

**AN ECONOMIC ANALYSIS OF *Litopenaeus
vannamei* SHRIMP FARMING IN
NAGAPATTINAM DISTRICT,
TAMIL NADU**

*Thesis submitted in part fulfillment of the requirements of the Degree
of **Master of Fisheries Science in Fisheries Economics**
to the Tamil Nadu Fisheries University, Nagapattinam.*

P.RAJARAJAN, B.F.Sc.

I.D.No. MFT 15077 (FEC)



**DEPARTMENT OF FISHERIES ECONOMICS
SCHOOL OF FISHERIES INFORMATION AND SOCIAL SCIENCES
FISHERIES COLLEGE AND RESEARCH INSTITUTE
TAMIL NADU FISHERIES UNIVERSITY
THOOTHUKUDI-628008**

2017

CERTIFICATE

This is to certify that the thesis entitled, "An Economic Analysis of *Litopenaeus vannamei* Shrimp Farming in Nagapattinam district, Tamil Nadu," submitted in part fulfillment of the requirements of the degree of **Master of Fisheries Science in Fisheries Economics** to the Tamil Nadu Fisheries University, Nagapattinam, is a record of bonafide research work carried out by **P.RAJARAJAN, MFT 15077 (FEC)** under my supervision and guidance and that no part of thesis has been submitted for the award of any other degree, diploma, fellowship or similar titles or prizes and that part of thesis has been published peer reviewed journal(s) and copy / copies appended.

Place : Thoothukudi

CHAIRMAN

Date :

RECOMMENDED

Place :

Date :

EXTERNAL EXAMINER

APPROVED BY

Chairman : **Dr. R. SENTHILADEBAN**

Members : **1. Dr. M. RAJAKUMAR**

: **2. Dr. R. SANTHAKUMAR**

Place :

Date :

***Dedicated to my parents and
my guide***

ACKNOWLEDGEMENTS

Gratitude is the smallest I can express for every blessing life has bestowed on me and the oceans, which has inspired me to venture into this field of study.

I express my deepest sense of gratitude and indebtedness to Dr. R. Senthiladeban, Director, Staff Training Institute, Chennai, Tamil Nadu Fisheries University (TNFU) and Chairman of my Advisory Committee for his immense fortitude, valuable guidance, critical comment, care and encouragement throughout the period of research work. I am extremely grateful and profoundly obliged to the benevolent guidance, valuable suggestions and constructive criticism extended by Members of Advisory Committee Dr. M. Rajakumar, Professor and Head, Department of Fisheries Economics and Dr. R. Santhakumar, Professor and Chair, School of Fisheries Information and Social Sciences for their valuable suggestions.

I take this opportunity to show my deep debt of gratitude and regard to Vice-Chancellor of TNFU, Dr. S.Felix and G. Sugumar Dean, Fisheries College and Research Institute (FC&RI), Thoothukudi for their constant support, timely concern and for providing facilities to undertake this study.

I am grateful to, Dr. N. Sujathkumar, M.F.Sc Co-ordinator, Professor and Head, Department of Fisheries Information and Statistics for his help and encouragement during my study period.

I am grateful to my beloved teacher Mrs. Umamaheshwari, Asst. Professor, Department of Fisheries Economics, for assisting me during the study.

I gratefully acknowledge to Jagadeesh, Kanaga, A.Anuja, Jeelani and my classmates Pasupathi, Vignesh for the help rendered in framing the questionnaires for the survey work and statistical analysis of data.

I convey my special thanks to Mr. Karthikeyan, Mr. Annadurai and Mr. Artheeswaran for provide accommodation facilities during the Survey work.

I thank Mrs. Krishnammal, Attendant, and all other staff members of the Department of Fisheries Economics for their help and friendliness during the course of my study period. It is my privilege to express my heartfelt thanks to all my farmer friends for their cooperation in successfully carrying out my work.

I take this opportunity to thank my well-wishers Mogalekar, Dilipmaniraj, Arunprasath, Mariyappan, Kandharam, Karthi and Pavithran, for their co-operation during the study. I express my sincere thanks to my seniors, juniors, UG and PG classmates for their encouragement and moral support.

I would like to acknowledge all the teaching and non-teaching faculty, staff of boy's hostel, library staff, FC&RI, Thoothukudi for their kind assistance and co-operation during my study period.

I am grateful to Tamil Nadu Fisheries University, Nagapattinam for offering TNFU Merit Scholarship for my M.F.Sc Programme. Finally I thank my family and Almighty Lord for their blessing for the successful completion of the work.

(P.RAJARAJAN)

ABSTRACT

Title	: An Economic Analysis of <i>Litopenaeus vannamei</i> Shrimp Farming in Nagapattinam district, Tamil Nadu
Name of the student	: P.RAJARAJAN
Degree	: M.F.Sc
Chairman	: Dr. R. Senthiladeban
Department	: Fisheries Economics
School	: Fisheries information and social sciences
College	: Fisheries College and Research Institute
Year and University	: 2017, Tamil Nadu Fisheries University

The present study was taken up to carry out the economic analysis of the shrimp farming practices in Nagapattinam district, Tamil Nadu during the period 2016-17. The specific objectives of the study were to study the present status of *L.vannamei* farming practices and the socio-economic characteristics of the selected shrimp farmers, to estimate the costs and returns of *L.vannamei* shrimp farming, to analyze the various risks involved in shrimp farming and suggest policy measures for the overall development of *L.vannamei* farming in Nagapattinam district, Tamil Nadu. Nagapattinam district was chosen as the study area in view of abundant *L.vannamei* shrimp farming activities in the district. The total sample size was fixed as 100 for the present study which was equally distributed among the five coastal taluks namely, Sirkazhi, Tharangambadi, Nagapattinam, Kilvelur and

Vedaranyam of the Nagapattinam district. The above stated samples were divided into small, medium and large *L.vannamei* shrimp farmers based on shrimp culture area. The above stated shrimp farmers were selected randomly for data collection in the present study. The shrimp farmers stocked at a density of 40-60 numbers/m² in their ponds. The average culture period was 90 – 120 days and the average survival rate of the stocked shrimp seeds was 70% – 80%. The predominant age group of the shrimp farmers (50%) were aged between 36 and 45 years. Most of the shrimp farmers were educated up to middle school and they had own ponds for shrimp farming. For the small, medium and large shrimp farmers, the mean total cost per ha per crop was estimated as ₹22,65,304, ₹22,10,022 and ₹21,82,933 respectively. The mean total gross returns was calculated as ₹25,58,725, ₹25,66,905 and ₹26,40,621 respectively and the mean total net returns per ha per crop was ₹2,93,420, ₹3,56,882 and ₹4,57,687 respectively. Among the shrimp farmers, the BCR on TVC basis was 1.24, 1.27 and 1.31 for the small, medium and large farmers respectively. Similarly on TC basis, it was 1.13, 1.16 and 1.21 respectively and the rate of returns on capital investment on TVC basis ranged 96.5% to 182.6% for small, medium and large shrimp farmers and the rate of returns on capital investment on TC basis ranged between 57% and 135% for small, medium and large shrimp farmers. The average production cost per kg was calculated ₹270, ₹263 and ₹260 for the small, medium and large shrimp farmers. The net returns per kg was calculated as ₹34.92, ₹42.51 and ₹54.42 for the small, medium and large shrimp farmers. Factors determining the total shrimp production was estimated by linear regression model. The explanatory variables used were supplementary feed, fertilizer, chemicals and drugs, stocking density, survival rate, electricity, labours and fuel. The partial regression co-efficient of supplementary

feed, fertilizer, stocking density and survival rate were positive and significant at $p = 0.05$ in the shrimp farming. The co-efficient of multiple determination (R^2) in the estimated function was found to be 0.859 implying that 85.90% of the variation in the total shrimp yield was explained by the eight independent variables included in the functional analysis. The production risks were expressed as the foremost risks among the various types of risks in shrimp farming by the selected shrimp farmer respondents. The major constraints comes under the various types of risks in shrimp farming were the lack of good quality shrimp seeds, inadequate institutional financial assistance, shrimp price fluctuations, inadequate consultation & meeting with Govt. officials, floods and direct discharge of waste water into the open sea. The socio economic status of the shrimp farmers had substantially improved and hence the present study recommends the farming of *L.vannamei* with good management practices in Nagapattinam district of Tamil Nadu.

CONTENTS

Chapter No.	Title	Page No.
1.	INTRODUCTION	1-6
	1.1. Indian fisheries	1
	1.2. Indian Fisheries Resources	2
	1.3. Tamil Nadu fisheries	3
	1.4. Objectives of the study	4
	1.5. Scope of the study	5
	1.6. Limitations of the study	5
	1.7 Organization of the thesis	5
2.	REVIEW OF LITERATURE	7-15
	2.1 Review of earlier studies	7
3.	MATERIALS AND METHODS	16-40
	3.1 Concepts	16
	3.1.1 Capital investment	16
	3.1.2 Total fixed cost	16
	3.1.3 Total variable cost	17
	3.1.4 Miscellaneous cost	18
	3.1.5 Total cost	18
	3.1.6 Depreciation	18
	3.1.7 Gross returns	19
	3.1.8 Net returns	19
	3.1.9 Inputs	19
	3.1.10 Output	19
	3.1.11 Benefit cost ration (BCR)	19
	3.1.12 Rate of returns on capital investment	20
	3.1.13 Primary occupation	20
	3.1.14 Secondary occupation	20

	3.1.15 Classification of shrimp farmers	20
	3.1.16 Stocking Density	21
	3.1.17 Survival Rate	21
	3.1.18 production function	21
	3.1.19 Marketing channels	22
	3.1.20 Biosecurity	22
	3.1.21 Shrimp farming risks	23
	3.1.22 Production risks	23
	3.1.23 Marketing risks	23
	3.1.24 Financial risks	24
	3.1.25 Natural risks	24
	3.1.26 Social risks	24
	3.1.27 Extension risks	25
	3.2 Design of the study	25
	3.2.1. Choice of study area	25
	3.2.2. Sampling procedure	26
	3.2.3. Tools of analysis	26
	3.2.3.1. Descriptive Statistics	26
	3.2.3.2 Tabular Analyses	27
	3.2.3.3 Functional analysis of shrimp culture	27
	3.2.3.4 Garrett's Ranking Technique	28
	3.3 Description of the study area	29
	3.3.1 An overview of Nagapattinam district	29
	3.3.2 Location	29
	3.3.3 Demographic features	30
	3.3.3.1 Population	30
	3.3.3.2 Water Availability	31
	3.3.3.3 Climate and Rainfall	31

	3.3.4 Economy	32
	3.3.4.1 Agriculture	32
	3.3.4.2 Animal husbandry	32
	3.3.4.3 Industries	33
	3.3.4.4 Minerals	33
	3.3.4.5 Tourism	34
	3.3.5 Fisheries	34
	3.3.5.1 Marine Fisheries	34
	3.3.5.2 Infrastructure facilities for marine fisheries	35
	3.3.5.3 Inland Fisheries	36
	3.3.5.4 Brackish water aquaculture resources of Nagapattinam district	37
	3.3.6 Infrastructure and support services available for shrimp culture	37
	3.3.6.1 Shrimp seed supply	37
	3.3.6.2 Disease diagnostic service	37
	3.3.6.3 Market	38
	3.3.6.4 Transport	38
	3.3.6.4.1 Roadways	38
	3.3.6.4.2 Railways	39
	3.3.6.4.3 Seaport	39
4	RESULTS AND DISCUSSION	41-73
	4.1. Present status and details of shrimp culture activities in the study area	41
	4.2 Demographic characteristics of the selected shrimp farmers	43
	4.3 Costs and returns of the shrimp farming practices	46
	4.3.1 Classification of the shrimp farmers based on the area	46
	4.3.2 Costs and returns of the shrimp farmers	46

	4.3.2.1 Items of capital investment for the selected shrimp farmer respondents	46
	4.3.2.2 Items of fixed cost for the selected shrimp farmer respondents	49
	4.3.2.3 Items of variable cost for the selected shrimp farmer respondents	52
	4.3.2.4 Total cost of the selected shrimp farmer respondents	54
	4.3.2.5 Mean production and the Mean Gross Returns of the selected shrimp farmer respondents	56
	4.3.2.6. Economic Indicators of the farming practices of the selected shrimp farmer respondents	57
	4.3.2.7 Benefit Cost Ratio of the shrimp farmers	58
	4.3.2.8 Rate of returns on capital investment of the shrimp farmers	59
	4.3.2.9 The Average Cost Analysis for the selected shrimp farmer respondents	60
	4.3.2.10 Production function analysis in shrimp farmer respondents	63
	4.4 Risk analysis in the shrimp farming practices	65
	4.4.1 Constraints in the shrimp farming Practices	65
	4.4.1.2 Production constraints for the selected shrimp farmer respondents	66
	4.4.1.3 Marketing constraints for the selected shrimp farmer respondents	68
	4.4.1.4 Financial constraints for the selected shrimp farmer respondents	69
	4.4.1.5 Natural constraints for the selected shrimp farmer respondents	70

	4.4.1.6 Social constraints for the selected shrimp farmer respondents	71
	4.4.1.7 Extension constraints for the selected shrimp farmer respondents	72
5	SUMMARY AND CONCLUSION	74-83
	5.1 Summary	74
	5.2 Conclusion	79
	5.3 Strategies suggested for the development of shrimp farming	81
6	REFERENCES	84-89
7	7.1 Plates	
	7.2 Survey schedule	
	7.3 BMPs Guidelines	

LIST OF TABLES

Table No.	Title	Page No.
1.1	Fisheries Resources of India	3
1.2	Fisheries Resources of Tamil Nadu	4
3.1	Demographic characteristics of Nagapattinam District, Tamil Nadu	30
3.2	Marine fisheries potential of Nagapattinam district	35
3.3	The infrastructure facilities of Nagapattinam district for marine fisheries	35
3.4	Inland fisheries potential of Nagapattinam district	36
3.5	Details of Brackish water shrimp farming in Nagapattinam district	37
4.1	Demographic characteristics of the selected shrimp farmers	43
4.2	Primary occupation and farming experience of the shrimp farmers	45
4.3	Classification of the shrimp farmers based on the culture pond area	46
4.4	Item of capital investment for the selected shrimp farmer respondents	47
4.5	Items of fixed cost for the selected shrimp farmer respondents	50
4.6	Items of fixed cost for the selected shrimp farmer respondents per crop	51
4.7	Items of variable cost for the selected shrimp farmer respondents	53
4.8	Total cost of the selected shrimp farmer respondents	55
4.9	Mean production and the Mean Gross Returns of the selected shrimp farmer respondents	56
4.10	Economic Indicators of the farming practices of the selected shrimp farmer respondents	58

4.11	Average Cost Analysis for the selected shrimp farmer respondents	61
4.12	Various types of risks involved in <i>L.vannamei</i> shrimp farming in the study area	65
4.13	Production constraints among the selected shrimp farmer respondents	66
4.14	Marketing constraints among the selected shrimp farmer respondents	68
4.15	Financial constraints among the selected shrimp farmer respondents	69
4.16	Natural constraints among the selected shrimp farmer respondents	70
4.17	Social constraints among the selected shrimp farmer respondents	71
4.18	Extension constraints among the selected shrimp farmer respondents	72

LIST OF FIGURES

Figure No.	Titles	Page No.
3.1	Map showing the study area	40
4.1	Costs and returns of the selected shrimp farmers	60
4.2	Average Cost Analysis for the selected shrimp farmer respondents	62

LIST OF PLATES

Plate No.	Titles	
1	Pond Preparation for shrimp Seed Stocking.	
2	Water Filling and Seed Stocking	
3	a. Shrimp supplementary feed given through feed Boats.	
	b. Dyke feeding	
4	Sampling of shrimp	
5	Growth & Size checking	
6	Aqua medicines and probiotics application	
7	Aeration given to shrimp through paddle wheel and spiral aerators.	
8	Feed Check tray observation and water quality parameter kits	
9	Shrimp Harvesting	

I. INTRODUCTION

Fisheries sector has a strategic role in food security, international trade and employment generation. The Fisheries sector over the years has transformed from subsistence-based artisanal activities to modern livelihood activities with the application of science and modern technologies in the field of capture fishing and culture fisheries. Fisheries and aquaculture directly or indirectly play a vital role in the livelihood of millions of people round the world. In the last three decades, the number of fishers and fish farmers has grown faster than the world's population and employment in traditional agriculture (FAO, 2011). In developing countries, fishery exports are higher than those of other agricultural commodities (sena, 2000). Global production of fish, crustaceans, molluscs and other aquatic animals continued to grow and reached 167.2 million tonnes in 2014. Of this total, capture production was 93.4 million tonnes, an increase of 0.8 percent compared with the previous year. Aquaculture production has increased at an average annual growth rate of 5.8 percent, from 44.3 million tonnes in 2005 to 73.8 million tonnes in 2014. The value of aquaculture production is estimated at USD 160.2 billion in 2014. China was the top-ranking fishing country in terms of quantity followed by Indonesia, the United States of America, India and the Russian Federation. (FAO, 2014)

1.1 Indian Fisheries

In the world, India is amongst the top three producers of rice, wheat, liquid milk, poultry products, fruits, vegetables, coconut, tea, spices, marine and fresh water products including fish and shrimp. India is the second largest fish producer in the world contributing to 6.3% of global fish production. India is also a major producer of fish through aquaculture and ranks second in the world after China.

The fisheries sector provides employment to millions of people and contributes to food security of the country and usually makes a valuable contribution to socio-economic development of coastal areas in the country. In recent years, it has assumed greater significance and its contribution towards the National economy in terms of livelihood and nutritional security, rural employment generation and foreign exchange earnings have been enormous in the country. Fisheries include marine, freshwater and brackish water subsectors has been recognized as a source of cheap and nutritious food in the country. The fishery sector also accounts for 0.83 percent of total GDP and 4.75 percent of the agriculture sector's GDP at current price for the 2012-13. During 2013-14, the volume of fish and fish products exported was 9, 83,756 tonnes worth 30,213.26 crores (Handbook on Fisheries Statistics, 2014). The total fish production during 2014-15 was at 1,00,72,411 tonnes with a contribution of 65,81,121 in tonnes) from inland sector and 34,91,290 tonnes from marine sector respectively (BAH&FS, 2015).

1.2 Indian Fisheries Resources

Fisheries is an important sector in India with a coastline of over 8,118 km, an Exclusive Economic Zone (EEZ) 2.02 million sq. km, there are 3,322 marine fishing villages and 1,537 marine fish landing centres in 9 maritime states and 2 union territories. The total marine fisher folk population was about 4 million comprising of 8,74,749 families. The inland fishery resources of the country comprises of the rivers and canals, reservoirs, tanks and ponds, estuaries, brackish water lakes, backwaters, floodplain lakes or derelict waters (oxbow lakes) etc. while the marine water bodies are mainly used for capture fisheries resources, the inland water bodies are widely used for culture and capture fisheries. India has a total inland water bodies accounting for 73.59 lakh ha in the form of numerous rivers,

streams, wetlands, lakes, etc. The country as a whole has a river lengths (including canals) of 1,95,210 km, reservoirs of 29.07 lakh ha, tanks and ponds of 24.14 lakh ha, flood plain lakes and derelict water bodies of 7.98 lakh ha, and brackish water areas of 12.40 lakh ha. The details of Indian fisheries resources are presented in Table 1.1.

Table 1.1. Fisheries Resources of India

Marine	
Length of coast line (km)	8,118
Exclusive Economic Zone (EEZ) million Sq km	2.02
Continental Shelf ('000 sq km)	530
Number of Fish Landing Centres	1,537
No of Fishing villages	3,322
No of fishermen families	8,74,749
Fisher-folk population	40,56,213
Inland	
Total inland water bodies (lakh ha)	73.59
Rivers & canals (km)	195210
Reservoirs (lakh ha)	29.07
Tanks & ponds (lakh ha)	24.14
Flood plain lakes/derelict waters (lakh ha)	7.98
Brackish water areas (lakh ha)	12.4

(Source: Basic Animal Husbandry & Fisheries Statistics, India.2015)

1.3 Tamil Nadu fisheries

Tamil Nadu is one of the leading maritime states in Fisheries Development having coastal length of 1076 km in India. Tamil Nadu is bordered on the north by Andhra Pradesh State, on the northwest by Karnataka state, on the west by Kerala state and on the east and south by the Bay of Bengal and the Indian Ocean. The different types of aquatic resources in Tamil Nadu like marine, freshwater, brackish water, riverine stretches and cold water streams in upland area are bestowed with rich biodiversity of aquatic fauna and flora. There are more than 2500 species of

fishes found in different aquatic environment. The fisheries in the state is one of the vital source for food security. The total fish production during 2014-15 was at 6,97,612 tonnes with a contribution of 2,40,158 tonnes from inland sector and 4,57,454 tonnes from marine sector respectively (BAH&FS, 2015). The fisheries resources of Tamil Nadu are presented in Table 1.2.

Table 1.2. Fisheries Resources of Tamil Nadu

Marine	
Length of coast line (km)	1076
Continental Shelf ('000 sq km)	41
Number of fish landing centres (Nos)	407
No of marine fishing villages (Nos)	573
No of fishermen families (Nos)	192697
Fisher-folk population (Nos)	802912
Inland	
Total inland water bodies (lakh ha)	6.93
Rivers & canals (km)	7420
Reservoirs (lakh ha)	5.70
Tanks & ponds (lakh ha)	0.56
Flood plain lakes/derelict waters (lakh ha)	0.07
Brackish water areas (lakh ha)	0.60

(Source: Basic Animal Husbandry & Fisheries Statistics, India.2015)

1.4 Objectives of the study

The overall objective of the study is to work out the economics of *L.vannamei* shrimp farming in Nagapattinam district, Tamil Nadu.

The specific objectives were as follows:

1. to study the present status of *L.vannamei* farming practices and the socio-economic characteristics of the selected shrimp farmers
2. to estimate the costs and returns of *L.vannamei* shrimp farming
3. to analyze the various risks involved in shrimp farming

4. to suggest policy measures for the overall development of *L.vannamei* farming

1.5 Scope of the study

The results of the proposed study would provide information on the costs involved and returns from *L.vannamei* shrimp farming and reveal the profitability and constraints of *L.vannamei* farming in Nagapattinam district so that it could be used by the farmers elsewhere in Tamil Nadu. This information would be highly useful for the aquaculture farmers that encourage them to adopt in *L.vannamei* farming in Tamil Nadu. The study would help us to formulate strategies for the overall development of *L.vannamei* shrimp farming.

1.6 Limitations of the study

The limitations of the study is that it covers only a part of the shrimp farmer respondents in Nagapattinam district due to lack of time and logical constraints. The data were collected from the memories of shrimp culture farmers for the study since they do not kept the farm records. Shrimp farmers in the study area were reluctant to reveal the information on the costs and returns in shrimp farming for various reasons. The results of the study are subject to many factors like farm-specific situations, levels of knowledge of farmers, access to information sources and extension agencies and the other factors like inter-temporal and inter-regional variations have to be considered while applying the results of the study. Hence, the findings of this study could not be over generalized.

1.7 Organization of the thesis

Chapter 1 Introduction-objectives, scope and limitations of the study.

Chapter 2 Review of Literature – A review of earlier studies is presented.

Chapter 3 Materials and Methods

3.1 Concepts – A review of earlier concepts and the concepts used for the present study are presented.

3.2 Design of the Study-methodology and tools of analyses used.

3.3 Description of the Study Area-A short profile of the study area.

Chapter 4 Results and Discussion – the results of the study are presented along with discussion considering the earlier studies.

Chapter 5 Summary and Conclusion: the summary of the study is presented along with the conclusions and policy implications.

Chapter 6 References- the references used for the study are presented.

II. REVIEW OF LITERATURE

2.1. Review of Earlier Studies

Shrimp farming is an aquaculture business which produce shrimps for human consumption. In India, commercial shrimp farming was started in the early 1980s and attained industrial proposition in the late 1980s. As the returns were lucrative, many medium and small farmers and corporate sectors started extensive, semi-intensive and intensive shrimp culture operations. Frozen shrimp is the largest export item from India in the marine sector. SPF *Litopenaeus vannamei* - the newly introduced shrimp has the potential of increased production compared to *P.monodon*. Indian shrimp aquaculture production has more than tripled due to rapid development of white leg shrimp semi-intensive farming.

MPEDA (2016) reported that frozen shrimp was the major export value item accounting for 3,73,866 tonnes and amounting to Rs.20,045.50 crores with a Unit Value realization of 8.28 \$ / kg during the year 2015-16. The total area utilized for *L.vannamei* Shrimp aquaculture production was 59,116 ha which produced 4,06,018 MT during the year 2015-16 in India. The export of Vannamei shrimp has improved from 2,22,176 MT to 2,56,699 MT in 2015-16 with a growth rate of 16%. Andhra Pradesh was the largest *L.vannamei* producer with a total production of 2,95,332 MT, followed by Tamil Nadu with a production of 44,453 MT.

Sawant and sawant (2003) studied the constraints in traditional shrimp farming in west Bengal. This study revealed that the non-availability of good quality seeds, inadequate technical guidance from extension personnel, non-availability of good quality shrimp feed, incidence of white spot disease, poor cooperation among the farmers, inadequate credit support from government sponsored institutions and

NGOs, lack of updated information about the trend of shrimp production were the reasons for low yield in shrimp production in west Bengal.

Iekshmi et al. (2005) studied the socio-economic profile of shrimp farmers in AP and Nagapattinam in TN. The study revealed that more than 47.00% of the shrimp farmers were old, 40.00% had collegiate level of education, 63.33% had big farm size, 36.67% had medium level of annual income, 70.00% sold their produce to exporters, 56.67% had low level participation and 57.50% had medium level of extension contact. Among the Nagapattinam shrimp farmers, most of them had collegiate level of education, medium level of annual income, medium level of extension contact and all of the shrimp farmers sold their produce to exporters in Nagapattinam district.

Kumaran et al. (2008) observed that majority of Andhra Pradesh (AP) farmers and half of the Tamil Nadu (TN) farmers were aged above 40 years and the rest of them below 40 years, TN had highly qualified farmers than AP in education level, majority of the AP farmers (85%) had above seven years of experience in shrimp culture whereas below seven years among TN farmers (65%), aquaculture was the primary occupation for most of the farmers of both the states, majority of the farmers of both the states hold 2 – 5 ha of farm size, most of the farmers 84.00% in AP and 93.00% in TN had not attended any training on shrimp farming.

Swathilekshmi et al. (2008) analysed the information utilization behaviour and constraints among the 60 selected shrimp farmers of Nellore district in AP. They reported disease incidence was the foremost constraint followed by poor quality of shrimp seeds, lack of quality control agencies, lack of information on

market price and interference by middle men, weed infestation in culture, lack of co – operation among the farmers, poor credit and insurance facilities, high cost for electricity, lack of technical guidance, lack of government support, incidence of cyclones and the damages caused and losses due to theft were the constraints expressed by the farmers. Setting up of disease diagnostic centers and seed certifying agencies by State Fisheries department, strengthening shrimp farmers associations, provision of credit and insurance facilities, speedy settlement of legal hurdles, reduction on electrical tariffs were the suggestions offered by the shrimp farmers to overcome the constraints.

Sathiadhas et al. (2009) worked out the break-even analysis and the profitability of aquaculture practices in India. They calculated that the annual net profit for tiger shrimp culture as Rs.8.36 lakh/ha/year with a rate of return of 98%, whereas Rs.4.43 lakh/ha/year with a rate of return of 66% to the capital investment for white shrimp culture in semi-intensive farming and net profit is worked out at Rs.5.51 lakh/ha/year for tiger shrimp culture and Rs.4.24 lakh/ha/year for white shrimp culture in improved extensive culture systems.

Balakrishnan, et al. (2011) analysed the growth of cultured white leg shrimps in different stocking densities in Bhimavaram, west Godavari district, Andhra Pradesh, India and they reported that the Production cost for one kg shrimp was calculated as Rs.121.44 with the average body weight of 19.2g and 52 counts. The feed cost was Rs.61.2/kg, followed by the seed cost of Rs.18.6/kg. The Profit /kg shrimp was Rs.78.56 and overall total profit was Rs.22, 85,468 in the 3.3 ha area. They reported that excess feed, faecal matter and metabolites will exert tremendous influence on the water quality of the shrimp farms so that the maintenance of good water quality is essential for optimum growth and survival of

shrimp and good water quality characterized by adequate dissolved oxygen, temperature, pH and salinity.

Manoj Sharma et al. (2011) observed the economics of black tiger shrimp farming in five experimental ponds in Gujarat. They concluded that the cost of production per kg of shrimp in these experimental ponds varied from Rs.220-230, whereas the selling farm gate prices per kg of shrimp were Rs.470-475. The average net profit obtained from these five ponds was estimated as Rs.27, 80,000.

Sahu et al. (2012) studied on the econometric modeling of shrimp (*penaeus monodon*, *fabricius*) farming at nandigram 2nd block from west Bengal. They reported that about 73% of the respondents had shrimp farming as their major source of income, most of the farmers (75%) constructed their farms in leased land, most of them (74%) middle class family having annual income from Rs.70, 000 to Rs.1,20, 000. There are 40% small size farms ranging from 1,000 m² to 2,000 m². Most of the farms (79%) recorded the average production in the range of 2301-2600kg/ha/crop. They also estimated the total expenditure of Rs.9, 92, 550 and the total income of Rs.11, 14, 750 and the net profit of Rs.1,22, 200/5000 m² in the year 2011. They concluded that the extensive training programmes are to be conducted for the shrimp farmers, crop insurance facilities should be introduced, implement the market strategies can make shrimp farming as a major contributor in earning foreign exchange.

Nagothul et al. (2012) studied on the climate change and shrimp farming in Andhra Pradesh, India. The study revealed that most of the shrimp farmers had 14 years farming experience, educated up to primary level (41%), undergone at least one training course and majority of them had shrimp farming as their main

occupation. This study also revealed that the average production cost was Rs.80, 186 per ha and net returns in summer and winter crop was Rs.2, 21,901 per ha and Rs.1, 41, 715 per ha. The most risk event was floods followed by cyclone in their study.

Rahaman, et al. (2013) studied the problems and constraints in production and marketing of fish in West Bengal. They reported that the major constraints faced in production and marketing of fishes are theft and pilferages, non-availability of quality fish seeds, lack of government support both technically and financially, quarrel and litigations among the owners of the pond, poor adaptability of fish seeds in new environment, etc.

Margabandu and Ramamurthy (2013) studied the farming practices for pacific white shrimp, *Peneaus vannamei* in Kalainanapuram village, Thoothukudi district, Tamil Nadu, India and observed the total operational cost with Rs.1,76,000/4000 m²; profit Rs.2, 59,500/4000 m²; net profit Rs.83,500/4000 m² with 170 days of the culture period and the average body weight of the harvested shrimp ranged between 20 and 25 g.

Nakul et al. (2013) reported that the average yield in shrimp farming was 1.14 tonnes/ha in Maharashtra. The average input cost was Rs. 2.31 lakh/ha. The average profit earned by the shrimp farmers was Rs.42,000/ha and the average cost of production was Rs.202 per kilogram of the shrimp.

According to Babu, et al. (2013) the current issues and problems in *L.vannamei* farming in India were limited quarantine facilities, diseases, production cost towards supplementary feed, demand and price fluctuations, seed stock quality and availability, feed quality and availability, cost of fuel, banned chemicals

and antibiotics used, illegal farming and the others. They had recommended for *L.vannamei* culture were continued development of biosecurity, high density and low salinity culture systems, vaccination and other effective treatments for shrimp viruses, replacement of costly marine meals in shrimp feeds, efficient water treatment and techniques for reducing bacterial loads in shrimp culture systems, effective disinfection procedures for eggs, nauplii and post larvae in hatcheries, effective replacements for antibiotics for successful *vannamei* farming.

According to Vadher and Manoj (2014) 48.1% of the shrimp farmers had studied up to SSLC, about 30.20% of the farmers had completed graduation or post-graduation, 18.30% of the farmers had primary school level education and 3.40% of the shrimp farmers were illiterate. They also indicated about 65.70% of the farmers had other occupations in addition to shrimp farming and 34.30% of the shrimp farmers had only aquaculture occupation.

Srinivas and Venkatrayalu (2016) studied 228 shrimp farms from west Godavari district of Andhra Pradesh to assess the present problems and prospects of shrimp farming. Their study indicated that majority of the shrimp farmers had education level of below 10th class. They also indicated that more than three fourths of the farmers had other occupations in addition to shrimp farming and they reported that the disease outbreaks, lack of quality shrimp seed and problems in quality brood stock, increased cost of production on account of feed, poor co-operation among the shrimp farmers, poor water quality, erratic power supply, differential rates of power tariff for shrimp culture, lack of credit and insurance, lack of Government support, labour and the mandatory certificate requirements were the main constraints expressed by the shrimp farmers of west Godavari district. Suggested policy measures by them for the overall development of shrimp were

the quality shrimp seeds ensured from registered hatcheries by Coastal Aquaculture Authority (CAA), implementation of Information and communication technologies, shrimp farmers should be educated about the importance of better management practices (BMPs), ensuring the contents and the proximate composition of chemicals and probiotics to be used, establishment of disease diagnostic labs, Institutional credit and insurance facility, treating aquaculture on par with agriculture for power tariff, Government support and technical guidance in time.

Anushalini et al. (2016) worked out the economic analysis of shrimp culture in lined ponds. They reported that the approximate cost of expenditure, total profit, net profit and benefit cost ratio for their shrimp culture were calculated as Rs.1, 89,500, Rs.2, 33,300, Rs.43, 800 and 1.23 per 0.06 ha per 3months in Thoothukudi. They also reported that the black soil accumulation, formation of NH_3 & H_2S in pond by excreta and feed waste, electric current fluctuations, heavy rain fall, infestation of aquatic animals, temperature fluctuations were the problems in that culture and they suggested the measures to overcome the above problems by removal of wastes accumulated in pond center by motor, provision for generator, bio security measures should be adopted and water should be filtered from both the sources and inlet valves.

Srinivas et al. (2016) studied about the sustainability of exotic shrimp *Litopenaeus vannamei* (boone, 1931) farming in coastal Andhra Pradesh, India along with problems and issues. The study revealed that the disease problems, lack of quality shrimp seeds available, high feed cost, unauthorized shrimp farming, international market price fluctuations, less demand in domestic market are the major problems faced by the farmers in Andhra Pradesh. They reported the

implementation of Better Management Practices (BMPs), bio security measures and cluster approach supported by the government policy measures can help the sustainable *L.vannamei* farming in Andhra Pradesh.

kumar et al. (2016) studied the economic assessment of shrimp farming (*L.vannamei*) in Gujarat. They reported that majority of the shrimp farmers are males (86.68%), middle aged (between 35-45years) and education up to secondary school (40%). Most of the farmers have more than or equal to 5ha (60%) land, less than or equal to 5 years of shrimp farming experience. The study revealed that the total fixed cost of Rs.1,11,781.38/ha/yr, the total variable cost of Rs.11,68,011.07/ha/yr, the total cost of Rs.12,79,792.65/ha/yr were incurred, the gross income was being Rs.16,30,177/ha/yr, the net income was Rs.3,50,384.55, BCR & Pay Back Period (PBP) was calculated as 1.27 and 156 days.

Jitendrakumar et al. (2016) conducted a socio-economic survey of shrimp aquaculture practices in valasad district, Gujarat, India. The survey revealed that most of the shrimp farmers had studied at primary level, most of them are up to 40 years old, only 17.50% of the farmers had aquaculture alone as their primary occupation and main source of income whereas around 50% of the farmers are active as fishermen in addition to aquaculture business. Majority of the farmers have 2-5 ha farm size and had less than 5 years of shrimp farming experience. They also reported that the seeds (PL-20) were purchased at the rate of Rs.0.55/piece and stocked at the density of 25-30 seeds/m² in ponds, about 1200-1500 kg of feed/ha/crop used at cost of Rs.84/kg and the yield was in between 900-1800 kg/ha/crop within 110-130 culture days in valasad. They suggested the biosecurity concept was important to shrimp farming to prevent the shrimp farming against the incidence of diseases.

III. MATERIALS AND METHODS

3.1 Concepts

The formation of various concepts are basic for any research problem. The concepts would help to understand the objectives and the important issues of the chosen study. The process of conceptualization is done to bring clarity in making inferences and permitting comparisons with the concepts of similar studies .The concepts used in the present study followed by a short review of previous studies are discussed in this chapter.

3.1.1 Capital investment

Capital is a produced good used in production.

Sahu et al (2012) referred capital investment which includes cost of pond construction, inlet and outlet structure of pond, pump house, watchmen shed, pumps, aerators, electric installation, land, farm equipments and miscellaneous items.

In the present study, capital investment refers to initial investment which is required to produce the output like pond construction, bore well, pipe lines, pumps & motors, generator, electric installations, construction of watchman shed and store room, farm accessories, water quality kits and miscellaneous items.

3.1.2 Total fixed cost

This also considered as initial cost of the shrimp farm.

kumar et al (2016) defined fixed costs which doesn't change with an increase or decrease in the level of production.

Salim et al. (2005) defined fixed cost as the prime costs which does not change with the level of input and it must be paid regardless of whether the farmer engages in production or not.

In the present study, fixed costs include depreciation for capital items such as buildings, motors, aerators and nets, interest on capital investment, repairs and maintenance, taxes paid, consultancy charges, watch and ward, insurance premium paid and other miscellaneous expenses.

3.1.3 Total variable cost

Salim et al. (2005) defined variable cost otherwise known as operational cost or working cost or supplementary cost, which change the level of production. It is the cost incurred for buying the items that are used in the production

Johl and Kapur (2007) defined variable cost as the cost of using the variable inputs. These costs vary with the level of production. Higher the production more will be the variable costs; lower the production, lower will be the variable costs.

Department of Agriculture, Forestry and Fisheries (2015) Variable costs represent that portion of the total costs that vary in (approximately) direct proportion to changes in the scale of that enterprise within a given production system or if the intensity of production per unit changes. In other words, variable costs are those costs that can be controlled or avoided in the short term.

In the present study, variable costs refer to pond preparation, cost of shrimp seeds and supplementary feed, fertilizers, chemicals & drugs, biosecurity measures, electricity charges, fuel, harvesting charges, labour cost, and the other farm miscellaneous charges for the shrimp farmers.

3.1.4 Miscellaneous cost

Miscellaneous costs included all incidental expenses paid by the shrimp farmers for producing the shrimp in the study area

3.1.5 Total cost

Department of Agriculture, Forestry and Fisheries (2015) Total costs include the total costs of all the resources used in the farming enterprise during a particular time period including stock adjustments and non-cash items. Total costs consist of fixed and variable costs.

3.1.6 Depreciation

Depreciation is the change in value associated with the aging of an asset. As an asset ages, its price changes because it declines in efficiency, or yields fewer productive services, in the current period and in all future periods.

Sharma et al., (2014) defined depreciation as the decline in the value of long life assets due to its use, wear and tear, obsolescence and accidental losses.

In the present study, the straight line method was used to compute depreciation of capital items, pumps and motors, pipelines, bore well, aerators, generators, farm accessories.

The formula used is,

$$\text{Depreciation} = \frac{\text{Original value} - \text{Salvage value}}{\text{Economic life Period}}$$

3.1.7 Gross returns

Gross returns is calculated by the quantity of shrimp production multiplied with the selling price per unit

3.1.8 Net returns

The total cost is substrated from the gross returns to arrive at the net returns.

In the present study, net returns on the basis of total variable cost was obtained by deducting the total variable cost from the gross returns and the net returns on total cost basis was calculated by deducting the total cost from the gross returns.

3.1.9 Inputs

Inputs are the factors of production that required to produce an output in farming. Inputs can be either variable or fixed. In this study, the inputs are the shrimp seeds, feeds, fertilizers, chemicals, labour, electricity, fuel, etc.

3.1.10 Output

In the present study, the yield of shrimps from the shrimp farmer's pond is considered as output. It also varies with operational area, production strategies, etc.

3.1.11 Benefit cost ratio (BCR)

Average returns to each rupee spent in production is important for measuring the profitability of growing any farming enterprise. In this study, BCR is the ratio of gross returns and the total costs per hectare.

3.1.12 Rate of returns on capital investment

Rate of return on capital investment on the basis of total variable cost is the difference between the gross returns to the total variable cost to the capital investment. Rate of return on capital investment on the basis of total cost is the difference between the gross returns to the total cost to the capital investment. It is always expressed in percentage. This concept is used in the present study.

3.1.13 Primary occupation

An occupation by which the major source of household income is obtained is called as primary occupation and the same concept is used in the present study.

3.1.14 Secondary occupation

An occupation by which the minor source of household income is obtained is called as secondary occupation and the same concept is used in the present study.

3.1.15 Classification of the shrimp farmers

Subba reddy et al. (2014) opined that the size of the farm influence the welfare of the farmers.

Viswantha et al. (2014) classified fish farmers into three categories with those ponds owned up to 2 ha as small farmers, pond owned between 2-4 ha as medium farmers and the ponds owned more than 4 ha as large farmers.

In the present study shrimp farmers are classified, as small farmers who own ponds less than 2 ha, between 2 to 4 ha as medium farmers and who own shrimp farms above 4 ha as large farmers.

3.1.16 Stocking Density

Fish stocking density refers either the numbers or the weight of fish per unit area of water environment.

In the present study, stocking density is defined as the total number of shrimp post larvae stocked per meter square water spread area. Recommended stocking density of shrimps by Costal Aquaculture Authority (CAA) is 60 pieces per square meter water spread area.

3.1.17 Survival rate

. Survival rate can be defined as the percentage of final harvested shrimp quantity compared to the total number of shrimp post larvae stocked per unit water spread area.

$$\text{Survival rate (\%)} = \frac{\text{Number of shrimp post larvae stocked}}{\text{Quantities of Final harvested shrimp}} \times 100$$

3.1.18 Production function

A production function is the functional relationship between the inputs and the output. It shows the maximum output which can be obtained for a given combination of inputs. It expresses the technological relationship between the inputs and the output of a product. In general, we can represent the production function for a firm as:

$$Q = f(x_1, x_2, \dots, x_n)$$

Where Q is the maximum quantity of output, x_1, x_2, \dots, x_n are the quantities of various inputs, and " f " stands for functional relationship between the inputs and the output.

Items of output, such as yield from shrimp ponds and the inputs such as supplementary feed, fertilizer, chemicals and drugs, stocking density, survival rate, electricity, labours and fuel were used in the analysis for the present study.

3.1.19 Marketing channels

Senthilathiban and Rajakumar (2004) defined marketing channel as a route through which goods and services are moved from the place of production to the place of consumption.

Jayaraman.R (2005) defined marketing channels are the routes by which goods move from producer to consumer including the ownership aspects of the produce

In the present study, marketing channel is defined as the path through which the cultured *L.vannamei* shrimps are taken from the shrimp farmers of the study area to the consumers.

3.1.20 Biosecurity

Lotz J.M (1997) defined the term biosecurity as the practices that reduce the probability of pathogen introduction and subsequent spread from one place to another. The first consideration in biosecurity is to prevent the contamination carriers like infected hosts, non-host biological carriers and inanimate objects contaminated with pathogens.

In the present study, biosecurity measures include bird fencing, crab fencing, effluent treatment plant (ETP), release water after bleaching in shrimp farming.

3.1.21 Shrimp farming risks

“Generally, risks associated with aquaculture are similar to those agriculture enterprises like disease, equipment failures, and unexpected competition”. – McIntosh.D (2008).

In the present study, production risks, marketing risks, financial risks, natural risks, social risks, extension risks are considered as the major risks involved in shrimp farming.

3.1.22 Production risks

There are many risks in the production process which can reduce the profitability of shrimp farm business. McIntosh.D (2008) stated that the disease, predation, natural events, poor water quality, and equipment failures are some of more common production risks in aquaculture.

In the present study, production risks include lack of good quality seed, high price of seed, high cost of feed, over dosage of chemicals, shortage of water, poor water quality, prevalence of disease outbreak, high cost of electricity, sudden fall in DO due to power failure, lack of scientific knowledge, non-availability of skilled labour, inadequate technical experts, improper lcing, partial damages during harvesting, predation and lack of certification of inputs by CAA.

3.1.23 Marketing risks

McIntosh.D (2008) referred marketing risks include cost of production exceeds the market price of product, competition from other production strategies, competition from alternative commodities are occurred in aquaculture.

In the present study, marketing risks include shrimp price fluctuations, demand & supply fluctuations, lack of cold storage facilities, physical damages during transportation, problems of direct selling to buyers and the distance of market.

3.1.24 Financial risks

Financial risks that involve financial loss to the firms. The probability of loss inherent in financing methods which may impair the abilities to provide adequate returns. Financial risks generally arise due to the instability and losses in the financial market caused by movements in stock prices, currencies, interest rates.

In the present study, financial risks include buy back system, low net returns, no insurance for shrimp farms, inadequate institutional financial assistance, problem in collateral security in institutional finance, high interest rate for non-institutional credit and inadequate credit from the nationalised banks.

3.1.25 Natural risks

Senthilathiban et al (2007) stated that the natural risks are also called as physical risks which cause damage to the aquaculture farms through wind storms, floods, droughts, earthquakes, and the prime risks are flooding, drought, changes in salinity and silt deposition

In the present study, the natural risks include flood, sudden change in climate, cyclone and heavy rain fall.

3.1.26 Social risks

Senthilathiban et al (2007) stated that the common social risks include theft, damages, fraud etc. Poaching has been the major risk to fish farmers.

In the present study, social risks include direct discharge of waste water into open sea, location of farms nearby the residential areas and poaching problem.

3.1.27 Extension risks

Extension risks occur when there is information and communication gap among the shrimp farmers or due to lack of information and communication transformation from the sources to shrimp farmers.

In the present study, extension risks include updated information on shrimp farming, inadequate awareness on production technologies, lack of social network among the shrimp farmers, lack of shrimp farmers associations, inadequate consultation & meeting with the Govt. officials.

3.2 Design of the study

The success of any research is dependent upon its research design. The research design will help to draw meaningful results and inferences from the study. Being the basis for a scientific research, this chapter describes the choice of the study area, sampling procedure, selection of respondents, methods of data collection and the analytical techniques used in this study.

3.2.1 Choice of study area

Nagapattinam district, Tamil Nadu had been selected as the study area because of more than 800 shrimp farms are there and more than 200 farms are now in active condition (CAA). They undertake shrimp farming continuously because of its profitability and economic feasibility.

3.2.2 Sampling procedure

The study area was chosen as Nagapattinam district in view of abundant shrimp farming activities in the district and the total sample of the shrimp farmers was fixed as 100 for the present study which was randomly selected and equally distributed among the shrimp farms in the selected five taluks namely, Sirkazhi, Tharangambadi, Nagapattinam, Kilvelur, and Vedaranyam.of the Nagapattinam district. The 100 shrimp farmers once again divided into small, medium and large shrimp farmers based on shrimp culture area. A survey schedule was designed based on the objectives of the study and used for collection of data from the shrimp farmers. The shrimp farmers were contacted individually and the objectives of the study were explained to them before commencing the data collection to ensure their co-operation. The collected data were tabulated and analysed using the appropriate statistical tools. The investigation was carried out during the period from December, 2016 to March, 2017.

3.2.3 Tools of analysis

The following statistical tools were employed to analyse the data collected from the selected shrimp farmer respondents.

3.2.3.1 Descriptive Statistics

Descriptive statistics attempts to analyze the general demographic characteristics of the respondents such as age, education, experience, family size, family type, source of income. Ratios and percentages were used for analyzing the various socio-economic variables.

3.2.3.2 Tabular Analyses

Tabular analyses were followed to analyse the socio-personal characteristics, details of the cost components and the returns from shrimp farming. Economic analysis was also carried out to assess the profitability.

3.2.3.3 Functional analysis of shrimp culture

To measure the factors determining the total shrimp production, a production function was estimated. Eight explanatory variables are included in the empirical model. They were supplementary feed, fertilizer, chemicals, stocking density, survival rate, electricity, labours and fuel. The linear regression model was specified as follows:

$$Y = a + b_1X_1 + b_2X_2 + b_3X_3 + b_4X_4 + b_5X_5 + b_6X_6 + b_7X_7 + b_8X_8$$

Where,

Y - Total shrimp production in kg

X₁ - supplementary feed in kg

X₂ - fertilizer in kg

X₃ - chemicals in kg

X₄ - stocking density in numbers

X₅ - survival rate in percentage

X₆ - electricity consumed in units

X₇ - number of labours employed

X₈ - fuel in litres

b₁, b₂, b₃, b₄, b₅, b₆, b₇, b₈ = regression co-efficients

The signs of regression co-efficients are expected to be positive.

Test of Significance

Regression analysis was carried out to test the significance of the coefficient of multiple determination and to test the significance of regression parameters.

3.2.3.4 Garrett's Ranking Technique

The Garrett's ranking technique was adopted in this study to identify the various constraints and rank them. The respondents were asked to identify the various constraints affecting of the *L.vannamei* shrimp farmers. According to the order of severity, ranks were given by them. Garrett's ranking technique provides the change of orders into numerical scores. The prime advantage of this technique over simple frequency distribution is that the reasons and factors are arranged based on their importance from the point of view of respondents. The percent position of each rank was converted into scores referring to the table given by Garret and Woodworth (1969). Garret's formula for converting ranks into percent is given below:

$$\text{Percent position} = 100 \times \frac{R_{ij} - 0.5}{N_j}$$

Where,

R_{ij} = Rank given for i_{th} factor by j_{th} individual

N_j = Number of factors ranked by j_{th} individual

By referring to Garrett's table, the percent positions estimated were converted into scores. The scores of various respondents were added and mean value calculated.

The factors with the highest mean value was considered to be the most important, followed by second, third and so on.

3.3 Description of the study area

Farming technologies are location-specific and hence their performance has to be assessed by understanding the salient characteristics of the research location chosen for the study. In this chapter, an overall description of the study area which includes demographic characteristics, literacy rate, water sources, rainfall and climatic conditions, different economic sectors, infrastructure and the fisheries activities of the study area are presented.

3.3.1 An overview of Nagapattinam district

Nagapattinam is an old Port Town. This district has a numerous places of historical importance. The modern Nagapattinam district was carved out of the earlier composite Thanjavur district on 18.10.1991. Tamil is the main language spoken in the district. The Nagapattinam district has 11 panchayat unions, 3 municipalities, 9 town panchayats, 2 revenue divisions and 8 taluks. There are 523 revenue villages in the district. There are 11 blocks considered as development areas in the district.

3.3.2 Location

The plain and coastal regions are the general geological formation of the district. The district lies between 10°10' and 11°20' Northern Longitude and 79°15' and 79°50' Eastern longitude. The Nagapattinam district boundaries are Bay of Bengal in east, Tiruvarur district in west, River Kollidam and Cuddalore district in north, Palk Strait in south.

3.3.3 Demographic features

3.3.3.1 Population

Nagapattinam district ranked 23rd place among the highest population in the State. The Nagapattinam District occupies an area of 2569 Sq. Km. and during the year 2011, Nagapattinam district had the population of 16,16,450 of which male and female were 7,98,127 and 8,18,323 respectively. The rural and urban population were 12,51,826 and 3,64,624 respectively accounting for 77.44% and 22.56% of the total population. The density of the population is 629 per Sq. Km. The population of females per 1000 males is 1025. The district has a total literacy rate of 83.59% which is higher than the State literacy rate (80.1%). The demographic characteristics of Nagapattinam District furnished in Table 3.2.

Table 3.1. Demographic characteristics of Nagapattinam District, Tamil Nadu

Description	2011	2001
Actual Population	16,16,450	1,488,839
Male	7,98,127	739,074
Female	8,18,323	749,765
Population Growth	8.57%	8.07%
Area Sq. Km	2569	2,569
Density/km ²	629	616
Proportion to Tamil Nadu Population	2.24%	2.39%
Sex Ratio (Per 1000)	1025	1014
Child Sex Ratio (0-6 Age)	959	963
Average Literacy	83.59	76.34
Male Literacy	89.79	84.89
Female Literacy	77.58	67.96
Total Child Population (0-6 Age)	165,245	183,346
Male Population (0-6 Age)	84,335	93,396
Female Population (0-6 Age)	80,910	89,950
Literates	1,213,008	996,580
Male Literates	640,916	548,142
Female Literates	572,092	448,438

(Source: District census handbook, Nagapattinam - 2011)

3.3.3.2 Water availability

The district area falls under two river basins namely Cauvery sub basin and Vennar sub basin. The district forms the delta part of river Cauvery and Kollidam. The district is surrounded by Kollidam and Cauvery in the north, Virasolanar, Uppanar in the central part and Arasalar, Tirumalairajan river, Vettar, Kedurai river, Pandavai river, Vedaranyam canal and Harichandra Nadi in the southern part of the district.

3.3.3.3 Climate and rainfall

Temperature: The average maximum temperature for the district as a whole is about 35.04° C and the average minimum temperature is 25.70°C. The relative humidity ranges from 70 – 77% and it is high during the period of October to November.

The district receives rainfall almost throughout the year under the influence of both south west and north east monsoon. The North east monsoon that starts in October and ends in December which contributes about 60% of the total annual rainfall. The Southwest monsoon which rains from June to September and from March to May that accounts equally for the rest of the annual rainfall in Nagapattinam.

The district seasonal and annual rainfall observed was 19.8 mm in winter, 162.1 mm in pre-monsoon, 186.9 mm during monsoon, 1378.8 mm during post-monsoon and 1747.6 mm for the year 2015 (Rainfall statistics of india,2015).

3.3.4 Economy

3.3.4.1 Agriculture

One of the major economies of the district is Agriculture which contributes a higher share of rice production in the State. The important agricultural crops in Nagapattinam district are rice, sugarcane, cotton, groundnut, gingelly, green gram, black gram, vegetables and coconut. The total area of cultivation under paddy, cereals and pulses were 1,57,855 hectares, 1,57,861 hectares and 81,142 hectares respectively during 2009-10. Extension services, input supply and quality control services, subsidies and schemes are offered by the Government to enhance the productivity of agricultural crops in the district. The availability of inputs and the details of subsidies available for agriculture may be known from the Agricultural officers or Agricultural development officers of the Agricultural extension centres and these details exist in the information boards kept in the Agricultural extension centres in the district.

3.3.4.2 Animal husbandry

Animal husbandry is a remunerative occupation for alleviating poverty, unemployment and reducing the migration of human population from rural areas to urban areas. Livestock development plays an important role next to Agriculture in Nagapattinam district since livestock provides raw materials such as blood, bones, offal, skin, hide, hoof, horns, bristles and hair to many non-farm industries like pharmaceutical, leather and by-products industry. The livestock found in this district are generally cattle and buffaloes, sheep, goats, pigs and poultry birds. The services provided by veterinary institutions in the district are artificial insemination,

treating infertility cases, vaccination, castration, cases treatment, deworming, extension services, implementation of various schemes and training to the farmers.

3.3.4.3 Industries

The district is primarily agrarian in nature and so the district has good scope for development of industries based on agricultural inputs such as extraction of rice bran oil, straw board, cultivation and extraction of palm oil, cultivation and processing of horticultural products and floriculture. The district is a flourishing centre of cottage and handicrafts industry. Madras Refineries Limited is the major refinery unit located in the district. Major exportable items in the district are Industrial salts, fishes and Prawns. In the year 2010-11, there were 86 factories in this district. The estimated numbers of persons employed in these factories was 3566 persons. There are about 26,112 micro, small & medium enterprises totally situated in the district (Ministry of MSME, Govt. of India).

3.3.4.4 Minerals

The important major minerals available in Nagapattinam District are crude oil, natural gas, silica sand, lime shell, heavy mineral sand (garnet, ilmenite, rutile zircon, monozite). The oil and natural gas have been extracted in narimanam, kuthalam villages by the Oil and Natural Gas Commission (ONGC). The silica sand deposits are estimated to be 4.86 million tonnes which occur in vadamalai manakkadu, vanduvancherri, thanikottagam villages of vedaranyam taluk in Nagapattinam district. There are 7 silica sand leases functioning in Nagapattinam district. Lime-shell deposits are about 1.87 lakhs tonnes in Nagapattinam district. It is used for making lime-mortar and bleaching agent in Sugar industries and one lime-shell lease is functioning in Nagapattinam. Sirkali and Tharangamapadi Taluks

are very rich in the heavy mineral sands in Nagapattinam district. Garnet is used in the abrasive industries, and manufacturing synthetic gems. Ilmenite is used for aircraft industry. Zircon is used for manufacturing zirconium crucibles. Minor minerals such as Sand and brick earth quarries are also available in Nagapattinam district.

3.3.4.5 Tourism

Poompuhar, Tharangampadi, Velankanni, Nagore, Kodiakkarai birds sanctuary and point calimere wild life sanctuary are the main tourist spots in the Nagapattinam district.

3.3.5 Fisheries

Fisheries sector is the economic backbone of this coastal district. The total coastal length of the district is 187.9 km. The total estuaries and brackish water area of the district is 2000 ha. The Inland fresh water area spreads for about 1020 hectares. The inland fish production was 7,714 tonnes during 2016.

3.3.5.1 Marine fisheries

Marine fishing is practiced in 53 coastal villages of the district with the total fishermen population of 94,364 of which 48,028 are fishermen and 46,336 are fisher women. The marine fish catch mainly comprises of leiognathids, sharks, flying fish, chank, catfish, prawns, silver bellies, crabs, rays and other miscellaneous varieties. Mechanized boats, catamarans and country canoes are all used for marine fishing. There are 5,436 fishing crafts in the district of which 1,175 are mechanised boats, 136 are traditional crafts and 4,125 are FRP motorised boats. A fish-landing jetty has been constructed at Kodiakkarai which caters to the needs of marine fishermen and is the only marine workshop in this

coastal area. A comparison indicates that the coastal fish production is higher than the Inland Fish Production. The marine fisheries potential of Nagapattinam district is furnished in table 3.2.

Table 3.2. Marine fisheries potential of Nagapattinam district.

Marine fisheries potential	
Coastal length (km)	187.9
Marine fishing villages	53
Total fishermen population	94,364
Fishermen population	48,028
Fisherwomen population	46,336
Total fishermen co-operative societies	95
Fishermen co-operative societies	49
Fisherwomen co-operative societies	46
Total fishing crafts	5,436
Mechanized boats	1,175
Traditional crafts	136
FRP motorized boats	4,125

(Source: State Fisheries Department, Nagapattinam district, Tamil Nadu, 2016)

3.3.5.2 Infrastructure facilities for marine fisheries

The infrastructure facilities of Nagapattinam district for marine fisheries is furnished in table 3.3.

Table 3.3. The infrastructure facilities of Nagapattinam district for marine fisheries.

Infrastructure facilities	
Fish market	4
Community hall	53
Auction hall	6
Fish drying platform	8
Net mending sheds	4
Fish landing centers	4
Fishing harbors	3

(Source: State Fisheries Department, Nagapattinam district, Tamil Nadu, 2016)

There are four fish landing centres, three fishing harbours, four net mending sheds, eight fish drying platforms, six auction halls and four fish markets in the district.

3.3.5.3 Inland fisheries

The total agriculture engineering department tanks of the district are 45.6 ha. This district has 662 ha of panchayat union tanks. The total length of rivers/canals of the district is 367 km. There are 54 fish farmers development agencies at present in the district and the total FFDA farmers pond area is 62 ha. The average production is 2 ton/ha/year for the FFDA farmer. The Traditional ponds owned by Revenue Department of the district are 662(ha). The inland fish production was 7,714 tonnes during 2016.

The inland fisheries potential of Nagapattinam district is furnished in table 3.5.

Table 3.4. Inland fisheries potential of Nagapattinam district.

Inland fisheries potential	
Agriculture Engineering Department Tanks (ha)	45.6
Panchayat Union Tanks (ha)	662
Length of rivers/canals (km)	367
Number of FFDA farmers	54
Area of FFDA farmer ponds (ha)	62
Average production in FFDA farmer pond ton/ha/year	2
Traditional ponds-owned by Revenue Dept. water retention max. 6 months (ha)	662
Inland fish production (tonnes)	7,714
Private hatcheries	3Nos with production capacity of 47.50 million per year

(Source: State Fisheries Department, Nagapattinam district, Tamil Nadu, 2016)

3.3.5.4 Brackish water aquaculture resources of Nagapattinam district

The brackish water farming details of Nagapattinam district is furnished in table 3.4.

Table 3.5. Details of Brackish water shrimp farming in Nagapattinam district

Total estuaries and brackish water area (in ha)	2000
Registered brackish water farms	803
Culture species	<i>L.vannamei</i> and <i>P.monodon</i>
Average annual shrimp production (in tonnes)	4800

(Source: State Fisheries Department, Nagapattinam district, Tamil Nadu, 2016)

The total estuaries and brackish water area of the district is 2000 ha. Nearly 803 brackish water farms are registered in Nagapattinam district for shrimp culture. The *L.vannamei* and *P.monodon* are the cultured species for shrimp farming in this region and the average annual brackish water fish/shrimp production is 4800 tonnes.

3.3.6 Infrastructure and support services available for shrimp culture

3.3.6.1 Shrimp seed supply

As per the list of hatchery operators permitted by CAA for the import of brood stock and seed production of SPF *L. vannamei* for the year 2015-2016 the district has three hatcheries which are located in sirkali taluk, Nagapattinam.

3.3.6.2 Disease diagnostic services

Rajiv Gandhi centre for aquaculture (RGCA) offers the diagnostic services at the central aquaculture pathology laboratory, technology transfer training &

administrative complex, sirkali for screening the aquatic shrimp pathogens, freshwater prawn pathogens and marine finfish pathogens in this district.

3.3.6.3 Market

Marketing of shrimp in Nagapattinam is mostly done by the private processing plants. The harvested shrimps from Nagapattinam district are supplied to the private processing plants namely Nila sea foods, Edhayam frozen foods private limited, Diamond seafood exports(DSF), Theva & co, Ashwini sea foods and Liberty frozen foods Thoothukudi. Several ice plants are available there which help to preserve the quality of shrimps marketed.

3.3.6.4 Transport

Transport facilities are well established in Nagapattinam district for the supply of inputs to shrimp farming and the transportation of the harvested shrimps.

3.3.6.4.1 Roadways

The Nagapattinam district has the total road length of 1275.612 km of which state highways are 248.460 km, major district roads are 299.817 km and the other district roads are 695.335 km. Nagapattinam municipality accommodates 104.539 km (64.958 mi) of roads; 27.328 km (16.981 mi) of cement roads, 72.993 km (45.356 mi) of bituminous roads, 1.2 km (0.75 mi) of water bound macadam roads (WBM) and 3.018 km (1.875 mi) of earthen roads. NH 45A and NH 67 are the two national highways which connected the nagapattinam district to villupuram and Coimbatore and Gundlupete in Karnataka state. Nagapattinam district is connected with Chennai, Vellore, Coimbatore, Tiruchirapalli, Karaikal and other major towns of Tamil Nadu through the state highways.

3.3.6.4.2 Railways

Railways in the district comes under Tiruchirappalli railway division of the southern railway zone in Nagapattinam district in Tamil Nadu. The Nagapattinam Junction railway station is a focal point of the historic main line that connects chennai with places like Tiruchirappalli Jn, Thanjavur Jn, Thiruvarur Jn, Rameswaram, etc.

3.3.6.4.3 Sea port

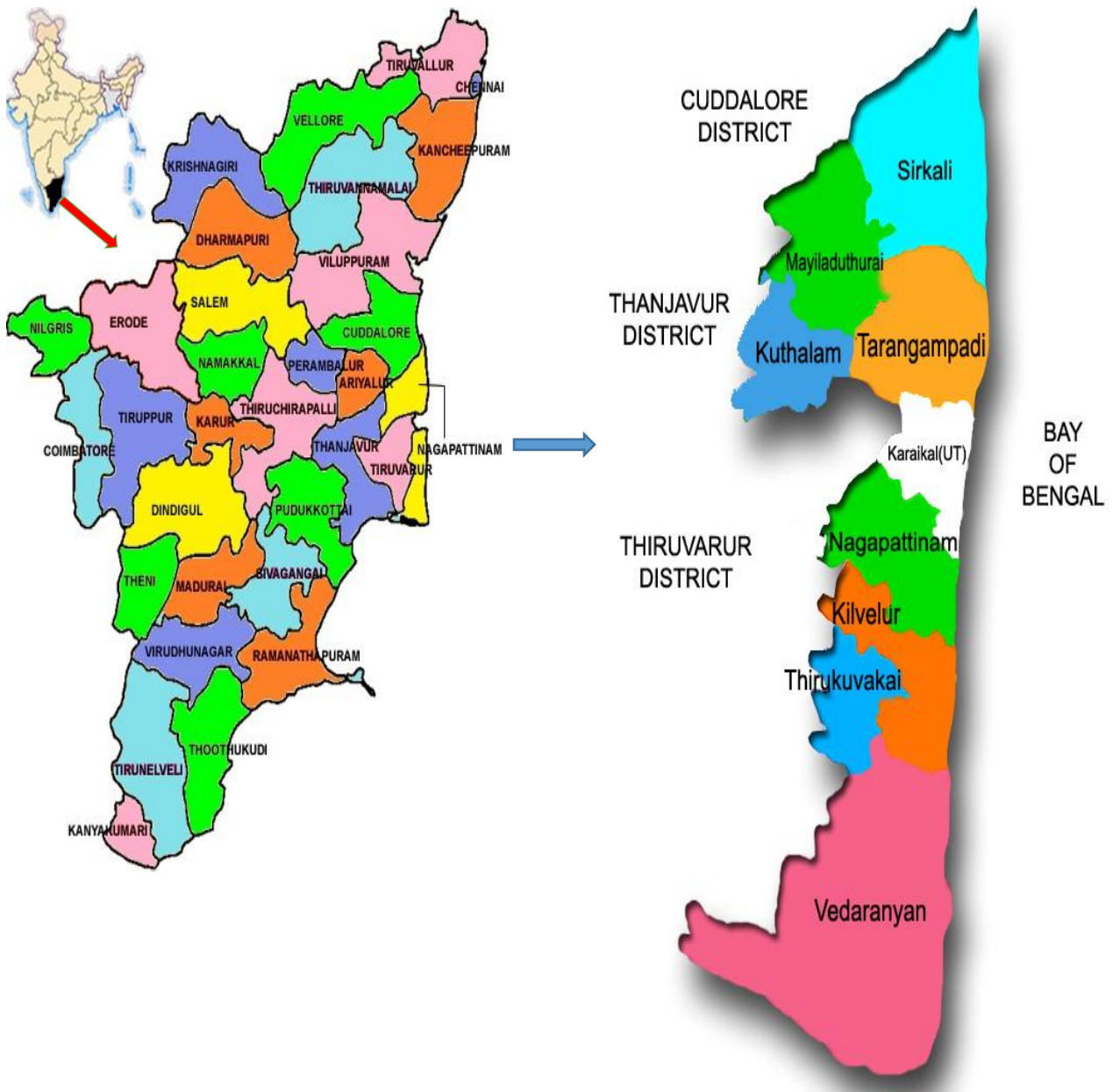
Nagapattinam harbour is a small sea port located at the mouth of the river Kaduvayar in the Bay of Bengal. The port is maintained by the Tamil Nadu Maritime Board under the Government of India. The anchorage of this port is an open roadstead and the facilities provided by the port are the wharves, stacking area, cargo sheds, passenger terminal station, weigh bridge, slipway.

Fig 3.1 Map showing the study area

India

Tamil Nadu

Nagapattinam District



IV. RESULTS AND DISCUSSION

The results of the analyses of the data gathered from the *L.vannamei* shrimp farmers in Nagapattinam district and the inferences drawn are presented and discussed in this chapter. The findings of the study are organised as follows:

4.1. Present status and details of shrimp culture activities in the study area

4.2. Demographic characteristics of the shrimp farmers

4.3 Costs and returns of the shrimp farming practices

4.4 Risk analysis in the shrimp farming practices

4.1 Present status and details of shrimp culture activities in the study area

For the details of the general shrimp farming performance, measurements like average culture period, average stocking seed size, shrimp seed resources, average survival rate, depth of pond, water source, feed brand and marketing channels were recorded from the shrimp farms. The shrimp farmers were culturing two crops per year. Most of the shrimp farmers were purchased *L. vannamei* seeds in the size of Post Larvae-11 at the average rate of ₹0.60 per piece (₹600 per thousand pieces) from commercial hatcheries in Marakkanam, Tamil Nadu. Seeds were packed in polythene bags and master packed in thermocoal or insulated boxes. Majority of the shrimp farmers stocked at a density of 40-60 numbers/m² in their ponds and followed the splashing method for shrimp seeds stocking. The Average culture period was 90 to 120 days or 3 to 4 months. The average survival rate of the stocked seeds were 70% to 80%. Majority of the shrimp farmers used to keep their pond depth at 1 to 1.5 meter. Creek was the main water source to most of the shrimp farms while some shrimp farmers used canal as water source for their ponds.

The major shrimp feed companies present in shrimp aquaculture market of Nagapattinam district are CP aquaculture (India), Avanti feeds, Godrej Agrovet feeds, Grobest feeds, Cargill feeds and Growell feeds. Majority of the shrimp farmers were using CP and Avanti commercial pelleted feeds followed by Grobest, Cargill and Growell shrimp feeds. The cost of the feed varied within the price range of ₹72 to ₹84/kg and ₹1800 to ₹2100/25kgs. Frequency of feeding varied from 2 to 4 times during the culture period (two times per day up to one month, four times per day after one month). The average feed conversion ratio (FCR) for shrimp culture was 1.3-1.5 and commercially available products like vitamin C, minerals, binder and Gut probiotics also mixed with feed and applied by most of the farmers. Majority of the shrimp farmers procured shrimp feeds and other inputs from the dealers on credit basis and store their input items in well-established store rooms. For the management of the pond, farmers generally employed farm consultant from the nearby shrimp farms and they were paid ₹3 to ₹5 per kg of shrimp during the harvest, two labours per hectare are employed from the nearby villages and other state were paid ₹8000 – ₹8500/labour/month. Most of the shrimp farmers were regularly monitored soil and water quality conditions of the ponds manually, feed intake and health of the shrimps by check tray. Additional labours were being employed on daily wages basis during the harvest and post-harvest operations. After the 40 days of culture, sampling of the cultured shrimp was carried out at every fifteenth day interval during the crop. The average shrimp harvest yielded 6930 kg to 9600 kg/ha/crop in 90-120 days. Price of the harvested shrimp varied due to the season, stage and time of harvesting. These results were coincided with the details of pond performance which was analysed by Jitendrakumar et al. (2016) in Gujarat.

Several ice plants are available in Nagapattinam which helps to preserve the quality of shrimp marketed. Marketing of shrimp in the Nagapattinam district is mostly done by the private processing plants like Nila sea foods, Edhayam frozen foods private limited, Diamond seafoods exports (DSF), Theva & co Thoothukudi, Asvini sea foods Thoothukudi and Liberty frozen food private limited.

4.2. Demographic characteristics of the shrimp farmers

The information on the demographic characteristics of the randomly selected *L.vannamei* shrimp farmers are discussed in Table 4.1.

Table 4.1. Demographic characteristics of the selected shrimp farmers.

Profile characteristics	In numbers	In percentages
Age composition (in years)		
up to 35	10	10%
36-45	50	50%
above 45	40	40%
Sex		
Male	88	88%
Female	12	12%
Educational status		
Illiterate	6	6%
Middle school	41	41%
Intermediate(10+2)	33	33%
Graduate	14	14%
Post Graduate	6	6%
Religion		
Hindu	79	79%
Christian	5	5%
Muslim	16	16%
Residential status		
Owned house	100	100%
Family type		
Nuclear	67	67%
Joint	33	33%
Family size (in members)		
Up to 4 members	24	24%
More than 5 members	76	76%

Most of the shrimp farmers (50.00 %) were middle aged between 36 and 45 years followed by above 45 years old farmers (40%) and up to 35 years aged farmers accounting for 10%. Cyril et al. (2013) reported that 31-50 age group farmers were predominantly engaged in shrimp farming in north Canara and Udupi district of Karnataka accounting for 56.66%. Majority of the males (88.00%) and females (12%) are involved in shrimp farming. Kumar et al. (2016) observed that most of the *L.vannamei* shrimp farmers were males (86.68%) and females (13.33%) in valsad district of Gujarat.

The educational status of the shrimp farmers were illiterate (6%), middle school level (41%), intermediate +2 (33%), graduate and above (20%). Jitendrakumar et al. (2016) observed that illiterate (3.70%), primary school level (42.59%), up to SSLC (34.25%), graduate and above (19.44%) as educational status of shrimp farmers of valsad district in Gujarat.

The percentage of shrimp farmers followed nuclear type family were 67% and 33% were followed joint type family system in the study area. This finding was in contradiction to the findings of Cyril et al. (2013) in which the percentage of shrimp farmers following nuclear type family was 68% and above 32% of the shrimp farmers followed joint family system. All the respondents (100%) are living in their own houses in the study area. Vichare (2010) had found out that majority of the fish workers (100%) were living in their owned houses in satpati.

The total number of family members were up to 4 accounting for 24 % among the selected shrimp farmers. On the other hand, the total number of family members were more than 5 accounting for 76% among the selected shrimp farmers. kumar et al. (2016) stated that the family size up to 4 members (30%) was less comparatively with family size with more than 5 members (70%) in Gujarat.

Most of the selected shrimp farmers belonged to Hindu religion representing 79.00% followed by Muslim (16%) and Christian (5%) respectively. Jagadeesh (2015) reported that 80% of shrimp farmers belonged to Hindu religion in non-BMPs category in Prakasam district, Andhra Pradesh.

The primary occupation and farming experience of the shrimp farmers are given in Table 4.2.

Table 4.2. Primary occupation and farming experience of the shrimp farmers.

Profile characteristics	In numbers	In percentages
Shrimp ponds ownership details		
Owned	56	56%
Leased	28	28%
Both owned + Leased	16	16%
Occupational status		
Aquaculture alone	86	86%
Aquaculture + others	14	14%
Farming Experience		
Up to 10 years	18	18%
Above 10 years	82	82%

Majority of the shrimp farmers have owned ponds representing 56% and had leased ponds for 28% and both the owned & leased ponds were accounting for 16% respectively. jagadeesh (2015) reported that majority of the shrimp farmers have owned ponds (66.66%) followed by leased ponds (21.67%) and both owned + leased ponds (11.67%) in prakasam district, Andhra Pradesh.

Among the selected shrimp farmers, 18% of them had shrimp farming experience up to 10 years and 82% of the shrimp farmers had more than 10 years of shrimp farming experience. These findings were in accordance with Arul oli (2014).

4.3 Costs and returns of the shrimp farming practices

The economic analysis of the shrimp farming practices was carried out for one crop with a culture period of 3 to 4 months.

4.3.1 Classification of the shrimp farmers based on the area

The classification of the shrimp farmers based on the culture pond area are given in Table 4.3.

Table 4.3. Classification of the shrimp farmers based on the culture pond area

Farmers	Area	Sample size
Small farmers	Up to 2 Hectares	50
Medium Farmers	2-4 Hectares	25
Large Farmers	Above 4 Hectares	25

The selected shrimp farmers of the study were classified into 3 groups based on their culture area. Culture area up to 2 ha was classified as small shrimp farmers, culture area 2 to 4 ha was classified as medium shrimp farmers and the large shrimp farmers whose culture area was above 4 ha. This classification was similar to Viswanatha et al. (2014) in which the fish farmers owned up to 2 ha was small farmers, 2-4 ha was medium farmers and the above 4 hectares was large farmers.

4.3.2 Costs and returns of the shrimp farmers

4.3.2.1 Items of capital investment for the selected shrimp farmer respondents

The details of the mean capital investment for the selected shrimp farmer respondents are presented in Table 4.4

Table 4.4. Item of capital investment for the selected shrimp farmer respondents

(Amount in ₹/ha)

Items of Capital investment	Small Farmers	Medium Farmers	Large Farmers
Pond construction	30008.99±11323.22 (5.83)	29981.16±6378.9 (6.31)	30039.72±11473.71 (8.86)
	10008-49539; 37.73	20394-39600; 21.28	21382-72660; 38.20
Bore well & Pipe lines	20005.99± 7548.534 (3.88)	19987.44±4252.38 (4.21)	20026.48±7649.195 (5.90)
	6672-33026; 37.73	13596-26400; 21.28	14255-48440; 38.20
Pumps & Motors	39615±6318.384 (7.70)	20922±4117.08 (4.41)	15743± 5908.988 (4.65)
	20850-41700; 15.94	16500-24750; 19.68	12975-38060; 37.53
Generator	126768±71960.02 (24.61)	165000±18150 (34.76)	86500±20760 (25.52)
	0-166800; 56.77	146850-183150; 11.00	76985-107260; 24.00
Aerators	232269±93923.41 (45.10)	176682±18236.79 (37.22)	128988.8±36364.43 (38.06)
	100080-400320; 40.44	158400-219450; 10.32	114180-290640; 28.19
Farm electrification works	50014.98±18871.75 (9.71)	49968.6±10631.28 (10.53)	48260.08±13578.25 (14.24)
	16680-82566; 37.73	33990-66000; 21.28	35638-86500; 28.14
Store rooms, other sheds.	9849.54±3255.102 (1.91)	6672.6± 1199.22 (1.40)	4691.76± 938.352 (1.38)
	4170-17514; 33.05	4950-8580; 17.98	3633-8304; 20.00
Farm accessories	6430.14±821.49 (1.25)	5517.6±812.46 (1.16)	4650.24±468.657 (1.37)
	5004-8340; 12.78	3630-6600; 14.73	3979-5709; 10.08
Total	514961.6± 196769.8 (100)	474731.4± 42680.55 (100)	338900.1±73997.29 (100)
	165132-798972; 38.21	416955-555555; 8.99	292889-636813; 21.83

(The first row indicates mean and standard deviation with percentages in bracket respectively. Second row indicates range & C.V respectively)

In the case of small shrimp farmers, the capital investment items such as aerators, pumps and motors and generators were worked out to 77.40% and the

other items such as pond construction, bore well and pipe lines, Farm electrification works, store rooms and other sheds and farm accessories were estimated to 22.60% respectively. The mean total capital investment was worked out to ₹5,14,961/ha with the co-efficient of variance (C.V) of 38.21%.

Sahu et al. (2013) had worked out the pumps and the motors cost as ₹44,000, electric installation cost as ₹.25,000 and shed cost as ₹14,000 in west Bengal. In the present study, the mean cost towards the pumps and motors as ₹39,615/ha. The mean cost for electric installation as ₹50,014 and the shed cost as ₹9,850/ha in the case of small shrimp farmers. These mean values were more or less similar to the values of Sahu et al. (2013) who worked out the mean capital cost for shrimp farming per 0.5 ha with ₹3,71,000. In the present study, the mean capital cost for small shrimp farmers was worked out to ₹5,14,961/ha.

In the case of medium shrimp farmers, the capital investment items such as aerators, pumps and motors and generators were worked out to 76.37% and the other items such as pond construction, bore well and pipe lines, Farm electrification works, store rooms and the sheds and farm accessories were estimated to 23.63% respectively. The mean total capital investment was worked out to ₹4,74,731/ha with the co-efficient of variance (C.V) of 8.99%.

In the case of large shrimp farmers, the capital investment items such as aerators, pumps and motors and generators were worked out to 68.22% and the other items such as pond construction, bore well and pipe lines, Farm electrification works, store rooms and the sheds and farm accessories were estimated to 31.78% respectively. The mean total capital investment was worked out to ₹3,38,900/ha with the co-efficient of variance (C.V) of 21.83%.

Syed et al. (2013) had worked out the mean capital investment for shrimp culture and the capital items such as aerators, semi-permanent buildings and the cost of land/lease value of land were worked out to 65.92 % and the other capital items such as pumps and motors, pond excavation, pipe lines and bore well were estimated to 34.08 % respectively.

In the present study, the mean capital cost for small, medium and large shrimp farmers per ha was worked out to ₹5,14,961, ₹4,74,731 and ₹3,38,900 respectively. These values are higher than the values of Syed et al. (2013) who worked out the capital cost for shrimp farming per ha with ₹1,44,900 which might be due to the culture practices and the level of adoption of culture technologies.

4.3.2.2 Items of fixed cost for the selected shrimp farmer respondents

The items of fixed cost for the selected shrimp farmer respondents are furnished in Table 4.5

The mean total fixed cost for small shrimp farmers was estimated as ₹4,07,424/ha/annum with the co-efficient of variance (C.V) of 35.39%. Among the various fixed cost items, the lease or rental value for own land was accounted for 44.20% and repair and maintenance for capital goods was accounted for 7.70%.

The mean total fixed cost for medium shrimp farmers was estimated as ₹3,64,489/ha/annum with the co-efficient of variance (C.V) of 16.31%. Among the various fixed cost items, the lease or rental value for own land was accounted for 49.35% and the expenditure towards the repairs and maintenance for capital goods was accounted for 5.66%.

Table 4.5 Items of fixed cost for the selected shrimp farmer respondents

(Amount in ₹/ha/annum)

Items of fixed cost	Small Farmers	Medium Farmers	Large Farmers
Lease value/ rental value for own land	180053.9±67940.14 (44.20)	179887±38273.4 (49.35)	180238.3±68842.76 (55.96)
	60048-297237; 37.73	122364-237600; 21.28	128296-435960; 38.20
Depreciation for Capital items	39144.39±15104.57 (9.60)	35530.35±2360.16 (9.75)	23454.03±4549.9 (7.28)
	12400-60017; 38.59	32631-40495; 6.64	21221-42988; 19.40
Interest on capital investment	61795.4±23612.21 (15.17)	56967.77±5121.6 (15.63)	40668.01±8879.571 (12.63)
	19816-95876; 38.21	50034-66667; 8.99	35146-76417; 21.83
Repairs &Maintenance	31366.74±12682.64 (7.7)	20638.2±2103.75 (5.67)	12891.96±4493.675 (4.00)
	13510-54043; 40.43	18150-25410; 10.19	1211-30275; 34.86
Consultancy Charges	47993.36±47993.36 (11.78)	47969.86±10206.24 (13.16)	48063.55±18358.07 (14.92)
	16012-79263; 37.76	32630-63360; 21.28	34212-116256; 38.20
Salary to permanent staff	47070.96±9687.744 (11.55)	23496±1966.14 (6.45)	16746.4±16746.4 (5.20)
	25020-60048; 20.58	21450-26400; 8.37	14359-29410; 20.44
Total	407424.8±144171.9 (100)	364489.1±364488.96 (100)	322062.3±107587.7 (100)
	147480-646487; 35.39	277755-459933; 16.31	245007-731307; 33.41

(The first row indicates mean and standard deviation with percentages in bracket respectively. Second row indicates range & C.V respectively)

The mean total fixed cost for the large shrimp farmers was estimated as ₹3,22,062/ha/annum with the co-efficient of variance (C.V) of 33.41%. Among the various fixed cost items, the lease or rental value for own land was accounted for 55.96% and the expenditure towards the repairs and maintenance for capital goods was accounted for 4.00%.

In all the types of shrimp farming practices, the expenses towards the land lease or the rental value was the highest expenditure of fixed items in the culture practices.

The items of fixed cost per crop for the selected shrimp farmer respondents are furnished in Table 4.6

Table 4.6 Items of fixed cost for the selected shrimp farmer respondents per crop

(Amount in ₹/ha/crop)

Items of fixed cost	Small Farmers	Medium Farmers	Large Farmers
Lease value/ rental value for own land	90026.964 _± 33970.071 (44.20)	89943.48 _± 19136.7 (49.35)	90119.16 _± 34421.37 (55.96)
	30024-148619; 37.73	61182-118800; 21.28	64148-217980; 38.20
Depreciation for Capital items	19572.19524 _± 7552.287 (9.60)	17765.1738 _± 1180.08 (9.75)	11727.0126 _± 2274.95 (7.28)
	6199-30009; 38.59	16315-20248; 6.64	10611-21494; 19.40
Interest on capital investment	30897.69 _± 11806.10 (15.17)	28483.88 _± 2560.8 (15.63)	20334 _± 4439.7855 (12.63)
	9908-47938; 38.21	25017-33333; 8.99	17573-38209; 21.83
Repairs & Maintenance	15683.37 _± 6341.319 (7.7)	10319.1 _± 1051.875 (5.67)	6445.98 _± 2246.8375 (4.00)
	6755-27022; 40.43	9075-12705; 10.19	606-15137; 34.86
Consultancy Charges	23996.68 _± 23996.682 (11.78)	23984.928 _± 5103.12 (13.16)	24031.776 _± 9179.034 (14.92)
	8006-39632; 37.76	16315-31680; 21.28	17106-58128; 38.20
Salary to permanent staff	23535.48 _± 4843.872 (11.55)	11748 _± 983.07 (6.45)	8373.2 _± 8373.2 (5.20)
	12510-30024; 20.58	10725-13200; 8.37	7180-14705; 20.44
Total	203712.39 _± 72085.96 (100)	182244.57 _± 182244. 48 (100)	161031.14 _± 53793.83 (100)
	73740-323243; 35.39	138878-229966; 16.31	122503-365654; 33.41

(The first row indicates mean and standard deviation with percentages in bracket respectively. Second row indicates range & C.V respectively)

Sathiadhas et al. (2009) worked out the annual fixed cost as ₹1,94,000/ha for tiger shrimp farming in India during 2006 to 2007. In the case of small, medium and large shrimp farmers, the mean total fixed cost per crop was calculated as ₹2,03,712, ₹1,82,244 and ₹1,61,031 respectively which includes the lease value or rental value for own land, depreciation for capital items, interest on capital investment, repairs and maintenance, consultancy charges and salary to permanent staff with watch and reward expenses. These values are higher than the values of Sathiadhas et al. (2009) because of those values were worked out before 10 years and the Present study dealt with the gross returns for the shrimp species *L.vannami* culture which is characterized for fast growth rate whereas the earlier studies dealt with the economic analysis for *Penaeus monodon* culture.

4.3.2.3 Items of variable cost for the selected shrimp farmer respondents

In the case of shrimp farmers, the pond preparation cost includes complete removal of organic wastes from the pond bottom, ploughing, levelling, checking of soil pH, liming, bleaching of water and inlet filter net. The cost of shrimp seeds includes shrimp seed cost, PCR testing of seeds in the labs and transport cost for seeds. The shrimp supplementary feed cost includes cost of the supplementary feed and transport cost for feed. The fertilization cost includes cost of fertilizers like potash, super phosphate, urea and others. The chemicals cost includes cost of probiotics, minerals, zeolite and others. The Health management aspects cost includes cost of water quality kits, sampling, sanitation, water bleaching and drugs. Other variable cost items are electricity cost, fuel cost, labour cost, harvesting cost and miscellaneous cost.

The items of mean variable cost for the selected shrimp farmer respondents are furnished in Table 4.7

Table 4.7 Items of variable cost for the selected shrimp farmer respondents

(Amount in ₹/ha/crop)

Items of variable cost	Small Farmers	Medium Farmers	Large Farmers
Pond preparation	50014.98±18871.75 (2.43)	49968.6±10631.28 (2.46)	50066.2±19122.9 (2.48)
	16680-82566; 37.73	33990-66000;21.28	35638-121100;38.2
Seed cost	361775.9±135880.3 (17.54)	360433.92±76547 (17.74)	360822.6±137686 (17.85)
	121764-596143;37.6	245388-475860;21.4	256939-872266;38.2
Feed cost	907859± 340597.3 (44.03)	905830.2±191937.9 (44.67)	906423.1±345562 (44.83)
	306078-1494528;37.5	617430-1195260; 21.19	645809-2190526; 38.12
Fertilizer cost	31229.18±11783.59 (1.51)	31198.86±6636.63 (1.54)	31261.31±11940.3 (1.55)
	10415-51554; 37.73	21223-41210; 21.27	22252-75615; 38.2
Chemicals cost	373611.9±140975.2 (18.12)	373265.44±79417.8 (18.40)	373994.5±142849 (18.5)
	124599-616768;37.7	253905-493020; 21.3	266215-904617;38.2
Health management aspects cost	74941.57±26720.53 (3.64)	72734.64±15070.44 (3.59)	72269.02±27290.4 (3.57)
	27689-120763;35.66	50226-95700;20.72	51796-174470;37.75
Electricity charges	150044.9±56616.09 (7.27)	149905.8±31894.5 (7.40)	150198.6±57368.9 (7.42)
	50040-247698;37.73	101970-198000;21.3	106914-363300;38.2
Fuel cost	50014.98±18871.75 (2.43)	49968.6±10631.28 (2.46)	50066.2±19122.9 (2.48)
	16680-82566; 37.73	33990-66000; 21.28	35638-121100;38.2
Labour cost	35445±35445 (1.72)	19800±3049.86 (0.98)	16400.4±5101.943 (0.81)
	20850-41700; 27.23	16500-26400; 15.40	13840-38060; 31.11
Harvesting charges	22668.12±2101.68 (1.09)	12421.2±813.12 (0.61)	8864.52±412.605 (0.44)
	20850-26688; 9.27	11550-13860; 6.55	8650-10380; 4.66
Miscellaneous cost	3986.52±540.432 (0.2)	2250.6±212.19 (0.11)	1536.24±192.203 (0.08)
	3336-5004; 13.56	1980-2640; 9.44	1384-2076; 12.51
Total	2061592±760001.7 (100)	2027777.9±426167 (100)	2021903±766492.9 (100)
	718981-3364310; 36.86	1388318-2673950; 21.02	1445077-4873510; 37.91

(The first row indicates mean and standard deviation with percentages in bracket

respectively. Second row indicates range & C.V respectively)

The mean total variable cost for the small shrimp farmers came to ₹20,61,592/ha/crop with the range and the co-efficient of variance (C.V) of ₹7,18,981 to ₹33,64,310 and 36.86 % respectively. The shrimp seed and the supplementary feed cost were the major share in the variable cost items with 17.54% and 44.03% respectively. The mean total variable cost for the medium shrimp farmers was worked out as ₹20,27,777/ha/ crop with the range and the co-efficient of variance (C.V) of ₹13,88,318 - ₹26,73,950 and 21.02% respectively. In this case also, the shrimp seed and the supplementary feed cost contributed to the major share among the variable cost items that is accounting for 17.77 and 44.67% respectively. The mean total variable cost for the large shrimp farmers came to ₹20,21,903/ha/ crop with the range and the co-efficient of variance (C.V) of ₹14,45,077 - ₹48,73,510 and 37.91% respectively. The shrimp seeds and the supplementary feed cost were contributing much to the total variable cost with 17.85% and 44.83% respectively.

Kumar et al. (2016) reported that the mean total variable cost in the case of *L.vannamei* shrimp farming was worked out to ₹11,68,011/ha with the major share for supplementary feed representing 38.20% respectively. In the present study, the mean total variable cost per ha per crop for small, medium and large shrimp farmers was worked out to ₹20,61,592, ₹20,27,777 and ₹20,21,903 respectively. In this case also supplementary feed cost accounted for the major share in the total variable cost representing above 44% in all the categories of shrimp farmers.

4.3.2.4 Total cost of the selected shrimp farmer respondents

The mean total cost of the selected shrimp farmer respondents is presented in Table 4.8

Table 4.8 Total cost of the selected shrimp farmer respondents**(Amount in ₹/ ha/crop)**

Cost	Small Farmers	Medium Farmers	Large Farmers
Fixed cost	203712.39±72085.956 (16.50)	182244.6±182244.5 (15.24)	161031.13±53793.83 (13.74)
	147480-646487; 35.39	277755-459933;16.3	245007-731307; 33.41
Variable cost	2061592±760001.7 (83.5)	2027777.9±426166.6 (84.76)	2021903±766492.9 (86.26)
	718981-3364310; 36.86	1388318-2673950; 21.02	1445077-4873510; 37.91
Total cost	2265304.5±903622.3 (100)	2210022±485567.61 (100)	2182933.9±874011.6 (100)
	866462-4010797; 36.60	1666073-3133883; 20.30	1690171-5604818; 37.29

(The first row indicates mean and standard deviation with percentages in bracket respectively. Second row indicates range & C.V respectively)

In the case of small shrimp farmers, the mean total fixed cost and the mean total variable cost per ha per crop was worked out to ₹2,03,712 and ₹20,61,592 respectively. The mean total cost of shrimp farming per ha per crop came to ₹22,65,304 with the range and the CV of ₹8,66,462 - ₹40,10,797 and 36.60% respectively. For the medium shrimp farmers, the mean total fixed cost and the mean total variable cost per ha per crop was estimated as ₹1,82,244 and ₹20,27,777 respectively. The mean total cost per ha per crop was estimated as ₹2,10,022/ha/ crop with the range and CV of ₹16,66,073 - ₹31,33,883 and 20.30% respectively. Similarly for the large shrimp farmers, the mean total fixed cost and the mean total variable cost per ha per crop was ₹1,61,031 and ₹20,21,903 respectively. The mean total cost came ₹21,82,933/ha/crop with the range and CV of ₹16,90,171 - ₹56,04,818 and 37.29 % respectively.

Sahu et al. (2012) worked out the mean total cost of shrimp farming with ₹11,52,840 per 0.5 ha, splitting into ₹1,94,840 and ₹9,58,000 for the mean total fixed cost and the mean total variable cost, respectively. In the present study the mean total cost per ha per crop was ₹22,65,304, ₹22,10,022 and ₹21,82,933 for the small, medium and large shrimp farmers respectively. These values are higher than the estimates of Sahu et al. (2012) who worked out the total cost was ₹11,52,840 per 0.5 ha which might be due to the culture area, culture practices, and the level of adoption of culture technologies.

4.3.2.5 Mean production and the Mean Gross Returns of the selected shrimp farmer respondents

The mean production and the mean gross returns of the selected shrimp farmer respondents are furnished in Table 4.9

Table 4.9 Mean production and the Mean Gross Returns of the selected shrimp farmer respondents

(Yield in kg and gross returns in ₹/ ha/crop)

	Small Farmers	Medium Farmers	Large Farmers
Total Yield	8402.517±3170.5	8394.7± 1786.1	8411.1216±3212.6
	2337-11568; 37.73	5710-11088; 21.28	5987-20345; 38.20
Price	305.2 ± 14.74	307.6 ± 14.51	315.2 ± 15.84
	280-340; 4.83	290-340; 4.72	300-350; 5.02
Gross returns	2558725.3	2566905.264	2640621.34
	± 959296.36	± 488230.7864	± 982681.07
	784627-4300037; 37.49	1830352-3326400; 19.02	1831032-6306888; 37.21

(The first row indicates mean and standard deviation with percentages in bracket respectively. Second row indicates range & C.V respectively)

The mean shrimp production and the mean price received per kg, for small shrimp farmers was 8402 kg/ha/crop and ₹305 respectively. Similarly, the mean

production and the mean price received per kg for the medium shrimp farmers was 8394 kg/ha/crop and ₹308 respectively. The mean production and the mean price received per kg for the large shrimp farmers was estimated 8411 kg/ha/crop and ₹315 respectively. These estimates were higher than the estimates of Jayaraman et al. (1994) who analysed the economics of improved extensive shrimp farming in Vedaranyam, Tamil Nadu state. Production of farm raised shrimps was reported to vary from 600 to 1,360 kg/ha/crop which might be due to culture practices followed, adoption of modern technologies and different shrimp species cultured. The average shrimp production in the Nagapattinam district was 4800 tonnes (State Fisheries Department, Nagapattinam, 2016).

The mean gross returns for the small, medium and large shrimp farmers was estimated as ₹25,58,725/ha/crop ₹25,66,905/ha/crop and ₹26,40,621/ha/crop respectively. These total mean gross returns was very much higher than the values reported by Balakrishnan et al. (2011) which was ₹22,85,468 per 3.3 ha/ crop and Kumar et al. (2016) reported the average gross revenue for *L.vannamei* shrimp farming as ₹15,88,445/ha/crop which might be due to variation of culture practices, season and adoption of improved technologies.

4.3.2.6. Economic Indicators of the farming practices of the selected shrimp farmer respondents

The economic indicators of the farming practices of the selected shrimp farmer respondents are furnished in Table 4.10

The total cost, gross returns and the net returns per ha per crop were estimated as ₹22,65,304, ₹25,58,725 and ₹2,93,420 respectively for the small shrimp farmers. Similarly for the medium shrimp farmers, the corresponding values per crop ₹22,10,022, ₹25,66,905 and ₹3,56,882 respectively. On the other hand,

the estimated total cost, gross returns and the net returns per crop were ₹21,82,933, ₹ 26,40,621 and ₹4,57,687 respectively for the large shrimp farmers.

Table 4.10 Economic Indicators of the farming practices of the selected shrimp farmer respondents

(Amount in ₹/ha/crop)

Economic indicators	Small Farmers	Medium Farmers	Large Farmers
Total Gross returns	25,58,725	25,66,905	26,40,621
Total fixed cost	2,03,712	1,82,244	1,61,031
Total Variable cost	20,61,592	20,27,777	20,21,903
Total cost	22,65,304	22,10,022	21,82,933
Net returns on TC	2,93,420	3,56,882	4,57,687
Net returns on TVC	4,97,133	5,39,128	6,18,719
BCR on TVC basis	1.24	1.27	1.31
BCR on TC basis	1.13	1.16	1.21
Rate of returns on capital investment TVC basis	96.5%	113.6%	182.6%
Rate of returns on capital investment TC basis	57%	75.2%	135%

These estimates were higher than the estimates of Sathiadhas et al. (2009) where in the estimated total cost, and the net returns per ha per annum were ₹9,64,000 and ₹4,18,000 respectively which might be due to the adoption of improved culture practices and the shrimp species cultured.

4.3.2.7 Benefit Cost Ratio of the shrimp farmers

BCR is the ratio between the total benefits divided by the total cost. The BCR of the shrimp farmers on the basis of total variable cost and total cost in Nagapattinam district was estimated.

In the case of small shrimp farmers, the BCR on the basis of total variable cost was estimated as 1.24 which means that if one rupee is invested in shrimp farming, the mean gross returns were arrived at 1.24 which indicates the profitability of shrimp farming practices. Similarly on the basis on total cost, the BCR was 1.13. In the case of medium shrimp farmers, the BCR on the basis of total variable cost was estimated as 1.27 and the BCR on the basis of total cost was 1.16. In the case of large shrimp farmers, the BCR on the basis of total variable cost was estimated as 1.31 and the BCR on the basis of total cost was 1.21.

Bhattacharya (2009) worked out the BCR for small, medium and large traditional shrimp farming as 1.23, 1.67 and 2.25 on the basis of total cost and 1.84, 2.10 and 2.57 on the basis of variable cost. These values were higher than the present study values because of the total cost was low in traditional shrimp farming in contrast with the present study.

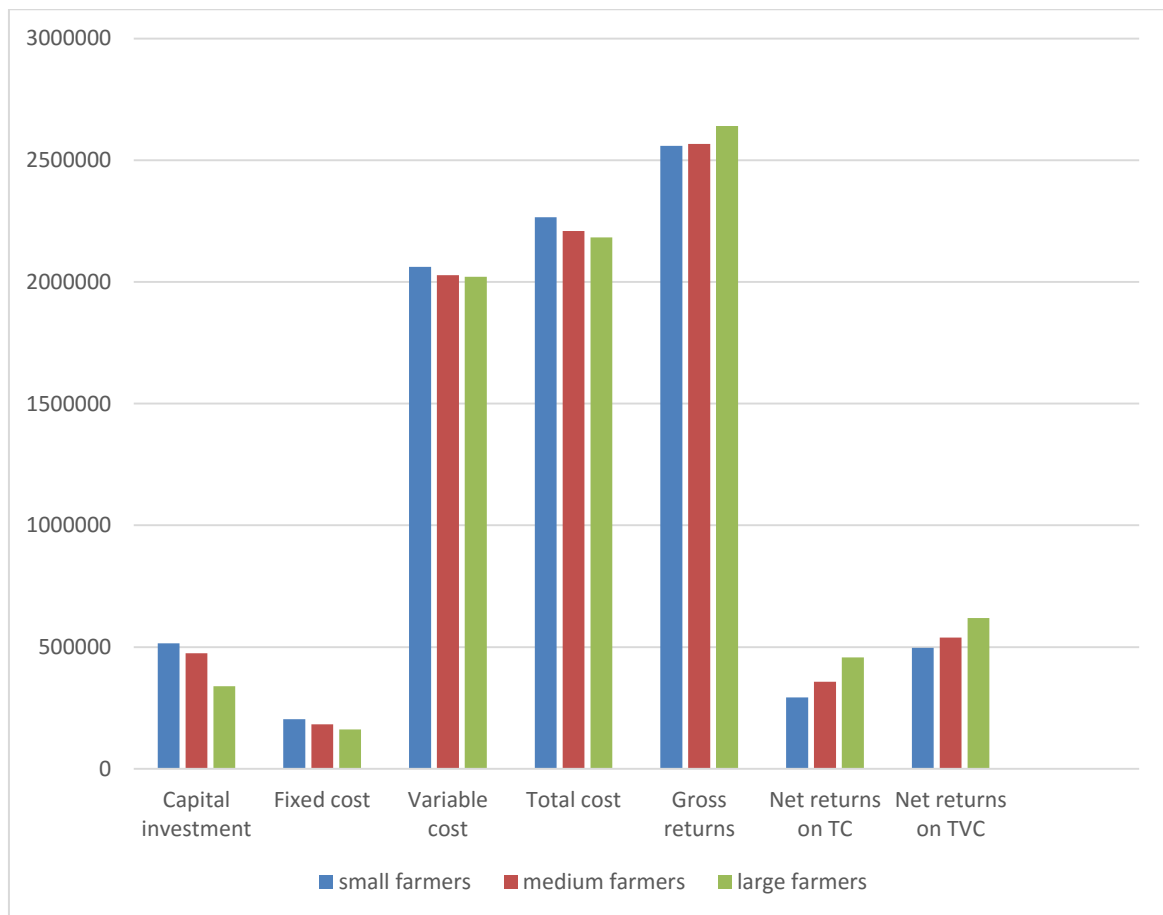
4.3.2.8 Rate of returns on capital investment of the shrimp farmers

The rate of returns on capital investment for the small shrimp farmers on the basis of total variable cost was estimated as 96.50% and on the basis of total cost, it came to 57.00%. The rate of returns on capital investment for the medium shrimp farmers on the basis of total variable cost was estimated as 113.60% and on the basis of total cost, it came to 75.20%. The rate of returns on capital investment for the large shrimp farmers on the basis of total variable cost was estimated as 182.60% and on the basis of total cost, it came to 135.00%.

In the present study ,the rate of returns on capital investment for all the case of shrimp farmers values were lower than the estimates of Syed et al (2013) who worked out the rate of returns on capital investment on the basis of total variable cost with 233.47% and on the basis of total cost it was 198.57%. But the profitability

estimates were calculated for the *Penaeus monodon* Sp by Syed et al (2013). In the present study, the economic estimates were done for *L.vannamei* culture in Nagapattinam district.

Fig 4.1. Costs and returns of the selected shrimp farmers



4.3.2.9 The Average Cost Analysis for the selected shrimp farmer respondents

In this part the various inputs cost contribution was calculated to produce one kg of shrimp in Nagapattinam district and the details are furnished in Table 4.11

The total production cost was calculated as ₹269.60/kg of which ₹245.35/kg was variable cost and ₹24.24/kg was total fixed cost for the small shrimp farmers to produce per kg of shrimp. The total production cost was calculated as ₹263.26/kg

of which ₹241.56/kg was variable cost and ₹21.71/kg was total fixed cost for the medium shrimp farmers to produce per kg of shrimp. The total production cost was calculated as ₹259.53/kg of which ₹240.38/kg was variable cost and ₹19.15/kg was total fixed cost for the large shrimp farmers to produce per kg of shrimp respectively.

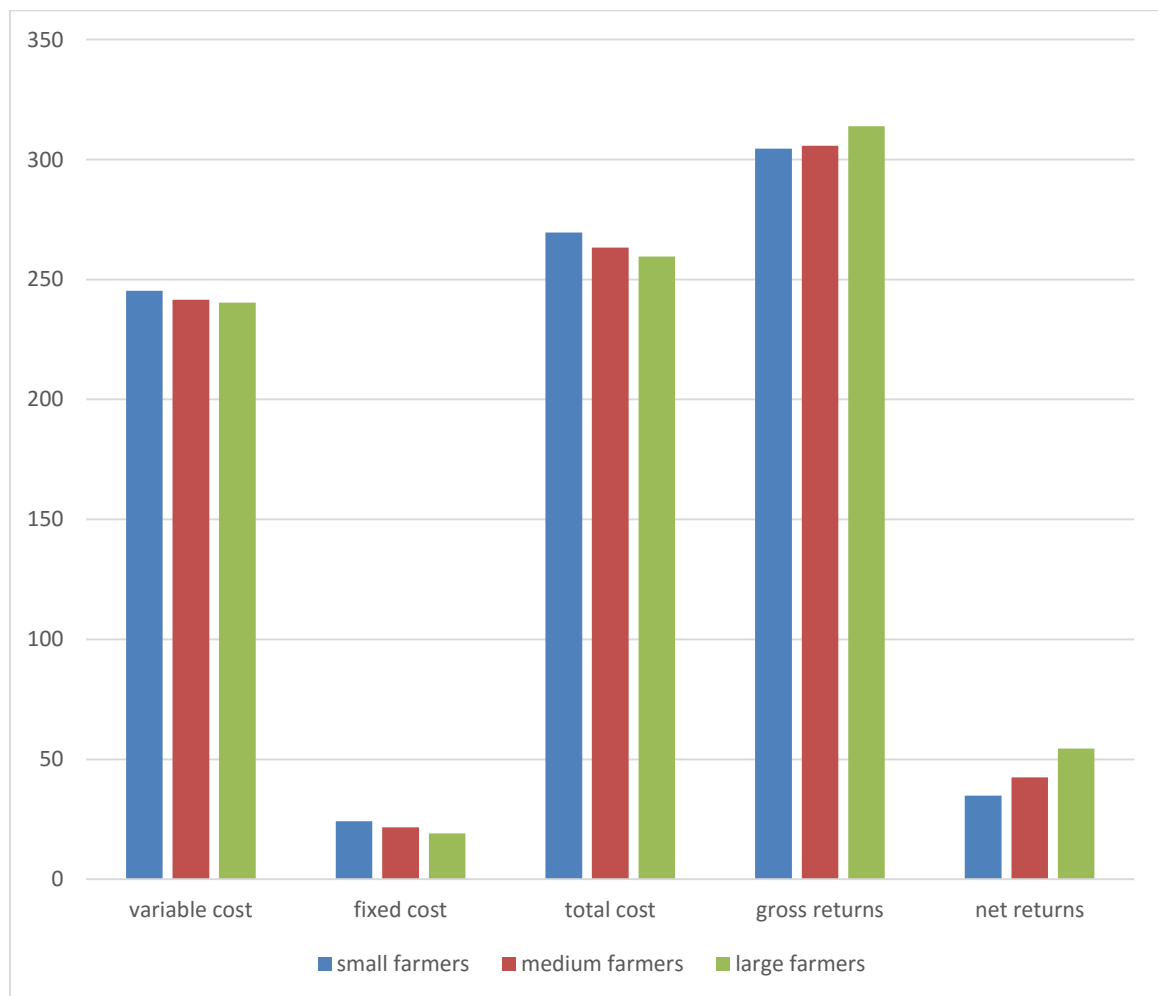
Table 4.11 Average Cost Analysis for the sample shrimp farmer respondents

(Amount in ₹ /ha/crop)

Particulars	Small Farmers	Medium Farmers	Large Farmers
Area (ha)	Up to 2 ha	2 – 4 ha	Above 4 ha
Density (numbers/m ²)	60	60	60
DOC (days)	120	120	120
Survival (%)	70	70	70
Pond preparation cost ₹/kg	5.95	5.92	5.94
Seed cost ₹/kg	43.06	42.94	42.90
Feed cost ₹/kg	108.05	107.90	107.76
Fertilization cost ₹/kg	3.717	3.716	3.72
Chemicals cost ₹/kg	44.45	44.50	44.46
Health monitoring cost ₹/kg	8.919	8.664	8.592
Electricity cost ₹/kg	17.86	17.857	17.86
Fuel cost ₹/kg	5.95	5.952	5.952
Labour cost ₹/kg	4.22	2.359	1.950
Harvesting cost ₹/kg	2.698	1.480	1.054
Miscellaneous cost ₹/kg	0.474	0.268	0.183
Total variable cost ₹/kg	245.354	241.555	240.384
Total fixed cost ₹/kg	24.244	21.709	19.145
Production cost ₹/kg	269.60	263.264	259.529
Price ₹/kg	305.20	307.60	315.20
Net profit ₹/kg	34.921	42.513	54.415

The feed cost was the major share in the production cost per kg with above ₹107/ kg in all the categories of shrimp farmers representing above 40.00%. Kumar et al. (2016) reported that the feed cost was high in the total variable cost representing 38.20% which coincides with the present study values. Balakrishnan et al. (2011) also reported that feed cost was the major share in the production cost representing 50.39% and the net profit was 78.56 / kg of shrimp. In the present study the net profit per kg was estimated as ₹34.92, ₹42.51 and ₹54.415 for the small, medium, large shrimp farmers. These values are less than the estimates of Balakrishnan et al. (2011) for the net profit due to the input factors cost variation.

Fig 4.2. Average Cost Analysis for the selected shrimp farmer respondents



4.3.2.10 Production function analysis in shrimp farmer respondents

The factors which determining the total shrimp production in culture ponds was studied by production function analysis. The linear regression model was used and the estimated function for the shrimp farmers is presented below:

$$Y = - 4656.315 + 0.466 X_1^* + 0.273 X_2^* - 0.34 X_3^{NS} + 15.66 X_4^* \\ (1436.31) \quad (17.36) \quad (12.61) \quad (1.704) \quad (0.005) \\ + 12.654 X_5^* - 30.074 X_6^{NS} - 6.285 X_7^{NS} - 0.113 X_8^{NS} \\ (7.68) \quad (40.94) \quad (11.598) \quad (0.214)$$

Where,

Y - Total shrimp production in kg

X₁ - supplementary feed in kg

X₂ - fertilizer in kg

X₃ - chemicals in kg

X₄ - stocking density in numbers

X₅ - survival rate in percentage

X₆ - electricity consumed in units

X₇ - number of labours employed

X₈ - fuel in litres

R = 0.873

R² = 0.859

F Value = 3.63

n = 100

(Figures in parentheses indicate standard error)

* Significant at 5 % level

NS = Not significant

The R value represent the simple correlation and is 0.873 which indicates a high degree of correlation.

The co-efficient of multiple determination (R^2) in the estimated function was found to be 0.859 implying that 85.9 % of the variation in the total shrimp yield in the shrimp ponds was explained by the eight independent variables included in the functional analysis.

The partial regression co-efficient of supplementary feed was positive and significant at $p = 0.05$. The partial regression co-efficient of stocking density and survival rate was positive and significant at $p = 0.05$.

The regression co-efficient of 0.466 for X_1 revealed that for the increase of one kg of supplementary feed application per ha could result in an increase of total shrimp yield by 0.466 kg per ha. The partial regression co-efficient of 0.273 for X_2 indicated that an increase of one kg of fertilizer per ha application could result in an increase of total shrimp yield by 0.273 kg per ha. The partial regression co-efficient of 15.66 for X_4 indicated that an increase of stocking density of shrimp post larvae per ha in culture, it would significantly play a vital role to increase the total shrimp yield by 15.66 kg per ha. The partial regression co-efficient of 12.654 for X_5 indicated that an increase of survival rate by one percent would by and large increase the total shrimp produced by 12.654 kg per ha which indicated the importance of survival rate in shrimp yield.

The production function analysis for shrimp farming indicate that supplementary feed, fertilizer, stocking density and survival rate play a vital role in enhancing the total shrimp yield. Hence the shrimp farmers could pay their attention to the above variables to enhance their total yield. In the present study, supplementary feed, fertilizer, chemicals and drugs, stocking density, survival rate,

electricity, labours and fuel were considered as explanatory variables whereas yield was considered as response variable.

4.4 Risk analysis in the shrimp farming practices

The various types of risks involved in *L.vannamei* shrimp farming in the study area are furnished in Table 4.12

Table 4.12 Various types of risks involved in *L.vannamei* shrimp farming in the study area

S.No	Risks	Frequency (N=100)	Percentage	Rank
1	Production risks	89	89%	I
2	Financial risks	76	76%	II
3	Marketing risks	68	68%	III
4	Extension risks	45	45%	IV
5	Natural risks	30	30%	V
6	Social risks	12	12%	VI

The production risks were expressed as the foremost risk in *L.vannamei* shrimp farming represented by 89% of the selected shrimp farmers in Nagapattinam district. The production risks were considered as high because of the problems in the supply of inputs were related to decrease the production of shrimp. The financial risks concerned as the second major risk that accounted for 76%. Shrimp farming business requires more investment and hence the shrimp farmers expressed financial risks as one of the main risks in shrimp farming. The marketing risks were third ranked by the shrimp farmers in the present study which registering 68%. The extension risks, natural risks and social risks were identified as the fourth, fifth and sixth ranked risks for the shrimp farmers.

4.4.1 Constraints in the shrimp farming Practices

The different constraints comes under the various types of risks in the present study and it is explained and ranked by the following

4.4.1.2 Production constraints for the selected shrimp farmer respondents

The various production constraints expressed by the selected shrimp farmer respondents are furnished in Table 4.13

Table 4.13 Production constraints among the selected shrimp farmer respondents

S.No	Constraints	Garrett score	Mean score	Rank
1	Lack of good quality seed	85	83.15	I
2	High cost of feed	76	71.63	II
3	High cost of electricity	70	51.4	III
4	Prevalence of disease outbreak	66	55.57	IV
5	High price of seed	61	75.08	V
6	Over dosage of chemicals	58	65.06	VI
7	Sudden fall in DO due to power failure	55	48.6	VII
8	Lack of scientific knowledge	52	44.46	VIII
9	Non availability of skilled labour	48	42.54	IX
10	Inadequate technical experts	45	38.08	X
11	Poor water quality	42	57.46	XI
12	Shortage of water	39	63.05	XII
13	Lack of certification of inputs by CAA	35	17.25	XIII
14	Improper Icing	30	35.92	XIV
15	partial damages during harvesting	24	27.99	XV
16	predation	15	23.76	XVI

The most important constraint from the shrimp farmers was the lack of good quality shrimp seeds and the same was reported by Koteswari et al. (2014). The reason for the lack of good quality shrimp seeds might be due to the poor quality of brood stock and the same was reported by Srinivas and Venkatrayalu (2016). The farmers perceived that the high cost of supplementary feed was the second important constraint in shrimp farming, whereas Srinivas and Venkatrayalu (2016) ranked high feed cost as the third important constraint. The cost of feed was high because of the raw materials cost and price of fish meal which is required to produce high protein content feed might be high and the same was reported by

Babu et al. (2013). High cost of electricity is the third most important constraint in the present study, whereas the electricity charges high was the sixth most important constraint reported by Srinivas and Venkatrayalu (2016). The regular use of aerators and pumping motors led to increase the electricity cost in shrimp farming and the farmers had no subsidy on electricity but the agricultural farmers are getting electricity at free of cost in Tamil Nadu. The prevalence of disease outbreak was considered as the fourth constraint but Srinivas and Venkatrayalu (2016) reported disease outbreak as the main constraint. In the present study, the biosecurity measures might be reduce the disease outbreak. High price of seed was the fifth constraint in the present study and the reason was the brooder cost and the hatchery management cost was high.

Over dosage of chemicals was the sixth most important constraint because of the farmers might have used the chemicals more than the required level. Sudden fall in DO due to power failure was the seventh ranked constraint and the small farmers were affected mostly because most of them had no generators in their farm. Lack of scientific knowledge was the eighth ranked constraint because most of the farmers were educated up to middle school. Non availability of skilled labour was the ninth ranked constraint because most of the labours do not knew about the technical aspects in shrimp farming. Inadequate technical experts was the tenth ranked constraint. The guidance of the technical experts is necessary to reduce the risks in shrimp farming but technical experts with more experience were inadequate in the present study. Sawant and Sawant (2003) also reported the inadequate availability of technical experts due to the reason that the farmers showed partial attitude towards the technical experts. Poor water quality was the eleventh ranked constraint whereas Srinivas and Venkatrayalu (2016) reported as the fifth rank in

their study. Shortage of water was the twelfth ranked constraint whereas Jagadeesh (2015) reported shortage of water as the fifth ranked constraint in Andhra Pradesh. Lack of certification of inputs by CAA was the thirteenth constraint because without certification the farmers used poor quality of inputs, Improper Icing and partial damages during harvesting were the fourteenth and fifteenth constraints and this led to decrease the quality and price of shrimp. Predation was the sixteenth and the last constraint because of the biosecurity measures reduced this constraint and the same was reported by Jitendrakumar et al. (2016).

4.4.1.3 Marketing constraints for the selected shrimp farmer respondents

The various marketing constraints reported by the selected shrimp farmer respondents are furnished in Table 4.14

Table 4.14 Marketing constraints among the selected shrimp farmer respondents

S.No	Constraints	Garrett score	Mean score	Rank
1	Shrimp price fluctuations	72	71.01	I
2	Lack of cold storage facilities	63	63.99	II
3	Problem of direct selling to buyers	54	52.4	III
4	Distance of market	46	47.6	IV
5	Demand and supply fluctuations	36	34.18	V
6	Physical damage during transportation	23	24.82	VI

Shrimp price fluctuations was the first and the most important marketing constraint for the shrimp farmers and Sahu et al. (2014) also reported the price fluctuations as the first most important constraint. The rapidly increasing production of shrimp has led to price depression in the markets. Lack of cold storage facilities was the second ranked constraint and the farmers reported that they could store their produced shrimp in cold stores and sell them when the price was high. The problem of direct selling to buyers (which means that getting money from the buyers

after the sale is difficult sometimes) was identified as the third ranked constraint whereas Jagadeesh (2015) reported this constraint as the fourth ranked in his study in Andhra Pradesh. Distance of market was ranked as the fourth constraint because the inputs transportation cost increases when the market distance is high. Demand and supply fluctuations were the fifth ranked constraint which might be due to the competition from alternative commodities or other shrimp producers in either local, regional, national or international. Physical damage during transportation was the least marketing constraint and the reason for this constraint was improper handling of produced shrimp during transportation.

4.4.1.4 Financial constraints for the selected shrimp farmer respondents

The various financial constraints reported by the selected shrimp farmer respondents are furnished in Table 4.15

Table 4.15 Financial constraints among the selected shrimp farmer respondents

S.No	Constraints	Garrett score	Mean score	Rank
1	Inadequate co-operative & society financial assistance	78	75.36	I
2	Inadequate credit from banks	66	68.64	II
3	High interest rate for non- institutional credit	57	56.16	III
4	No insurance for shrimp farm	50	50.84	IV
5	Low net returns	42	38.2	V
6	Buy back system	34	35.2	VI
7	Problem in collateral security in institutional finance	22	24.48	VII

Among the shrimp farmers, inadequate co-operative & society financial assistance was the first and most important financial constraint because shrimp farming requires more money investment. The farmers perceived that inadequate credit from banks was the second important constraint for shrimp farmers and the

Srinivas and Venkatrayalu (2016) and Kumaran et al. (2003) also reported the inadequate credit was the major problem in shrimp farming. High interest rate for non-institutional credit was ranked as the third main constraint. Generally, the insurance programs are intended to transfer risk from the producer to the insurance underwriter and so the no insurance for shrimp farms was the fourth ranked constraint whereas Kumaran et al. (2003) ranked lack of insurance for shrimp farming as the sixth main constraint in shrimp farming. Low net returns was the fifth ranked constraint in the present study and Jagadeesh (2015) ranked low net returns as third main constraint in shrimp farming. Buy back system was the sixth ranked constraint in the present study because most of the farmers obtained inputs on credit basis from the local traders through buy back arrangements and the same reason was reported by Kumaran et al. (2003). Recently, the farmers expressed the Problem of collateral security in institutional finance and ranked as seventh position among the various financial constraints in the present study.

4.4.1.5 Natural constraints for the selected shrimp farmer respondents

The various natural constraints among the selected shrimp farmer respondents are furnished in Table 4.16

Table 4.16 Natural constraints among the selected shrimp farmer respondents

S.No	Constraints	Garrett score	Mean score	Rank
1	Flood	73	72.06	I
2	Cyclone	56	50.28	II
3	Heavy rain fall	43	49.66	III
4	Sudden change in climate	27	27	IV

Flood was the first and the main natural constraint for shrimp farming followed by cyclone which was ranked as the second main constraint in the present

study and Nagothu et al. (2012) reported that the highest risk rating climate change event was floods followed by cyclone in Andhra Pradesh. The farmers reported that the impact of flood was brought out the culturing shrimps from the pond to outside area. Heavy rain fall was the third ranked constraint in the present study. Especially, the Avarikkadu village which comes under Vedharanyam taluk was highly affected by the heavy rain fall in rainy season and the heavy rain fall had reduced the salinity of pond water leading to low growth of shrimp. Nagothu et al. (2012) reported that the heavy rain fall were ranked as fifth position among the various climate change events. Sudden change in climate was the least ranked natural constraint for shrimp farming in the present study.

4.4.1.6 Social constraints for the selected shrimp farmer respondents

The various social constraints among the selected shrimp farmer respondents are furnished in Table 4.17

Table 4.17 Social constraints among the selected shrimp farmer respondents

S.No	Constraints	Garrett score	Mean score	Rank
1	Direct discharge of waste water into open sea	69	69	I
3	Poaching problem	50	50	II
2	Location of farms nearby residential area	31	31	III

The direct discharge of waste water into open sea was the first and the main constraints of various social risks in the present study. According to CAA rules the waste water from the shrimp farm should be treated by ETP and bleached before discharge because the water as a culture medium in shrimp farming which would transfer the pathogens from the infected pond to other ponds. Poaching problem was the second ranked social constraints. The shrimp farmers from Sirkali taluk expressed poaching problem occurred there slightly higher than in the other

regions shrimp farmers from Nagapattinam district. However, the poaching problems were too decreased nowadays compared to the ten years back.

4.4.1.7 Extension constraints for the selected shrimp farmer respondents

The various extension constraints opined by the selected shrimp farmer respondents are furnished in Table 4.18

Table 4.18 Extension constraints among the selected shrimp farmer respondents

S.No	Constraints	Garrett score	Mean score	Rank
1	Inadequate consultation & meeting with Govt. officials	75	88.8	1
2	Lack of social network among the shrimp farmers	60	67.8	2
3	Lack of shrimp farmers Associations	50	39.8	3
4	Updated Information on shrimp farming	39	35.6	4
5	Inadequate awareness on production technologies	24	18	5

The Inadequate consultation & meeting with the Govt. officials was the first ranked and the main extension risk which was expressed by the shrimp farmers in the present study because the shrimp farmers want more consultation and meeting with government officials. Sawant and Sawant (2003) also reported the extension personnel were transferred frequently and that was the major constraint for the inadequate technical guidance from extension personnel. The lack of social network among the shrimp farmers was the second ranked constraint because of competition, ignorance and poor cooperation among the shrimp farmers and the same reason was reported for the lack of social network among the shrimp farmers by Sawant and Sawant (2003). The lack of shrimp farmers Associations was the third ranked constraint and the farmers reported that they want meeting hall for the shrimp farmers associations. The updated Information on shrimp farming was the

fourth ranked constraint that occurred because of poor mass media support. The inadequate awareness on production technologies was the least and last ranked extension constraint in the present study. This constraint occurred when the shrimp farmers did not adopt to the modern production technologies in shrimp farming.

V. SUMMARY AND CONCLUSION

5.1 Summary

The present study was undertaken to work out the economics of *L.vannamei* shrimp farming practices in Nagapattinam district, Tamil Nadu. The specific objectives of the study were to study the present status of *L.vannamei* farming practices and the socio-economic characteristics of the selected shrimp farmers, to estimate the costs and returns of *L.vannamei* shrimp farming, to analyze the various risks involved in shrimp farming and suggest policy measures for the overall development of *L.vannamei* farming in Nagapattinam district, Tamil Nadu.

Nagapattinam district was chosen as the study area in view of abundant *L.vannamei* shrimp farming activities in the district. The total sample size was fixed as 100 for the present study which was equally distributed among the five coastal taluks namely, Sirkazhi, Tharangambadi, Nagapattinam, Kilvelur and Vedaranyam of the Nagapattinam district. The above stated samples were divided into small, medium and large *L.vannamei* shrimp farmers based on shrimp culture area. The shrimp farmers were selected randomly for data collection in the present study.

The shrimp farmers were culturing two crops per year. Most of the shrimp farmers purchased *L.vannamei* seeds in the size of Post Larvae-11 at the average rate of ₹0.60 per piece from the hatcheries. The shrimp farmers stocked at a density of 40-60 numbers/m² in their ponds. The average culture period was 90 – 120 days and the average survival rate of the stocked seeds were 70% – 80%. The average harvesting size of the shrimp was 20g from the culture ponds of the selected shrimp farmer respondents.

The predominant age group of the selected shrimp farmers was 36-45 years representing 50.00 %. Majority of the shrimp farmers were males representing

88.00%. About 41.00% of the shrimp farmers were educated up to middle school. Most of the shrimp farmers belonged to Hindu religion representing 79.00% and all of the respondents had their own houses. Majority of the shrimp farmers had nuclear type of family representing 67.00%. About 76.00% of the shrimp farmers had family size with more than five members.

Most of the shrimp farmers have owned ponds representing 56.00% and leased ponds 28.00%, both owned & leased ponds with 16.00% respectively. About 86.00% of the shrimp farmers followed aquaculture alone as their primary occupation and the rest of the farmers had other secondary occupation along with shrimp farming. Among the shrimp farmers, 82.00% of them had shrimp farming experience above 10 years and 18.00% of them had up to 10 years of experience.

The mean total capital investment of the small, medium and large shrimp farmers was worked out to ₹5,14,961/ha ₹4,74,731/ha and ₹3,38,900/ha respectively. Among these three groups, aerators and farm accessories were accounting for above 45%.

The mean total fixed cost per ha per crop of the small, medium and large shrimp farmers was calculated as ₹2,03,712, ₹1,82,244 and ₹1,61,031 respectively. Among these three groups, lease value or rental value for own land were accounting for 44.20%.

The mean total variable cost per ha per crop of the small, medium and large shrimp farmers was estimated as ₹20,61,592, ₹20,27,777 and ₹20,21,903 respectively. The contribution of supplementary feed and shrimp seeds together in the TVC came to above 60% for all the three categories of shrimp farmers.

The mean total cost of the small, medium and large shrimp farmers came to ₹22,65,304, ₹22,10,022 and ₹21,82,933 respectively, per ha per crop.

The mean production of the small shrimp farmers was worked out to 8402 Kgs per ha and per crop. The mean production for the medium shrimp farmers was 8394 kgs per ha and per crop. Similarly, for the large shrimp farmers it was 8411 Kgs per ha and per crop.

The mean price received per kg of the small, medium and large shrimp farmers was estimated as ₹305.2, ₹307.6 and ₹315.2 respectively. There were fluctuations in the mean price per kg received which was due to market trends.

The mean total gross returns per ha per crop of the small, medium and large shrimp farmers was worked out to ₹25,58,725, ₹25,66,905 and ₹26,40,621 respectively.

The mean net returns per ha per crop of the small, medium and large shrimp farmers was calculated on the TC basis came to ₹2,93,420, ₹3,56,882 and ₹4,57,687 respectively. On the basis of total variable cost, the net returns per ha per crop was estimated as ₹4,97,133, ₹5,39,128 and ₹6,18,719 respectively.

Among the selected shrimp farmers, the BCR on TVC basis was 1.24, 1.27 and 1.31 for the small, medium and large farmers respectively. Similarly on TC basis, it was 1.13, 1.16 and 1.21 respectively.

The rate of returns on capital investment was calculated on TVC and TC basis. Among the selected shrimp farmers, the rate of returns on capital investment on TVC basis ranged 96.5% to 182.6% for small, medium and large shrimp farmers and the rate of returns on capital investment on TC basis ranged between 57% and 135% for small, medium and large shrimp farmers.

The average production cost per kg was calculated as ₹270, ₹263 and ₹260 for the small, medium and large shrimp farmers. The net returns per kg was calculated as ₹34.92, ₹42.51 and ₹54.42 for the small, medium and large shrimp

farmers in the study area. The feed cost was the major share in the production cost with above ₹107/kg in all the categories of shrimp farmers.

The factors determining the shrimp production was estimated by linear regression model. Eight explanatory variables are included in the empirical model. They were supplementary feed, fertilizer, chemicals and drugs, stocking density, survival rate, electricity, labours and fuel. The partial regression co-efficient of supplementary feed, fertilizer, stocking density and survival rate were positive and significant at $p = 0.05$ in the shrimp farming. The co-efficient of multiple determination (R^2) in the estimated function was found to be 0.859 implying that 85.90% of the variation in the total shrimp yield was explained by the eight independent variables included in the functional analysis.

The various types of risks involved in shrimp farming was reported by the shrimp farmers were listed and ranked. The important risks involved in shrimp farming reported were production risks, marketing risks, financial risks, natural risks, social risks and extension risks. The production risks were expressed as the foremost risks in shrimp farming by the selected shrimp farmers.

The sixteen production constraints in shrimp farming was reported by the shrimp farmers of Nagapattinam district were ranked and listed. The important production constraints reported were the lack of good quality seed, high cost of feed, high cost of electricity, prevalence of disease outbreaks, high price of seed, over dosage of chemicals, sudden fall of DO due to power failure, lack of scientific knowledge, non-availability of skilled labour, inadequate technical experts, poor water quality, shortage of water, lack of certification of inputs by CAA, improper icing, partial damages during harvesting and predation.

The six constraints of shrimp marketing as reported by the shrimp farmers in Nagapattinam district were ranked and listed. The important marketing constraints reported were the shrimp price fluctuations, lack of cold storage facilities, problem of direct selling to the buyers, distance of markets, demand and supply fluctuations and physical damages of shrimps during transportation.

The seven major constraints of financial risks in shrimp farming as reported by the shrimp farmers in Nagapattinam district were ranked and listed. They were inadequate co-operative & society financial assistance, inadequate credit from banks, high interest rate for non- institutional credit, no insurance for shrimp farms, low net returns, buy back system and problems in providing collateral security in the case of institutional finance.

The natural constraints were flood, cyclone, heavy rain fall, sudden changes in climate which come under the natural risks in shrimp farming as reported by the shrimp farmers.

The three major constraints of social risks in shrimp farming as reported by the shrimp farmers in Nagapattinam district were ranked and listed. They were the direct discharge of waste water into open sea, poaching problems and location of farms nearby residential areas.

The five major constraints of extension risks in shrimp farming as reported by the shrimp farmers in Nagapattinam district were ranked and listed. They were the inadequate consultation & meeting with Govt. officials, lack of social network among shrimp farmers, lack of shrimp farmers associations, lack of updated information on shrimp farming practices and inadequate awareness on shrimp production technologies.

5.2 Conclusions

The present study dealt with the economic analysis of shrimp farming practices in Nagapattinam district, Tamil Nadu. Based on the results, the following conclusions could be drawn,

1. The mean total capital investment of the small shrimp farmers per ha was worked out to ₹5,14,961. The mean total fixed cost and the total variable cost per ha per crop was worked out to ₹2,03,712 and ₹20,61,592 respectively. The total cost per ha per crop was accounted to ₹22,65,304. The gross returns and the net returns per ha per crop was worked out to ₹25,58,725 and ₹2,93,420 respectively. The mean shrimp production per ha per crop was estimated as 8402 kg. The BCR on the basis of TVC and TC was worked out to 1.24 and 1.13 respectively. The rate of return on capital investment on the basis of TVC and TC was estimated as 96.50% 57.00 % respectively
2. The mean total capital investment of the medium shrimp farmers per ha was worked out to ₹4,74,731. The mean total fixed cost and total variable cost per ha per crop was worked out to ₹1,82,244 and ₹20,27,777 respectively. The total cost per ha per crop was calculated as ₹22,10,022. The gross returns and the net returns per ha per crop was worked out to ₹25,66,905 and ₹3,56,882 respectively. The mean shrimp production per ha per crop was estimated as 8394 kg. The BCR on the basis of TVC and TC was worked out to 1.27 and 1.16 respectively. The rate of return on capital investment on the basis of TVC and TC was estimated as 113.60% and 75.20% respectively

3. The mean total capital investment of the large shrimp farmers per ha was estimated as ₹3,38,900. The mean total fixed cost and the total variable cost per ha per crop was worked out to ₹1,61,031 and ₹20,21,903 respectively. The total cost per ha per crop was calculated as ₹21,82,933. The gross returns and the net the returns per ha was worked out to ₹26,40,621 and ₹4,57,687 respectively. The mean shrimp production per ha per crop was estimated as 8411 kg. The BCR on the basis of TVC and TC calculated as 1.31 and 1.21 respectively. The rate of return on capital investment on the basis of TVC and TC was estimated as 182.6% and 135.00% respectively
4. The average production cost per kg was calculated as ₹270, ₹263 and ₹260 for the small, medium and large shrimp farmers. The net returns per kg was calculated as ₹34.92, ₹42.51 and ₹54.42 for the small, medium and large shrimp farmers in the study area. The feed cost was the major share in the production cost with above ₹107/kg in all the categories of shrimp farmers
5. The partial regression co-efficient of supplementary feed was positive and significant at $p=0.05$. The partial regression co-efficient of fertilizer, stocking density and survival rate was positive and significant at $p = 0.05$ for the shrimp farming practices
6. The production risks were expressed as the foremost risks in shrimp farming by the selected shrimp farmer respondents
7. The major production constraints were the lack of good quality shrimp seeds followed by the high cost of supplementary shrimp feed
8. Shrimp price fluctuations were the main marketing constraint as reported by the shrimp farmer respondents

9. Inadequate institutional credit was the main financial constraint faced by the selected shrimp farmer respondents
10. Flood was reported as the major natural constraint by the selected shrimp farming respondents
11. Direct discharge of waste water into open sea was the foremost social constraint as reported
12. Inadequate consultation & meeting with Govt. officials was the main extension constraint as reported
13. The overall observations of the study is that the net returns per ha per crop and the rate of returns on capital investment per ha were high among the large shrimp farmers compared with the small and medium shrimp farmers. The socio economic status of the shrimp farmers had substantially improved and hence the present study recommends the farming of *L.vannamei* with good management practices in Nagapattinam district of Tamil Nadu

5.3 Strategies suggested for the overall development of *L.vannamei* shrimp farming

1. There are no shrimp hatcheries established by the state Government in the coastal districts of Tamil Nadu. In shrimp culture, good quality shrimp seeds play a vital role in determining the total productivity. The production and the supply of good quality shrimp seeds by the Government owned hatcheries could solve the problems of disease outbreaks and ensure high survival rate leading to high production per hectare
2. Supply of good quality of shrimp seeds along with certification by the state fisheries departments could solve the problems of disease outbreaks and ensure high survival rate leading to high production in shrimp farming

3. As the supplementary feed plays a prominent role in shrimp farming, efforts have to be made by the Government to produce and supply the supplementary feed at subsidised rate to the shrimp farmers in this regard, the Government should establish supplementary feed production plants and as well as create employment opportunities to the rural people and to the fisheries graduates
4. Control on supplementary feed rates by the Government could reduce the input cost and increase the returns in shrimp farming and so the shrimp farmers' socio economic status could be improved
5. Establishment of disease diagnosis and treatment labs or mobile labs in coastal villages could control the diseases in shrimp farming. Disease diagnosis and treatment measures are to be simplified & popularised by the concerned state Fisheries Department and the Central Institute of Brackish water Aquaculture and they could play a vital role in providing skill development training among the shrimp farmers with respect to disease diagnosis and treatment measures
6. Production credit should be made available by the financial institutions as well as by State Government with subsidies which would give the needed thrust to shrimp farming
7. The state Government has to ensure that the electricity should be given to the shrimp farmers at lower tariff rates or at subsidised rates as it is presently to the agriculture sector
8. Dissemination of price information through the mass media like newspapers, television and radio during harvesting would help the farmers to secure good price for their produced shrimps

9. Educate the shrimp farmers to chlorinate the contaminated or waste water before discharge and adopt to BMPs. This would help to prevent the disease spread from one pond to another pond in shrimp farming
10. Speedy settlement of the legal hurdles like the CAA should provide the license for *L.vannamei* shrimp farming to the new farmers or the renewal for the existing farmers as soon as possible without delay. This would encourage the shrimp farmers to practice more culture
11. The state Government should provide the technical guidance to the shrimp farmers frequently by recruiting the professional graduates. This would help the farmers to prevent from the various risks and increases the employment opportunities

VI. REFERENCES

- Anushalini, S.V., Vijay, K., Rajeswari, C., Sudhan, C., Deepika, S., Ruby, P., Surya, T., Ranjithkumar, K., 2016. Economic analysis of shrimp culture in lined ponds. *International journal for innovative research in multidisciplinary field*. 2 (8), 28-32.
- Arul Oli. G., Jeevitha, C., 2014. An overview of the socio-economic status of the fisherfolk of Thoothukudi District. Tamil Nadu. *Journal of Fisheries Economics and Development*. 13, 18-28.
- Babu, Y.M., Ramudu K.R., Dana, S.S. and Dash, G. 2013. An overview on *Litopenaeus vannamei* farming practices in India, current issues, problems and future perspectives. *International Journal of Current Research*, 5 (8), 2118-2122.
- BAH&FS. 2015. Basic Animal Husbandry & Fisheries Statistics, Ministry Of Agriculture & Farmers Welfare (Government of India) Department of Animal Husbandry, Dairying and Fisheries, Delhi.
- Balakrishnan, G., Peyail, S., Ramachandran, K., Theivasigamani, A., Savji K.A., Chokkaiah, M. and Nataraj, P., 2011. Growth of Cultured White Leg Shrimp *Litopenaeus Vannamei* (Boone 1931) In Different Stocking Density. *Advances in Applied Science Research*, 2 (3), 107-113.
- Cyril, A.R.L., Immanuel, S., Ananthan, P.S., Thongam, B., Viswanatha, B.S., 2013. Association of Socio-economic Attributes with Adoption of Better Management Practices in Shrimp Farming in Karnataka, India. *Fishery technology*. 50, 3; 265-271.

DAFF. 2015. Department: Agriculture, Forestry and Fisheries, Republic of South Africa. Some agricultural economic concepts, p 5.

District census handbook - Nagapattinam. 2011. Directorate of census operations. Tamil Nadu.

FAO yearbook. 2014. Fishery and Aquaculture Statistics. Rome, p xvi.

FAO. 2011. Fish for Food, Livelihood and Trade, FAO technical paper on Fisheries and Aquaculture, Rome, p 2.

FAO. 2014. Fishery and Aquaculture Statistics, Rome, p xvi.

Garret, H.E., Woodworth, R.S., 1969. Statistics in psychology and education. Vakils, Feffer and Simons Pvt. Ltd., Bombay, India: 329.

Handbook on Fisheries statistics (2014). Ministry of Agriculture (Government of India) Department of Animal Husbandry, Dairying and Fisheries, Delhi.

Jagadeesh, T. 2015. An economic analysis of shrimp farming practices in prakasam district, Andhra Pradesh. M.F.Sc Thesis submitted to Tamil Nadu Fisheries University, Nagapattinam.

Jayaraman, R., 2005. Manual on fisheries economics, Fisheries College and Research Institute, TANUVAS, Thoothukudi, p 42.

Jayaraman, R., Karl Marx, K., Sunderraj, V., 1994. Economics of improved extensive shrimp farming in Vedarnyam. In: Proceedings of National seminar on Aquaculture for 2000 A. D, Madurai Kamaraj University, Madurai, India.

- Johl, S. and Kapur, T.R., 2007. Fundamentals of Farm Business Management, Kalyani Publishers, pp. 95-105.
- Kaur, S., Purohit, M.K., 2015. Rainfall Statistics of India – 2015. India meteorological department (ministry of earth sciences), Government of India.
- Koteswari, N., Sheela Immanuel., Leo Cyril, A.R., Viswanatha, B.S., 2014. Impact of aqua societies on shrimp farming in Andhra Pradesh, India. *Fishery Technology* 51, 130-135.
- Kumar, B., Sharma, R., Lakra, W.S., Sharma, A., Prakesh, S., Sharma, M.M. 2016. Economic assessment of shrimp farming (*Litopenaeus vannamei*) in Gujarat – A profitable venture. *International journal of innovative research in science*. 5 (8), 15334-15342.
- Kumaran, M., Alagappan, M., Raja, S., Sarada, C., Vimala, D.D., Chandrasekaran, V.S., Kalaimani, N., 2008. Extent of adoption gaps in good management practices (GMPs) of shrimp farming. *Indian journal of fisheries*. 55 (3), 267-272.
- Kumaran, M., Ravichandran, P., Gupta, B.P., Nagavel, A., 2003. Shrimp farming practices and its socio-economic consequences in east Godavari district, Andhra Pradesh, India – A case study. *Aquaculture Asia*. VIII (3), 48-52.
- Lekshmi, P.S., Chandrakandan, K., Kumaran, M., Balasubramani, N., 2005. Socio economic profile of shrimp farmers and its influence on the extent of adoption of shrimp culture technologies. *Fishery technology*. 42 (2), 225-230.

- Lotz, J.M., 1997. Special topic review: Viruses, biosecurity and specific pathogen-free stocks in shrimp aquaculture. *World journal of microbiology & biotechnology*. 13, 405-413
- Margabandu, V., Ramamurthy, D., 2013. Study on Recent Farming Practices for Culturing Sustainable Pacific White Shrimp, *Peneaus Vannamei*. *International Journal of Science and Research (IJSR)*, 4 (2), 9-12.
- McIntosh, D. 2008. Aquaculture risk management. *Northeastern regional aquaculture center*. NRAC publication No:107, University of Maryland, 1-4.
- MPEDA. 2016. Annual report. The Marine Products Export Development Authority (Ministry of Commerce and Industry) Govt. of India.
- Nagothu, U.S., Muralidhar, M., Kumaran, M., Muniyandi, B., Umesh, N.R., Prasad, K.S., Silva, S.D., 2012. Energy and Environment Research. *Canadian Center of Science and Education*. 2 (2), 137-148.
- Nakul, A., Sadaful, Shyam Salim, S., Pandey, S.K., 2013. An economic analysis of shrimp farming in the coastal districts of Maharashtra. *Indian journal of fisheries economics and development*. XIV, 42-54.
- Poulomi Bhattacharya, 2009. Economics of Shrimp Farming: A Comparative Study of Traditional Vs. Scientific Shrimp Farming in West Bengal. The Institute for Social and Economic Change, pp.1-22.
- Sahu, S., Jana, A.K., Sarkar, S., Dora, K.C., Chowdhury, S., 2012. Econometric modelling of shrimp (*penaeus monodon, fabricius*) farming at nandigram-ii block, purba medinipur district (W.B.). *International Journal of Innovative Research in Science, Engineering and Technology*. 1(1), 121-124.

- Salim, S.S., Biradar, R.S., Pandey, S.K., 2005. Economic analysis of fisheries projects. CIFE, Versova, Mumbai, pp. 125-135.
- Sathiadhas, R., Najmudeen, T.M., Sangeetha, Prathap., 2009. Break-even Analysis and Profitability of Aquaculture Practices in India. *Asian Fisheries Science*. 22, 667-680.
- Sawant, P.B., Sawant, T., 2003. Constraints in traditional shrimp farming in west Bengal. *Indian journal of extension education*. Xxx (1&2), 12-17.
- Sena, S.D., 2000. A Global Perspective of Aquaculture in the new Millennium, Technical Proceedings of the Conference on Aquaculture in the Third Millennium, Bangkok, Thailand. 20-25.
- Senthilathiban, R., Rajakumar, M., 2004. Manual on fisheries marketing, Fisheries College and Research Institute, TANUVAS, Thoothukudi, 86 p.
- Senthilathiban, R., Rajakumar, M., Suresh, R., Jayaraman, R., 2007. Text book on aquaculture economics, Fisheries College and Research Institute, TANUVAS, Thoothukudi, 104 p.
- Sharma, P.K., Dwivedi, S., Bhat, A., 2014. Practicals in Agricultural Economics. Daya Publishing House, A division of Astral International Pvt. Ltd., New Delhi. 121 p.
- Srinivas, D. and Venkatrayalu, Ch., 2016. Studies on present problems and prospects of shrimp farming in west Godavari district of Andhra Pradesh, India. *Advances in Applied Science Research*, 7(2), 49-54.
- Srinivas, D. and Venkatrayalu, Ch., Swapna, B., 2016. Sustainability of exotic shrimp *Litopenaeus vannamei* (bonne, 1931) farming in coastal Andhra

Pradesh, India: problems and issues. *European journal of journal of experimental biology*. 6 (3), 80-85.

State industrial profile, Tamil Nadu. 2014-15. ministry of micro, small and medium enterprises (MSME) Government of India.

Swathilekshmi, P.S., Chandrakandan, K., Balasubramani, N., 2008. Information utilization behaviour and constraint analysis among shrimp farmers. *Indian journal of social research*. 49 (3), 265-272

Tandel, J.T., Tandel, K.V., Tandel, G.M., Patel, M.R., 2016. A socio-economic survey of shrimp aquaculture practices in valsad district, Gujarat, India. *International journal of research in applied, natural and social sciences*. 4 (9), 93-98.

Vadher, K.H. and Manoj, K., 2014. Study on socio-economic profile of shrimp farmers of Gujarat State, India. *International Journal of Fisheries and Aquatic Studies*; 2(2), 202-205.

Vichare, P.S., 2010. A study on effect of migration on livelihood of coastal fishers in Maharashtra. M.F.Sc Thesis submitted to Central Institute of Fisheries Education, Mumbai.

Viswanatha. B.S., Bhatta, R. Shankar, K.M., 2014. An economic of fish and prawn health management in Andhra Pradesh. *Agricultural economics research review*, 27 (1), 83-90.

7.1 Plates

Plate 1. Pond preparation for shrimp seed stocking



Plate 2. Water filling and seed stocking



Plate 3. a. Shrimp supplementary feed given through feed boats



b. Dyke feeding



Plate 4. Sampling of shrimp



Plate 5. Sampling the growth of shrimp



Plate 6. Aqua medicines and probiotics application



Plate 7. Aeration given to shrimp through paddle wheel aerators



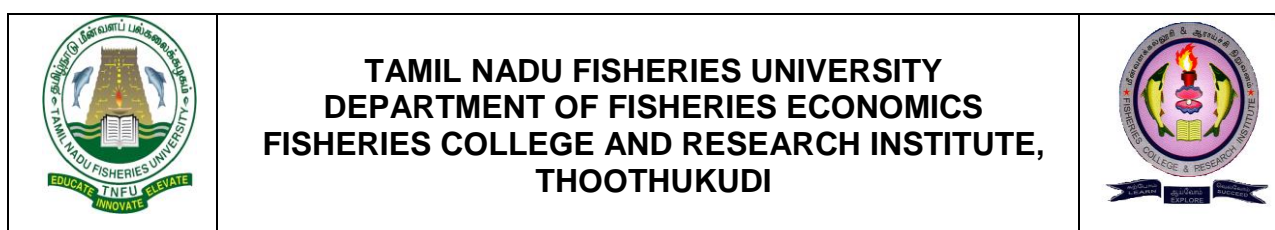
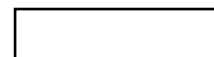
Plate 8. Feed check tray observation and water quality parameter kits



Plate 9. Shrimp harvesting



7.2 survey schedule



An Economic Analysis of *Litopenaeus vannamei* Shrimp Farming in Nagapattinam District, Tamil Nadu

Socio economic characteristics of shrimp farmers:

1.	Name of the farmer	
2.	Address	
3.	Age	
4.	Gender	Male / female
5.	Literacy level	Illiterate / Primary / Middle school / High school / Higher secondary / Graduate / Post Graduate / Professional Graduate
6.	Religion	Hindu / Christian / Muslim / others
7.	Residential house status	Owned / Leased / Rented
8.	Family type	Joint family / Nuclear family
9.	Farming experience	
10.	Occupation status	Aquaculture alone / Aquaculture + Others
11.	Farming type	Primary / Secondary / Both
12.	Details of ownership	Owned / Leased / Owned + Leased
13.	Source of income	
14.	Annual income	

Farm details:

1.	Name of the farm			
2.	Location of the farm			
3.	Area of the farm			
4.	Distance (Km) of farm from			
	District HQ		Residence	
	Main canal		Main road	
	Source of shrimp seed supply to the farm		Nearest village market	
5.	CAA registration no. of the farm			
6.	Average culture period (in months)			
7.	Average stocking seed size	PL -		mm -
8.	Shrimp seed sources (hatchery)	Private / Government / Others		
9.	Average survival rate (%)			
10.	Depth of pond			
11.	Water source	Canal / Creek / Bore well		
12.	Feed brand and protein percent			

13.	Marketing channels	Direct sell to consumer Sell to middle man Sell to exporter
-----	--------------------	---

Cost and returns in shrimp farming:

Capital cost:

Sl. No	Particulars	Year of purchase	No	Purchase value/unit (₹)	Total value (₹)	Economic life (year)	Salvage value (₹)
1.	Pond construction						
2.	Bore well Pipe lines						
3.	Pumps & Motors						
4.	Generator						
5.	Aerators with accessories						
6.	Electric installation with electrification						
7.	Watchman shed						
8.	Store room						
9.	Farm accessories						
10.	Miscellaneous						
Total							

Variable cost:

Sl. No	Particulars	Quantity	Price	Total cost (₹)
A	Pond preparation			
1	Complete removal of organic waste from pond bottom			
2	Ploughing			
	Levelling			
	Checking of soil pH			
	Liming			
	Bleaching of water			
	Filling the water using 2 layers of fine nets in the inlets			
B	Seed			
	Seed cost			
	Transportation cost for seed			
C	Feed management			
	Check trays			
	Feed cost			
	Boat to feed			
	Feed transport cost			

D	Manuring			
	Compost			
	Cow dung			
E	Fertilization			
	Urea			
	Super phosphate			
	Potash			
	Others			
F	Chemicals & Drugs			
	Probiotics			
	Minerals			
	Zeolite			
	Others			
	Drugs			
G	Health monitoring & Biosecurity			
	Checking of water quality parameters			
	Bird fencing			
	Crab fencing			
	Sampling			
	ETP			
	Release water after bleaching			
H	Electricity			
I	Fuel			
J	Labour			
K	Harvesting			
L	Miscellaneous			
	Total Variable Cost / crop			

Fixed cost

SI.NO	Items	AMOUNT (₹)
1.	Lease / rent	
2.	Depreciation for capital items	
3.	Interest on fixed capital/borrowed capital	
4.	Repairs & maintenance	
5.	Taxes paid, if any	
6.	Insurance premium paid, if any	
7.	Consultancy charges	
8.	Salary to permanent staff	
9.	Watchmen and ward	
10.	Others	
	Total	

Total quantity harvested (kg):@₹ /kg

Risks involved in shrimp farming:

	Production based risks	Ranking (1=most important)
1.	Lack of good quality seed	
2.	High price of seed	
3.	High cost of feed	
4.	Over dosage of chemicals	
5.	Shortage of water	
6.	Poor water quality	
7.	Prevalence of disease outbreak	
8.	High cost of electricity	
9.	Sudden fall in DO due to power failure	
10.	Lack of scientific knowledge	
11.	Non availability of skilled labour	
12.	Inadequate technical experts	
13.	Improper Icing	
14.	partial damages during harvesting	
15.	Predation	
16.	Lack of certification of inputs by CAA	
Marketing risks		
1.	Shrimp price fluctuations	
2.	Demand & supply fluctuations	
3.	Lack of cold storage facilities	
4.	Physical damage during transportation	
5.	Problem of direct selling to buyers	
6.	Distance of market	
Financial risks		
1.	Buy back system	
2.	Low net returns	
3.	No insurance for shrimp farm	
4.	Inadequate institutional financial assistance	
5.	Problem in collateral security in institutional finance	
6.	High interest rate for non- institutional credit	
7.	Inadequate credit from banks	
Natural risks		
1.	Flood	
2.	Sudden change in climate	
3.	Cyclone	
4.	Heavy rain fall	

7.3 BMPs Guidelines

- Increasing demand for the shrimp products is leading to high stocking densities and usage of more chemicals in the aquaculture sector. If the process continued, aquaculture will be dropped into the unsustainable condition. BMPs are the only approach to overcome the problems.
- BMP can be defined as a set of guidelines that are developed, based on risk factor studies, in consultation with the practitioners and relevant stakeholders and on the evaluation of current issues. Production should be increased to meet the demand, at the same time we should keep in mind the sustainability. BMPs should be simple, science-based, cost-effective and appropriate to their context if farmers are to adopt and implement them. Some important BMPs steps.

1. Preparation of pond bottom and water management before stocking

- Sludge removal and disposal away from the pond site.
- Ploughing on wet soil if the sludge has not been removed completely and water filtration.
- Using twin bag filters of 300 µm mesh size and ensuring a water depth of at least 80 cm at the shallowest part of the pond.
- Water conditioning for 10 to 15 days before stocking.

2. Post Larvae selection and stocking

- Selecting PL of uniform size and colour, which are actively swimming against the water current, testing (with nested PCR) PL for WSSV (using batches of 59 PL pooled together Negative test results indicate, with 95% confidence, that the prevalence of WSSV infected PL is less than 5% in that population).
- Eliminating weak PL before stocking, using formalin (100 parts per million [ppm]) stress for 15 to 20 minutes in continuously aerated water, on-farm nursery rearing of PL for 15 to 20 days.

- Stocking from the first week of February to the second week of March (early spring) ensuring a transportation time for PL of less than six hours from hatchery to pond site.
- Stocking into green water with stable algal blooms and avoiding transparent water during stocking.
- Filling grow-out ponds with water from reservoirs that has been left to 'age' for at least 10 to 15 days.

3. Water quality management

- Periodical monitoring and management of salinity, pH, dissolved oxygen and microbial load.
- Chemicals used in maintaining the water quality are...
 - Zeolite – soil conditioner.
 - Benzal Konium Chloride (BKC) – disinfectant.
 - Iodine compounds.
 - Lime.
- The water depth at the shallowest part of the pond should be at least 80 cm.

4. Pond bottom management

- Check on weekly basis, especially at the feeding area for black soil, benthic algae and bad odour.
- Rapid consumption of feed in the check trays can be a cause of bottom sludge.
- If soil is black, exchange water and reduce feeding.
- Black soil area should be agitated carefully during the water exchange.

5. Feed management

- Excessive feeding is dangerous than under feeding.
- Check trays should be introduced after one week of stocking.
- If any size difference occurs, use two different size pellets at least for 7 days.

- First indicator of a serious disease problem: abrupt decline in feed consumption and low dissolved oxygen.

6. Feed and Health monitoring

Gut content color	Probable food item	Probable cause(s)
Light or golden brown	Manufactured feed	Normal
Black, dark brown	Benthic detritus, sediment	Under-feeding; inadequate feeding frequency
Green	Benthic algae	Under-feeding
Red, pinkish	Cannibalized body parts from dead shrimp	Disease event in pond
Pale, whitish	None (disease condition)	Gregarines, or some other disease condition

7. Health monitoring

- Daily visual inspection of the animals.
 - Sampling once a week for general health condition.
 - Monitor soil and water quality.
 - Regular removal of benthic algae, exchanging water only during crucial periods (e.g. periods of low oxygen, algal bloom crash).
 - Weekly checking of pond bottom mud for blackish organic waste accumulation and bad smells.
 - Regular shrimp health checks, and weekly health and growth monitoring, were using a cast net.
 - Removal and safe disposal of sick or dead shrimp.

8. Handling the disease outbreak

- Check the water and soil quality.
- Remove dead animals and bury them.
- If mortality is increasing, emergency harvest can be carried out.
- Inform the neighbor farmers and FDO immediately. Drain the water only after treatment with bleaching powder and aged up to 5-7 days.

9. Harvesting

- If newly moulted shrimps are >10% avoid harvesting.
- Don't feed the shrimp 6 hrs. before harvesting.
- Pre-harvest testing is done for antibiotic residues.
- Harvesting is done only after the receipt of test report and the report is submitted to the buyer along with the shrimps harvested.
- Chill killing and thereafter shipped to the processing plant in insulated carriers packed in ice.
- The water should be discharged after ensuring the standards prescribed.

10. Record Keeping

- To identify problems in the pond environment
- Useful to learn from the past experiences
- To estimate the production cost and to find out the net profit or loss

❖ Advantages of BMPs in shrimp farming

- ✓ Reduces the risk of disease occurrence.
- ✓ Improves growth performance.
- ✓ Decreases operational cost.
- ✓ Improves environmental conditions.
- ✓ Attains food quality standards.
- ✓ Fetches higher market prices.
- ✓ Facilitate sustainability among the others.

Source:

www.nacsa.gov.in

www.caa.gov.in

www.naca.gov.in