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Profitability of shrimp culture in canara brackish water ecosystem

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Abstract
The present study is on the profitability of shrimp culture in the Kanara brackish water ecosystem. The Uttara Kannada, Udupi, and Dakshina Kannada districts were selected purposefully as shrimp farming is practised in these state coastal districts. In each district, 40 farmers from four river backwaters were selected randomly to know the profitability of shrimps in the region. The relevant data collected from primary sources was analysed through descriptive statistics, cost and return analysis. White shrimp is the only species the farmers were rearing in the study area. The cost of production of shrimp per acre in the study area was ₹526791. Out of which, the respective shares of variable and fixed costs were ₹431435 (82%) and ₹95356 (18%), respectively, and this farming was found to be profitable by rupee of investment (B: C) of 2.13. In this study, we inferred that rearing shrimps in the study area is profitable by adopting the scientific method of shrimps farming. Hence, the government has to look upon this sector for the nation's economic development.

Keywords: Shrimp farming, brackish water ecosystem, white shrimp, cost, returns etc

Introduction
India is the second-most populous country in the world. Agriculture, including aquaculture, dominates the Indian economy. It plays a vital role in government plans to reduce poverty and protect natural resources. Considering the increasing health consciousness worldwide, aquaculture products may be considered the safest food of animal origin. In India, fisheries are a well-established sector as far as marine aquaculture is concerned. Fish production has almost reached saturation due to overfishing and increased operational costs. On the other hand, the consumption of fishery products has been increasing rapidly with the exponential growth of the population. This leaves a large gap between production and demand, which suggests exploring alternative sources of fish production. Shrimp farming has emerged as one of the alternative sources of fish production in India. Among the aquaculture industries, brackishwater aquaculture has gained great momentum in India.

In India, three types of aquaculture are commonly practised: Mariculture, freshwater aquaculture and brackishwater aquaculture. Mariculture refers to the growing of aquatic organisms in marine water where the salinity concentration of water is more than 30 per cent. The organisms reared in this environment are marine fish, finfish, shellfish, etc. Freshwater aquaculture refers to rearing aquatic organisms in ponds, lakes, reservoirs, etc., where water salinity is less than 0.5 per cent. The organisms reared under this environment are carp, catla, rohu, magur, prawn, pearl, ornamental fish, etc. Brackish aquaculture is defined as rearing organisms under brake water where salinity concentration is more than 0.5 per cent (freshwater) and less than 30 per cent (marine water). The organisms grown in this condition are shrimps, sea bass, grey mullet, mud crabs, etc.

India is the second largest aquaculture products-producing country globally, accounting for 7.56 per cent of global production. It contributes about 1.24 per cent to the country's Gross Value Added **(**GVA) and over 7.28 per cent to the agricultural GVA. The aquaculture sector has demonstrated an outstanding double-digit average annual growth of 10.87 per cent since 2014

-15, with a record total production of 145 lakh tonnes from 2020-21. In terms of employment, this sector employs around 28 million people who belong primarily to marginalized and vulnerable society groups. (Anon., 2021a) [1]

The brackishwater areas are estuaries, coastlines, backwaters, lagoons and mangroves. About 3.9 million ha of estuaries and 0.5 million ha of coastal mangrove areas are available in the country. The estimated brackishwater area suitable for undertaking shrimps farming in India is around 11.90 million ha, which is spread over nine states and four union territories, out of which 1.23 million ha are already under shrimps farming, which is only 12.96 per cent of the potential area (9.49 million ha). Hence, India has a lot of potential in shrimp farming. (Anon., 2021b) [2]

Shrimp farming is an aquaculture business in a brackish water environment, producing shrimp for human consumption. In India, mainly three types of shrimps are commonly reared and they are tiger shrimps (*Penaeus monodon*), white shrimps (*Litopenaeus vennamei*) and scampi shrimps (*Macrobrachium rosenbergii).* Commercial shrimp farming in India started in the 1900s with tiger and scampi shrimps, while white shrimp production started in 2009. As a result, the aquaculture business grew quickly. The tiger shrimps (*Penaeus monodon*) and white shrimps (*Penaeus vannamei)* are generally considered for farming in India's environment. Apart from these species, other commercially important species such as *Metapenaeus ensis*, *Metapenaeus monocarps*, *Metapenaeus brevicornis*, *Penaeus semisulcatus* and *Penaeus merguiensis* are also potential species that can be grown in India.

Shrimp farming has gained importance in recent years due to increased demand in the international and domestic markets. This sector contributes almost 1.02 per cent of the Gross Domestic Product (GDP) and 5 per cent of the Agricultural GDP of the country. Hence, the present study aims to explore the profitability of shrimp farming, which will help identify the bottlenecks related to shrimp production and implement the policy related to shrimp farming in the study area. Against this backdrop, the present paper attempts to examine the profitability of shrimp culture in the Canara brackish water ecosystem of Karnataka.

Methodology

The study was based on primary data. The primary data were collected through personal interview methods from shrimp farmers using well-structured and pre-tested schedules exclusively designed for the study. For the present study, a multi-stage sampling procedure was adopted. The first stage comprised the selection of districts in the state. Uttara Kannada, Udupi, and Dakshina Kannada were the three districts selected purposively for the study, as shrimp farming is practised in these coastal districts in the state.

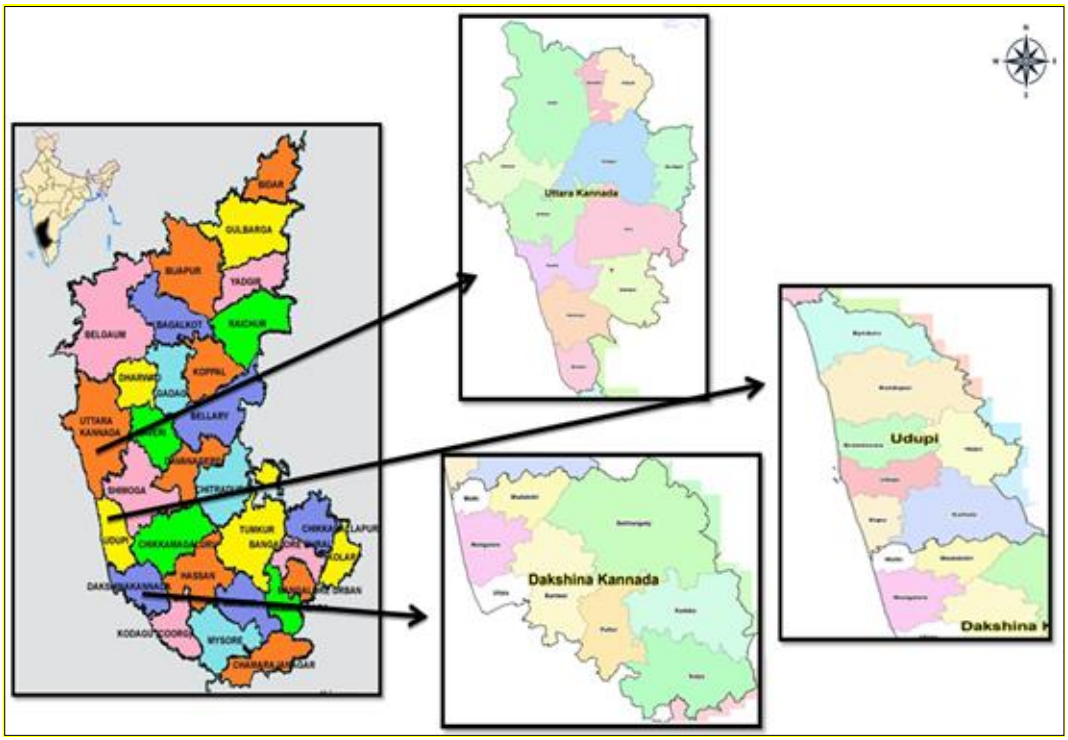

Fig: Map showing the study area

The second stage comprised selecting brackish water areas of the particular districts. In this stage, four major river backwaters were selected from each district to collect primary data. Ten sample respondents were selected from each river backwater. Thus, 40 farmers were selected from each district, and 120 shrimp farmers were selected for the study. Five villages were selected from each river backwater from each village, and two sample respondents were selected (Fig. 2). In the study area, white shrimps were the only species the farmers were rearing. Hence, this present study is mainly about white shrimp farming only.

Analytical tools used

The descriptive statistics, tabular analysis and return per rupees of investment techniques were employed to study the socio-economic characteristics of respondents, production, labour, input management and costs and returns concerning the production management of shrimps in the study area.

Returns per rupee of investment

This ratio is obtained when the gross return is divided by the cost of production.

$$\text{Returns per rupee of investment} = \frac{\text{Gross returns}}{\text{Cost of production}}$$

Results and Discussion

General characteristics of shrimp growing farmer in the study area

Table 1 reveals the general characteristics of shrimp-growing farmers in the study area. The present study covers 40 farmers from each district. The shrimp growers were of middle age group in all the districts. The younger population will have better knowledge about the recent developments in production technologies and be inclined to adopt these technologies. Since they are more agile, aggressive, energetic and capable of making better decisions, the shrimp production process will have more advantages. The involvement of young blood in shrimp production also reflected productivity improvement, as evidenced by the increased growth rate. Of the overall shrimp growing farmers in the study area, around 35.83 per cent of farmers studied up to high school education, 25.00 per cent had completed P.U.C, 21 per cent had completed primary school, 16 per cent completed a degree and above, and the remaining belonged to the no formal education category. This implies that most shrimp farmers in the study area are literate and will find it easy to understand and adopt new technological innovations and production methods and, hence, are likely to be efficient in their production.

The sample respondents of all three districts practising shrimp farming were classified into joint or nuclear family holders to determine the type of family. Most respondents across all three districts had nuclear families (95%). This could have either a positive or negative impact on adoption since a larger family can mean either access to more labour or more burdens on the family.

Table 1: General characteristics of shrimp growing farmers in the study areas

Sl. No.	Particulars	Uttara Kannada (n=40)	Udupi (n=40)	Dakshina Kannada (n=40)	Overall (n=120)
1.	**Average age of farmers (Years)**	39.20	38.23	41.87	39.76
2.	**Type of family (No's)**				
a.	Nuclear family	37 (92.50)	38 (95.00)	39 (97.50)	114 (95.00)
b.	Joint family	03 (7.50)	02 (5.00)	01 (2.50)	06 (5.00)
3.	**Family size (No/household)**				
a.	< 4 members	22 (55.00)	26 (65.00)	23 (57.50)	71 (59.17)
b.	5 - 8 members	15 (37.50)	12 (30.00)	16 (40.00)	43 (35.83)
c.	> 8 members	03 (7.50)	02 (5.00)	01 (2.50)	06 (5.00)
4.	**Education (No's)**				
a.	No formal education	01 (2.50)	01 (2.50)	01 (2.50)	03 (2.50)
b.	Primary school	08 (20.00)	08 (20.00)	09 (22.50)	25 (20.83)
c.	High school	14 (35.00)	13 (32.50)	16 (40.00)	43 (35.84)
d.	P.U.C.	10 (25.00)	11 (27.50)	09 (22.50)	30 (25.00)
e.	Degree and above	07 (17.50)	07 (17.50	05 (12.50)	19 (15.83)
5.	**Main occupation (No's)**				
a.	Aquaculture	32 (80.00)	36 (90.00)	33 (82.50)	101 (84.16)
b.	Business	08 (20.00)	04 (10.00)	07 (17.50)	19 (15.84)
6.	**Average shrimp land holdings (Hectare)**				
a.	Marginal farmers (< 1 Ha)	11 (27.50)	14 (35.00)	13 (32.50)	38 (31.66)
b.	Small farmers (1-2 Ha)	27 (67.50)	25 (63.50)	26 (65.00)	78 (65.00)
c.	Semi-medium farmers (2 - 4 Ha)	02 (5.00)	01 (2.50)	01 (2.50)	04 (3.34)
7.	**Types of shrimps rearing**				
a.	White shrimps	40 (100.00)	40 (100.00)	40 (100.00)	120 (100.00)
8.	**Experience in shrimp farming**				
a.	< 4 years	07 (17.50)	05 (12.50)	07 (17.50)	19 (15.84)
b.	5 – 10 years	28 (70.00)	27 (67.50)	23 (57.50)	78 (65.00)
c.	> 10 years	05 (12.50)	08 (20.00)	10 (25.00)	23 (19.16)

Note: Figures in parentheses indicate percentage to the respective totals.

Most farmers depend on aquaculture because a brackish area is available (80%). Experienced farmers may be more confident than less experienced farmers when facing unpredictable problems in production (65%). The majority of the sample respondents were from the small farmers' category with one to two hectares of land, which may affect the adoption of technology, unable to withstand the losses during production. Hence, they have to go for contract farming and cooperative farming. All the farmers are rearing white shrimps as the main species, mainly due to more productivity and demand in the international market. (Table 2). The results align with the studies by Naik *et al.* (2020) [4], who stated that most of the shrimp farmers belonged to middle age groups and Salunkhe (2018), who reported that a maximum number of shrimp farmers belonged to the nuclear family. Parallel results were observed in the study of Patil *et al.* (2018), in which they reported that a higher percentage of shrimp farmers had farming experience between 6 and 10 years. Mohite (2007) [3] reported that most shrimp farmers had less than two hectares of farm holdings.

Production management in shrimp farming

Fingerlings rate: The selection of disease-free, quality shrimp seed is the foremost requirement for the success of shrimp farming operations. It could be observed from the table that the maximum number of the sampled respondents who practised shrimp farming in the study area used the above recommendation of fingerlings remaining, which directly relates to the cultured shrimps' survival and growth. Stocking density is completely based on the pond's carrying capacity, and the normally recommended stock density of the shrimps is 80,000-1,00,000 per acre for sustainable farming). The advantage of a good quality and specific pathogen-free seed is that it results in a healthy appearance, uniform size, potential for high survival, better growth, and less or no disease usually in the pond. (Central Institute of Brackishwater Aquaculture, Package of Practice. (CIBA, POP)

Type of soil and Source of irrigation

The type of soil is the most critical in site selection. Since the shrimp will spend most of their time at the bottom of the pond during the culture period. In the study area, shrimps are rearing in coastal alluvial soil. These soils are of marine origin and are seen along the coastal plains and basin lands as a narrow strip. Generally, they are alkaline, rich in nutrients such as phosphorous and potassium but deficient in nitrogen and other contents and have good water-holding capacity. Hence, this soil is suitable for the shrimp rearing.

Nutrition management

In the study area, farmers applied manures and fertilisers to the pond as per recommended dosages in anticipation of better quality yields in the culture. All the farmers applied fertilisers in split dose form to the pond because of their efficiency and capital constraints. The respondents usually applied fertilisers as a basal dose during the pond preparation. Proper application of fertilisers such as organic (manures) and non-organic (chemical fertilisers) were necessary to produce phytoplankton in the pond, increasing food availability for shrimp. Farmers would mix the fertilisers with water and spread it all over the pond in a split dose.

Feed management

Shrimp feed comprises formulated ingredients containing essential nutrients such as proteins, fats, carbohydrates, minerals, trace elements, and vitamins. Proper feeding protocols and strict feeding management are essential for successful shrimp farming, and they account for 50-60 per cent of the operational cost. Generally, feed management starts from the 30 days of culture, initially based on assumption, and most of the feed goes as a nutrient for planktons rather than for shrimps, which in turn feed post larvae. The daily feed rations can be offered at three- to four-hour intervals, at least four times. Feeding schedules must be followed. Generally, more feeding is done early morning and late night, mainly due to shrimps being more active during this period. There must be proper monitoring of feed consumption through check tray observations and six hours before harvesting; we should not feed the shrimps because it will affect their shell life. In the case of feed management, a per cent of respondents.

Table 3: Production management aspects of shrimp growers

Sl. No.	Particulars	Uttara Kannada (n=40)	Udupi (n=40)	Dakshina Kannada (n=40)	Over all (n=120)
1.	**Fingerlings rate/ac**				
a.	As per recommendation	18 (45.00)	16 (40.00)	19 (47.50)	53 (44.16)
b.	Above recommendation	22 (55.00)	24 (60.00)	21 (52.50)	67 (55.83)
2.	**Type of Soil**				
a.	Coastal alluvial soil	40 (100.00)	40 (100.00)	40 (100.00)	120 (100.00)
3.	**Sources of Irrigation**				
a.	Backwater	40 (100.00)	40 (100.00)	40 (100.00)	120 (100.00)
4.	**Nutrition management**				
a.	**Type of manures & fertilizers used**				
i.	Manures and Fertilizers	40 (100.00)	40 (100.00)	40 (100.00)	120 (100.00)
b.	**Fertilizer dose**				
i.	As per recommendation	33 (82.50)	38 (95.00)	35 (87.50)	106 (88.33)
ii.	Above recommendation	07 (17.50)	02 (05.00)	05 (12.50)	14 (11.66)
c.	**Fertilizer application**				
i.	Split dose application	40	40	40	120

		(100.00)	(100.00)	(100.00)	(100.00)
5.	**Feed Management**				
a.	**Methods of Feeding**				
i.	Floating feed	40 (100.00)	40 (100.00)	40 (100.00)	120 (100.00)
b.	Frequency of feeding/day	04	04	04	04
6.	**Growth promoters**				
a.	As per recommendation	40 (100.00)	40 (100.00)	40 (100.00)	120 (100.00)
7.	Period of Pond Drying				
a.	< 20 days	13 (32.50)	12 (30.00)	11 (27.50)	36 (30.00)
b.	20-45 days	24 (60.00)	25 (62.50)	22 (55.00)	71 (59.16)
c.	> 45 days	03 (7.50)	03 (07.50)	07 (17.50)	13 (10.84)
8.	**Pest and Disease management**				
a.	Preventive measures	04 (10.00)	07 (17.50)	05 (12.50)	16 (13.34)
b.	Curative measures	36 (90.00)	33 (82.50)	35 (87.50)	104 (86.66)
9.	**Criteria for harvesting**				
a.	Based on size and weight	32 (80.00)	31 (77.50)	29 (72.50)	92 (76.66)
b.	Based on market demand and price	08 (20.00)	09 (22.50)	11 (27.50)	28 (23.34)
10.	**pH test**				
a.	**Soil test**				
i.	Practiced	31 (77.50)	29 (72.50)	30 (75.00)	90 (75.00)
ii.	Not practiced	09 (22.50)	11 (27.50)	10 (25.00)	30 (25.00)
b.	Water test				
i.	Once in a week	28 (70.00)	31 (77.50)	29 (72.50)	88 (73.33)
ii.	Fortnightly	12 (30.00)	09 (22.50)	11 (22.50)	32 (26.67)

Note: Figures in parentheses indicate percentage to the respective totals.

used floating feed rather than bag feeding, which is mainly due to better feed conversion ratio (FCR); this feed is not easily destroyed and can be spread evenly so that the size of the shrimps at harvest is more uniform and the frequency of feeding was four times per day which helps to increase in the efficiency of feed utilization and reduce the wastage.

Growth promoters

Growth promoters are generally used in modern aqua farming for increased growth and productivity. For optimum shrimp growth, a growth promoter should be fed a nutritional diet containing sufficient amounts of essential amino acids, fatty acids, vitamins and minerals. Sometimes, nutrients in the feed may only partially help in the growth of shrimp. To make all essential nutrients a part of the shrimp diet, promoters are fed. A growth promoter contains all essential nutrients in the right amounts and helps increase shrimps' growth and performance. Some commonly used growth promoters are bulk probiotic manufacturers, Moult Active, AquaGROMAX, LIVERTREAT-BW, etc. All the farmers in the study area use growth promoters as per the recommendation but not below it.

Pond drying

It is one of the essential packages of practice in shrimp farming. Drainable ponds can be completely sun-dried for a minimum period of 30 to 45 days. Drying and cracking of pond bottom enhances aeration, favours microbial decomposition of soil organic matter and reduces the probability of disease occurrence. In cases where complete drying is impossible, organic, biodegradable oil cake can be used. The accumulated black material on the bottom of the pond is flushed as thin slurry. The bottom of the pond is ploughed for 5-10 cm, which can enhance the aeration and accelerate organic matter decomposition. Later, liming of the pond has to be done to neutralize the soil acidity. Most farmers in the study area practised pond drying for 20 to 45 days, a common practice between the two cultures.

Pest and disease management

Shrimp suffer from various diseases due to infectious and non-infectious causes. The best way to eliminate diseases is through good farm management or prevention. Concerning pest and disease management, more than 82 per cent of the farmers across districts followed curative measures for pest and disease management, and the rest followed preventive measures for pest and disease control. Shrimps suffer from various diseases due to infectious and non-infectious causes. Viruses, bacteria, fungi and certain parasites cause infectious diseases. Treatment can't be carried out effectively when shrimp diseases occur in a pond. The best way to eliminate diseases is through good farm management or prevention. Some major diseases are loose smell, muscle necrosis, white gut, brown gill, white muscle, soft shell and black spots. Concerning pest and disease management, the farmers in the study area followed curative and preventive pest and disease control measures.

Criteria for harvesting

Harvesting is the final phase of a culture operation. The economy of the culture operation depends on the quantity harvested and that of marketing on the quality achieved. To retain the freshness and quality of shrimps, the following measures have to be adopted, i.e. frequent exchange of water before the harvest. There should be minimum stress while harvesting and harvesting should not be done on hot days. Harvested shrimp can be kept between layers of crushed ice before transporting the consignment to market. The shrimp growers decided on harvesting based on two categories: size and weight and market demand and price. Most of the farmers decided harvesting criteria based on the size and weight of the species because visual observation was the easiest and best method. Some farmers also practised harvesting based on market demand and price because they usually concentrated on higher returns.

pH test

The farmer has to maintain a pH ranging between 6.5 to 7.5, which is best suited where the availability of nitrogen, phosphorous, potassium, calcium and magnesium is maximum. Before releasing the post larvae, a soil test must be carried out. In all the districts, 75 per cent of the farmers conducted a soil pH test before culturing shrimp. Concerning water pH, 73 per cent of farmers tested water pH once a week, followed fortnightly in the study area.

Soil test: The pH ranging between 7.5 to 8.5 is best suited where the availability of nitrogen, phosphorous, potassium, calcium and magnesium is maximum. The soil test must be carried out before releasing the fingerlings to the ponds. In the study area, cent per cent of the farmers conducted a soil pH test before culturing shrimps.

Water test: The pH of the pond water indicates its fertility or potential productivity. Water pH 7.5 to 9.0 is generally considered suitable for shrimp production. The growth of shrimps is retarded if pH falls below 5.0. Water with low pH falls can be corrected by adding lime to neutralize the acidity. Water of excessive alkalinity (pH values > 9.5) may also be harmful to shrimp growth and survival. In ponds which are excessively rich in phytoplankton, the pH of pond water usually exceeds 9.5 during the late afternoon. However, at daybreak, the pH is usually lower. Excessive plankton growth can be corrected by water exchange. Periodical water exchange as and when required will help maintain the water quality in an optimal range. Using aerators results in mixing water at the surface and bottom, breaking down the dissolved oxygen and thermal stratification. In the study area, 75 per cent of the farmers practice a water test once a week, and the remaining farmers practice fortnightly. (Table 3)

Labour management in shrimp farming

The operation-wise labour requirement was calculated in shrimp farming and presented in Table 4. This table revealed that feeding required the highest number of person-days of labour because feeding was a prime and critical operation in aquaculture. After all, there was no possibility of mechanical feeding. Watch and the Ward are the second major labour requirement operation in shrimp farming, which mainly avoids the theft problem and protects the shrimp from bird picking. However, the other major operations were fertilizer application, harvesting, pond maintenance, etc., operations increasing yield in aquaculture. In the case of machine labour in shrimp farming, a maximum number of machine hours were employed for the operations, such as pond preparation and repairing of dykes. The pond preparation and maintainable includes the removal of sludge between culture cycles, which helps to improve the pond bottom, thereby increasing the carrying capacity, light ploughing after sludge removal (which helps to expose the soil layers underneath to sunlight and atmospheric oxygen, which assists the breakdown and oxidation of organic waste (sludge) into less harmful substances), liming and pond filling. Repairing of dyke's resulting bunds should be strengthened by compacting to avoid seepage of water; De-silting, tilling and harrowing operations were done to remove bottom soil completely from the pond bottom. (Table 4).

Table 4: Labour management in shrimp farming (per acre)

Sl. No.	Operations	Uttara Kannada (n=40)		Udupi (n=40)		Dakshina Kannada (n=40)		Over all (n=120)	
		HL	ML	HL	ML	HL	ML	HL	ML
1.	Pond preparation and maintenance	05.36 (3.87)	11.29 (58.51)	05.30 (3.77)	10.25 (56.33)	04.97 (3.64)	09.93 (56.43)	05.21 (3.77)	10.49 (57.15)
2.	De-silting	01.94 (1.40)	02.13 (11.05)	01.71 (1.22)	02.04 (11.21)	01.64 (1.20)	02.42 (13.75)	01.76 (1.27)	02.19 (11.97)
3.	Repairing of dykes	02.50 (1.81)	05.87 (30.44)	02.28 (1.62)	05.90 (32.43)	02.32 (1.70)	05.24 (29.78)	02.36 (1.70)	05.67 (30.88)
4.	Purchase of fingerlings from hatchery	02.98 (2.59)	-	03.01 (2.14)	-	03.04 (2.23)	-	03.01 (2.18)	-
5.	Lime application	03.58 (2.59)	-	03.52 (2.51)	-	03.50 (2.56)	-	03.53 (2.55)	-
6.	Manure application	04.86 (3.52)	-	04.87 (3.47)	-	04.76 (3.49)	-	04.83 (3.49)	-
7.	Fertilizer application	14.98 (10.86)	-	14.20 (10.13)	-	14.02 (10.29)	-	14.40 (10.43)	-
8.	Feeding	69.32 (50.29)	-	68.32 (48.76)	-	70.32 (51.61)	-	69.32 (50.21)	-
9.	Watch and ward	16.75 (12.15)	-	15.30 (10.92)	-	14.80 (10.86)	-	15.61 (11.62)	-
10.	Control of aquatic weeds, predatory and weed fish	03.33 (2.41)	-	04.20 (2.99)	-	04.12 (3.02)	-	03.88 (2.81)	-
11.	Harvesting	12.24 (8.87)	-	13.40 (9.56)	-	13.20 (9.68)	-	12.94 (9.97)	-

	Total	137.84 (100)	19.29 (100)	140.10 (100)	18.19 (100)	136.24 (100)	17.59 (100)	138.06 (100)	18.35 (100)

Note: HL: Human Labour = In man days; ML: Machine Labour = In hours;
Figures in parentheses indicate percentage to the respective totals.

Input management in shrimp farming

The input utilization pattern in shrimp production in the study area is depicted in Table 5; the results revealed that the farmers used more fingerlings in the study area. The utilization of fingerlings depended on the pond's depth and water level in the pond. If the stocking density was high, it would result in improper/stunted growth and also lead to disease incidence. Even in manures and fertilizers, the same trend was observed as above. Lime was also applied periodically in small doses at frequent intervals in shrimp ponds; it attempted to regulate phytoplankton abundance and pH. The increased pH led to reduced soluble phosphorus and free carbon dioxide in water, which helped pond productivity by increasing the light available to plants and organisms. Bleaching powder also killed predatory and weed fish in the pond and helped prevent and treat shrimp diseases. Fertilizers, minerals, feed, growth promoters and medicine are also used in shrimp farming. (Table 5)

Table 5: Input management in shrimp farming (per acre)

Sl. No.	Inputs		Units	Uttara Kannada (n=40)	Udupi (n=40)	Dakshina Kannada (n=40)	Over all (n=120)
1.	Fingerlings		Numbers	1,12,486	1,15,282	1,08,286	1,12,018
2.	Manures		tonnes	1.91	2.16	2.01	2.03
3.	Bleaching powder		kg	97.29	99.20	100.23	98.91
4.	Agricultural lime		tonnes	0.58	0.73	0.61	0.64
5.	Fertilizers	Urea	kg	44.15	42.56	43.60	44.15
		SSP	kg	42.86	41.80	41.95	42.86
		MOP	kg	72.73	72.80	73.22	72.73
6.	Minerals		kg	11.74	11.86	11.42	11.67
7.	Feed		tonnes	3.56	3.22	3.34	3.37
8.	Growth promoters		litres	2.59	2.64	2.68	2.64
9.	Medicines		litres	7.97	7.92	7.68	7.86
10.	Human labour		man-days	137.84	140.10	136.24	138.06
11.	Machine labour		hrs	19.29	18.19	17.56	18.35

Costs and returns of shrimp farming in the study area

The costs and returns of shrimp farming in the study area are presented in Table 6. A cursory look at Table 6 shows the distribution pattern of variable costs of various inputs used in the production. Among all the variable costs, feeds accounted for the major share of the cost, around 216462 (41%), followed by fingerlings 63380 (12%), human labour 38222 (07%), and electricity 25121 (05%). Machine labour, manures, medicines, miscellaneous expenditure, bleaching powder, growth promoters, minerals, fertilisers and agricultural lime occupied the remaining costs. Meanwhile, interest on variable cost at 8 per cent was 31944, which accounted for a share of six per cent of the total cost of production. In the case of fixed costs, the distribution pattern was as follows: Rental value of the land 41641 (07.90%) was the major cost, followed by amortised cost 23447 (04.45%), depreciation on tools and machinery and land revenue 20003 (03.80%). And the interest on fixed capital was 10264 (01.95%). This was calculated for an interest rate of 12 per cent mainly because the interest on long-term loans in banks and financial institutions was 10 to 12 per cent per annum. The average yield of shrimps in the study area was 3736 kg. The average selling price was 300/kg. The gross returns obtained per acre were 1122820, with secured net returns of 596029. Production of shrimp in the study area was found to be profitable by the magnitude of returns per rupee of investment of 2.13.

Table 6: Cost and returns of shrimp farming (In ₹ per acre)

Sl. No.	Particulars		Uttara Kannada (n=40)	Udupi (n=40)	Dakshina Kannada (n=40)	Overall (n=120)
	A. Variable Cost					
1.	Fingerlings		63922.33 (12.12)	63234.51 (12.00)	62985.43 (11.98)	63380.75 (12.03)
2.	Manures		9113.13 (1.73)	9196.98 (1.70)	8987.2 (1.71)	9099.09 (1.73)
3.	Bleaching powder		4493.77 (0.85)	4325.92 (0.80)	4454.2 (0.85)	4424.63 (0.84)
4.	Agricultural Lime		1012.18 (0.19)	1034.12 (0.20)	1021.49 (0.19)	1022.59 (0.19)
5.	Fertilizers	Urea	292.37 (0.06)	289.45 (0.10)	298.45 (0.06)	293.42 (0.06)
		SSP	369.54 (0.07)	376.21 (0.10)	372.94 (0.07)	372.33 (0.07)
		MOP	821.4 (0.16)	815.39 (0.20)	832.91 (0.16)	823.23 (0.16)
6.	Minerals		2590.08 (0.49)	2293.43 (0.40)	2389.59 (0.45)	2424.36 (0.46)
7.	Feeds		216369.59	216493.98	216523.54	216462.37

		(41.02)	(41.10)	(41.19)	(41.09)
8.	Growth promoters	3656.83 (0.69)	3456.45 (0.70)	3554.56 (0.68)	3555.94 (0.68)
9.	Medicines	7877.42 (1.49)	7603.42 (1.40)	7503.56 (1.43)	7661.46 (1.45)
10.	Human labour	37848.56 (7.18)	38832.02 (7.40)	37985.93 (7.23)	38222.17 (7.26)
11.	Machine labour	21547.58 (4.09)	21521.03 (4.10)	20994.97 (3.99)	21354.52 (4.05)
12.	Electricity	25232.54 (4.78)	25145.93 (4.80)	24985.39 (4.75)	25121.28 (4.77)
13.	Miscellaneous expenditures	5085.84 (0.96)	5349.02 (1.0)	5384.21 (1.02)	5272.66 (1.00)
14.	Interest on variable cost @8%	32019.45 (6.07)	31974.06 (6.10)	31838.18 (6.06)	31943.89 (6.06)
Total Variable Cost		432252.61 (81.96)	431941.92 (81.90)	430112.55 (81.81)	431434.69 (81.90)
B. Fixed Costs					
15.	Rental value of land	41540.83 (7.88)	42332.02 (8.00)	41049.9 (7.81)	41640.91 (7.90)
16.	Land revenue	50 (0.01)	50 (0.01)	50 (0.01)	50 (0.01)
17.	Depreciation on tools and machineries	19777.98 (3.75)	20092.02 (3.80)	19989.92 (3.80)	19953.3 (3.79)
18.	Amortized cost of pond	23558.33 (4.47)	22549.8 (4.30)	24232.2 (4.61)	23446.77 (4.45)
19.	Interest on Fixed Cost @ 12%	10245.25 (1.94)	10256.86 (1.90)	10292.64 (1.96)	10264.91 (1.95)
Total Fixed Cost		95172.39 (18.04)	95280.7 (18.10)	95614.66 (18.19)	95355.89 (18.10)
Total Cost of Production		527425 (100.00)	527222.62 (100.00)	525727.21 (100.00)	526790.58 (100.00)
Yield (kg)		3755.11	3780.57	3673.47	3736.38
Selling price (₹/kg)		301.58	301.14	298.83	300.51
Gross returns (₹)		1132466.07	1138480.85	1097743.04	1122819.55
Net returns (₹)		605041.0	611258.23	572015.83	596028.97
Return per rupee of investment		2.14	2.15	2.08	2.13

The cost and returns of shrimp farming are presented in Table 6. It was indicated that the production cost was higher in shrimp farming than in other aquaculture farming, mainly because feed usage was highest to get a good count and weight of the shrimp. In aquaculture, especially shrimp count and weight played critical path in the decision of selling price, *i.e.* good count fetched good market price and demand, and feeding accounted for the major cost in variable components, i.e. around 41 per cent in shrimps because feed was directly proportional to yield component, good quality feed resulted in good and robust growth in shrimp that in turn resulted in good count and market price. The cost of fingerlings accounted for the next highest cost in shrimps. We have to purchase them from high-tech shrimp hatcheries, followed by the cost of human labour, which accounted for the third highest variable cost because aquaculture was labour-intensive. The lower mechanisation rate in aquaculture was due to the small shrimp farms in the study area.

In the study area, fingerlings accounted for the second highest variable costs, nearly 12 per cent of shrimps, because the culture required good quality and specific pathogen-free seed (SPF). During seed selection, the growers should consider factors such as the seed being active, healthy in appearance, uniform in size, and having the potential for high survival, better growth, and less or no disease. To reduce the culture period and potential for survival, it is advisable to stock PL10 to PL15 (Post-laxative) production stages that result in uniform growth. The pattern of variable cost distribution showed that, In shrimp, the distribution pattern of operational cost of inputs like manures, bleaching powder, feed, growth promoters and medicines were higher in the study area because these lands were highly irrigated and fertile.

The farm's construction of a pond and water supply channel accounted for a major cost among the fixed-cost components in the study area. For aquaculture, irrigation played a crucial role in the culture, and maximum culture was seen in and around canals and river banks in the study area. In the wake of current advanced technologies, the cost of cultivation could be reduced by using live feed cultures such as the Bio-floc system and recirculating aquaculture system (RAS). These two systems significantly reduce the cost of shrimp production. It was observed from the table that the average yield per acre in shrimps was less than 4000-5000 kg per acre, which was mainly due to a need for improved, advanced management practices. The selling price per kilogram of shrimp was based on the count, *i.e.*, the lower the count, the higher the selling price. Return per rupee of investment was more than one, indicating aquaculture farming was a profitable agribusiness enterprise in the study area. (Table 6)

Conclusion

The feed cost accounted for 40 per cent of the major costs among the variable costs in the total cost of production of shrimps. Government may encourage farmers to adopt the Re-circulatory Aquaculture System (RAS) and Bio-floc Farming Technology where water is recycled. The mechanism proved to help in feed control management. Hence, adoption of these technologies may reduce cost of production by minimizing the feed cost.

References

1. Anonymous. Economic Survey. The Department of Economic Affairs, Ministry of Finance, Government of India, New Delhi. 2021a, p. 236-237.
2. Anonymous. Annual Report, (2019-20). Marine Products Export Development Authority, 2021b, p. 651.
3. Mohite YT. Efficacy and constraints in adoption of improved aquaculture practices by shrimp farmers in Raigad district of Maharashtra. *M.F.Sc. Thesis*, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, India, 2007, p. 58.
4. Naik BV, Patil SV, Shirdhankar MM, Yadav BM, Tibile RM, Chaudhari KJ, *et al*. Socio-Economic Profile of Shrimp Farmers of South Konkan Region, Maharashtra, India. International Journal of Current Microbiology and Applied Sciences. 2020;9(09):1371-1380.
5. Patil S, Sharma A. Empirical analysis of constraints faced by shrimp farmers of Maharashtra. Journal of Experimental Zoology. 2020;23(2):1867-1875.
6. Salunke AB. Efficacy and constraints in adoption of Penaeus (Litopenaeus vannamei (Boone, 1931) culture practices by the farmers of North Konkan region of Maharashtra. *M.F.Sc. Thesis*, Dr. Balasaheb Sawant Konkan Krishi Vidyapeeth, Dapoli, India, 2018, p. 206-208.
7. Santhosha KM, Naik AD. Constraint analysis of shrimp farming in Karnataka RBQ Analysis, Journal of Farm Sciences. 2022;35(4):460-464.
8. Yadava CG. Area Expansion and Output Projection of Arecanut - An Economic Study in Karnataka State, *M.Sc. Dissertation*, University of Agricultural Sciences, Bengaluru, 2008.
9. Yadava CG, Chandrarekha C, Santhosha KM, Gagana MD, Pushpa P. Economic assessment of black pepper under hilly zone multi-storeyed ecosystem of Karnataka, India Int. J Environ. And Climate Change. 2022a;12(12):849-855.
10. Yadava CG, Gagana MD, Chandan K, Santhosha KM, Chandrarekha C, Srinivasulu GB. Economic Analysis of Arecanut Cultivation in Central Western Ghats Region of Uttara Kannada District, Karnataka. Agro Economist – An International Journal. 2022b;10(01):01-06.