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INDIAN FISH EXPORTS AND DEPENDENCE ON *P. VANNAMEI*: SHARE AND EXTERNALITIES

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ABSTRACT

Fishery products play a prominent role in contributing significantly for the success of the export scenario of India. India exported 13.8 lakh tonnes of seafood worth an all-time high of US $ 7.08 billion (45000 crores) in 2017-18. Amidst the global recession and economic meltdown, the sector performed well. Contrary to the major competitors' slowdown in export growth, the country's sea food trade grew by double digit in quantum as well as value. The introduction of *P. vannamei* has boosted the Indian exports and brought a sea change in the Indian shrimp production and processing industry. The production of vannamei had registered a hike from 2009-10 to 2017-18 (622327 t in 2017-18 compared to 1731 tonnes in 2009-2010) with a high productivity of 6.65 t ha^{-1} (MPEDA, 2010; MPEDA, 2019) and marked as one of the major reason for the performance of Indian export industry during the recession period. A*s an alternative to P. monodon, P. vannamei has completely resulted in achieving the goal of higher productivity and thereby increasing contribution in the export earnings.* The present paper studied the significance of *P. vannamei* over other shrimps in the Indian fisheries export over the years with special focus on analysing the export performance in terms of trends and forecast of Indian frozen shrimp. The study also assessed the different externalities associated with the *P. vannamei.* The results revealed that, frozen shrimp registered the highest growth rate in quantity from 3.15 per cent to 18.95 per cent over the years. Forecasting results shows that India is becoming more and more a vannamei exporter leading to a one commodity exporter nation. Export profiling analysis validates the forecast result that *P. vannamei holds the major share of 73 % of the total value of shrimp export which is about 50.36 % of the total export. A total of Rs.16000 crore is estimated as the total production externality associated with the production of P. vannamei and also there exists a h*igh cost of importing brood stock for *P. vannamei* causing huge market risk and thereby declining the price by 30 %. The study advocates the need for accounting externalities in farming operations for the sustainable production of *P.vannamei*. Moreover strict implementation of scientific farming techniques, strengthening the alternate internal marketing and species diversification should be promoted in a consistent manner for enhancing the varied shrimp products and thereby the Indian shrimp export.

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Introduction

Shrimp is the world's most important seafood contributing to about 19 percent of international trade in value terms and the leading markets are USA, Japan, Spain, France, UK and Italy. It remained as a major export earner in Indian seafood industry. Frozen shrimp accounted 68.5 per cent of the total seafood export earnings of the country in US$ during 2018-19 (MPEDA, 2019).The increase in exports was mainly due to the increase in production of industry based monoculture of shrimp with two main candidate

species namely Pacific white shrimp (*Peneaus vannamei) and Black tiger shrimp (Penaeus monodon). Since 1960s, several food processing plants were established in India focussed on export of frozen products from marine catches. Later the industry faced shortage of raw material supply due* to uncertain marine catches and consequent suboptimal capacity utilization of these plants. Several studies have reported that fluctuations and uncertainty in supply often lead to underutilization of the installed capacity (Kannan & Bandhyopadhyay, 1993; Unnithan *et al.,* 1998; Geethalakshmi *et al.*, 2011). Growth in area under cultured shrimp production became a potential solution to this problem and cultured shrimp became a vital raw material for the seafood processing industry (Arathy *et al.,* 2015).

P. 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 (Mathew *et al.,* 2004), following which a tremendous growth in production was observed. *P. monodon* was the major candidate species of cultured shrimp in India till 2009-2010 and later *P. vannamei* production gained momentum. Considering the cultured shrimp production in India, the percentage contribution of *P. vannamei* had reached 90 per cent in 2017-18. The production of vannamei had registered a hike from 2009-10 to (compared to 1731 tonnes in 2009-2010) with a high productivity of 6.50 t ha-1 (MPEDA, 2010; MPEDA, 2019).The giant leap in production and productivity of *P. vannamei* has resulted in wider adoption of this species by farmers and has resulted in an increased raw material flow to the processing industry. In all means, the *introduction of vannamei as an alternative to monodon has completely resulted in achieving the goal of higher productivity and thereby increasing contribution in the export earnings.* This necessitated the need for a study on analysing the significance of *P. vannamei* over other shrimps in the Indian fisheries export over the years. The present paper attempts to assess the impacts and aftermaths of the introduction of *P. vannamei* in the fisheries sector of India to analyse the export performance in terms of trends and forecast of Indian frozen shrimps including *P. vannamei* and assessing the different externalities associated with *P. vannamei.*

Materials and methods

The study is based on the secondary data which included marine fish landings sourced from different published sources including FAO Year Book of Fishery Statistics, Statistics of Marine Product Export from India, published by the Marine Products Export Development Authority (MPEDA, Cochin), Ministry of Commerce, Government of India, and National Marine Living Resource Data Centre and Central Marine Fisheries Research Institute. The study was conducted based on the export data from 1995 to 2017 and shrimp production data from 2000-2017. The study was designed to elicit the impact of *P.vannamei* in the Indian fisheries export. Trend analysis, moving average methods, forecasting techniques (ARIMA models) and other econometrical tools have been employed for analysing the data.

Results and discussions

Export Performance of Indian Fisheries (updated for 2017-18)

Frozen shrimp continued to be the major item of export in terms of quantity and value, accounting for a share of 41.1% in quantity and 68.46% of the total USD earnings in 2017-18. Shrimp exports during the year increased by 30.26% in terms of quantity. However, unit value realization decreased to 8.56 USD/Kg in 2017-18 from 10.38 in 2014-15 with a depreciation of 2.09%. The overall export of shrimp during 2017-18 was to the tune of 5, 65,980 MT worth USD 4848 Million. USA is the largest market (2, 25,946 MT) for frozen

shrimp, followed by South East Asia (1, 59,145 MT), EU (78,426 MT), Japan (33,828 MT), Middle East (23,441 MT) and China (13,107 MT) in 2017-18.The export of vannamei shrimp has improved from 3, 29,766 MT to 4, 02,374 MT in 2017-18 with a growth of 24.7% in value. In value terms about 53%of total vannamei shrimp was exported to USA followed by 21% to South East Asian countries, 11.3% to EU, 4.7% to Japan, 3% to Middle East, 1.35% to China in 2017-18 Japan is the major market for black tiger shrimp with a share of 43.18% in terms of value followed by USA (20.07 %) and South East Asia (17.38%).

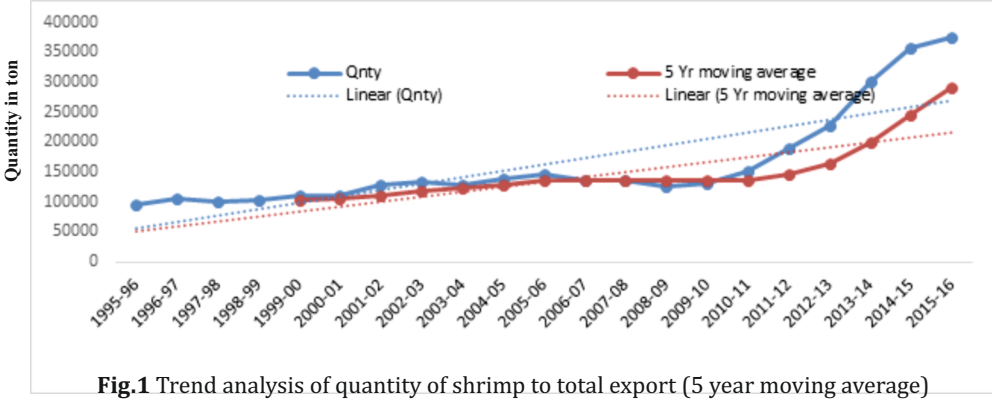

Fig.1 Trend analysis of quantity of shrimp to total export (5 year moving average)

5 year moving average method was employed to analyse the trend of quantity of shrimp (Fig.1) in total export and indicates that the yearly exports of frozen shrimps from India experienced stability up to the period of 2009-10, following which a huge increase in the export quantity was observed. The advancement of the shrimp farms with the gain in momentum of *P.vannamei* is considered as the major reason for this constant increase in the shrimp export. Better management practices in shrimp farming led to growth in the overall productivity of the shrimp farms there by allowing farmers to produce higher quantity of shrimps within the existing culture ponds. Studies shows that owing to the high demand for shrimps around the world, *P.vannamei* production has changed the shrimp production scenario by developing shrimps as the major export commodity. It has become a major foreign exchange revenue generator of the country and may continue to be so in the following years.

Forecasting future trends of Indian Shrimp export

Forecasting models were applied to estimate the future trend of the shrimp exports of India which validates the importance of *P vannamei* in the export scenario of the country. The results show that India is becoming more and more vannamei exporter leading to acquiring the status of a one commodity exporter nation. ARIMA model was used to forecast the 12 years export performance of shrimps from India. The forecasting process adopted the best fit model of forecasting for the period of 12 years (2017 - 2028) for each of the variables and generated the output. It was done in terms of the total quantity exported in tons, the total value of exports in Indian rupees and the total value of exports in terms of US dollars. The ARIMA model forecasted a significant and consistent increase in the total exported quantity from India during this period. In terms of the export value in Indian rupees, the forecast remained plateaued and constant. While the US dollar export forecast showed a downward trend and estimating a decline in the total value (fig. 2, 3 & 4).

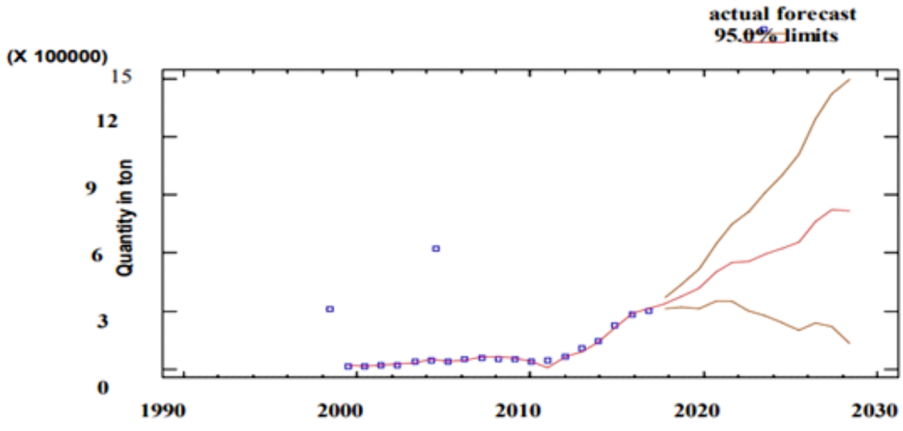

Fig 2. Time sequence pqot for Quantity in in ton ARIMA (0, 2, 0) x (2, 0, 2)

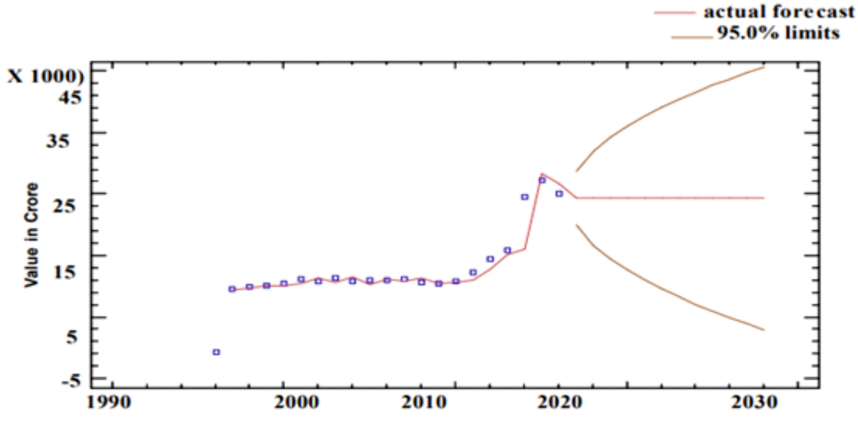

Fig: 3 Time sequence plot for value in Rs. crores ARIMA (0,1, 1)x(0,0,0)

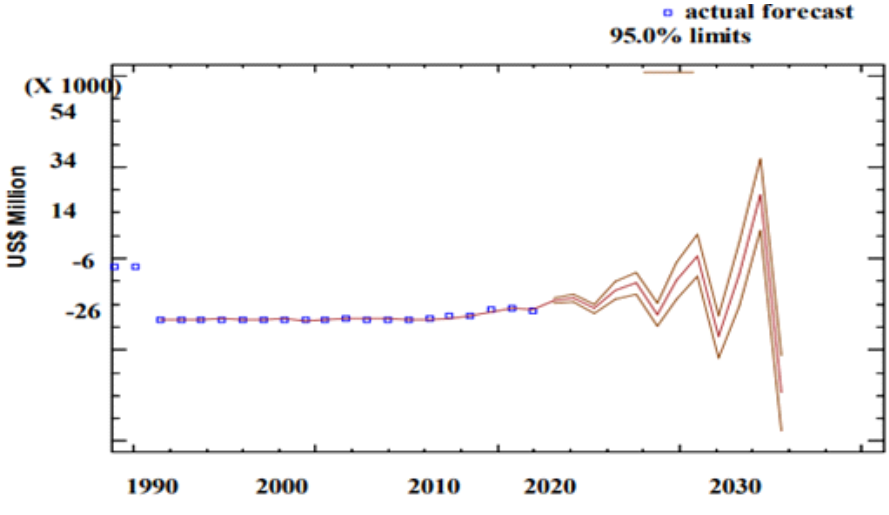

Fig: 4 Time Sequence Plot for US$ Million Model: ARIMA (2, 2, 2) x (0,0,0)

Export profiling of P. vannamei to total shrimp export

The introduction of *P. vannamei* has drastically changed the Indian shrimp production, processing industry and the export performance of the Indian fisheries export.It has been widely farmed in many parts of the world for some time. However, the incidence of *P. vannamei* in India has attained its peak due to its relatively recent introduction. Due to its fast growth, good average body weight, high productivity and low protein requirement, the *P. vannamei* makes a good substitute species for *P. monodon*. Tackling *P. vannamei* culture is not a cakewalk though (Briggs *et al.,* 2004). It requires a lot of input, management resolve and a lot of effort in order to attain a desired result. The increasing share of cultured shrimp over the years (1.1 LT to 5.5 LT) was ranged from 20.88% to 74.48% during 2000-2017 (Fig. 5). The production contribution of the shrimps clearly defines the relevance of *P. vannamei* over other species throughout the years.

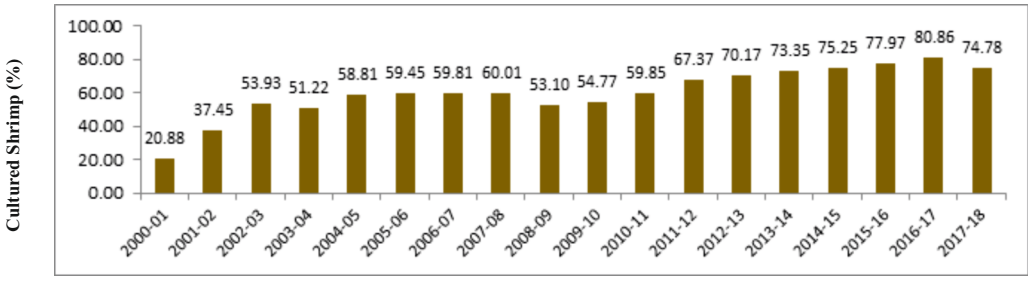

Fig. 5. Share of cultured shrimp over the years

The profiling analysis shows that percentage share of common shrimp *P. monodon* (tiger prawn) production has declined sharply from 91.82 percent to 3.30 percent over the time period of 2009-18. Now, *P. vannamei* holds the major share of 96.31 percent production among all the other shrimp varieties of total shrimp export (fig. 6).

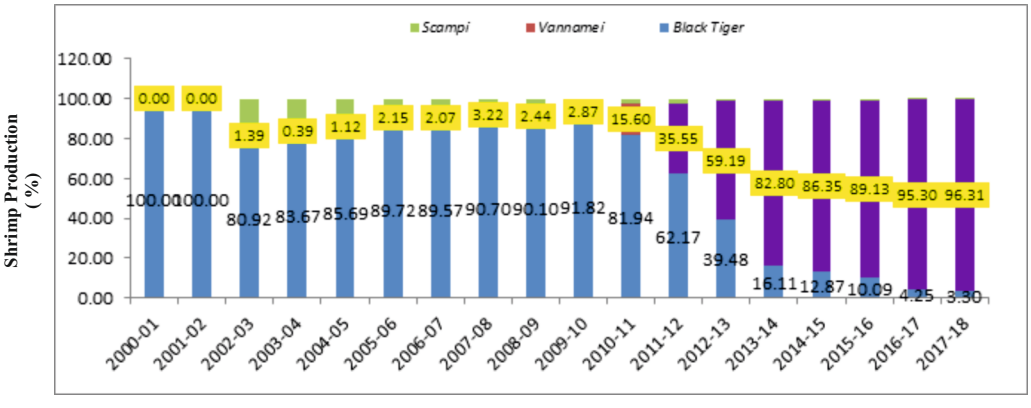

Fig. 6. Profiling analysis of shrimp production over the years

The share in quantity of P. vannamei to total shrimp export and quantity share to total export for P. vannamei holds a ratio of 70: 30 which reciprocates the fact that India is becoming a commodity exporter nation. Species P. vannamei holds the major share of 73 percent of the total value of shrimp export which is about 50.36 percent of the total export. Moreover, P. vannamei gives 71.09 percent of quantity share to total shrimp export and 29.22 percent share of quantity to the total export (fig. 7, 8, 9 & 10).

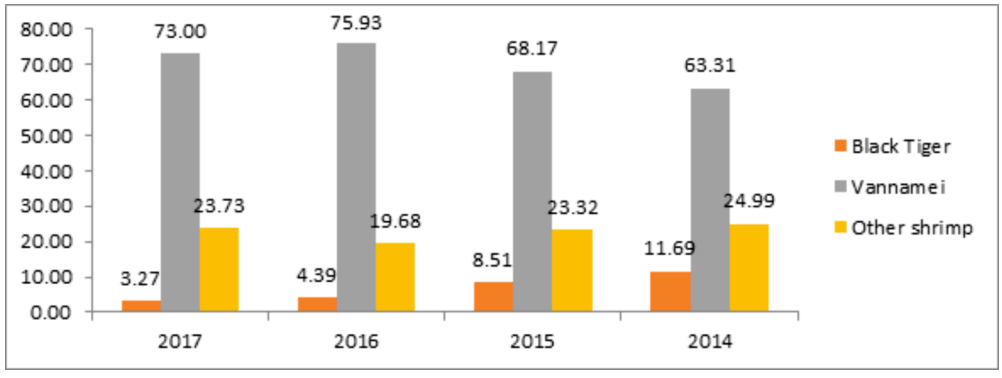

Fig 7. Value share percent to total shrimp

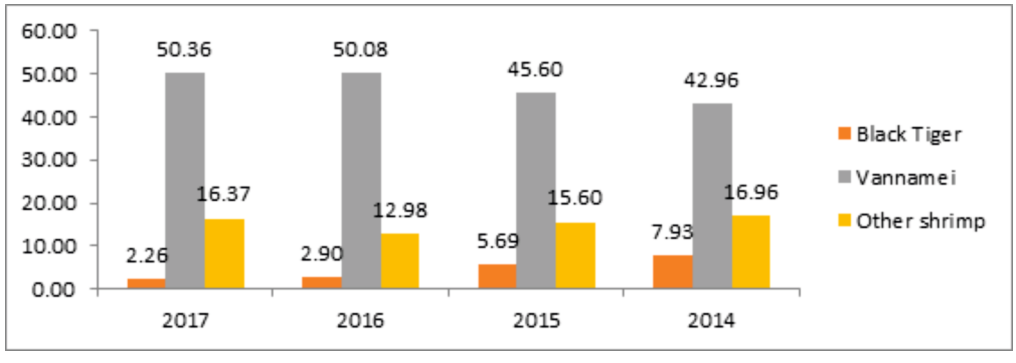

Fig 8. Value share percent to total export

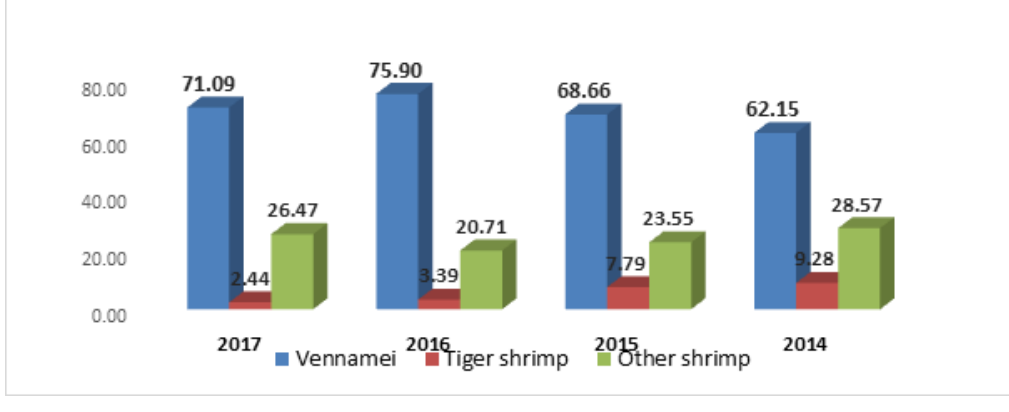

Fig 9. Quantity share % to total shrimp export

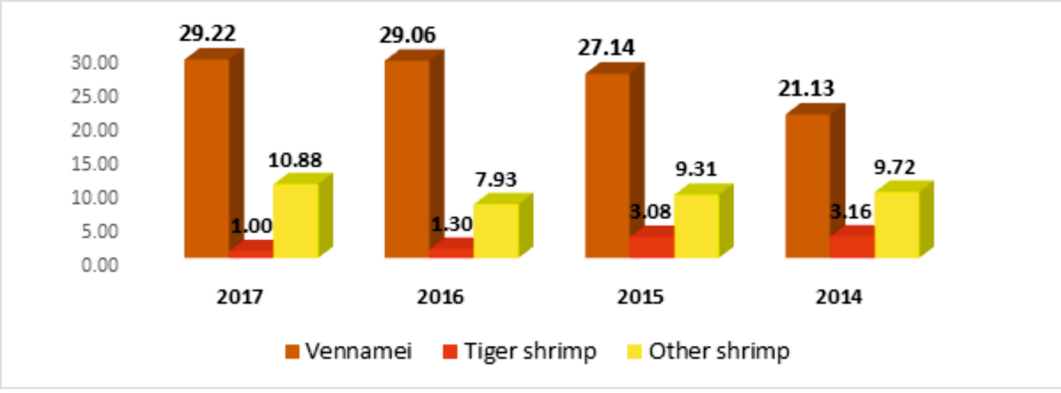

Fig.10. Quantity share % to total shrimp export

The aquaculture sector of India witnessed a boom with the introduction of white leg shrimps that outpaced the native species such as the black tiger which was the dominant farmed species until 2008. The dominant place that black tiger held in global shrimp farm production was due to a number of factors, including their rapid growth rate, large harvest size and relatively high market price. However, the growing importance of vannamei variety had attributed to the favourable characteristics of their commercial production in the form of higher adaptability to the production environment (tolerance to varied temperature, salinity etc.), superior disease resistance capability, and higher growth rate, ease of breeding and relatively higher demand in the global market. Commercialization of vannamei shrimps in India along with the huge marine potential has resulted in significant growth in the export earnings from export of processed shrimps and still a significant growth potential persists. Frozen shrimps ranks first in the marine export basket and since last five years, it has dominated the marine export basket in terms of value of foreign exchange earned. Out of the said export value, the frozen shrimp segment comprised share of about 65% with a volume contribution of 38% (of which 76% was vannamei and 24% was black tiger shrimps). However, beside all these supremacies the vannamei inclusion has created several forms of externalities in the aquaculture sector and thereby the Indian sea food export. An externality is a positive or negative consequence of an activity experienced by unrelated third parties. Externalities indicate the social cost or benefit which accrue to the society/ system on account of a conscious action / effort of individuals. In fisheries systems, externalities are defined as every external effect caused by individual action/ effort which are not included while assessing the economic benefit/ losses of such actions. Externally imposed benefit is a positive externality and those imposed cost is a negative externality. Internalizing the externalities is extremely important while arriving at benefits / loses of such individual action/ efforts. There are positive as well as negative externality exists for shrimp production. The different kinds of externalities associated with farming of *P. vannamei* include production, integration and risk and uncertainties.

Over the years *P. Vannamei* holds the main source and reason for the increased production and export. There is about 20 per cent increase in shrimp production after the introduction of vannamei. This point outs increased production, increased number of hatcheries, processing plants and the resulted export earnings as one of the positive externality of the shrimp production. After the introduction of *P. Vannamei* into India, the

total culture scenario has changed drastically. Farmers were able to increase their production into 2 – 4 folds. Currently in India, more than 95% of the farms have been converted to produce *P. Vannamei*. Initially there were difficulties in growing vannamei to bigger sizes, presently this had been overcomed by higher growth strains and 30-35g size under high stocking densities is achievable. At present the *P. Vannamei* production has reached (about 6-7 tonnes) ahead of threefold times that of *P.monodon* production (1-2 tonnes). The schematic representation of input industry of *P.vannamei* is shown in fig 11. The results shows that a total of Rs.16000 crores has been estimated as the production externality of vannamei production. About 37 percent of cost is incurred at a market share of Rs.6000 crores for feed followed by drugs (22 percent, Rs.3500 crores), value chain players (19 percent, Rs.3000 crores), seed (12 percent, Rs.2000 crores) and labour (10 percent, Rs.1600 crores).The higher cost of brood stock and the transportation ultimately get transferred to the farmers who purchase seeds at higher price has got declined due to the increased production rate of *P. vannamei* over the years has marked as the significant outcome of the production externalities of *P. vannamei*.

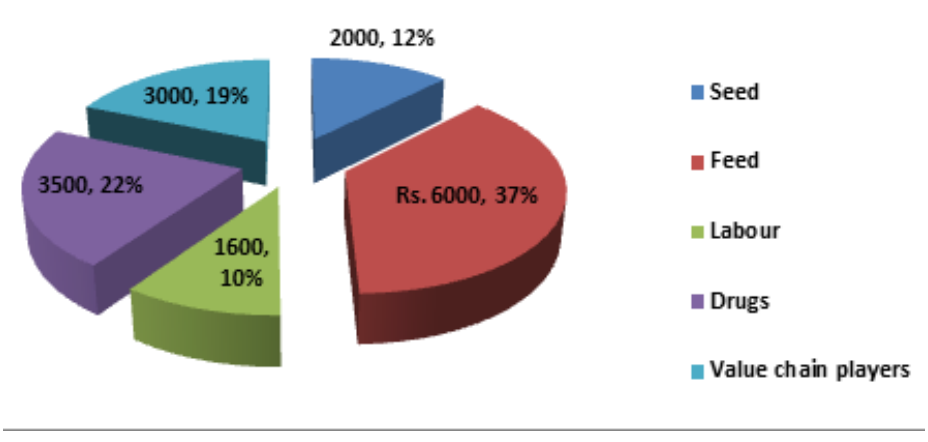

Fig 11. The input industry of *P.vannamei*

The production increase not only led to the increase in export but also it creates a huge impact in the value chain of the shrimp production. The value chain of shrimp production consists of backward (seed, feed, labour etc.) as well as forward integration (marketing, export, value addition etc.). The study also indicates that total cost of production of *P. vannamei* is 2.3 times more than that of tiger shrimp. The investment requirements like aerators and generators are more in *P. vannamei*. Due to the high stocking density practised in *P. vannamei*, the seed cost is also on the higher side. The annual net profit obtained from the farming of white leg shrimp is 1.5 times more than that of tiger shrimp. The break-even production is 62 per cent of the actual production in *P. vannamei* shrimp. The break-even price for the *P. vannamei* is comparable with that of tiger shrimp. The input-output ratio shows that *P.vannamei* shrimp culture is economically better than that of *P. monodon*. Many economic indicators like annual net profit, break-even price and input-output ratio favour white leg shrimp culture over tiger shrimp culture. Though the cost of production is higher for *P. vannamei* culture, the risk factor (disease incidence) is much less. Even though all these holds, the culture of *P. vannamei* also create sufficient increase in the number of employment days and labour.

Table 1. The economic analysis of *P. monodon* and *P. vannamei*

Parameters	*P. vannamei*	*P. monodon*
Total costs (Rs. Lakh/ha)	21.92	9.64
Annual net profit (Rs. Lakh/ha)	13.32	8.36
Break-even production (kg./ha)	9842	875
Break-even price (Rs./Kg/ha)	151	161
Input-output ratio	2.3	1.8

P. vannamei are very efficient at utilizing the natural productivity of shrimp ponds, even under intensive culture conditions. Additionally, feed costs are generally less for *P. vannamei* than the more carnivorous *P. monodon*, due to their lower requirement for protein (18–35 percent compared to 36–42 percent), especially where bacterial floc systems are used. Feed prices for *P. vannamei* ranged from USD 0.6 per kg in Latin America and Thailand to USD 0.7–1.1 per kg elsewhere around Asia and in India it ranges from Rs.70.-80 per kg; FCRs of 1.2–1.8:1 is generally obtained. However, the average cost of importing brood stock is quite high. The average cost of bloodstock when it reaches the hatchery is estimated to be US$91, (Basic cost, US60$+transport +duty). Currently, shrimp hatcheries import *P. vannamei* brood stock from US, Thailand and Singapore with high shipping cost and transit loss due to mortality. The higher cost of brood stock and transportation ultimately get transferred to the shrimp farmers who purchase seeds at a higher price. High cost of brood stock is also prompting some hatcheries to source brood stock from shrimp ponds, which ultimately results in the production of poor quality seeds and subsequent crop loss to farmers. The Coastal Aquaculture Authority (CAA) grants approval for the import of SPF *P. vannamei* brood stock and seed production in bio secured hatcheries and also for farming SPF *P. vannamei* in bio secured farms (fig. 12).

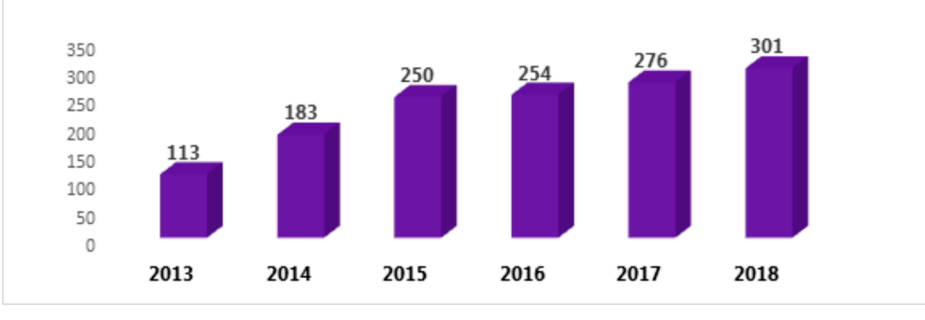

Fig.12. Hatcheries importing the brood stock of *P. vannamei* from 2013 to 2018.

As per the CAA (2013), hatcheries should have required bio-security facilities such as fencing, vehicle/tyre baths, foot wash, hand wash etc. There should be a PCR laboratory with the required kits and reagents with a qualified laboratory technician. Proper Effluent Treatment System (ETS) should be functional in the hatcheries. After CAA approval, the hatcheries should get Sanitary Import Permit (SIP) from the dept. of Animal Husbandry. Altogether, Letters Of Permission (LOP) have so far been issued to 259 hatcheries (198 in Andhra Pradesh, 54 in Tamil Nadu, 3 in Gujarat, 3 in Odisha and 1 in Karnataka) with production capacity of 24,209 million post larvae per annum and they were permitted to import 6,05,264 numbers of SPF *P. vannamei* brood stock for the year 2015-2016.In spite of the low cost of production *P.vannamei* over *P. monodon*, the external costs related with the production of *P.vannamei* is quite high and unbearable to the farmers. This shows one of the most important negative eternality of the *P. vannamei* farming. The figure 13 below shows the increasing trend of *P.vannamei* brood stock production in India during 2011-2018. Moreover, the economic loss due to the disease of *P.vannamei* is inevitable and is estimated about 50,000 tonnes worth 1,000 crores creating 20 lakh man days employment loss in the total production.

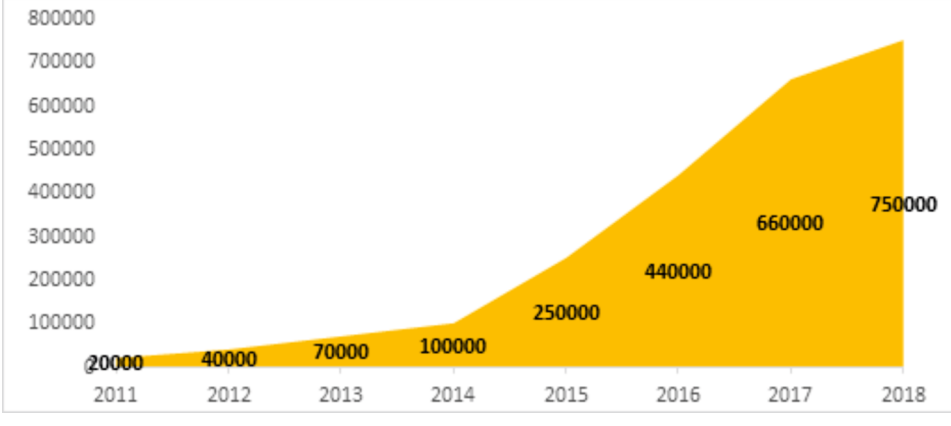

Fig. 13. *P.vannamei* production in India during 2011 to 2018.

Indian shrimp export rejection by USA, EU, Japan etc., was a serious issue which affects exporters, processing units, producers profit and Indian economy. Though rejections on Indian shrimp exports have gone down consistently in last five years, it is considered as a major negative externality since supply chain of entire industry will be getting affected by these refusals. USA rejected 63 shrimp consignments during 2018 in which 55 were from India.

Standards for sanitation and the use of drugs and chemicals, and common food safety regulations for seafood (particularly shrimp) are already high in all major importing countries. The European Union market has more strict regulations (zero tolerance) on residues of chemicals and antibiotics, as well as the Generalized System of Preference (GSP) on import tax. The United States of America market enforces more strictly on a sanitary standard such as HACCP or Sensory Assessment, but has also instigated strict controls over banned antibiotics in shrimp. From June 2005, the final antidumping tariffs on cultured shrimp imported into the United States of America from 6 main shrimp producing countries were finalized and set (for the general rate) at

approximately 113 percent for China, 26 percent for Viet Nam, 10 percent for India, 7 percent for Brazil, 6 percent for Thailand, and 4 percent for Ecuador. Mexico and Indonesia escaped these tariffs.

Conclusion

The high productivity of *P.vannamei* led to an increase in the capacity utilization adding to employment opportunities. However, the expansion of *P. vannamei* culture has led to reduced value of harvested shrimp. The market for vannamei is expected to become more competitive in future, mainly due to the saturation of export markets and reduction in world economic growth, as well as the emergence of non-tariff barriers in shrimp trade. Strict implementation of scientific farming techniques is highly imperative for the sustainable production of *P. vannamei* .The shrimp farmers should be made aware of the growing need to farm shrimp in a responsible, traceable and low impact manner which can enhance biosecurity, and help protect the environment, whilst producing shrimp in a cost efficient manner. In order to continue the growth of shrimp farming smoothly in the long term, domestic consumption should be promoted to supplement the complex export markets. Strengthening the alternate internal marketing would meet the supply shocks incurred due to of shrimp export. Moreover species diversification for the production of other shrimp species should be promoted in a consistent manner for enhancing the varied shrimp products and thereby the Indian shrimp export.

Acknowledgement

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