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# Value chain approaches in farmed white leg shrimp *Penaeus vannamei* in Nagapattinam district of Tamil Nadu

**T Umamaheswari, M Rajakumar, R Senthiladeban, N Felix, S Athithan and G Sugumar**

**Abstract**
The study estimated the value chain of farmed white leg shrimp *Penaeus vannamei* (*P.vannamei*) in Nagapattinam district of Tamil Nadu during 2017. Field data was collected from 50 Coastal Aquaculture Authority (CAA) registered shrimp farms with pre-tested survey schedule. The final farm gate price of shrimp was quoted as ₹ 436.64 per kg with a profit margin of ₹116.00 per kg. The estimated cost of value chains was highest for feed and feeding management with a share of 42.81% to the final price. The results of multiple regression model showed that the value chain operations such as grading and packing, harvesting, check tray monitoring were negatively correlated and not significant at 5% level. Factor analysis on frequency of VCM processes with a cumulative variance of 67.74% indicated the less performed waste water management, although adding value to the final price. The study recommends the shrimp farmers to pay special attention on power usage for cost reduction, water quality management and waste water management for better final price.

**Keywords:** Nagapattinam district, Shrimp farming, Value Chain Analysis, FGD

## Introduction
With capture fishery production relatively static since late 1980s, aquaculture has been responsible for the impressive growth in the supply of fish for human consumption. As the second largest country in aquaculture production, the share of inland fisheries and aquaculture production has gone up from 46% in 1980s to over 85% in recent years to total fish production (Handbook of Fisheries and Aquaculture, ICAR, 2017) [2]. Though coastal aquaculture has taken up long way back, the present scenario lays emphasize on the cultivation of *Penaeus vannamei* (*P. vannamei)*, the white-leg shrimp, owing to its significant contribution in marine products exports and foreign exchange earnings.

## Overview of shrimp farming sector in Tamil Nadu
In Tamil Nadu, shrimp farming has grown considerably and has emerged as a major commercial enterprise owing to the introduction of Specific Pathogen Free (SPF) shrimp *P. vannamei* and is being carried out in 11 coastal districts. Tamil Nadu ranks 4th in total fish production of the country with a total fish production of 7.12 lakh tons (P) (marine - 4.97 lakh tonnes, freshwater and brackish water - 2.15 lakh tonnes) during 2017-18. It is one among the leading exporters of seafood with the export of marine products of 88,257 Metric Tonnes (MT) and earned a foreign exchange of ₹ 4,341.78 crore during 2016-17. The fisheries sector has contributed 0.7 percent of the total Gross State Domestic Product (GSDP) of the State. In Tamil Nadu, an estimated area of 56,000 ha is under capture fisheries and an area of 6115.68 ha is under coastal aquaculture, mainly shrimp aquaculture. So far, 1,859 shrimp farms (3,712.02 ha) and 63 shrimp hatcheries have been registered under CAA, a regulating authority for coastal aquaculture (Policy Note, Department of Fisheries, Govt. of Tamil Nadu (2018-19)) [11].

## Need for value chain analysis
Value Chain Analysis is one of the managerial strategies that can reduce various costs associated with production/processing and can improve the quality and productivity/processing of the product, also reduces distribution cost. (Porter, 1985) [9]. The value chain describes the

full range of activities which are required to bring a product or service from conception, through the different phases of production and delivery to final consumers (Kapilinsky and Morris, 2000) [4]. Value-chain analysis looks at every step a business goes through, from raw materials to the eventual end-user. The goal is to deliver maximum value for the least possible total cost (Investopedia, 2011) [12]. Thus to supplement the activities of CCA and to generate great value for the shrimp produce with minimum cost, it is necessary to estimate and disseminate the value added cost in successive stages of shrimp farming activities to the shrimp farmers.

Against this background, the research was undertaken during 2017 in Nagapattinam district (Fig 1), and a total of 50 shrimp farms (www.caa.ac.in) [13] spread over 6 taluks were selected for the study. The research was carried out with the aims of discovering socio-economic status of shrimp farmers, general characteristics and VCM practices adopted in shrimp farms and the key challenges faced in farming operations.

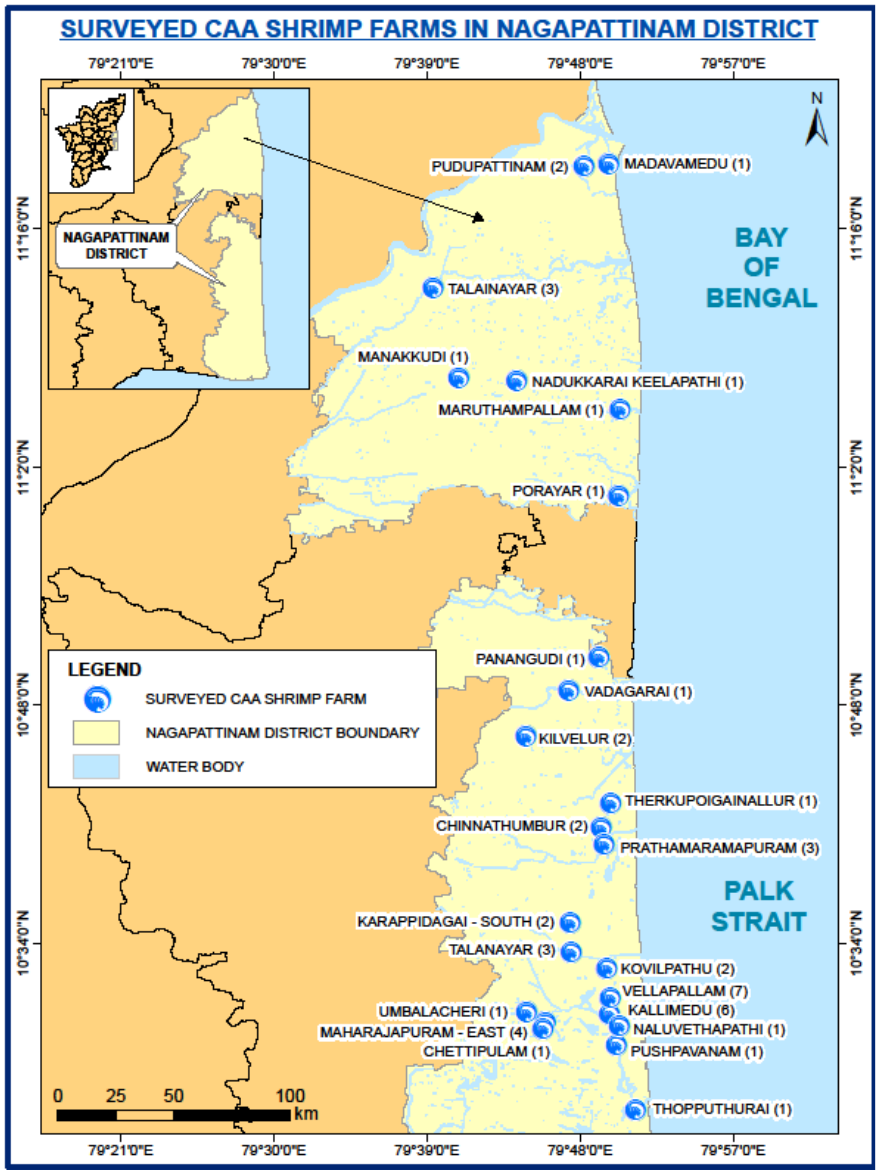


**Fig 1:** Map showing the study area

## Methodology

Structured survey schedules were designed by incorporating different variables relevant to the objectives of the study. Simple random sampling technique was adopted to collect primary data in the study area. Descriptive statistics, Multiple regression (Harshna *et al*., 2012) [7] and factor analyses (Krishnaswami and Ranganatham, 2007) [5] along with the conventional methods were used for data analysis. Tests of data reliability was performed through Kaiser-Mayer-Olkin measure of sampling adequacy (Hair *et al*., 1998) [3] and Bartlett's test of sphericity (Akansha Anchaliya *et al*., 2012) [1]. The driving changes in the shrimp farming industry was documented through Focus Group Discussion (FGD) with shrimp farmers and officials of Department of Fisheries, Government of Tamil Nadu.

## Results and Discussion

The findings of the study on socio-economic profile classified under social and economic characteristics of the shrimp farmers in surveyed district are as follows:

### Social characteristics

In Nagapattinam district, it was found that 48% of the respondents were less than 50 years of age (mean – 44.64 years) and most (96%) of the farmers had an education above primary school level. The shrimp farming community in

Nagapattinam district was dominated by males (92%) and Backward Class (98%). All the farmers belonged to Hindu religion and had the farming as their primary occupation, though found cost intensive and highly risk oriented. Almost all the farmers were associated with Shrimp Farmers Association (SFA) at the district level (94%).

**Economic characteristics**

From the study, it was observed that the proportion of shrimp farmers with 10 -15 years of shrimp farming experience accounted for 84% of the total respondent-farmers. All the farmers had an absolute ownership towards their farms. Though the shrimp farmers of this district were having an exclusive interest in gaining knowledge on shrimp culture techniques (70%) and disease prevention methods (72%), none of them exposed to any of the shrimp farming related training programmes and trade shows. Moreover, only 20% of the farmers were referring to scientific journals. All the farmers had their own investment for taking up this business enterprise. While the technical and financial support was extended by about 60% and 34% of input suppliers, respectively, only 22% and 2% of the processors were extending technical and financial support to the shrimp farmers in this district. The main sources of market information were farmers and other sources (28%), farmers (22%) and both Co-operatives/NGOs and farmers (12%).

**General characteristics of shrimp farms**

While the total surveyed area in the district was 121.70 ha, the number of ponds per farm varied from 2 to 13. About 60% of the farmers had farm size of more than 2 ha. The size of the shrimp ponds varied from 0.20 – 0.50 ha, with 0.38 ha as average and a mean depth of 1.44 m. Although, the farmers had easy accessibility (2.58 km) to the water source followed by approach road (3.04 km), high tide (4.02 km), local village market (5.14 km), residence (6.80 km), bank (9.04 km), EB office (9.32 km) and shops (7.18 km), they have to travel a minimum distance of 13 km to reach district headquarters. On the other hand, for seed purchase the distance ranged from 100 to 270 km, with 197.80 km, on an average. The farmers (70%) mainly depend on creeks for their water source. The farmers in this district were practising all the three types of farming *viz*., extensive (28%), semi-intensive (66%) and intensive (6%) with an average culture period of 4 months and 2 crops per annum. While the farmers were stocking PL12@39/$m^2$, the survival rate was recorded at 71.50%, on an average. The shrimps were fed with granules type shrimp feed (100%) and the probiotics were administered orally (100%). In this district, three types of aerators namely, paddle wheel (92%), air injector (4%) and sludge motor (2%) were used for aerating the ponds. Majority of the respondents were adopting complete harvest of shrimps @ 7.04 tonnes per ha, on an average.

**Inbound and outbound logistics**

Inbound and outbound logistics of shrimp farms was documented for various inevitable inputs like shrimp seed, feed, farm equipment and machinery, farm accessories, fuel and farm produce (shrimps) through the various mode of transport, means of storage and distribution.

**Inbound logistics**

The shrimp seeds packed in polythene seed bags (40%) and containers (60%) were mainly transported from the hatcheries to shrimp farms through single trailer trucks (88%), while the remaining through insulated medium trucks (12%). Feed (86%), farm equipment and machinery (86%), farm accessories (64%), fuel (80%) and other inputs (84%) were also transported through single trailer trucks. While feed, farm equipment and machinery (100%), farm accessories (100%) and other inputs were stored in store room (100%), barrels were used for storing fuel. Farm workers (100%) were engaged in distributing almost all the farm inputs.

**Outbound logistics**

While the farm raised shrimps were equally stored in tubs with ice-slurry (50%) and ice packed barrels (50%), the entire harvest in Nagapattinam district was loaded only by the engaged workers for the purpose and transported through insulated single trailer trucks (100%).

**Farm inputs**

This chapter dealt with sources of supply of inevitable inputs like seed and feed type and frequency of purchase and channel of distribution of farm inputs. Shrimp seeds were procured from Seven Star (38%) and Grow best (6%) hatcheries, besides CP Aquaculture (56%) by farmers of Nagapattinam district. Among the reported 15 brands of feed for shrimp culture, CP Blanca had the major share of 55.1% besides the major contribution of CP Blanca, Avanti and Shenlong. In this district, majority of the shrimp farmers were purchasing shrimp seed, feed, manure, fertilizer, medicines and probiotics on credit basis and other inputs like fuel, aerator, vehicle, machinery, farm accessories, pumps and motors, pipelines, electrical items and sampling nets were mostly settled by cash. From the analysis, it was found that all the shrimp farmers of Nagapattinam district were placing the orders to wholesalers for shrimp seed procurement and to agents and dealers (78%) for feed.

**Value addition management processes adopted by shrimp farmers in Nagapattinam district**

The Value Chain framework is "an interdependent system or network of activities, connected by linkages (Porter, 1990) [10]. The value addition management processes in shrimp farming refer to the activities performed by the value chain players (like shrimp farmer, wholesaler, dealer, agent, retailer etc.) to make it marketable for direct consumption, processing, value addition etc. The cost of value addition processes for 40 counts per kg on an average was estimated and represented as below. In the study, the pre-investment was calculated based on depreciation charges @12%, interest on fixed capital @ 10%, repairs and maintenance and consulting charges @ 2% to 3%.

**Shrimp value chain of Nagapattinam district**

The final farm gate price of shrimp for Nagapattinam district was quoted as ₹ 436.64 per kg (Table 1).

**Table 1:** Cost of each value chain and addition of value to final price

| Particulars | Average price (₹/kg) | Contribution to final price ₹436.64 (%) |
|---|---|---|
| Pre-investment | 19.06 | 4.37 |
| Pond preparation | 2.47 | 0.57 |
| Manuring and fertilization | 1.81 | 0.42 |
| Bio-security measures | 2.14 | 0.49 |
| **Value Chain Management operations performed by shrimp farmer at farm level** | | |
| Shrimp seed stocking | 14.49 | 3.32 |
| Feed and feeding management | 186.90 | 42.81 |
| Check tray monitoring | 0.81 | 0.18 |
| Sampling | 0.65 | 0.15 |
| Application of probiotics, chemicals and minerals | 21.10 | 4.83 |
| Water quality management | 1.01 | 0.23 |
| Disease management | 1.91 | 0.44 |
| Disinfection | 1.24 | 0.29 |
| Farm hygiene management | 2.00 | 0.46 |
| Waste water management | 0.95 | 0.22 |
| Labour management | 15.89 | 3.64 |
| Power and fuel | 45.03 | 10.31 |
| Harvesting | 2.96 | 0.68 |
| Grading and packing | 0.22 | 0.05 |
| Profit margin | 116.00 | 26.57 |

The shrimp farmers were fixing a profit margin of ₹116.00 per kg, the highest among other districts. The post stocking management practices shared a percentage contribution of 94.15 and the rest towards pre-stocking (5.85%) farming operations. The percentage share of value addition to various VCM operations namely feed and feeding management, farmer's profit share and power and fuel were recorded as 42.81, 26.57 and 10.31 per kg of shrimp, respectively. The feed and feeding management (₹ 186.90 per kg) contributed higher to the final price. A similar study conducted by Navghan *et al*. (2017) [8] emphasized the analysis of value chain identification, actors involved and their processes, value addition at each stage and the prevailing constraints in the value chain of farmed shrimp in Gujarat. Value addition in the chain for *P. vannamei* was ₹ 253/kg at the farming level which was maximum share in profit and cost in chain. The study also reported the unavailability of quality seed, high feed cost as the major constraints faced by Gujarat shrimp farmers.

**Analysis of association among variables and its contribution to final price**

Considering the final price of farmed shrimp as dependent variable and cost of value chain processes as independent variable, the following multiple regression model was derived as follows:

**Final price** = 164.762 + 0.288 pre-investment + 0.222 pond preparation + 0.090 manuring and fertilization - 0.001 biosecurity measures – 0.256 shrimp seed stocking + 0.502 feed and feeding - 0.175 check tray monitoring - 0.554 sampling + 0.309 application of probiotics, chemicals and minerals + 0.358 water quality management + 0.255 disease management + 0.164 disinfection + 0.005 farm hygiene management + 0.217 waste water management + 0.240 labour + 0.400 power and fuel - 0.075 harvesting + 0.217 grading and packing + 0.495 profit margin

**Table 2:** Model summary and ANOVA table

| Model | R | R Square | Adjusted R Square | Std. Error of the Estimate | Durbin - Watson |
|---|---|---|---|---|---|
| **1** | **0.918** | **0.843** | **0.744** | **8.41619** | **1.478** |

| ANOVA | | | | | | |
|---|---|---|---|---|---|---|
| **Model** | | **Sum of Squares** | **df** | **Mean Squares** | **F** | **Sig.** |
| 1 | Regression | 11407.031 | 19 | 600.370 | 8.476 | 0.000 |
| | Residual | 2124.969 | 30 | 70.832 | | |
| | Total | 13532.000 | 49 | | | |

According to the model, the results showed significance at 0.000 level with F value of 8.476 (Table 2). $R^2$ was represented as 0.843 indicating 84.3% significance between the cost of value chains and farm gate price. Further analysis together explained 74.4% (adjusted $R^2$) of the variance in final price.

The regression coefficients showed significant values at 5% level of significance for feed and feeding management, profit margin, power and fuel, pre-investment, application of probiotics, chemicals and minerals, disease management and labour management (Table 3). Based on T test, water quality management, pond preparation and waste water management were estimated as the next level value adders. The addition of value to the final price was less quoted by biosecurity measures, manuring and fertilization, disinfection and farm hygiene management. The value chain operations such as grading and packing, harvesting, check tray monitoring were negatively correlated. Though found significant, negative correlations were observed for seed stocking and sampling. The Nagapattinam shrimp farmers are therefore recommended to pay additional care on water quality management, pond preparation and waste water management and subsequently on biosecurity measures, manuring and fertilization, disinfection and farm hygiene management to realize better price.

**Table 3:** Regression coefficients for Nagapattinam district

| Model | Variables | Unstandardized Coefficients | | Standardized Coefficients | T | Sig. |
|---|---|---|---|---|---|---|
| | | B | Std. Error | Beta | | |
| 0 | Constant | 164.762 | 58.348 | | 2.824 | 0.008 |
| 1 | Pre-investment | 1.073 | 0.457 | 0.288 | 2.348 | 0.026 |
| 2 | Pond preparation | 1.511 | 0.779 | 0.222 | 1.941 | 0.062 |
| 3 | Manuring and fertilization | 1.741 | 1.870 | 0.090 | 0.931 | 0.359 |
| 4 | Biosecurity measures | 29.715 | 31.246 | 0.217 | 0.951 | 0.349 |
| 5 | Shrimp seed stocking | -4.527 | 1.636 | -0.256 | -2.768 | 0.010 |
| 6 | Feed &feeding management | 0.656 | 0.168 | 0.502 | 3.898 | 0.001 |
| 7 | Check tray monitoring | -5.893 | 9.063 | -0.175 | -0.650 | 0.521 |
| 8 | Sampling | -17.499 | 5.727 | -0.554 | -3.056 | 0.005 |
| 9 | Application of probiotics, chemicals and minerals | 0.453 | 0.224 | 0.309 | 2.025 | 0.044 |
| 10 | Water quality management | 2.585 | 1.147 | 0.358 | 2.003 | 0.056 |
| 11 | Disease management | 2.151 | 0.956 | 0.255 | 2.249 | 0.032 |
| 12 | Disinfection | 2.876 | 4.586 | 0.164 | 0.627 | 0.535 |
| 13 | Farm hygiene management | 0.292 | 6.616 | 0.005 | 0.044 | 0.965 |
| 14 | Waste water management | 10.694 | 6.939 | 0.217 | 1.541 | 0.134 |
| 15 | Labour management | 2.795 | 1.398 | 0.240 | 1.999 | 0.046 |
| 16 | Power and fuel | 0.642 | 0.214 | 0.400 | 3.000 | 0.005 |
| 17 | Harvesting | -6.410 | 15.213 | -0.075 | -0.421 | 0.676 |
| 18 | Grading and packing | -0.008 | 1.490 | -0.001 | -0.006 | 0.996 |
| 19 | Profit margin | 0.705 | 0.199 | 0.495 | 3.549 | 0.001 |

**Analysis of frequency of VCM processes**

In this section, an attempt has been made to analyse the frequency of performing VCM operations in shrimp farm by factor analysis method. The factor analysis was performed using principal component extraction method with varimax rotation. Through this, the most frequently and also the less frequently performed VCM processes were identified and finally a comparative analysis over the multiple regression and factor analysis was carried out. To run the factor analysis, the shrimp farmers were asked to respond on a five point likert scale (every time [5], frequently [4], sometimes [3], rare [2], never [1] with regard to the identified thirteen VCM processes such as feeding management, check tray monitoring, sampling, application of probiotics, chemicals and minerals, water quality management, disease management, disinfection, farm hygiene management, waste water management, labour management, power and fuel, harvesting and grading and packing.

To determine the reliability of frequency of performing VCM processes, data reliability test (Kaiser Meyer Olkin (KMO) and Bartlett's test of sphericity) was performed (Table 4). The results showed that the KMO measure was found higher than the threshold value which indicate the absence of error in 61.8% of the sample and with the p value of 0.000. The cumulative variance was calculated as 67.74% (Table 5) and the VCM processes were reduced to five factor dimensions. The corresponding factor scores performed on frequency of VCM processes is detailed in Table 6 based on priority.

**Table 4:** KMO and Bartlett's Test for frequency of performing VCM processes in Nagapattinam district

| Kaiser-Meyer-Olkin measure of sampling adequacy | | 0.618 |
|---|---|---|
| Bartlett's Test of Sphericity | Chi-square (approx.) | 149.807 |
| | df | 78 |
| | Significance | 0.000 |

***Source*:** Factor Analysis Data Reduction (SPSS 22.0)

**Table 5:** Factors : Frequency of performing VCM processes in Nagapattinam district

| Factor | Eigen value | Total variance (%) | Cumulative variance (%) |
|---|---|---|---|
| Factor 1 | 3.017 | 23.207 | 23.207 |
| Factor 2 | 1.779 | 13.687 | 36.894 |
| Factor 3 | 1.710 | 13.151 | 50.045 |
| Factor 4 | 1.184 | 9.109 | 59.153 |
| Factor 5 | 1.117 | 8.589 | 67.743 |

**Table 6:** Factor scores matrix – Frequency of performing VCM processes in Nagapattinam district

| Variables | Factor 1 | Factor 2 | Factor 3 | Factor 4 | Factor 5 |
|---|---|---|---|---|---|
| Check tray monitoring | 0.807 | | | | |
| Disease management | 0.756 | | | | |
| Application of probiotics, chemicals and minerals | 0.736 | | | | |
| Feed and feeding management | | 0.783 | | | |
| Sampling | | 0.701 | | | |
| Power and fuel | | | 0.819 | | |
| Water quality management | | | 0.744 | | |
| Harvesting | | | | 0.704 | |
| Waste water management | | | | | 0.777 |

Variables removed: Disinfection, farm hygiene management, labour management and grading and packing

- The first factor was formed with an Eigen value of 3.017, variance of 23.21% and three associated variables were check tray monitoring, disease management and application of probiotics, chemicals and minerals
- The second factor was formed with an Eigen value of 1.779, variance of 13.69% and two associated variables were feed and feeding management and sampling
- The third factor was formed with an Eigen value of 1.710, variance of 13.15% and two associated variables were power and fuel and water quality management
- The fourth factor was formed with an Eigen value of 1.184, variance of 9.109% and associated variable was harvesting
- The fifth factor was formed with an Eigen value of 1.117, variance of 8.59% and associated variable was waste water management
- The eliminated variables were disinfection, farm hygiene management, labour management and grading and packing

The VCM operations such as feed and feeding management, application of probiotics, chemicals and minerals and disease management were found significant and also frequently performed by the shrimp farmers. On the other hand, the usage of power and fuel was moderately practiced by the shrimp farmers, though found significant. Another VCM process, check tray monitoring, an indicator for feed intake was frequently performed, and found negatively correlated with final price. Specifically, though sampling was negatively correlated to the final price, it showed significance and also regularly performed. In regression analysis, water quality management was the next value added to the final price, but the practice was moderately performed. Similarly, waste water management though adding value to the final price, it was not frequently performed.

Thus, it is concluded that the shrimp farmers of Nagapattinam district have to proceed with the VCM operations such as feed and feeding management, check tray monitoring, application of probiotics, chemicals and minerals, disease management and sampling as now in existence. Simultaneously, they have to pay little attention on power usage for cost reduction and water quality management and waste water management for better price. Kotni (2011) [6] in a similar study analysed cost of value addition processes being performed by fishermen in coastal villages of Andhra Pradesh state and proposed to concentrate on the processes which are of value added and not to concentrate on the processes which are of non-value added. As discussed in regression model, the farmers need to pay additional care on regularly performing the VCM operations such as disinfection, and farm hygiene management for better hygienicity. As the wage rate per day was estimated as ₹503.50, on an average for Nagapattinam district, labour management need to be taken care for placing permanent skilled labours with reasonable wage rate to reduce the cost.

**Challenges faced by shrimp farmers in Nagapattinam district**

Focus Group Discussion was held with 25 CAA registered shrimp farmers and officials of State Fisheries Department, Government of Tamil Nadu to document the driving changes in shrimp farming sector. The reflections include

- Need for placing permanent display boards (not flux board) depicting the farm details at the farm gate to create an identity for shrimp farmers. Also recommended to place laminated (Xerox copy) registration/license copy in farm premises.
- Suggested to establish the shrimp farms in places without social issues and avoid the encroachment of government land
- Undue delay in registration and renewal of registration to be addressed on time by the concerned authorities
- Recommended to obtain license for non-registered shrimp farms as valid registration will solve the social, financial and other issues.
- Strengthening of district level Shrimp Farmers Association was emphasized
- Proposed to fix the price by the local government with the base of every year's production cost to avoid processor's lobbying in high price fixation during off/lean season
- Cold storage facility shall be constructed by the government in districts based on the production capacity of shrimp farms
- Consultative meeting with MPEDA officials and establishment of Farmer Producers Organization (FPO) will find ways for solution
- Relaxation period for renewal of license may be extended to 10 years (presently 5 years) and suggested for online renewal of license (inspection not required) and a provision for name transfer for the existing farms
- A moderate tariff namely "Aqua tariff" exclusively for aquaculture (between Industry & Agriculture) irrespective of engine Hp may be implemented based on the following:

| | | |
|---|---|---|
| Up to 500 units | : | ₹ 1.50 / unit |
| 501 – 1500 units | : | ₹ 2.25 / unit |
| > 1500 units | : | ₹ 3.50 / unit |

- Regular supply of quality SPF vannamei seeds may be ensured and to avoid adulteration, brood stock shall be maintained only in MPEDA hatcheries and culled after six cycles of hatching or let to CAA
- Inclusion of a shrimp farmer as one of the members in Inspection Committee for CAA hatcheries shall be considered

**Conclusion**

Shrimp farming is a lucrative industry of Tamil Nadu. Inbound and outbound logistics are sound enough in performing the business successful and the channel of distribution of inputs vary with farmers. The value addition management processes performed at farm level increase the value of shrimps to make it marketable for direct consumption, processing, value addition etc. The attempt made to correlate the contribution of Value Chain Management processes to final price of shrimps and the frequency of adoption of VCM practices revealed that the shrimp farmers need to pay attention on certain practices *viz.*, power usage and labour management for cost reduction and water quality management, waste water management, disinfection and farm hygiene management for better price realization.

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