sub total			52331.25
3) Interest on working capital			21224.70(8.34)
Total variable cost			198097.20(77.84)
II. Fixed cost			
1) Interest on fixed capital @ 12%			9337.5(3.67)
2) Depreciation			47058.75(18.49)
Total fixed cost			56396.25(22.16)
III. Total cost (I+II)			254493.45
IV. Returns			
1) Yield 95.65% survivability & 1.8 Kg/ fish			990
2) Price per Kg			380
3) Gross returns			376200
4) Net returns			121706.55
5) Cost per Kg			257.06
6) Net returns per Kg			122.94

Conclusion

The economic analysis of mariculture for sea bass and red snappers demonstrated its profitability and contribution to sustainable fishing practices. Mariculture has emerged as a promising alternative to open-access fisheries, particularly during breeding seasons or biological recruitment periods. This method offers a sustainable solution to alleviate the pressure on natural fish stocks while ensuring financial viability for fishermen.

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