



Research Article

GROWTH AND ITS PROJECTION OF SHRIMP FARMING IN GUJARAT

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Abstract: The study examined the growth and its projection of shrimp farming in Gujarat. From the Gujarat region, mainly four districts, namely, Valsad, Navsari, Surat, and Bharuch districts, were selected purposively to study the socio-economic characteristics of shrimp farmers. From each district, two talukas were selected purposively according to the availability of shrimp farmers. After that, two villages from each taluka and from each village, fifteen farmers were selected by simple random sampling (SRS) method. Thus, a total of 240 shrimp farmers were selected for this study. From this study, it was observed that most of the shrimp farmer family size were lying between 4 to 6 family members (i.e., 102 of total respondents) and the majority of the farmers were belonged from the category of Other Backward Class (i.e., 79.16 per cent). The majority of shrimp farmers in Gujarat state practice semi-intensive (i.e., 50.83 per cent) and intensive type (i.e., 42.92 per cent) shrimp culture. The compound annual growth rate (CAGR) in shrimp production in the overall period was positive statistically significant in India and Gujarat. This study illustrated that *L. Vannamei* replaces the area under tiger shrimp cultivation because it gave more production than the tiger and other shrimps.

Keywords: Socio-economic characteristics, Area, Production, Growth, Projection

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Introduction

Shrimp are decapod crustaceans. It has elongated bodies and a swimming mode of locomotion. Shrimp is synonymous with prawn, covering stalk-eyed with long, narrow muscular tails (abdomens), long whiskers (antennae), and slender legs. There were thousands of species adapted to a wide range of habitats. Shrimp are often solitary, although they can form large schools during the spawning season. They play a vital role as they were an important food source. The well-developed tails of many shrimps are edible to humans, because of that reason they are extensively caught and cultured for consumption. The Commercial shrimp species support an industry worth 50 billion dollars a year. Now a days, there were only two species which commercially cultured were white leg shrimp (*Litopenaeus Vannamei*) and Giant tiger prawn (*Penaeus Monodon*). White leg shrimp also known as Pacific white shrimp or King prawn commonly caught or farmed for food. White leg shrimp is the most widely cultivated species all over India.

Objective of study

To study the socio-economic characteristics of shrimp farmers
To estimate the growth rate of shrimp production.

Material and methods

Growth Rate

The compound growth rates of shrimp production were worked out using an exponential function of the form,

$$Y = A B^x$$

By taking logarithm on both sides of the equation, takes the linear form:

$$\log Y = \log A + x \log B$$

On writing $\log A = a$, $\log B = b$ and $\log Y = y$, the equation becomes

$$y = a + bx$$

Where;

y = Dependent variable (production)

x = Time (independent variable)

a = Constant

b = Regression coefficient of y on x

The compound growth rate (r) is = $\text{Antilog}(b-1) \times 100$

The standard error of the compound growth rate was calculated using the formula:
Projection

The projection of shrimp production was worked out using the least square method. This model was a completely mathematical model. It was considered very appropriate for fitting regression equation for projection. Here, we assumed a mathematical model which is suitable for the trend and fit this equation to the time series data of shrimp production. In this model, fitting the model means estimating parameters involved in it, based on the principle that the sum of squares of deviations of the actual value from the corresponding estimate values from the fitted trend is minimum. First, we consider the linear model;

$$Y = a + Bx + e$$

Where,

Y = Year of production

X = Production

a and β = parameters

e = error term distributed as $N(0, \sigma^2)$

Let, a and b were the estimates of a and β . Then, the fitted equation was;

$$Y_c = a + bX$$

Where,

a = intercept

b = slope of trend line which gives the rate of growth

Y_c = Estimated value of Y

Under least square method, the quantity $\sum (Y - Y_c)^2$ is minimized. The line obtained was a dynamic average of the movement through time as given in the original data, thus it was average path. This method also possessed another characteristics that $\sum (Y - Y_c) = 0$. The trend as average path is also known as the line of best fit [1].

Results and Discussion

Table-1 presented the particulars regarding the family size and illustrated that most of the respondents' family size were lying between 4 to 6 family members (i.e., 102 of total respondents).

Table-1 The family size of the respondents, (n=240)

Sr. No.	Family size (No.)	No. of respondents	Per cent
1	<4	33	13.75
2	4 to 6	102	42.50
3	7 to 9	83	34.58
4	≥10	22	9.17
	Total	240	100.00

Table-2 presented the social status of the respondents. It was observed from Table-2 that 5.42 per cent of the respondents were Schedule Caste (SC) and Schedule Tribes (ST) respondents accounted 6.25 per cent. Majority of the farmers were in the category of Other Backward Class (OBC), i.e., 79.16 per cent of total sample size. In the coastal belt region, most of the people were belonging to other backward class.

Table-2 Social status of the respondents, (n=240)

S. No.	Social status	No. of respondents	Per cent
1	SC	13	5.42
2	ST	15	6.25
3	OBC	190	79.16
4	OC	22	9.17
	Total	240	100.00

Table-3 presented the age group of the respondents. It was observed from Table-3 that the numbers of respondents within the age group of 25-35 years were 62 in number. The respondents within the age group of 35-45 years were 122 in number (prime working age group). The respondents within the age group of greater than 45 years were 56 in number. In prime working age, farmers are more active, experienced and efficient in resource use with maintaining better management practices in shrimp farming than the others. Mozumder *et al.*, (2018) [2] and Begum *et al.*, (2015) [3] found the consistent result.

Table-3 Age group of the respondents, (n=240)

Sr. No.	Age group (Years)	No. of respondents	Per cent
1	<25	0	0.00
2	25-35	62	25.83
3	35-45	122	50.83
4	>45	56	23.34
	Total	240	100.00

Table-4 presented the type of shrimp farms. Table-4 illustrated that the semi-intensive farms are 50.83 per cent out of the total number of farms that show the predominance of semi-intensive farms in Gujarat state. Intensive farms constitute 42.92 per cent, and extensive farms constitute only 6.25 per cent of total farms. The study of Mozumder *et al.* (2018) revealed that fish farmers belonging from medium families were about 67 per cent [2]. Tammaroopa *et al.* (2016) also found a similar result for the family members.[4]

Table-4 Types of Shrimp Farms, (n=240)

S. No.	Type of farm	No. of respondents	Per cent
1.	Extensive	15	6.25
2.	Semi- intensive	122	50.83
3.	Intensive	103	42.92
	Total	240	100

Table-5 showed the particulars regarding the educational status. It observed from the figures in Table-5 that the number of respondents who completed education up to 7th standard was one (0.42%). In comparison, the number of respondents who had secondary school education was 84 (35%). The number of shrimp farmers who had educated up to graduate level was 54, i.e., 21.67 per cent of total shrimp farmer. Postgraduate degree found only 3.33 per cent of the total shrimp farmers. It was clear from the table that most of the farmers educated, denoting good literacy levels.

Education plays an important role in hastening the pace of the agricultural development and it greatly influences the new technology and scientific

knowledge in farm practices. Particulars regarding the experience of shrimp farming were illustrated in Table-6.

Table-5 Education level of the respondents, (n=240)

S. No.	Education level	No. of respondents	Per cent
1	Primary	1	0.42
2	Secondary	84	35.00
3	Higher Secondary	95	39.58
4	Graduation	52	21.67
5	Post-Graduation	8	3.33
	Total	240	100.00

It was observed from the Table-6 that 18.75 per cent of shrimp farmer have experience less than equal to 5 years. The majority of the farmers had experience greater than five to less than equal to ten years group and greater than ten to less than equal to fifteen years group that was 38.33 per cent and 30.84 per cent of total shrimp farmers, respectively. It was observed that 12.08 per cent of farmers having greater than fifteen years' experience. Tammaroopa *et al.*, (2016) [4] and Mozumder *et al.*, (2018)[2]. also found similar results.

Table-6 Experience of shrimp respondents, (n=240)

S. No.	Experience	No. of respondents	Per cent
1	≤5 years	45	18.75
2	>5 to ≤10 years	92	38.33
3	>10 to ≤15	74	30.84
4	>15	29	12.08
	Total	240	100.00

The area under cultivation (AUC) and estimated production (EP) under tiger shrimp (*L. Vannamei*) and white leg shrimp of the Gujarat state presented in Table-7. From the Table-7, it was observed that the area under cultivation of tiger shrimp was 1916 hectares in Gujarat, i.e., 99.53 per cent of total shrimp cultivated area in 2009 -10 and in the 2019-20 year, it decreased to 101 hectares of total shrimp cultivated area in Gujarat. It was also be observed from the Table-7 that the production under cultivation of tiger shrimp was 3606 tonnes during the year 2009-10 which accounted 98.74 per cent of total shrimp production in Gujarat and in the year 2019-20, total tiger shrimp production in Gujarat was decreased to 303 tonnes. As for now, the cultivation of white leg shrimp (*L. Vannamei*) dominated in the State of Gujarat. The area under cultivation of this species was 9 hectares, which accounted for only 0.47 per cent of total shrimp cultivated area in 2009-10. In the year 2019-20, it was increased to 9608 hectares, i.e., increased to 98.96 per cent of the total area under cultivation in Gujarat. It can also be observed from Table-7 that *L. Vannamei* productions were only 46 tonnes, i.e., 1.26 per cent of total shrimp production in 2009-10. The production of *L. Vannamei* in Gujarat estimated 73,539 tonnes in the year 2019-20, which accounted for 99.59 per cent of total shrimp production. These findings have been supported by Kumar *et al.* (2010)[5] and Maurya *et al.* (2018)[6]. The data presented in figure 4.1 indicated that *L. Vannamei* replaces the area under tiger shrimp cultivation because it gave more production than the tiger and other shrimps. Because of that, all the farmers of Gujarat preferred to cultivate only *L. Vannamei* in current years. Therefore, more farmers did *L. Vannamei* cultivation in more area and got more production which accounted for 3348.19 tonnes in year 2012-13. After the intensification of *L. Vannamei* in Gujarat, there was incidence of disease (viz; white spot syndrome disease) in 2017-18. Therefore, there was decrease in area under cultivation and production in 2017-18 and 2018-19. The study estimated the Compound Annual Growth Rate (CAGR) of area and production of shrimp at national as well as state level for Gujarat. The CAGR calculated for the overall period from 2001-02 to 2019-20 and two sub-periods. The period-I starts from 2001-02 to 2008-09 and the second period (Period-II) starts from 2009-10 to 2019-20. Table-8 shows the compound annual growth rate of total shrimp and white leg shrimp (*L. Vannamei*), respectively. The relevant data relating to area under the shrimp production for the India and Gujarat state had collected from reports of Marine Product Export Development Authority (MPEDA) and Directorate of Fisheries, Govt. of Gujarat. Compound Annual Growth Rate (CAGR) in the shrimp area showed a negative trend in period-I (-2.30 per cent per annum) whereas, it has positive trend statistically significant at one percent in Period-II (1.59 per cent per annum) in India.

Table-7 Production pattern of shrimp farming in Gujarat (Source: MPEDA, 2020)

Year	Total Shrimp		Tiger Shrimp				White leg Shrimp			
	AUC	EP	AUC	EP	AUC (%)	EP (%)	AUC	EP	AUC (%)	EP (%)
2009-10	1925	3652	1916	3606	99.53	98.74	9	46	0.47	1.26
2010-11	2030	6392	1966	5675	96.85	88.78	64	717	3.15	11.22
2011-12	2059	6064	1971	4869	95.73	80.29	88	1195	4.27	19.71
2012-13	2359	9393	1992	6045	84.44	64.36	366.71	3348.19	15.55	35.65
2013-14	2082	10688	1375	4362	66.04	40.81	707	6326	33.96	59.19
2014-15	4426.18	30156.82	880.78	2183.82	19.9	7.24	3545.4	26763	80.1	88.75
2015-16	4552	35499	398	1243	8.74	3.5	4154	32946	91.26	92.81
2016-17	7982	42755	437	1346	5.47	3.15	5219	41409	65.38	96.85
2017-18	7597	56781	55	162	0.73	0.29	7542	55161	100	97.15
2018-19	6792.5	59359	207	595	3.05	1	6585	58764	96.95	99
2019-20	9709	73842	101	303	1.04	0.41	9608	73539	98.96	99.59

Table-8 Compound annual growth rate and projection of shrimp

Country/ State	Period	CAGR (% per annum)		Projection of production in 2025 (tonnes)
		AUC	EP	
Gujarat	Period – I	5.84 **	9.56 **	72,889.89
	Period – II	9.50 **	14.92 **	
	Overall	6.40 **	11.86 **	
India	Period – I	-2.30 *	-0.29 NS	8,46,027
	Period – II	1.59 **	7.09 **	
	Overall	0.10 NS	5.55 **	

* Significant at 5 per cent level of significance, ** Significant at 1 per cent level of significance

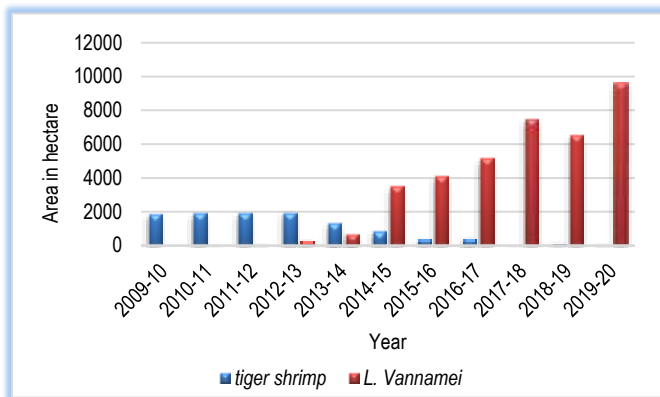


Fig-1 Area under cultivation of tiger shrimp and L. Vannamei in Gujarat

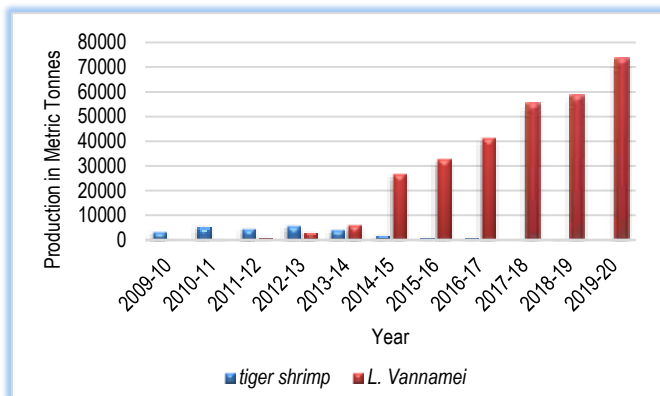


Fig-2 Production of tiger shrimp and L. Vannamei in Gujarat

The growth in shrimp area in overall period was positive (0.10 per cent per annum) in India which was non-significant. Compound Annual Growth Rate (CAGR) in area of shrimp culture of Gujarat showed a positive trend in all periods (i.e., 5.84 per cent per annum, 9.50 per cent per annum and 6.40 per cent per annum in period-I, Period-II and overall period, respectively). And they were statistically significant at one percent in all period.

Compound Annual Growth Rate (CAGR) in production of shrimp culture of India showed a negative trend in period-I (i.e., -0.29 per cent per annum) which was non-significant whereas it showed positive trend in period-II (i.e., 7.09 percent per annum) and in overall period (5.55 per cent per annum).

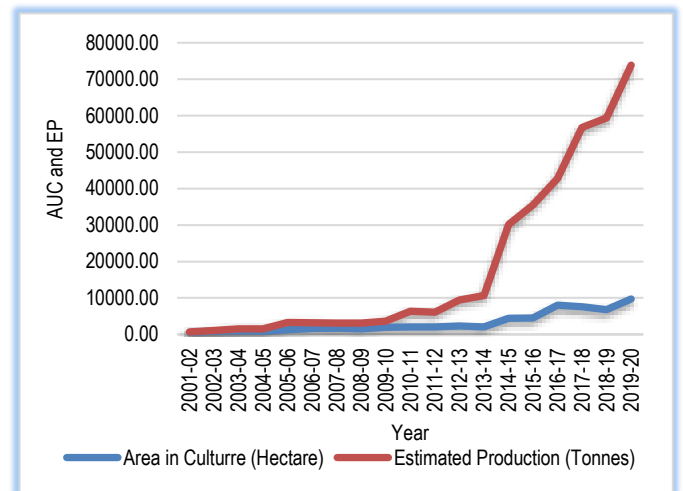


Fig-3 Area and Production of Shrimp in Gujarat

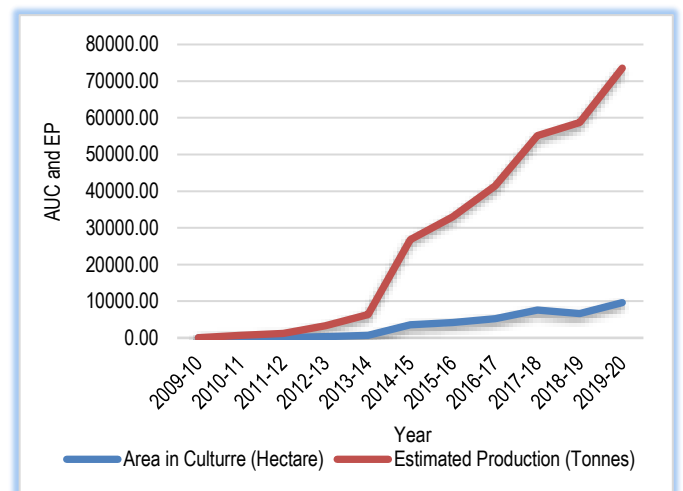


Fig-4 Area and Production of Shrimp in India

Period-II and overall period were statistically significant at one per cent. In Gujarat, Compound Annual Growth Rate (CAGR) in shrimp production showed a positive trend in all periods (9.56 per cent per annum in period-I and 14.92 per cent per annum in period-II and 11.86 per cent in overall period). The all-period growth rate was statistically significant at one percent.

Katiha *et al.* (2005) revealed that contribution of aquaculture in inland fish production has increased sharply from 46.36 per cent in 1984 to 85.65 per cent in 2002–03. This increase is primarily due to the tremendous rise in output from freshwater aquaculture (from 0.3 to 2.0 mt) [7]. Islam *et al.* (2016) reveals that in 2000-01 the total fish production was only 17, 81,057 tonnes and in 2012-13 it has increased to 34,10,254 tonnes. The growth rate of production is as high as 5% to 7% per annum during this period [8]. For total shrimp in India, the projection for production in 2025 was 8,46,027 tonnes and production in Gujarat was projected 72,889.89 tonnes in the year 2025.

Conclusion

It was concluded from this study that, most of the shrimp farmer family size were lying between 4 to 6 family members and majority of the farmers were belong from the category of Other Backward Class (OBC). Majority of the farmers were below the 45 years of age. The majority shrimp farmers in Gujarat state practice semi-intensive and intensive type of shrimp culture and they have experience about 5 to 10 years. The compound annual growth rate (CAGR) in shrimp area in overall period was positive in India which was non-significant whereas, the growth in shrimp area in overall period was positive statistically significant at one percent in all period in Gujarat. The compound annual growth rate (CAGR) in shrimp production in overall period was positive statistically significant in India and Gujarat. This study illustrated that *L. Vannamei* replaces the area under tiger shrimp cultivation because it gave more production than the tiger and other shrimps. Because of that, all the farmers of Gujarat preferred to cultivate only *L. Vannamei* in current years. Therefore, more farmers did *L. Vannamei* cultivation in more area and got more production.

Application of research: research helpful to study the compound annual growth rate and its projection in shrimp production.

Research Category: Agricultural Economics

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University: Navsari Agricultural University, Navsari, 396450, Gujarat

Research project name or number: PhD Thesis

Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: Valsad, Navsari, Surat, and Bharuch districts

Cultivar / Variety / Breed name: Shrimp (*Litopenaeus Vannamei*), Giant tiger prawn (*Penaeus Monodon*)

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.

Ethical Committee Approval Number: Nil

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