Fishery Technology 52 (2015) : 53 - 57

Impact of Pacific White Shrimp (*Litopenaeus vannamei*) on Shrimp Production and Seafood Processing in Andhra Pradesh

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Abstract

Introduction of new shrimp species *Litopenaeus vannamei* has brought a sea change in Indian shrimp production and processing industry. Andhra Pradesh is a leading state in cultured shrimp production and the present study investigates the changing trends in cultured shrimp production and its impact on seafood processing of the State. Results of the study showed that 83.6% of the cultured shrimp production in Andhra Pradesh was attributed to *L. vannamei*. With the increase in production, structural changes became pre-requisite for seafood processing firms and they have incorporated changes such as establishment of additional plants, increasing the capacity utilization of existing plants and installation of more efficient equipments. There was an increase of 37.12% in installed capacity and 53.1% increase in capacity utilization of shrimp processing plants due to increased shrimp production. Spillover effects were visible; employment opportunities and income of the employees increased. Strict implementation of scientific farming techniques and quality management are vital to sustain growth of the industry.

Keywords: *Litopenaeus vannamei*, seafood processing, installed capacity, capacity utilization

Introduction

Shrimp has remained a major export earner in Indian seafood industry. Frozen shrimp accounted for 64.11% of total seafood export earnings of the country during 2013-14 (MPEDA, 2014). Increased exports led to industry-based monoculture of shrimp with two candidate species namely Pacific white shrimp (*Litopenaeus vannamei)* and black tiger shrimp (*Penaeus monodon). P. monodon* was the major candidate species of cultured shrimp in India till 2009-2010 and later *L. vannamei* production gained momentum. Recent data shows a huge increase in production of *L. vannamei* (147 516 t in 2012-13 compared to 1731 t in 2009-2010) with a high productivity of 6.50 t ha^{-1} (MPEDA, 2010; MPEDA, 2013). The giant leap in production and productivity of *L. vannamei* has resulted in wider adoption of this species by farmers and has resulted in an increased raw material flow to the processing industry.

L. vannamei was first introduced in India in the year 2001 from the Taiwan Province of China (Mathew et al., 2004). Later in 2003, the Government of India sanctioned pilot scale culture of the species. Based on the risk analysis performed, final legal sanction was given in the year 2009 (Kumaran et al., 2012; Mahesh et al., 2013), following which a tremendous growth in production was observed. Considering the cultured shrimp production in India, the percentage contribution of *L. vannamei* had reached 54% in 2012 - 2013 (MPEDA, 2013).

Since 1960s, several seafood processing plants were established in India, primarily focusing on export of frozen products from marine catches. Later, the industry faced shortage of raw material supply due to uncertain marine catches and consequent sub-optimal capacity utilization of these plants. Several studies have reported that fluctuations and uncertainty in supply often lead to under utilization of the installed capacity (Kannan & Bandyopadhyay, 1993; Unnithan et al., 1998; Geethalakshmi et al., 2011). Growth in area under cultured shrimp

Received 10 March 2014; Revised 17 September 2014; Accepted 28 October 2014

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production became a potential solution to this problem and cultured shrimp became a vital raw material for the seafood processing industry. Presently 68% of shrimp export from India is from the aquaculture sector (MPEDA, 2013). Considering the importance of cultured shrimp in Indian seafood industry, the present study analyzes the changing production structure of cultured shrimp as well as estimating the impact of *L. vannamei* on seafood processing industry. Andhra Pradesh was selected as the study area because it is the leading state in India in aquaculture with a contribution of 58% of total cultured shrimp production and has one of the most developed seafood production and processing industries in India.

Materials and Methods

The present study was undertaken during 2012-2013. Secondary data on species-wise shrimp production were obtained from Marine Products Export Development Authority (MPEDA), India for assessing the changing trend in cultured shrimp production in India and Andhra Pradesh. The impact of introduction of *L. vannamei* in seafood processing industry of Andhra Pradesh was assessed using primary data collected from 20 shrimp processing plants from different districts of Andhra Pradesh *viz.*, West Godavari, East Godavari, Visakhapatnam, Krishna, Nellore and Prakasam with a structured questionnaire. There are 447 processing plants in India out of which 60% are European Union (EU) approved plants. Andhra Pradesh has 51 EU approved processing plants which are engaged in processing of fully or partially farm raised shrimp. From different background studies (Kethly et al., 1999; Geethalakshmi et al., 2011), the impact was conceptualized under seven dimensions *viz.*, changes in number of firms, changes in the installed capacity and capacity utilization, changes in the number of workers per firm and their wage structures and changes in productivity in terms of output per worker. Installed capacity of the processing firm mainly indicates the total per day freezing and cooking capacity. Reflexive comparison method was used for the impact assessment of *L. vannamei* introduction on seafood processing industry and data was collected under two scenarios *viz.*, before and after introduction of *L. vannamei*. Non parametric Wilcoxon signed rank test was used for testing the hypothesis whether *L. vannamei* production in Andhra Pradesh had any impact on the selected dimensions, *viz.*, average installed capacity, shrimp quantity processed per day, number of working days, number of workers, wage of workers, productivity per-worker and the processing cost of the products.

Results and Discussion

Export-based cultured shrimp production in India has shown a varying species dominance pattern over the years. *P. monodon* had achieved its peak production of 1 44 347 t in the year 2007. Gradually, *L. vannamei* successfully replaced *P. monodon* and became the largest contributor of aquacultured shrimp. Increased risk in terms of frequent disease occurrence, lack of availability of quality seed and lower productivity in the case of *P. monodon* led many farmers to shift their culture towards *L. vannamei*. Contribution of *Macrobrachium rosenbergii*, showed a declining trend in the past few years and the introduction of *L. vannamei* has resulted in further decline in culture of this species (Fig. 1) (MPEDA, 2001-2013).

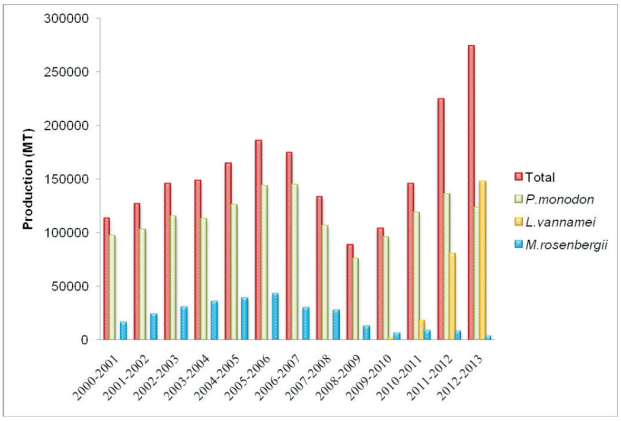

Fig. 1. Production of different species in Indian shrimp aquaculture

Andhra Pradesh has always remained an 'entrepreneurial hub' especially in case of aquaculture. Seafood industry in the state is very vibrant and it enjoys the top position in cultured shrimp production with a faster adoption of newly introduced species. As an alternative to *P. monodon* based monoculture, a new candidate species, *L. vannamei* was introduced in Andhra Pradesh for pilot testing and it has resulted in a higher production of 1 33 135 t from an area of 20 198 ha in the year 2012-13 with a productivity of 6.6 t ha^{-1} which is on par with the national productivity (6.5 t ha^{-1}). *L. vannamei* production has gained an 80 fold increase in 2012-13 compared to 2009-2010

in Andhra Pradesh and the productivity has always remained above 6.0 t ha^{-1} compared to the maximum productivity of 1.20 t ha^{-1} in case of *P. monodon*. The percentage contribution of *L. vannamei* to cultured shrimp production of Andhra Pradesh became the highest (83.6%) compared to other candidate species. In the year 2012-13, only negligible production of *M. rosenbergii* was observed which was mainly sourced from reservoirs (Fig. 2) (MPEDA, 2004-2013).

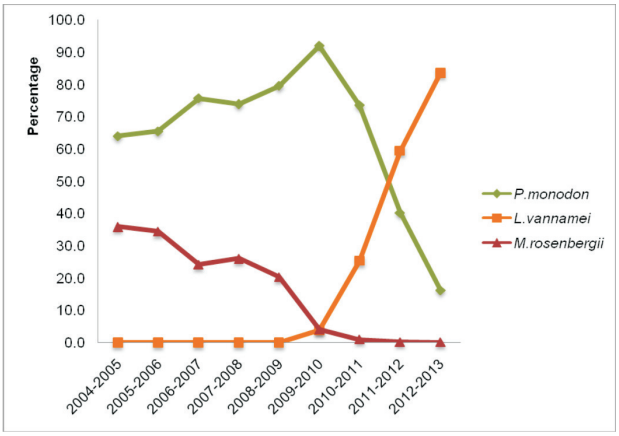

Fig. 2. Percentage contributions of different species in shrimp aquaculture in Andhra Pradesh

In order to supplement the supply chain for the new shrimp species *L. vannamei*, several hatcheries were established in Andhra Pradesh. In addition to the 53 existing hatcheries for *L. vannamei*, approval was given to 23 new ones during 2012-13 for importing brood stock and production of specific pathogen free *L. vannamei*. Presently 72% of the total *L. vannamei* hatcheries are located in Andhra Pradesh (Coastal Aquaculture Authority, 2013). Even though the supply of *L. vannamei* has increased, the farm gate prices almost doubled in 2013 compared to the year 2012. Higher demand and price for Indian shrimps due to problems associated with Early Mortality Syndrome (EMS) in shrimps from other countries may be the reason for this price hike.

In Andhra Pradesh, a number of new seafood processing plants (n=16) were established during 2009-2014 period, after the introduction of *L. vannamei* culture (Fig. 3).

Increased raw material flow, attributed to high production and productivity of *L. vannamei* may be the major reason for the increase in number of processing plants. Present trend of shrimp processing industry in Andhra Pradesh shows that on an

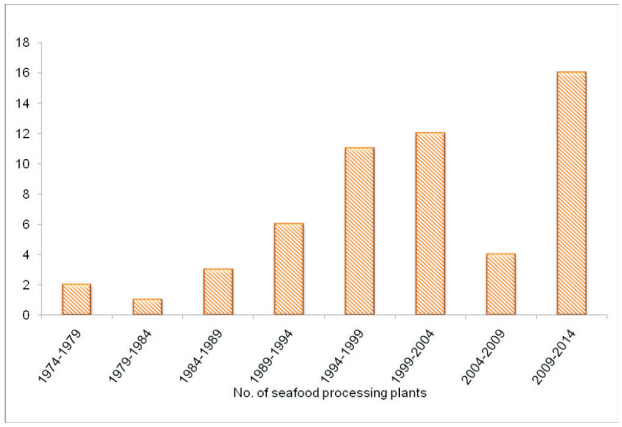

Fig. 3. Number of seafood processing plants established over years in Andhra Pradesh (Source: MPEDA)

average, 86.8% of the raw material was contributed by *L. vannamei*. In addition to this, the existing plants had enhanced their production capacity during the period. The results obtained indicated that 15% of the plants surveyed had established additional processing facilities in terms of new plants to accommodate the excess supply of *L. vannamei*. Also there was an increase in installed capacity, capacity utilization and number of workers and wage of the workers in the processing plants (Table 1).

The results given in Table 1 indicate a significant difference in the average installed capacity, quantity processed per day, average number of workers per firm and the average wage of workers before and after the introduction of *L. vannamei*. Percentage increase indicates that on an average, there was 37.12% increase in the installed capacity of the firms after the introduction of *L. vannamei*. Capacity utilization (actual quantity processed per day) also increased by 53.10% after the introduction of *L. vannamei*. Even though the firms were under-utilizing the existing installed capacity, an increase in the capacity utilization was observed after introduction of *L. vannamei.* Installed capacity mainly includes the capacity of different types of freezers used for processing *viz.*, plate freezers, blast freezers, IQF and cooker for making cooked products. Even though the installed capacity was high, the processors could use only specific machinery based on the demands of the importing countries. Consumer demand-based changes in the production technology, such as higher demand for IQF products compared to block frozen products, may be the reason for this machinery specific under utilization. In addition, many processors opined

Table 1. Structural changes in shrimp processing units after introduction of *L.vannamei*

Particulars	Before introduction of *L. vannamei*	After introduction of *L. vannamei*
Average installed capacity (t^{-1})	28.58 ± 11.54^a	39.19 ± 15.15^b
Quantity processed per day (t^{-1})	10.61 ± 6.25^a	16.24 ± 5.85^b
Average number of working days	347.65 ± 31.68^a	348.68 ± 32.10^a
Average number of workers	276.07 ± 211.17^a	402.10 ± 230.12^b
Average wage of workers (Rs. day^{-1})	253.52 ± 141.53^a	363.89 ± 192.32^b
Per worker productivity (t. day^{-1})	0.049 ± 0.040^a	0.054 ± 0.056^a
Processing cost of product (Rs. kg^{-1})	105.71 ± 7.87^a	97.78 ± 14.81^a

Values with same superscript in a column do not differ significantly ($p>0.05$)

Figures indicate mean ± SD (n=20)

that *L. vannamei* needs quick processing compared to *P. monodon* which also demands increased workforce. Even though there was negligible change in the number of working days, the processors employed larger number of people to handle the excess raw material flow. Socio-economic impact was evident from the 45.65% increase in the average number of employees and 43.54% increase in the salary of employees in the processing plants after introduction of *L. vannamei*.

It is evident from the above results that the introduction and wide spread farming of *L. vannamei* had positive impact on the seafood processing industry of Andhra Pradesh. Under-utilization of the processing plants which is mainly due to raw material shortage, has been addressed to some extent with the introduction of this species. The seasonality risk faced by seafood processing industry has declined by the increase in cultured shrimp production. According to Kohli et al. (1999), 90% of the peeling workers in shrimp processing industry are women. As the seafood processing industry predominantly engages women workers, the increase in salary of the workers might contribute towards their better livelihood.

As shrimp export is the backbone of Indian seafood industry, the changes following introduction of *L. vannamei* in seafood processing sector may be sustained further. The sustainability of the industry and the export earnings largely depend on production and export scenario. In spite of the huge contribution, *L. vannamei* production was showing a trend of monoculture like that of *P. monodon*. Lack of species diversity may pose a serious threat to the industry in terms of increased disease outbreaks as experienced earlier with *P. monodon* which was the sole species contributing to about 92% of total supply till 2009-2010 (Fig. 2). Hence, strict implementation of scientific farming techniques is imperative for maintaining a sustainable production of *L. vannamei*. Other alternative shrimp species such as western blue shrimp (*Litopeneaus stylirostris*) may be introduced on experimental basis to face potential disease outbreaks or any other raw material supply shocks that are possible in a monoculture dependent seafood processing industry. In spite of the positive structural changes in the industry, there is scope for product diversification and value addition for which industrial support is very essential.

Acknowledgement

The authors are grateful to the Director, Central Institute of Fisheries Technology, Cochin for granting permission to publish this paper. The authors also wish to thank the Marine Products Export Development Authority and the selected seafood units for providing necessary data.

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