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Research Article

Analysis of Socioeconomics and Occupational Dimensions of Shrimp Farmers of Tamil Nadu

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Studies on socioeconomic, communication media usage, occupational, and sociopsychological attributes of farmers are prerequisite for planning, designing, and successful implementation of sustainable management strategies of a sector which is true for *Penaeus vannamei* shrimp farming also. The state of Andhra Pradesh in India ranks first in shrimp farming. However, Tamil Nadu state has a lot of potential and is slowly catching with third position, so the baseline profile of shrimp farmers of Tamil Nadu was collected through interviews with 316 shrimp farmers in Nagapattinam, Mayiladuthurai, Thanjavur, and Thiruvallur districts. Most shrimp farmers were men of middle-age, with experience ranging from 1 to 5 years with secondary school to graduate level education. About 89.36% of shrimp farmers had taken loans for the purpose of shrimp farming whereas 78.16% were depending on income from shrimp farming as a repayment source. The benefit–cost ratio of shrimp farming was 2.2 indicating profitability so 79.37% of them were able to save money. However, for 86.53% this was a major expenditure too indicating its vital role in their life. For acquiring information for shrimp farming, 40% relied on friends and 24% relied on fellow farmers. Shrimp farmers were well-versed with the present-era mass-media and through smartphones they acquired information from apps like YouTube. Innovation proneness, scientific orientation, and economic motivation were found to be high in about 30% of farmers. Proper planning is essential for sustainable shrimp farming and sustaining the socioeconomic benefits. The studied attributes play an important role in formulation, designing, and successful implementation of sustainable shrimp farming.

1. Introduction

According to FAO [1], total fisheries and aquaculture production reached a record 214 million tons in 2020, largely due to the growth of aquaculture, particularly in Asia and global aquaculture production reached a record 122.6 million tons in 2020, with a total value of USD 281.5 billion. The contribution of aquaculture to the global production of aquatic animals reached a record 49.2%. Asia continued to dominate world aquaculture, producing 91.6% of the total. India is the second largest fish producing country in Asia accounting for 8% of global production [2]. During 2020–2021, the sector's gross value added (GVA) was about 1.1% of the national gross domestic product and 6.72% of the GVA from the agriculture and allied sectors. During the same year, the sector earned foreign exchange worth ₹575,864.8 million. Fish and fish product exports emerged as the largest group in agricultural exports and value. The fisheries sector has demonstrated an outstanding double-digit average annual growth of 10.34% with record fish production of 16.248 million tons in 2020–2021 (Handbook on Fisheries Statistics, 2022). In terms of employment, the sector supports the livelihood of over 28 million people in India especially the marginalized and vulnerable communities [1, 3].

Over the time, shrimp and prawn exports have increased drastically and account for a relatively stable share of the total value of global exports of aquatic products. In 1976, exports of shrimps and prawns were worth USD 1.2 billion accounting for 15.4% of the value of global exports of aquatic products, whereas in 2020, they were worth USD 24.7 billion making up 16.4% of the total in value terms. The markets of the United States of America and Japan are primarily supplied with warm water shrimp species by major producers such as India, Indonesia, Thailand, and Vietnam. In global

aquaculture production, at the level of species, with 5.8 million tons, white leg shrimp (*Penaeus vannamei*) was the top species produced in 2020, closely followed by grass carp (white amur; *Ctenopharyngodon idellus*) and cupped oysters nei (*Crassostrea* spp.) [1].

India had become the fourth major exporter in 2017. However, India was overtaken by Chile in 2020 as the value of India's exports has been on a downward trend since 2018. In 2020, the total value of India's exports of aquatic products reached USD 5.8 billion, down from USD 7.2 billion in 2017. Now, India ranks fifth among the top aquatic foods exporting countries by value [1]. In India, more than 90% of the shrimp-producing farmers are small farmers (those cultivating 1–2 ha) [4].

Shrimp and prawns have historically been some of the most heavily traded aquatic commodities. Frozen shrimp is the largest exported item, both in terms of quantity and value during the last decade. India exported 0.652 million MT of frozen shrimp worth USD 4,889.12 during 2019–2020 and 0.590 million MT worth USD 4,426.19 during 2020–2021 and 0.728 million MT worth USD 5,828.59 during 2021–2022. Frozen shrimp constituted 51.35% in quantity in 2020–2021 and 53.18% in quantity in 2021–2022 and 74.28% in terms of total USD earnings in 2020–2021 and 74.15% in terms of USD earnings in 2021–2022 [5] (Handbook on Fisheries Statistics, 2022).

A total area of 108,526.27 ha is under *P. vannamei* culture in nine maritime states producing 815,745 MT with Andhra Pradesh leading in total area under culture and production, followed by Gujarat and Tamil Nadu [5]. India's export growth story is primarily due to the success of brackish water aquaculture of shrimp [6].

Tamil Nadu is the third largest producer of *P. vannamei* shrimp in India, behind Gujarat (50,410 tons) and Andhra Pradesh (634,672 tons) [5]. Tamil Nadu has the second longest coastline in the country with rich natural resources in coastal areas for coastal aqua farming. The total estimated brackish water area is about 56,000 ha and an area of 8,600 ha is under *P. vannamei* culture [5, 7]. The all-India average productivity is 7.52 MT/ha/year and for Tamil Nadu 5.20 MT/ha/year. In Tamil Nadu, shrimp farming has grown considerably and has emerged as a major enterprise and is being carried out in 13 coastal districts. So far, 1,968 shrimp farms, 55 shrimp hatcheries, and 12 Nauplii rearing hatcheries have been registered under the Coastal Aquaculture Authority (CAA), a regulating authority for coastal aquaculture. Hence, Tamil Nadu has abundant scope for *P. vannamei* shrimp farming activities.

For any farming system to be sustainable, it is necessary to have in-depth information of the farmers involved in the system. The same is true for shrimp farming system also. There are few studies that provide information about shrimp farmers of India like Kumaran et al. [8, 9] who studied knowledge level, management practices, and sustainability issues of shrimp farmers of east and west coast of India. Patil et al. [10], Patil and Sharma [11], and Patil and Sharma [12] assessed the emergence of shrimp farming, training needs, and constraints faced by shrimp farmers of Maharashtra. Maity and Saha [13] analyzed the socioeconomics of *P. vannamei* shrimp farmers in West Bengal. Srinivas and Venkatrayalu [14] studied the sustainability of *P. vannamei* farming in coastal Andhra Pradesh and explored the status and prospects of *P. vannamei* farming in coastal Andhra Pradesh. Tank et al. [15] analyzed the constraints of *P. vannamei* shrimp farming in Saurashtra, Gujarat and Navghan et al. [16] analyzed the economics of shrimp aquaculture in Navsari district of Gujarat.

In Tamil Nadu, Rajarajan [17], Narkis et al. [18], and Umamaheswari et al. [19] have studied about shrimp farmers of Nagapattinam district. A study by Durai and Alagappan [20] on 35 shrimp farmers practicing nursery rearing covered Thiruvallur, Kancheepuram, Villupuram, Cuddalore, and Nagapattinam districts. Value chain analysis has been reported by Umamaheswari et al. [21] for Ramanathapuram, Cuddalore, Thanjavur, and Nagapattinam districts. In all these studies a small component about the profile of shrimp farmers has been reported.

However, there is a research gap about in-depth detailed study on social, economic, occupational, and sociopsychological attributes of *P. vannamei* shrimp farmers of Tamil Nadu. Lack of authentic information on socioeconomic conditions is one of the serious obstructions to the successful implementation of developmental policies [22]. The socioeconomic profile would be helpful in formulation of effective need-based strategic programs for development of sustainable livelihood of shrimp farmers through sustainable farming practices by utilizing the baseline data information by different policymakers.

With this background, a study was performed with an objective of analyzing the social, economic, occupational, and sociopsychological attributes of *P. vannamei* shrimp farmers of Tamil Nadu.

2. Methodology

The state of Tamil Nadu was selected for the present study. The districtwise total number of *P. vannamei* shrimp farms in Tamil Nadu was collected from the State Government organization, that is, Department of Fisheries and Fishermen Welfare (DoFFW), Tamil Nadu.

Based on these statistics and discussions with officials of DoFFW, Tamil Nadu three districts of Tamil Nadu namely, Nagapattinam, Thanjavur, and Thiruvallur which have a high number of *P. vannamei* farms were purposively selected in stage 1 for the study. Figure 1 represents the map showing the study area. The population size (N) was 1,958 shrimp farms. The sample size was calculated as follows using Slovin's formula [23]:

$$n = \frac{N}{1 + N(e^2)}, \tag{1}$$

where n, sample size needed; N, population size; and e, acceptable margin of error.

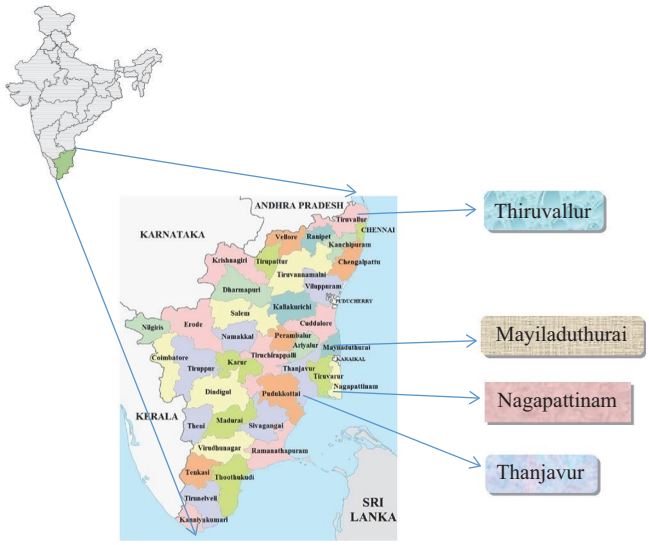

Figure 1: Map showing the study area.

Table 1: Districtwise sample size for the study.

District	Total shrimp farmers as per records available with Coastal Aquaculture Authority	Sample size
Nagapattinam	851	60
Mayiladuthurai		106
Thanjavur	300	90
Thiruvallur	125	60
Total		316

Total number of respondents for the study,

$$n = \frac{N}{1 + N(e^2)}, \tag{2}$$

where $n = 1{,}958/(1 + 1{,}958\ (0.05)^2)$, $n = 332.14$, $n \approx 330$.

In the second stage of sampling, based on the number of farms in each of the districts selected in stage 1, the number of respondents in each district was decided upon calculating a sufficient minimum of at least 20% of the total number of farms in the respective districts through probability proportional to size sampling. However, the district of Nagapattinam has been bifurcated as Nagapattinam and Mayiladuthurai in 2020 by the Government. After the data collection it was found, that among the 166 respondents from Nagapattinam, 106 were from Mayiladuthurai. So it has been recorded as fourth sampling district. Table 1 shows the districtwise sample size of the study. Though the samples aimed were 330, due to sampling constraints, data could be recorded from a total of 316 shrimp farmers from the selected districts as follows:

To achieve the objectives of the study the key outcome variables on which information was collected using an interview schedule were as follows:

(1) Social attributes included age, gender, caste, religion, education, family size, primary occupation, land ownership, farm area, secondary occupation, and social participation.
(2) Economic attributes included annual income, source of income, credit/loan availed, source of credit/loan, purpose of credit, outstanding loan amount, repayment source, subsidies availed, saving habit, mode of saving, purpose of saving, revenue generated, costs involved, annual expenditure pattern, and assets.
(3) Occupational attributes included source of experience, years of experience, source of water, pond nature, culture system, year of start of farm, stocking density (number per m^2), and days of culture.
(4) Communication media usage.
(5) Sociopsychological attributes included innovation proneness, scientific orientation, and economic motivation.

The methodology adopted to measure communication media usage, innovation proneness, scientific orientation, and economic motivation are explained below.

3. Communication Media Usage

A list of communication media used by the shrimp farmers was made after interaction with 10 shrimp farmers. Responses of the shrimp farmers regarding usage of the respective communication media were recorded using a Likert scale with 4 points (Never = 1, Sometimes = 2, Often = 3, and Most often = 4). Thereafter, a relative importance index (RII) was calculated to rank the communication media usage. RII was used to determine the relative importance of the quality factors involved.

The RII ranged from 0.25 to 1. It was used to rank the communication media usage in the order of importance. The RII was calculated by using the equation below [24].

$$\text{Relative importance index} = \frac{\Sigma w}{AN} = \frac{4n_4 + 3n_3 + 2n_2 + 1n_1}{4N}, \tag{3}$$

where w is the weighting given to each factor by the respondent shrimp farmer, ranging from 1 to 4. The points of the Likert scale used are equal to the value of w, weighting given to each factor by the respondent. A is the highest weight (i.e., 4 in the study), N is the total number of respondents, n_1 represents the number of shrimp farmers who have responded never, and n_4 represents the number of shrimp farmers who have responded most often.

3.1. Innovation Proneness. Innovation proneness refers to the inclination of an individual to accept new ideas and practices. The innovation proneness was measured by using a self-rating scale developed by Moulik [25] with slight modifications to suit shrimp farmers. This is the standard scale most commonly used for studying the innovation proneness

Table 2: Quartiles for sociopsychological variables.

Quartiles		Innovation proneness	Scientific orientation	Economic motivation
25 (Quartile 1)	Low	<22	<21	<23
50 (Quartile 2)	Medium	22–23	21	23–24
75 (Quartile 3)	High	>23	>21	>24

among agricultural farmers. Though it is an old scale it is still being used by a number of researchers [26, 27]. The scale consists of nine items. The positive statements in the scale were, I try to keep myself up to date with information on new farm practices, but that does not mean I try out all the new methods on my farm; I feel restless till I try out a new farm practices, I have heard about; From time to time I have heard of several new farm practices and I have tried out most of them in the last few years; I usually wait to see what results my neighbors obtain before I try out the new farm practices and If the new practices are promising I would surely like to adopt them. And the negative statements in the scale included they talk of many new farm practices these days but who knows if they are better than the old ones; somehow I believe that the extensive system of farming with low stocking is the best; I am cautious about trying a new practice and after all our progressive/neighboring farmers were wise in their farming practices, I do not see any reason for changing these farming methods and trying something new. Out of the nine items, five were positive and four were negative statements. Each item in the scale was provided with three response categories. These were agreed, undecided, and disagree with weightage of 3, 2, and 1, respectively, for the positive statement and 1, 2, and 3 for the negative statement. The total score of a shrimp farmer on the scale was obtained by adding the scores of all the individual items on that scale. The maximum score, a shrimp farmer could get on this scale was 27 and the minimum was 9. Based on the scores obtained, categorization of low (less than 22), medium (22–23), and high (more than 23) was done as per the quartile values given in Table 2. Then frequency analysis was performed to identify the percentage of the shrimp farmers having low, medium, and high innovation proneness.

3.2. Scientific Orientation. Scientific orientation refers to the respondent's orientation toward scientific approaches that can be employed in cultivation aspects. Scientific orientation was operationalized as the degree to which a farmer was oriented toward the use of scientific methods in shrimp farming. The scale developed by Supe [28] with some modifications was used to measure scientific orientation. The scale consisted of five positive statements and had 5 points which were Strongly agree (5), Agree (4), Undecided (3), Disagree (2), and Strongly disagree (1). The statements in the scale were: scientific methods of farming give better results to a farmer than unsystematic random methods; even a farmer with lots of experience should use scientific methods of farming; though it takes time for a farmer to learn scientific methods in farming it is worth the efforts; a good farmer experiments with new scientific ideas in farming; unscientific methods such as dumping of inputs without knowing the use and consequence in the farming system have to be curbed. The scores on all the statements were added to arrive at the total scientific orientation score of an individual. The maximum score, a farmer could get on this scale was 25 and the minimum was 5. Based on the scores obtained by the shrimp farmers they were categorized into three categories namely, low, medium, and high toward scientific orientation. Based on the scores obtained, categorization of low (less than 21), medium (21), and high (more than 21) was done as per the quartile values given in Table 2. Then frequency analysis was performed to identify the percentage of the shrimp farmers having low, medium, and high scientific orientation.

3.3. Economic Motivation. Economic motivation refers to the extent of orientation of shrimp farmers toward monetary values and economic returns. The scale of Supe [28] and the scale developed by Meena and Fulzele [29] were adapted with modifications to measure the economic motivation of shrimp farmers. The scale of Supe is a standard scale used most commonly to study the economic motivation among the agricultural farmers [30–33] and the scale developed by Meena and Fulzele was for studying the economic motivation of dairy farmers. The scale used for the present study consisted of nine items with one negative statement. The positive statements in the scale were: all I want from my farm is to make just a reasonable living for the family; economics drives most of my farming decisions; I would invest in farming to the maximum to gain large profits; I would not hesitate to borrow money in order to run the farm properly; cost-effective management of the inputs is more important than anything for achieving success; shrimp farming pays the farmer more than his investment; my main aim is maximizing monetary profit in farming by all possible means and a shrimp farmer can get more profits from his land than any other land use practice and the only negative statement was shrimp farming as a business is like gambling. Each item in the scale was provided with three response categories. These were agreed, undecided, and disagree with weightage of 3, 2, and 1, respectively, for the positive statement and 1, 2, and 3 for the negative statement. The total score for the farmers was obtained by adding the scores of all the individual items on that scale. The maximum score, a shrimp farmer could get on this scale was 27 and the minimum was 9. Based on the scores obtained by the shrimp farmers they were categorized into three categories namely, low, medium, and high toward economic motivation. Based on the scores obtained, categorization of low (less than 23), medium (23–24), and high (more than 24) was done as per the quartile values given in Table 2. Then frequency analysis was performed to

identify the percentage of the shrimp farmers having low, medium, and high economic motivation.

The primary data source was interviews with 316 *P. vannamei* shrimp farmers. The interview schedule was framed after extensive literature review and discussions with 10 experienced shrimp farmers with at least 10 years of experience. The interview schedule was primed with four subsections namely, social, economic, occupational, and sociopsychological attributes.

The schedule was discussed with a scientific panel of four experts from ICAR-Central Institute of Fisheries Education, Mumbai, Tamil Nadu Dr. J. Jayalalithaa Fisheries University, Department of Fisheries and Fishermen Welfare, Tamil Nadu, and ICAR-Central Institute of Brackishwater Aquaculture, Chennai. The schedule was modified as per the inputs provided by experts and accordingly ambiguous and noncontextual questions were removed. The interview schedule was then translated into Tamil language. The interview schedule was pretested with 10 shrimp farmers and during this process, it was found that a bilingual interview schedule would be apt for data collection apropos of ease of communication. The interview was conducted between October 2019 and September 2021 with each in-depth interview lasting for 40–90 min and the responses were noted in a printed interview schedule.

The results were extracted and coded using MS Excel and then imported and analyzed using SPSS version 25. Univariate descriptive analysis such as frequency and percentage were done for the variables.

Chi-squared goodness of fit test was used to test the hypothesis if there was a significant difference with reference to the innovation proneness, scientific orientation, and economic motivation ($P<0.05$) among the respondent shrimp farmers.

Spearman rank correlation analysis was performed to study the relationship between communication media usage of shrimp farmers and innovation proneness, scientific orientation, and economic motivation.

In this study, the amount is calibrated in Indian Rupees (₹) and the value of 1₹ is equal to 0.012 USD (as on July 13th, 2023).

The study had few limitations that could be taken into account by the future researchers. The cluster effect was not statistically accounted for and the sample size aimed for could not be achieved due to the COVID-19 pandemic.

4. Results and Discussion

4.1. Social Attributes. The social attributes of shrimp farmers of Tamil Nadu are presented in Table 3.

Data summarized in Table 3 shows that the mean age of shrimp farmers was 44.49 years, manifesting that most of the farmers are middle-aged. Similar results have been reported by other studies done in Nagapattinam district of Tamil Nadu. Rajarajan [17] found predominant age group of the shrimp farmers (50%) was between 36 and 45 years. Narkis et al. [18] found that majority of shrimp farmers belonged to the middle age group. Umamaheswari et al. [19] reported

Table 3: Social attributes of shrimp farmers of Tamil Nadu.

S. no.	Variables	Mean	Standard deviation
1.1	Age	44.49	9.49
1.2	Family size	3.97	0.78
		Frequency	Percentage
1.3	Gender		
	Male	270	85
	Female	46	15
1.4	Caste		
	General	7	2
	Backward Class	239	76
	Most Backward Class	57	18
	SC	8	3
	ST	5	2
1.5	Religion		
	Hindu	289	91.46
	Christian	23	7.28
	Muslim	4	1.27
1.6	Education		
	Nonliterate	6	2
	Primary	7	2
	Middle school	17	5
	High school	18	6
	Higher secondary	138	44
	Graduate	128	41
	Postgraduate	2	1
1.7	Family type		
	Nuclear	296	94
	Joint	20	6
1.8	Primary occupation		
	Shrimp farming	316	100
	Agriculture	0	0
	Business	0	0
1.9	Land ownership		
	Hut	0	0
	Tiled	30	9
	Terrace	262	83
	G + 1 Floors	24	8
1.10	Land for shrimp farming		
	Own	212	67
	Lease	86	27
	Partnership	18	6
1.11	Farm area		
	Upto 2 ha	275	87.0
	2–5 ha	37	11.7
	>5 ha	4	1.3
1.12	Secondary occupation		
	Agriculture	155	49.05
	Business	95	30.1
	Independent profession	6	1.9
	No secondary occupation	60	19.0

Table 3: Continued.

S. no.	Variables	Mean	Standard deviation
1.13	Social participation		
	No member in any organization	50	15.8
	Membership in one organization	69	21.8
	Membership in more than one organization	197	62.3
	Office holder	2	0.6
	Distinctive feature (MLA, Panchayat President, and so forth)	4	1.3

that 48% of the shrimp farmers were less than 50 years of age with an average of 44.64 years.

Only 15% of farm owners were female. Similar results were obtained by Umamaheswari et al. [21] and Umamaheswari et al. [19]. However, during the present study, it was noticed that though the farm owners are female, their involvement in the faming activities was negligible. This could be because, when the land ownership was with the female member of the family, by default the farm registration is done on her name. But the farm activities are managed by their male counterparts/husbands. However, 10% of these female owners, that is, two of the female farmers were exclusively managing the farm by themselves which shows that shrimp farms could be managed by female farmers and more women should be involved in shrimp farming activities in the future.

In Tamil Nadu, the Other Backward Classes category is further classified as Backward Class (BC) and Most Backward Class (MBC). The majority of shrimp farmers (76%) belonged to the BC and 18% of the shrimp farmers were from the MBC. The most common castes involved in shrimp farming in Tamil Nadu are Mudaliyars, Reddiyaars, Vaandaiyaars, and Vanniyars. Majority of the shrimp farmers were Hindus (91.46%). Umamaheswari et al. [19] in their study in Tamil Nadu reported that the shrimp farming community in Nagapattinam district was dominated by BC members (98%). In Nagapattinam district diagnostic study conducted by the Tamil Nadu Rural Transformation Project, it is reported that scheduled caste farmers are less in number which may be due to the less land holding and less proportion of land in their possession and this stands as an impediment for their development [34]. Similarly in the district diagnostic report of Thiruvallur district, it is reported that major land holding in this district is owned by others rather than by SC and ST people [35]. In West Bengal also the involvement of SC/ST communities in *P. vannamei* culture was found to be low but it was reasoned out that it might be due to poor financial resources as well as lack of awareness about beneficial aspects of *P. vannamei* culture [13].

As far as literacy is concerned, 44% had higher secondary level education and 41% were graduates and the results were in accordance with the studies done by Durai and Alagappan [20], Kumaran et al. [9], and Patil et al. [10] in Maharashtra and Kumaran et al. [8] in East coast and West coast of India.

It is necessary to highlight that education and experience can provide farmers with not only certain knowledge but also technology usage to maintain intensive production and shrimp farming sustainability [36]. Ray et al. [37] in their study on the role of shrimp farming in socioeconomic elevation and professional satisfaction in coastal communities in Bangladesh have also highlighted that shrimp farmers had better educational status.

However, the results of the present study were different from what Rajarajan [17] and Narkis et al. [18] reported. Rajarajan [17] reported that the shrimp farmers were mostly educated only up to middle school. In addition, Narkis et al. [18] also reported that 35% of shrimp farmers had secondary-level education and 21.67% had primary school education. Most (94%) of the shrimp farmers had nuclear families with a family size ranging from 3 to 5 with an average of 3.97. All of them had shrimp farming as their primary occupation, nearly half (48%) had agriculture as their secondary occupation and 30% had business as their secondary occupation. Most of them (83%) were found to have terrace house which in this study is operationalized as houses having concrete walls and roof indicating better housing facility.

More than half (67%) of the shrimp farmers were farming on their own land whereas 27% were farming on leased lands. The lands are leased in two ways, that is, as a shrimp farm itself and just as land. The lease amount in Thiruvallur district ranges from ₹35,000/- (USD 426.37) to ₹75,000/- (USD 913.66) per acre per year which amounts to ₹86,485/- (USD 1,053.57) to ₹185,325/- (USD 2,257.66) per hectare. The price range is reasoned out as, if the land is leased as such and with difficult access to road facilities is priced lesser and the land which is leased as shrimp farms and with good access to transport facilities is priced higher. The lease amount in Thanjavur district ranges from ₹75,000/- (USD 913.66) to ₹150,000/- (USD 1,827.32) per acre per year which amounts to ₹185,325/- (USD 2,257.66) to ₹370,650/- (USD 4,515.31) per hectare. In Thanjavur, the shrimp farms along with the facilities such as aerators and generators are leased out rather than as plain land. In Nagapattinam and Mayiladuthurai, the lease amount ranges from ₹100,000/- (USD 1,218.21) to ₹150,000/- (USD 1,827.32) per hectare. Similar to Thanjavur, in Nagapattinam and Mayiladuthurai districts, the shrimp farms with the facilities such as aerators and generators are leased out. In all the districts, these lease amount values are considered to be nominal.

About 6% had partnership meaning investors are involved in the farming practice. They provided the recurring costs and the farm owners with knowledge of shrimp farming take up the culture activities and the profit is shared. Another form of partnership arrangement is where the land owners serve as investors and the working partners (usually youngsters) with the knowledge of shrimp farming do the culture activities on a agreement basis and share the profits. These partnership arrangements have not been reported in any study so comparisons could not be made. The partnership arrangement

exists due to lack of adequate capital and availability of farm land. Small farms, that is, up to 2 ha (87%) were found to be dominant which has been reported by Narkis et al. [18] and Umamaheswari et al. [21] also. More than half (62%) of the shrimp farmers are members of more than one organization. Majority of them are members of the Shrimp Farmers Association and similar results were recorded by Umamaheswari et al. [21]. The shrimp farmer association serves as a pillar of support at the times of adversity and also serves as an informal regulatory body wherein the shrimp farmers are convinced that only if they co-operate and adopt the management practices properly they can reap the profits. Some of the respondent shrimp farmers were office holders of the associations (0.6%) and few had distinctive features like Panchayat President, MLA (1.3%).

4.2. Economic Attributes. Economic attributes of the shrimp farmers are presented as follows: income, credit/loan, and saving information of the shrimp farmers is presented in Table 4.

Income is the most efficient indicator of economic status and standard of living. The mean annual income (₹1,130,648.73, i.e., USD 13,773.72) shows that the shrimp farmers have very higher annual income when compared to the national per capita Income of ₹150,000 (USD 1,827.32) and to per capita income of Tamil Nadu being ₹284,788 (USD 3,469.33) in 2021 [38] as well as when compared to the annual income of shrimp farmers in other states. Dona et al. [60] reported the annual income of shrimp farmers of Kerala was ₹200,000 (USD 2,436.43) per crop per ha. Patil et al. [10] reported an average annual income of shrimp farmers of Palghar district, Maharashtra was ₹500,000 (USD 6,091.07).

However, the annual mean income per ha in Tamil Nadu was estimated as ₹5,881,000 (USD 71,643.17) by Umamaheswari et al. [21]. Durai et al. [39] in their study on the economic performance of *P. vannamei* in Tamil Nadu reported that the net revenue calculated was ₹538,897 (USD 6,564.92)/ha.

It is also pertinent to mention that as per the Situation Assessment of Agricultural Households and Land and Livestock Holdings of Households in Rural India, 2019, average monthly income from different sources per agricultural household is ₹8,337 (USD 101.56) (both the paid out expenses and imputed expenses approach) [38]. This shows that the income from shrimp farming is eleven times more than the average agricultural household.

It was found that, out of the total respondent shrimp farmers, 77.85% had availed credit. Among them, 75% have availed loans from banks and 38.9% have availed credit from sources like feed companies and input suppliers mainly because of the timeliness of credit. This is a prominent mode of credit in which shrimp feed and other inputs were purchased from the feed companies on credit. A difference of ₹2–3/kg of feed was reported for the feed cost purchased with ready cash and that of the feed purchased on a credit basis, where the amount will be settled after the harvest. A similar credit mode has been reported by Kumaran et al. [40] where it is mentioned that feeds and other inputs were procured on a credit basis and the trader was paid a commission of ₹10–15/kg for harvested shrimp.

The Government of India in 2018–2019 extended the facility of Kisan credit card (KCC) to Fisheries and Animal Husbandry farmers to help them meet their capital needs.

Table 4: Income, credit/loan and saving information of the shrimp farmers of Tamil Nadu.

S. no.	Variables	Mean	Standard deviation
2.1	Income in ₹	1,130,648.73	17,249.993
2.2	Outstanding loan amount in ₹	399,698	124,139
		Frequency	Percentage
2.3	Repayment source		
	Profit from shrimp farm	247	78.16
	Business	65	20.57
	Assets	4	1.27
2.4	Credit/loan availed		
	Yes	246	77.85
	No	70	22.15
2.5	Credit sources		
	Banks	237	75.0
	Others (feed companies/ input suppliers)	123	38.9
	Friends and relatives	23	7.3
	Money lender	12	3.8
	Co-operative	11	3.5
2.6	Purpose of loan		
	House building	56	17.73
	Children education	31	9.92
	Children marriage	43	13.83
	Shrimp farming	283	89.66
	Agriculture	42	13.48
	Business	40	12.77
2.7	Subsidies availed		
	Yes	16	5.06
	No	300	94.94
2.8	Subsidized electricity		
	Yes	22	6.96
	No	294	93.04
2.9	Saving habit		
	Yes	306	96.84
	No	10	3.16
2.10	Mode of saving		
	Bank	169	53.44
	Gold	96	30.45
	Real estate	24	7.66
	Others	27	8.45
2.11	Purpose of saving		
	Shrimp farming	251	79.37
	Agriculture	39	12.53
	Others	26	8.09

Table 5: Annual expenditure pattern of shrimp farmers of Tamil Nadu.

2.13	Annual expenditure	Mean (Rs.)	Contribution to total expenditure (%)
1.	Inputs for shrimp farming	1,448,782	86.53
2.	Food	98,411	5.88
3.	Education	50,976	3.04
4.	Clothing	25,424	1.52
5.	Health	21,946	1.31
6.	Entertainment	7,470	0.45
7.	Housing	4,133	0.25
8.	Others	17,238	1.03
	Total expenditure	1,674,380	

The cornerstone of agriculture credit is the scale of finance (SoF) being fixed for every crop at the district level which forms the basis for determining the eligible credit for each crop and farmer. The limit for KCC is also decided based on the SoF, crop grown, and area cultivated [41]. As per the approved SoF for working capital requirements of the fisheries sector for the year 2022–2023 in Tamil Nadu is ₹1,910,000 (USD 23,267.89) per ha for shrimp farming and ₹470,000 (USD 5,725.61) per ha for renovation of shrimp ponds. It looks like a very good opportunity to meet the credit needs of the shrimp farmers. However, it was reported that only 3.79% of shrimp farmers had availed this facility and all of them have obtained only up to ₹300,000 (USD 3,654.64) of which ₹160,000 (USD 1,949.14) is provided without collateral.

The picture of the outstanding loan of the shrimp farmers reveals that on an average each household was indebted to the tune of ₹399,000 (USD 4,860.61) and the wide range, that is from a minimum of ₹100,000 (USD 1,218.21) to maximum of ₹2,500,000 (USD 30,455.35) was reported in this variable and this could be attributed to the fact that the outstanding loan amount depends on several other factors like, size of the farm, the management capability, and so forth. This outstanding loan was found to be higher compared to the average amount of outstanding loans per agricultural household in Tamil Nadu, that is, ₹106,553 (USD 1,298.04). It was found that 78.16% depended on income from the shrimp farming as a repayment source of the loan availed.

Around 89% of the shrimp farmers have reported that the purpose of credit/loan is for shrimp farming. This means that most of the shrimp farmers avail credit to run the shrimp farms. Shrimp farming is the major reason for them to avail a credit/loan.

With reference to subsidies, it is reported in the Blue Revolution Scheme and Pradhan Mantri Matsya Sampada Yojana (PMMSY) of DoF, Govt. of India, subsidies are available for brackishwater shrimp farming. Under PMMSY, support is provided for quality brackish water shrimp farming to ensure sustained income transfers to the marginalized small farmers and fuel growth of exports [6].

As per the Government Order No. 1 of 2012 dated March 30, 2012 of the Tamil Nadu Electricity Regulatory Commission, the low tension tariff IV, where there is 100% subsidized electricity is applicable to fish/prawn culture carried out as allied activities of agriculture and it shall be construed as agricultural activities; fish/prawn culture carried out exclusively is categorized under LT Tariff IIIA1 with the condition that the contracted load for supply under this tariff category shall not exceed 12 kW. The 5.06% of shrimp farmers who have reported to have availed subsidies were the people who have availed of the centrally sponsored scheme under the blue revolution, and the 6.96% who have availed subsidized electricity have availed it for culture of fin-fishes and later converted to shrimp farms and presently they are not having the subsidized tariff as shrimp farming is considered as commercial activity.

Almost all the shrimp farmers were found to have saving habit (96.84%) and the mode of saving was mostly in the banks (53.44%) and gold (30.45%). Savings are an important aspect of the functioning of agricultural holdings, as they allow farmers to have a direct influence on the development and changes in their economic activity, as well as being a vital element of financial security in case of unforeseen events [42]. As illustrated by Lebel et al. [43], risk management includes technical practices, often related to water and stock management, informational practices, such as paying attention to weather forecasts, as well as organizational practices, like maintaining savings or building relations with firms in the value chain. Shrimp farming is a risky venture and thus savings is a good organizational practice to be followed. People with higher savings rate are expected to have higher financial capability to make farm investments [44].

The annual expenditure pattern of shrimp farmers of Tamil Nadu is presented in Table 5.

It can be seen from Table 5 that 61.44% of the total expenditure is toward shrimp farming. So it is clear from the study that shrimp farming is the major purpose of taking a credit/loan (89.36%), major source for loan repayment (78.16%), and also the major purpose of saving (79.37%) as well as major contributor to expenditure (86.53%). This indicates their dependence on shrimp farming and its vital role in their life. Lessons have to be learned from the mid-1990s crash of the shrimp industry in 1994–1995, where unplanned or unscientific intensification of culture systems, poor management, and lack of a master plan-based approach were the issues apart from some serious socioeconomic issues [45]. The setback in shrimp culture in the mid-1990s and 2008 due to outbreak and the success and failures of other developing countries necessitates update review of modern

Table 6: Assets owned by shrimp farmers of Tamil Nadu.

2.14 Assets owned		Frequency	Percentage
I. Immovable assets			
House	Yes	289	91.5
Shrimp farms	Yes	237	75.0
Plots	Yes	205	64.9
Apartment	Yes	83	26.2
II. Movable assets			
Car	Yes	267	84.5
Bike	Yes	222	70.3
III. Communication/electronic assets			
Mobile phones	Yes	316	100
Laptop	Yes	277	87.7
TV	Yes	316	100
Internet connectivity	Yes	246	77.8
Desktop	Yes	192	60.8

production technologies and disseminate the results to the farmers through various communication media can make the shrimp aquaculture sustainable with more viable and economic benefits [16]. The sustenance of socioeconomic viability of the shrimp farming lies in the long-term sustainability of the sector. This calls for the extension of sustainable scientific practices among the shrimp farmers through an e-extension module for easy and instantaneous access to scientific information and advisories.

Assets owned by shrimp farmers of Tamil Nadu are presented in Table 6.

As per Lerman and Mckernan [46] in their study on "The Effects of Holding Assets on Social and Economic Outcomes of Families" assets are stocks of resources; they are what people accumulate and hold over time. Assets provide for future consumption and are a source of security against contingencies. As investments, they also generate returns that generally increase aggregate lifetime consumption and improve a household's well-being over an extended time horizon. Low resource holdings limit the potential for social and economic development [46] Assets possession of the shrimp farmers clearly indicates that more than 90% of shrimp farmers had immovable assets like houses, around 84% had movable assets like cars. All were found to have mobile phones and television.

Revenue generated by shrimp farmers of Tamil Nadu is presented in Table 7.

The study revealed that the average production is 7 tons/ha/crop. The average price of the commodity as mentioned by the shrimp farmers was ₹285 (USD 3.47) per kg for a count of 35–40. Therefore, the estimated Average revenue generated per crop per ha is ₹1,995,000 (USD 24,303.37). The present study revealed that all the farmers are going for two crops per year.

Table 7: Revenue generated by shrimp farmers of Tamil Nadu.

Revenue generated	Mean
Production per crop per ha (in tons)	7
Price per kg in ₹ (count 35–40)	285
Revenue per crop in ₹	1,995,000

Jayaraman [47] reported that with production levels of 10–12 tons per ha per crop in 3–4 months, the production of *P. vannamei* has attained phenomenal levels. However, in West Bengal only around 56% were harvesting two crops [13]. About 70% of the respondent farmers had two crops in a year and the remaining 30% of the respondent farmers had only one crop per year [48]. *P. vannamei* shrimp farming in Gujarat was earning more due to its two culture crops in a year and more production compared to black tiger shrimp [16]. As per MPEDA, for *P. vannamei* culture, the general trend is to go for year-round culture with no distinct crop season except in West Bengal and Odisha [5]. In Maharashtra, majority (94.55%) of shrimp farmers are taking two crops/year [11]. Therefore, the estimated average production per ha per year can be multiplied by two, that is, 14 tons/ha/year. Hence the total revenue per ha per year is ₹3,990,000 (USD 48,606.74). This multiplication by two is also found to be followed by Navghan et al. [16] for calculating the economics of *P. vannamei* shrimp farming in Gujarat. The annual mean income per ha in Tamil Nadu was estimated as ₹5,881,000, that is, USD 71,643.17 [21]. The estimated average production per ha per year is double the all-India average productivity which is 7.52 MT/ha/year and almost 2.5 times the average productivity in Tamil Nadu which is 5.20 MT/ha/year as mentioned by MPEDA [5].

Costs involved in shrimp farming are presented in Table 8.

The mean total fixed cost per ha was calculated to be ₹347,534 and the mean total variable cost per ha per crop is ₹727,605. Therefore, the total variable cost per ha per year is ₹1,455,250. The land cost is the major contributor to fixed cost and as reflected in many studies [18, 21, 17], feed is the major contributor to variable cost and electricity charges are the next big contributor to variable cost in Tamil Nadu.

$$\begin{aligned}\text{Total cost (per ha per year)} &= \text{Total fixed cost} + \text{Total variable cost per year}\\ &= 347,534 + (727,605 \times 2) = 347,534 + 1,455,210 = ₹1,802,744,\end{aligned} \tag{4}$$

$$\text{Benefit} - \text{cost ratio (BCR)} = \frac{\text{Total revenue (per ha per year)}}{\text{Total cost (per ha per year)}} = \frac{3,990,000}{1,802,744} = 2.2. \tag{5}$$

Table 8: Costs involved in shrimp farming.

2.16	Costs involved	Mean	Contribution to the total (%)
Capital cost			
1	Pond excavation per ha and provision of inlet/outlet arrangement	186,829	34.52
2	Shed construction	38,342	7.08
3	Aerators per ha	132,354	24.46
4	Water pumps with electrical installations and pump house	125,502	23.19
5	Generator	58,183	10.75
	Total capital cost	541,210	
Fixed cost			
1	Land cost per ha (lease rent per ha)	195,796	56.34
2	Repairs and maintenance	16,435	4.73
3	Depreciation on capital cost @10%	54,121	15.57
4	Interest on capital investment @15%	81,182	23.36
	Total fixed cost	347,534	
Variable cost per ha per crop			
1	EB charges	162,231	22.30
2	Labor salary	62,392	8.57
3	Seed cost	63,234	8.69
4	Feed	209,758	28.83
5	Other inputs	34,551	4.75
6	Liming	19,527	2.68
7	Fertilizer	26,016	3.58
8	Pond preparation	67,302	9.25
9	Generator fuel	28,687	3.94
10	Harvest cost	13,924	1.91
11	Seed testing cost	2,589	0.36
12	Water quality testing	6,516	0.90
13	Disease expenses	2,297	0.32
14	Filtration	7,307	1.00
15	Miscellaneous (transportation, and so forth)	21,274	2.92
	Total variable cost	727,605	

The benefit–cost ratio (BCR) of more than unity, that is, exceeding one is itself considered to be economically viable. The BCR of 2.2 shows that shrimp farming in Tamil Nadu is very profitable. A BCR of 3.34 and 2.497 were reported by studies on shrimp farming in Bangladesh [49, 50]. Navghan et al. [16] reported a BCR of 3.06 in *P. vannamei* shrimp farming in Navasari district of Gujarat. And many studies have reported a BCR of more than one in India [51, 52] as well as in other countries [50, 53, 54]. Though *P. vannamei* shrimp culture is profitable in India [13, 16], there are certain factors that need to be addressed for the sustainability of the industry. They include regular extension programs; adequate understanding; improved management practices; and crop insurance facilities to prevent debt burden if there is a loss [13, 55–57]. Scientific shrimp farming is a profitable option in the long [51] to sustain the reported higher BCRs.

4.3. Occupational Attributes. Table 9 presents the occupational attributes of shrimp farmers of Tamil Nadu.

It is found that friends and neighbors are the major source of shrimp farming knowledge and more than 60% had less than 5 years of experience in aquaculture. In Tamil Nadu, shrimp farming started in the early 1990s and *P. vannamei* was allowed for farming in India since 2009. Then *P. vannamei* farming slowly increased in Tamil Nadu. A study conducted on shrimp farming in India found that majority of the shrimp farmers (62%) had 10–20 years of farming experience [9]. This shows that shrimp farmers of Tamil Nadu are comparatively have lesser years of experience. However, the study conducted by Umamaheswari et al. [21] in Nagapattinam district showed that the proportion of shrimp farmers with 10–15 years of shrimp farming experience accounted for 84% of the total respondent farmers. This difference could be attributed to the fact that two more districts were included in the study other than Nagapattinam district. Relying on friends and relatives (90%) as a source of information has been reported by Saengnore and Lebel [36] in Vietnam. The primary water source for the majority of farms (85.1%) is the creek and moreover nearly all of the farms (99%) are with Earthen Ponds. The semi-intensive culture system is predominantly practiced, representing 92.6% of the farms with an average stocking density of 55

Table 9: Occupational attributes of shrimp farmers of Tamil Nadu.

3.	Occupational attributes		Frequency	Percentage
3.1	Source of shrimp farming knowledge	Friends	129	40.8
		Neighbor	76	24.1
		Forefather	50	15.8
		Progressive farmer	45	14.2
		Relatives	12	3.8
		Organizations	3	0.9
		Others	1	0.3
3.2	Years of experience	1–5 years	198	62.6
		6–10 years	76	24.1
		11–15 years	5	1.6
		16–20 years	13	4.1
		>20 years	24	7.6
3.3	Source water	Creek	269	85.4
		Bore well	28	8.9
		Sea	18	5.7
3.4	Pond nature	Earthen	312	99.
		Lined	2	0.6
		RAS	1	0.3
3.5	Culture system	Semi-intensive	293	92.7
		Intensive	12	3.8
		Extensive	11	3.5
		Mean	Mode	Standard deviation
3.6	Stocking density per m^2	54.93	60	10.99
3.7	Days of culture	109.77	110	17.42

(54.93), with a mode of 60, as this is the recommended stocking density as per the guidelines of the CAA. Patil [11] found that in Palghar district of Maharashtra, about half (47.27%) were maintaining stocking density between 16 and 25 shrimps/m^2 followed by 26–50 numbers/m^2 (34.55%). The mean days of culture was found to be 109.77, and the mode is 110. The minimum days of culture is 90 days, unless the farm encounters an emergency situation like disease or natural calamities, majority of the farmers rear the shrimps at least for a period of 90–100 days and a considerable number of them prefer to rear the shrimps for a shorter period. The possible reason is the intent to reduce the feeding cost and earn returns in a short span of time.

Umamaheswari et al. [19] have reported that 70% of the farmers mainly depend on creeks for their water source. Since the culture of *P. monodon*, creeks have been the source of water for more than 98% of shrimp farms [58]. The farmers in Nagapattinam district were practicing all three types of farming namely, extensive (28%), semi-intensive (66%), and intensive (6%) with an average culture period of 4 months which is different from the data of the present study where majority of the farms were semi-intensive with less number of culture days.

Brackish water shrimp farming in India started during 1991–1994. Figure 2 shows the year of establishment of the present day *P. vannamei* shrimp farms. *P. vannamei* culture was permitted in India since 2009 and there was a peak in 2010 and 2017. The peak in 2010 can be attributed to the introduction of *P. vannamei* and the awareness of the performance of *P. vannamei* and the commercial farming of *P. vannamei* started only in 2009–2010 [5] and the peak in 2017 can be attributed to the huge profits earned by the shrimp farmers during the year 2016–2017. By the end of the year 2017, the area under culture had increased 50%, production had increased by almost 83% and India became the second-

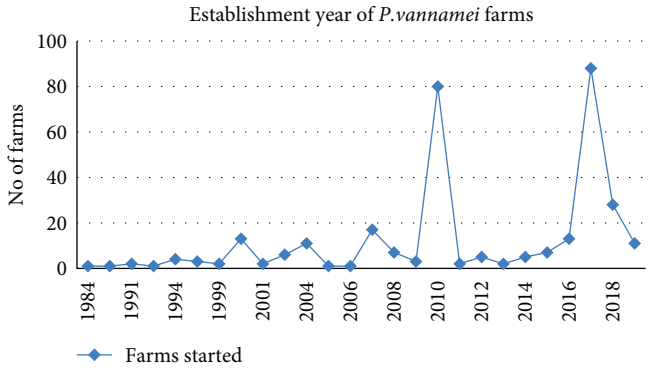

Figure 2: Establishment year of *P. vannamei* shrimp farms.

Table 10: Communication media usage—relative importance index.

Communication media	Never = 1 Never	Sometimes = 2 Sometimes	Often = 3 Often	Most often = 4 Most often	Total W	Total N	$A \times N$	RII	Rank
WhatsApp	9	52	57	1,044	1,162	316	1,264	0.919	1
YouTube	6	78	39	1,032	1,155	316	1,264	0.914	2
TV	9	78	84	960	1,131	316	1,264	0.895	3
Facebook	14	68	72	972	1,126	316	1,264	0.891	4
YouTube (for *P. vannamei* farming)	11	60	537	384	992	316	1,264	0.785	5
Pamphlet/bulletin	15	112	666	92	885	316	1,264	0.7	6
Newspaper	6	330	99	448	883	316	1,264	0.699	7
WhatsApp (for *P. vannamei* farming)	1	356	69	456	882	316	1,264	0.698	8
Facebook (for *P. vannamei* farming)	12	386	78	340	816	316	1,264	0.646	9
Krishimela and exhibition	26	474	102	72	674	316	1,264	0.533	10
Radio	188	120	165	52	525	316	1,264	0.415	11

Table 11: Sociopsychological variables.

Variables	Categories	Frequency	Percentage	χ^2 Value	P-value
Innovation proneness	Low	143	45.3	94.373	<0.001
	Medium	24	7.6		
	High	149	47.2		
Scientific orientation	Low	173	54.7	73.981	<0.001
	Medium	50	15.8		
	High	93	29.4		
Economic motivation	Low	113	35.8	8.057	<0.05
	Medium	82	25.9		
	High	121	38.3		

highest shrimp producer in the world [59]. The farms started before 2008 are the farms which were already culturing *P. monodon* and then shifted to *P. vannamei* culture.

4.4. Communication Media Usage. It is clear from Table 10 that among the RII for different communication media, WhatsApp was first followed by YouTube, TV, and Facebook inferring that the shrimp farmers are well-versed with the present-era mass-media. However, communication media used for gaining knowledge about shrimp farming revealed different results. In this context, YouTube had a 5th rank and WhatsApp and Facebook occupied 8th and 9th ranks. So the main communication tool for the shrimp farming was found to be YouTube. From these results, it is clear that through new age information and communication technology and communication media, knowledge dissemination to shrimp farmers can be done. However, credibility is a supremely key concern in the new media environment and is classically ascertained by considering the source of information. If the attributed source of a piece of information is a credible person or organization, then, according to conventional wisdom, that information is probably reliable [60]. Extension programmers should consider training programs with social media and internet applications for accessing and sharing agricultural information [61]. There is a need to develop an e-extension module that would cater to the information needs of the shrimp farmers. In a recent study also it is highlighted that shrimp farms are remotely located and farmers need customized farm advisories, which the conventional extension systems are not able to provide [62]. From these, it is clear that e extension module or an online resource platform for providing credible on-spot information to the shrimp farmers is inevitable.

4.5. Sociopsychological Variables. Innovation proneness, scientific orientation, and economic motivation of the shrimp farmers are the sociopsychological factors that influence the willingness or readiness toward the sustainable shrimp culture practices and hence they were also analyzed. Not many studies are available regarding the innovation proneness, scientific orientation, and economic motivation of shrimp farmers. However, innovation proneness, scientific orientation, and economic motivation are studied vastly in agriculture, horticulture, dairy, and animal husbandry.

It is clear from Table 11 and Figure 3 that innovation proneness was low in 45% of shrimp farmers, medium in 7.5%, and high in 47% of shrimp farmers. A study conducted in Andhra Pradesh revealed that shrimp farmers in Nellore district had medium (46.00%) to high (31.33%) level of innovative proneness [63]. Science and scientific knowledge have played in shaping the policy debate on the sustainability of shrimp aquaculture [64]. By careful observation of Table 11

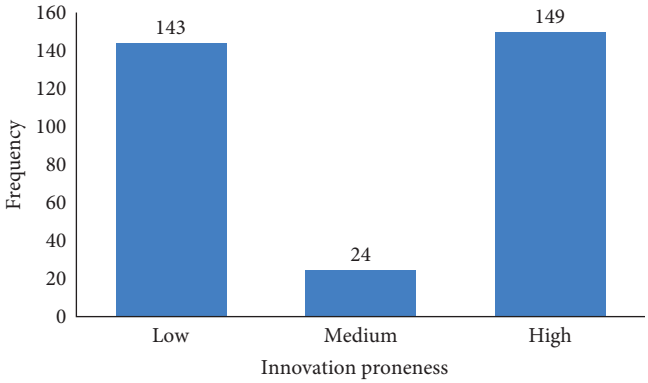

Figure 3: Innovation proneness of shrimp farmers of Tamil Nadu.

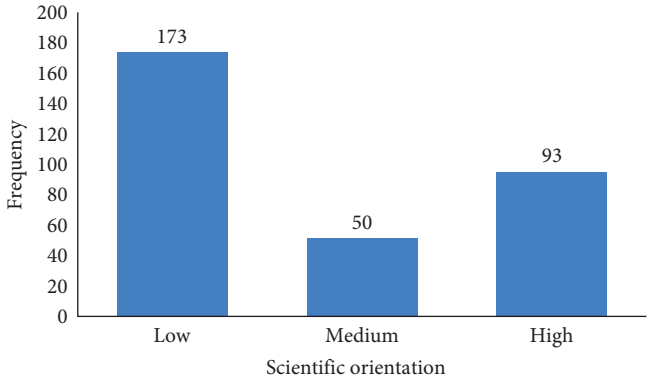

Figure 4: Scientific orientation of shrimp farmers of Tamil Nadu.

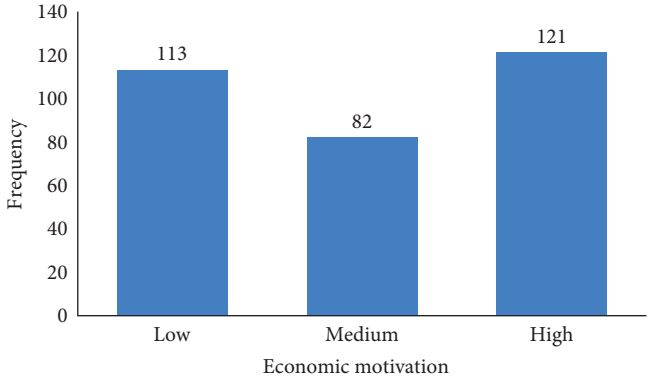

Figure 5: Economic motivation of shrimp farmers of Tamil Nadu.

and Figure 4, it is evident that 55% of the total selected shrimp farmers had a low level of scientific orientation and 29% were found to have high scientific orientation. The economic motivation of the respondents motivated their tendency to maximize their earnings and ultimately changed their attitude to adopt the scientific culture practices [65]. Good socioeconomic status acts as a supplementary factor to influence state of motivation regarding good earnings. However, from Table 11 and Figure 5, it is clear that 36% have low economic motivation and 38% are having high economic motivation. In West Bengal, 55.3% of shrimp farmers had medium level of economic motivation [13]. In Nellore district of Andhra Pradesh and Nagapattinam district of Tamil Nadu, 55.83% of shrimp farmers had medium level of economic motivation [66]. In Andhra Pradesh, majority (55%) of *P. vannamei* farmers had medium level of economic motivation [67]. Shrimp farmers of Nellore district of Andhra Pradesh exhibited medium (44.67%) to low (34.00%) level of economic motivation [63].

Chi-square goodness of fit test results (Table 11) showed that there was a significant difference in the innovation proneness, scientific orientation, and economic motivation ($P<0.05$) of the shrimp farmers.

Chi-square goodness of fit test results (Table 12) showed that there was a significant difference in the sociopsychological variables ($P<0.05$) of the shrimp farmers of different districts. Figure 6 shows the districtwise innovation proneness of shrimp farmers of Tamil Nadu. Figure 7 shows the districtwise scientific orientation of shrimp farmers of Tamil Nadu. It is evident from Table 12 and Figures 6 and 7 that shrimp farmers of Thanjavur district had higher innovation proneness and scientific orientation. This may be due to the fact that the people of above-mentioned district are historically involved in fish culture and are well-trained in aquaculture practices. Thanjavur district is one of the important districts with a significant quantity of Indian Major Carp production, availability of rich water resources and employment opportunities [68]. Furthermore, Thanjavur has been awarded the best Inland district in India for the year 2022 by the Department of Fisheries, Ministry of Fisheries, Animal Husbandry, and Dairying. However, with respect to economic motivation, shrimp farmers of Thiruvallur district had higher score. This may be because of the district being in the vicinity of Andhra Pradesh, the aquaculture bowl of India. The districtwise economic motivation of shrimp farmers of Tamil Nadu is shown in Figure 8.

In addition, the relationship between communication media usage and innovation proneness, scientific orientation, and economic motivation was also studied and is presented in Table 13.

It is clear from Table 13 that there is a significant positive linear relationship between communication media usage and innovation proneness ($\rho=0.212$, $P<0.05$), communication media usage versus scientific orientation ($\rho=0.562$, $P<0.05$), and communication media usage versus economic motivation ($\rho=0.454$, $P<0.05$).

It is clearly indicating that communication media usage has a significant relationship with innovation proneness, scientific orientation, and economic motivation of shrimp farmers. It indicates that as the communication media usage increases, the sociopsychological variables such as innovation proneness, scientific orientation, and economic motivation improve.

E-extension by communication media therefore influences the innovation proneness, scientific orientation, and economic motivation of the farmers.

Table 12: Districtwise sociopsychological variables.

Variables	Categories	District								χ^2 value	P-value
		Nagapattinam		Thanjavur		Thiruvallur		Mayiladuthurai			
		Frequency	Percentage	Frequency	Percentage	Frequency	Percentage	Frequency	Percentage		
Innovation proneness	Low	40	66.7%	3	5.0%	38	42.2%	62	58.5%	63.108	<0.001
	Medium	1	1.7%	9	15.0%	11	12.2%	3	2.8%		
	High	19	31.7%	48	80.0%	41	45.6%	41	38.7%		
Scientific orientation	Low	54	90.0%	9	15.0%	30	33.3%	80	75.5%	127.502	<0.001
	Medium	4	6.7%	10	16.7%	16	17.8%	20	18.9%		
	High	2	3.3%	41	68.3%	44	48.9%	6	5.7%		
Economic motivation	Low	24	40.0%	16	26.7%	26	28.9%	47	44.3%	101.622	<0.001
	Medium	34	56.7%	3	5.0%	9	10.0%	36	34.0%		
	High	2	3.3%	41	68.3%	55	61.1%	23	21.7%		

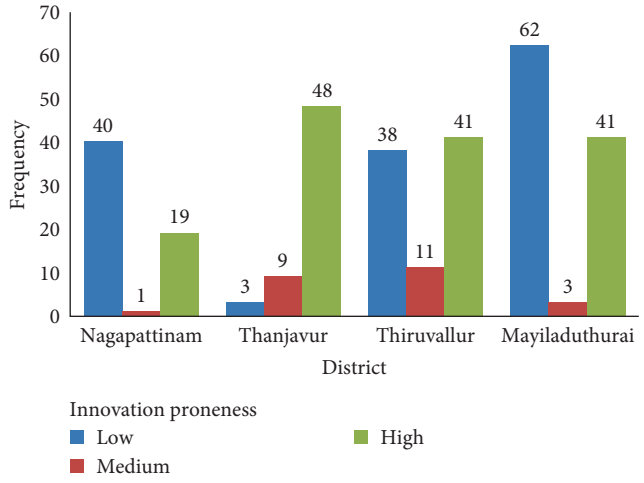

Figure 6: Districtwise innovation proneness of shrimp farmers of Tamil Nadu.

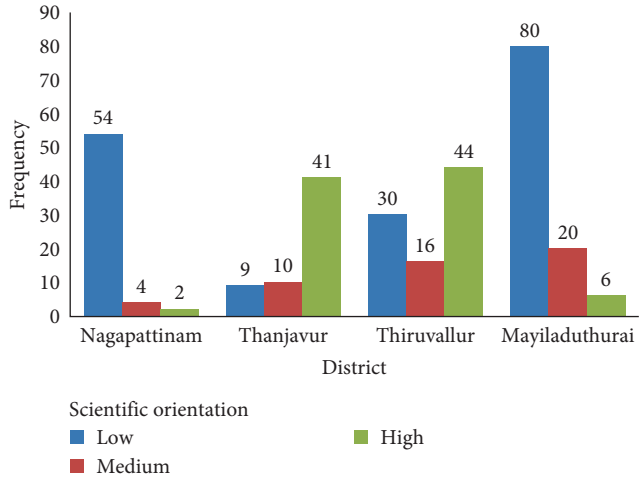

Figure 7: Districtwise scientific orientation of shrimp farmers of Tamil Nadu.

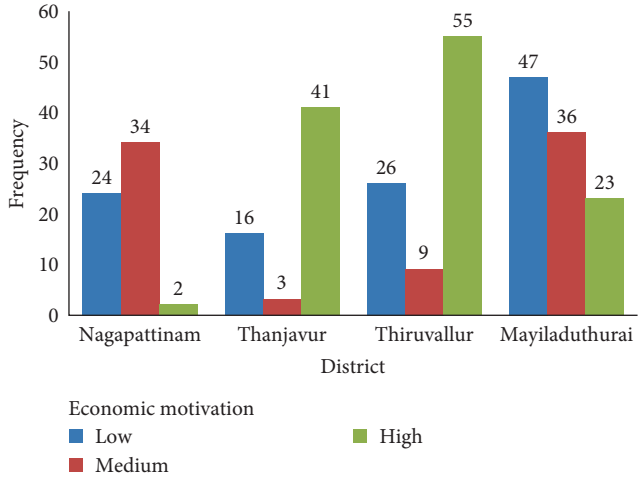

Figure 8: Districtwise economic motivation of shrimp farmers of Tamil Nadu.

5. Conclusion

P. vannamei shrimp farming has contributed to the employment opportunities, infrastructure development in the coastal regions, and socioeconomic improvement of the coastal population of Tamil Nadu. However, lessons have to be learned from the mid-1990s crash of black tiger shrimp and proper scientific methods have to be disseminated efficiently and sustainability of the *P. vannamei* shrimp farming should be ensured. Shrimp farmers have higher annual income when compared to the national per capita Income and to per capita income of Tamil Nadu. The average productivity of *P. vannamei* shrimp is 7.52 MT/ha/year and the average productivity in Tamil Nadu is 5.20 MT/ha/year. However, the study reveals that per crop production itself is 7 tons/ha and most of the shrimp farmers of Tamil Nadu are going for at least two crops per year. Most of the farmers still rely on friends and neighbors for the source of shrimp farming knowledge. Shrimp farmers of Tamil Nadu are

Table 13: Relationship between communication media usage and sociopsychological variables.

		Spearman correlation	Innovation proneness	Scientific orientation	Economic motivation
Spearman's rho (ρ)	Mass media	Correlation coefficient	0.212**	0.562**	0.454**
		Significant (two-tailed)	<0.001	<0.001	<0.001

Note. **Correlation is significant at the 0.01 level (two-tailed).

well-versed with present-day media and are resorting to YouTube for urgent information/knowledge needs pertaining to shrimp culture. An analysis of sociopsychological attributes such as scientific orientation, innovation proneness and economic motivation indicates that innovation proneness is high in almost half and low in almost half of the shrimp farmers. The extension personnel should concentrate their efforts in motivating the shrimp farmers to try new practices.

Economic motivation is one of the inducers to foot into venturesome risky activities and every farmer normally tends to possess the basic urge to earn more [32]. E-extension by communication media with credible and standard scientific package of practices information is the practicable solution to the issues in the sociopsychological attributes of shrimp farmers such as low scientific orientation and innovation proneness. Shrimp farming is a lucrative sector in Tamil Nadu and the shrimp farmers are socially and economically well off. It is concluded that the shrimp farmers of Tamil Nadu have a high socioeconomic status and shrimp farming is beneficial provided the socioeconomic benefits are sustained through proper planning in the promotion of shrimp aquaculture. These socioeconomic attributes must be taken into account for formulation, designing, and successful implementation of sustainable shrimp farming.

Data Availability

Data can be found with the researchers.

Conflicts of Interest

The authors declare that they have no conflicts of interest.

References

[1] FAO, "The state of world fisheries and aquaculture 2022. Towards blue revolution," in *The State of World Fisheries and Aquaculture 2022*, FAO, 2022.

[2] Handbook of Fisheries Statistics, 2022, https://dof.gov.in/sites/default/files/2023-08/HandbookFisheriesStatistics19012023.pdf.

[3] Government of India, "Economic survey 2021–22," 2022.

[4] Coastal Aquaculture Authority, 2021, https://caa.gov.in/.

[5] The Marine Products Export Development Authority, 2022, https://mpeda.gov.in/.

[6] PMMSY, 2020, https://pmmsy.dof.gov.in/.

[7] DoFFW, 2022, https://www.fisheries.tn.gov.in/.

[8] M. Kumaran, T. Ravisankar, P. R. Anand, D. D. Vimala, and C. P. Balasubramanian, "Knowledge level of shrimp farmers on better management practices (BMPs) of *Penaeus vannamei* farming: a comparative assessment of east and west coasts of India," *Indian Journal of Fisheries*, vol. 64, no. 3, pp. 93–99, 2017.

[9] M. Kumaran, M. Sundaram, S. Mathew et al., "Is Pacific white shrimp (*Penaeus vannamei*) farming in India sustainable? A multidimensional indicators-based assessment," *Environment, Development and Sustainability*, vol. 23, no. 4, pp. 6466–6480, 2021.

[10] S. Patil, A. Sharma, S. N. Ojha, M. M. Shirdhankar, and H. S. Dhaker, "Emergence of shrimp farming and profile of shrimp farmers in Palghar district," *Maharashtra Contemporary Research in India*, vol. 9, no. 1, pp. 37–41, 2019.

[11] S. Patil and A. Sharma, "Assessing and prioritizing training needs of shrimp farmers of Palghar district," *Maharashtra Indian Journal of Ecology*, vol. 45, no. 2, pp. 406–410, 2018.

[12] S. V. Patil and A. Sharma, "Constraints faced and test of agreement among shrimp farmers of Palghar district in Maharashtra," *Journal of Krishi Vigyan*, vol. 9, no. 2, pp. 22–28, 2021.

[13] A. Maity and B. Saha, "Economic viability of *Penaeus vannamei* shrimp farming in Purba Medinipur, West Bengal," *Journal of Community Mobilization and Sustainable Development*, vol. 15, no. 2, pp. 396–402, 2020.

[14] D. Srinivas and C. Venkatrayalu, "Current status and prospects of Pacific White shrimp *Litopenaeus vannamei* (Boone, 1931) farming in Coastal Districts of Andhra Pradesh in India," *International Journal of Science and Research*, vol. 5, no. 3, pp. 1211–1214, 2013.

[15] K. V. Tank, S. I. Yusufzai, and V. C. Bajaniya, "Constraints analysis of shrimp farming in Saurashtra Gujarat," *India Journal of Entomology and Zoology Studies*, vol. 7, no. 3, pp. 124–127, 2019.

[16] M. Navghan, N. Ranjan Kumar, S. Praksh, D. Gadkar, and S. Yunus, "Economics of shrimp aquaculture and factors associated with shrimp aquaculture in Navsari district of Gujarat," *India Ecology, Environment and Conservation*, vol. 21, no. 4, pp. 247–253, 2015.

[17] P. Rajarajan, "*An economic analysis of Littopenaeus vannamei shrimp farming in Nagapattinam district, Tamil Nadu*," M.F. Sc. Thesis, Tamil Nadu Fisheries Univesity, Thoothukudi, T. N, 2017.

[18] C. J. Narkis, K. Uma, A. Rohini, and R. Vasanthi, "An economic analysis of shrimp (*Litopenaeus vannamei*) in Nagapattinam district of Tamil Nadu," *Asian Journal of Agricultural Extension, Economics & Sociology*, pp. 449–454, 2021.

[19] T. Umamaheswari, M. Rajakumar, R. Senthiladeban, N. Felix, S. Athithan, and G. Sugumar, "Value chain approaches in farmed white leg shrimp *Penaeus vannamei* in Nagapattinam district of Tamil Nadu," *Journal of Entomology and Zoology Studies*, vol. 6, no. 5, pp. 2071–2077, 2018.

[20] V. Durai and M. Alagappan, "Study on socioeconomic analysis of white-leg shrimp, *Litopenaeus vannamei* nursery rearing in coastal districts of Tamil Nadu," *The Pharma Innovation*, vol. 9, no. 11S, pp. 94–97, 2020.

[21] T. Umamaheswari, M. Rajakumar, G. Sugumar, and R. Santhakumar, "Value chain analysis of farmed shrimp

sector in Tamil Nadu, South India," *Indian Journal of Fisheries*, vol. 67, no. 3, pp. 127–134, 2020.
[22] UNDESA, "Socio-economic," in *Department of Economic and Social Affairs*, United Nations, New York, 2020.
[23] E. Slovin, "Slovin's formula for sampling technique," 1960, https://prudencexd.weebly.com/.
[24] V. W. Y. Tam and K. N. Le, "Environmental assessment by power spectrum," in *Joint International Conference on Construction Culture, Innovation, and Management*, pp. 395–403, The British University in Dubai, Dubai, 2006.
[25] T. Moulik, *A Study on Predictive Values of Some Factors of Adoption of Nitrogen Fertilizers and the Influence of Sources of Information on Adoption Behavior*, Indian Agricultural Research Institute, 1965.
[26] M. A. Mir, M. F. Baqual, A. S. Kamili, S. A. Mir, S. Saleem, and G. R. Verma, "Impact of mass media exposure and innovation proneness on cocoon production," *Journal of Experimental Biology and Agricultural Sciences*, vol. 3, no. 5, pp. 453–457, 2015.
[27] A. K. Singha, M. J. Baruah, R. Bordoloi, P. Dutta, and U. S. Saikia, "Analysis on influencing factors of technology adoption of different land based enterprises of farmers under diversified farming system," *Journal of Agricultural Science*, vol. 4, no. 2, 2012.
[28] S. V. Supe, *Factors Related to Different Degrees of Rationality in Decision-Making among Farmers*, IARI, 1969.
[29] H. Meena and R. Fulzele, "Scale for measuring economic motivation," *Indian Research Journal of Extension Education*, vol. 8, pp. 21–25, 2008.
[30] S. Chand and A. P. Shukla, "Perception of the farmers towards technical capability of public extension personnel in middle Gujarat," *International Journal of Current Microbiology and Applied Sciences*, vol. 9, no. 12, pp. 3010–3015, 2020.
[31] A. Malik, Gautam, Kamaldeep, Rachna, and Sarita, "Livestock and gender-is it same for everyone?" *Haryana Veterinarian*, vol. 55, no. 1, pp. 12–16, 2015.
[32] S. Sangeetha, S. Praveena, and P. Jai Sridhar, "Study on the economic motivation level of farmers in the adoption process of precision farming technology," *International Journal of Scientific Research*, vol. 2, no. 2, pp. 402-403, 2013.
[33] D. K. Singh, A. K. Singh, V. P. Yadav, R. B. Singh, R. S. Baghel, and M. Singh, "Association of socio-economic status with economic motivation of the farmers," *Indian Research Journal of Extension Education*, vol. 9, no. 2, pp. 53–56, 2009.
[34] Tamil Nadu Rural Transformation Project, "District diagnostic study Nagapattinam," 2019.
[35] Tamil Nadu Rural Transformation Project, "District diagnostic report Tiruvallur," 2019.
[36] A. Saengnore and L. Lebel, "Experience, knowledge and the technology choices of shrimp farmers in Thailand and Vietnam," 2003, https://www.researchgate.net/publication/237684721.
[37] S. Ray, P. Mondal, A. K. Paul et al., "Role of shrimp farming in socio-economic elevation and professional satisfaction in coastal communities of Southern Bangladesh," *Aquaculture Reports*, vol. 20, Article ID 100708, 2021.
[38] Ministry of Statistics and Programme Implementation, 2019, https://www.mospi.gov.in/.
[39] V. Durai, C. Lloyd Chrispin, S. Bharathi, R. Velselvi, and A. Karthy, "Factors determining the economic performance of *Litopeneaus vannamei* (whiteleg shrimp), aquaculture in Tamil Nadu, India," *Aquaculture Research*, vol. 53, no. 13, pp. 4689–4696, 2022.
[40] M. Kumaran, P. Ravichandran, B. P. Gupta, and A. Nagavel, "Shrimp farming practices and its socio-economic consequences in East Godavari district, Andhra Pradesh, India—a case study," *Aquaculture Asia*, vol. 8, no. 3, pp. 48–52, 2003.
[41] NABARD, 2022, https://www.nabard.org/.
[42] B. Wieliczko, A. Kurdyś-Kujawska, and A. Sompolska-Rzechuła, "Savings of small farms: their magnitude, determinants and role in sustainable development. Example of Poland," *Agriculture*, vol. 10, no. 11, Article ID 525, 2020.
[43] P. Lebel, N. Whangchai, C. Chitmanat, and L. Lebel, "Climate risk management in river-based tilapia cage culture in northern Thailand," *International Journal of Climate Change Strategies and Management*, vol. 7, no. 4, pp. 476–498, 2015.
[44] L. Zheng, "Accessing the impacts of rural infrastructure investments on household farm investment and productivity—case study of shrimp aquaculture in rural Vietnam subtheme," in *The 9th ASAE International Conference: Transformation in Agricultural and Food Economy in Asia*, pp. 668–699, Asian Society of Agricultural Economists (ASAE), Bangkok, Thailand, http://ageconsearch.umn.edu, January 11–13, 2017.
[45] C. M. Muralidharan, "Need for ecosystem approach to brackishwater shrimp farming: a case from Andhra Pradesh, India," in *World Brackishwater Aquaculture Conference (BRAQCON 2019)*, pp. 49–52, ICAR-Central Institute of Brackishwater Aquaculture, Chennai, 2019.
[46] R. Lerman and S.-M. Mckernan, *The Effects of Holding Assets on Social and Economic Outcomes of Families: A Review of Theory and Evidence*, The Urban Institute, 2008.
[47] R. Jayaraman, "Sustainable coastal aquaculture in India," *Aquaculture*, vol. 21, no. 2, 2017.
[48] M. Kumaran, P. R. Anand, J. A. Kumar et al., "Is Pacific white shrimp (*Penaeus vannamei*) farming in India is technically efficient?—a comprehensive study," *Aquaculture*, vol. 468, pp. 262–270, 2017.
[49] N. Ahmmed, *Profitability of Shrimp Farming in Selected Areas of Bangladesh*, Sher-E-Bangla Agricultural University, 2018.
[50] K. Fatema and T. H. Miah, "Rice versus shrimp farming in Khulna district of Bangladesh: interpretations of field-level data," *Bangladesh Journal of Agricultural Economics*, vol. 34, pp. 129–140, 2011.
[51] P. Bhattacharya, "A comparative study of traditional and scientific shrimp farming in West Bengal," *The Indian Economic Journal*, vol. 58, no. 2, pp. 81–100, 2010.
[52] V. Durai, M. Alagappan, and M. Venkatesan, "Techno-economic analysis of shrimp farming in Coastal districts of Tamil Nadu," *Journal of Entomology and Zoology Studies*, vol. 8, no. 4, pp. 2193–2196, 2020.
[53] M. B. Clapano, J. M. T. Diuyan, F. G. B. Rapiz, and E. D. Macusi, "Typology of smallholder and commercial shrimp (*Penaeus vannamei*) farms, including threats and challenges in Davao Region," *Philippines Sustainability (Switzerland)*, vol. 14, no. 9, pp. 1–17, 2022.
[54] N. A. A. Shawon, M. M. H. Prodhan, M. A. Khan, and S. Mitra, "Financial profitability of small scale shrimp farming in a coastal area of Bangladesh," *Journal of the Bangladesh Agricultural University*, vol. 16, no. 1, pp. 104–110, 2018.
[55] M. N. Kutty, "Towards sustainable freshwater prawn aquaculture—lessons from shrimp farming, with special reference to India," *Aquaculture Research*, vol. 36, no. 3, pp. 255–263, 2005.
[56] N. A. Sadafule, S. S. Salim, and S. K. Pandey, "An economic analysis of shrimp farming in the Coastal Districts of Maharashtra," *Journal of Fisheries*, vol. 1, pp. 42–54, 2013.

[57] D. Srinivas, C. Venkatrayulu, and B. Swapna, "Sustainability of exotic shrimp *Litopenaeus vannamei* (Boone, 1931) farming in coastal Andhra Pradesh, India: problems and issues," *European Journal of Experimental Biology*, vol. 6, no. 3, pp. 80–85, 2016.
[58] K. O. Joseph, M. Wralidhar, B. P. Gupta, K. K. Knsmnani, and E. Mvickliandiran, "Quality of ground water in the vicinity of shrimp farms of Andhra Pradesh and Tamil Nadu," *Pollution Research*, vol. 21, no. 4, pp. 495–498, 1997.
[59] M. Salunke, A. Kalyankar, C. D. Khedkar, M. Shingare, and G. D. Khedkar, "A review on shrimp aquaculture in India: historical perspective, constraints, status and future implications for impacts on aquatic ecosystem and biodiversity," *Reviews in Fisheries Science & Aquaculture*, vol. 28, no. 3, pp. 283–302, 2020.
[60] S. S. Sundar, *The MAIN Model: A Heuristic Approach to Understanding Technology Effects on Credibility*, pp. 73–100, MacArthur Foundation Digital Media and Learning Initiative, Cambridge, MA, 2008.
[61] S. Moonsammy, D. Marie, and R. Moonsammy, "Social media application in agriculture extension programming for small scale rural farmers: is knowledge impeding the lack of adoption?" *Journal of International Agriculture and Extension Education*, vol. 27, no. 3, pp. 27–42, 2020.
[62] K. M. Anand, P. R. A. Kumar, and J. M. M. Ambasankar, "Development of a mobile application for Pacific white shrimp (*Penaeus vannamei*) farming and evaluation of its efficiency in technology communication and feedback," *Aquaculture International*, vol. 30, no. 6, pp. 2725–2739, 2022.
[63] M. Y. Babu, S. S. Dana, H. K. De, S. Kumar, and B. Prakash, "Attitude of shrimp farmers towards better management practices (BMPs) in Nellore district of Andhra Pradesh," *National Journal of Life Science*, vol. 13, no. 2, pp. 189–191, 2016.
[64] C. Béné, "The good, the bad and the ugly: discourse, policy controversies and the role of science in the politics of shrimp farming development," in *Development Policy Review*, vol. 23, Wiley, 2005.
[65] B. Goswami, U. Banga, and K. Vishwavidyalaya, "Adoption behaviour of fish farmers in relation to scientific fish culture practices in West Bengal," *Indian Research Journal of Extension Education*, vol. 10, no. 1, pp. 24–28, 2010.
[66] P. S. S. Lekshmi, K. Chandrakandan, M. Kumaran, and N. Balasubramani, "Socio-economic profile of shrimp farmers and its influence on the extent of adoption of shrimp culture technologies," *Fishery Technology*, vol. 42, no. 2, pp. 225–230, 2005.
[67] P. Bharathi Chittem, S. Kumar Kunda, and C. Prathibha Bharathi Chittem, "Socio-economic condition of the *Litopenaeus vannamei* farmers with implementation of better management practices (BMP's) in Andhra Pradesh," *India International Journal of Fisheries and Aquatic Studies*, vol. 6, no. 6, pp. 325–331, 2018.
[68] K. Vignesh, S. V. Kumar, M. Rajakumar et al., "An analysis of socio-economic profile and constraints of the Indian Major Carps (IMC) seed rearing farmers in Thanjavur district, Tamil Nadu," *International Journal of Fisheries and Aquatic Studies*, vol. 5, no. 4, pp. 308–310, 2017.
[69] P. Dona, S. Immanuel, S. N. Ohja, and P. S. Ananthan, "Occupational needs of shrimp farmers in Kerala," *Indian Research Journal of Extension Education*, vol. 16, no. 3, 2016.