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Status on non-alien species SPF Pacific white shrimp *Litopenaeus vannamei* in India – an overview

V.Sedhuraman, M.A.Badhul Haq*, P.Kavitha, A. Sajith Ahamed, M.Vishwas Rao, Chandan Tiwary and M.Srinivasan

Centre of Advanced Study in Marine Biology,Faculty of Marine Sciences,Annamalai University Parangipettai 608 502 Tamilnadu, India

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ABSTRACT

In Asia Non-alien species specific pathogen free (SPF) Pacific white shrimp Litopenaeus vannamei production reaches 1,875,542 metric tons in 2009. Major loss crises in shrimp forming industries due to pathogens reflected various molecular technique diagnostic method improvements. Of about 2961.33 hectares lands of India had approved for Litopenaeus vannamei farming. Illegal exportation of SPF L. vannamei exceeds 30,000 metric tons. The various WSSV infected L. vannamei farming regions in Tamil Nadu and Andhra Pradesh was listed out. 24 permitted broodstock production for SPF Litopenaeus vannamei includes Tamil Nadu, Andhra Pradesh and Gujarat states of Indian hatcheries where mentions the legal broodstock availability in India. Formers illegal cultivation of L. vannamei makes way for infection of native shrimp pathogen infection to the SPF L. vannamei. The illegal cultivation should be controlled by sanitizing with concern precaution measures constructed by national and international rules and regulations.

Keywords: *Litopenaeus vannamei,* SPF, Illegal cultivation, shrimp hectares, broodstock.

INTRODUCTION

Shrimp culture forms as a major contributor in the coastal aquaculture all over the world. About 1.2 million hectares of potential brackish water area in coastal regions of our country is under culture for shrimp cultivation. The cultured shrimps are exported from our country is about 50% of the total shrimp exports. Hence there is huge potential for the more expansion of costal shrimp aquaculture in our country. But the fast increase in shrimp farming has resulted in environmental and social concerns for the last decade. However these things are now largely considered and social recognition of shrimp farming has been attained.

The recent globalization in trading the products have many new issues such as traceability of the manufacture, strict quality profiling of the food safety vice aquaculture, particularly antibiotic residues, heavy metals and pesticides, disease transmission, etc. all of which for a strong framework for this sector and the various programmers undertaken by Coastal Aquaculture Authority (CAA) sufficiently address these problems (Anonyms, 2010). Several shrimp species are being cultured in ponds, and one particular species that is gaining popularity in tropical countries is the white shrimp, *L. vannamei*. This penaeid shrimp has fast growth rate, thus, its culture period is significantly reduced. It is now evident that *L. vannamei* is farmed and established in several countries in East, Southeast and South Asia and is playing a major significant role in shrimp aquaculture production. There is very limited research works were done on the culture and growth performance of *L. vannamei* with different stocking densities in brackish water ponds in India (Karuppasamy. *et al*., 2013).

India's shrimp industry has urged the Government to allow the import of specific pathogen-free (SPF) Pacific white shrimp, Litopenaeus vannamei, due to recession. It says that the main contribution from Panaeu monodon has declined in 2008 due to culture and disease problems. It also states that an Aquatic Quarantine Facility (AQF) was set up in Chennai and funded by the National Fisheries Development Board to ensure the SPF status of the imported *L. vannamei* (Remany, *et al*., 2010). To combat the prevailing challenges in farming *P. monodon, L. vannamei,* commonly called as the Pacific white shrimp widely cultivated in the US and the Western Hemisphere (Rosenbery,1997) is being introduced as an alternative species. *L. vannamei* is considered to be more disease resistant, tolerant to high stocking densities, low salinity and temperature and with high growth rate (Brigg, *et al*., 2004). The decision to import *L. vannamei* in India was spurred further by the continuous demand of the shrimp growers and traders for the introduction of this shrimp as they believed that there is good export market potential for this species. The importation of this exotic shrimp called for the set up of a quarantine facility which was essential to reduce the risks of adverse effects arising from the introduction of non native species (Sindermann , 1990). Subsequently, a dedicated quarantine centre for *L. vannamei* called the "Aquatic Quarantine facility for *L. vannamei*" (AQF), was established in Chennai, Tamil Nadu, as a technical arm of the Rajiv Gandhi Centre for Aquaculture (RGCA) under the Marine Products Export Development Authority (MPEDA), Ministry of Commerce & Industries, Government of India (Remany, *et al*., 2010).

A non-indigenous species of Asian product *L. vannamei* went from 2,310 metric tons in 2000 to 1,875,542 metric tons in 2009. *L. vannamei* production of about 18247 MT from 2,930 hectares in 2010-11, the production reached 80,717 MT from 7,837 hectares registering an increase of 342% and 167% respectively in production and area under culture respectively (SEAI, 2013). While comparing to the production through 2003 of main culture species *Penaeus monodon* indigenous to Asia, increased only 22.8% for the period (FAO- Fisheries and Aquaculture Information and Statistics Service in 24/02/2011 says 623,194 metric tons in 2000 to 765,346 in 2009). Asian shrimp industries face instable results in *P. monodon*, mainly due to the infection of disease in the wild brood stock production farms. Asian shrimp farms take advantage of genetically improved Specific Pathogenic Free (SPF) *L. vannamei* brood stock available from growers in the USA. Bio-security was the major prevention of infection in Asian *L. vannamei*. The next important factor was low cost production: about ½ when compared with *P. monodon* (Anonyms, 2010).

The level of pathogen changes depending on the bio-security level maintained under Specified Pathogen Free (SPF) shrimps which was designed to minimize the infection and spread of pathogen. SPF is specified only for shrimp that are maintained in high bio-security amenities, such as a Nucleus Breeding Center (NBC), which supports the SPF status with two or more years, tested of documented disease. Although up-to-date there is no international recognition for SPF list by the global shrimp farming industry, the US Marine Shrimp Farming Program (USMSFP) developed the list of specific pathogen for SPF penaeid shrimp in the United States. This data is potent and updated while new pathogen identified and more accurate disease diagnostic tools become available. In 1989 the Marine Shrimp Farming Program (USMSFP) develops the world first population of SPF shrimp, and the SPF stocks value of shrimp farming industry is now approved worldwide. (Moss, *et. al.*, 2003).

The Coastal Aquaculture Authority (CAA) while comparing with other related organizations has already shortlisted the SPF *L. vannamei* suppliers based on the genetic base and disease free status and the import of SPF brood stock has been directed only from such suppliers. It offers many potential suppliers of SPF *L. vannamei* brood stock in the approved list based on the genetic base and experience in the field. When the non-indigenous shrimp varieties – *L. vannamei* culturing was allowed by Indian Government; the CAA allowed importing broodstock seed production and permit for culturing SPF *L. vannamei* to the farmers. The formers very promisingly respond to it. It is inspirable to note that few years back closed many shrimp farms also started farming new shrimp variety shrimps. The aquaculture production boomed to manifold in the frequent years. In fact, this resulted for local demands for considerable extent. Other than shrimps, the farmers cultured other fish varieties and crabs are also being. Specific Pathogen Free (SPF) *Litopenaeus vannamei* broodstock developed for the first time in India by Rajiv Gandhi Centre for Aquaculture, the R & D arm of the Marine Products Export Development Authority in association with the Oceanic Institute, Hawaii, USA, is ready for supply to hatchery operators at reasonable rate. The primary objective of this initiative is to produce selectively bred *L. vannamei* shrimp broodstock (mother shrimp) that exhibit good hatchery performance for producing high quality shrimp seed which should exhibit fast growth and high survival on commercial shrimp farms in India (Anonyms, 2013).

Rajiv Gandhi Centre for Aquaculture is a Society functions under the Marine Products Export Development Authority, a statutory body set up by the Government of India under the MPEDA Act 1972, under the Ministry of Commerce & Industry, Govt. of India, for promotion of export of marine products from India. Specific Pathogen Free Post larvae imported from Nucleus Breeding Centre of Oceanic Institute, Hawaii, USA, shall be grown from PL to 40 gms in MPEDA/RGCA facility Vizag. Six to eight months period is required for growing PL to 40 gms size. The above project has the capacity to produce 45000 number of broodstock annually (Anonyms, 2013). This project shall help Indian farmers to produce 1.35 lakh MT of additional shrimp for export worth around Rs. 4000 crores per annum by utilizing about 10,000 Ha water spread area for two crops per annum. Most importantly, this initiative of MPEDA will deliver quality broodstock to shrimp hatcheries and thus ensure the supply of quality seeds required for several thousands of small and marginal farmers at affordable price. The first batch of around 20000 Nos. of high quality SPF *L.vannamei* broodstock produced at RGCA facility at Visakhapatnam is ready for supply to approved shrimp hatcheries in India at half the price of imported stock (Anonyms, 2013).

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During the financial year 2011-12, for the first time in the history of Marine product exports, the export earnings have crossed US$ 3.5 billion. Exports aggregated to 0.86 million tonnes valued at Rs. 16597.23 crores and US$ 3508.45 million. Compared to the previous year, seafood exports recorded a growth of 6.02% in quantity, 28.65% in rupee and 22.81% growth in US$ earning. Frozen Shrimp is the major export value item accounting for 49.63% of the total US dollar earnings. The above was achieved during a period of recession in the international market. One of the major reasons for the increase in production and higher export turnover was due to the introduction of SPF *L.vannamei* shrimp for Aquaculture production. Considering the established infrastructure for farming shrimps in India, it is reasonably easy for *L.vannamei* farming and can substantially contribute to marine product export from the country. However, one of the major obstacles for increasing the *L.vannamei* production is the non-availability of quality SPF broodstock in India in required quantities (Anonyms, 2013).

The governments decision to allow domestic farming of exotic prawn pecies, *Litopenaeus Vannamei* (commonly called white leg shrimp or Pacific white shrimp), in 2008, though much belated, has helped diversify the products basket for seafood exports. The countrys fast growing aquaculture industry had been demanding permission to farm Vannamei shrimp for long because it offered several advantages over some native species, including black tiger shrimp, which constituted the bulk of the shrimp exports. Vannamei prawns reared from selectively bred disease-free seed thrive well under intensive farming situations, tolerate a wide range of water salinity and temperature fluctuations, and require relatively low-protein diets to save on feed cost. Besides, it can breed (mate and spawn) under captivity, showing a relatively high survival rate in the hatcheries **(**Surinder Sud, 2013)**.** Its introduction has indeed paid immediate dividends by way of a spurt in exports. Official numbers indicate that marine products exports touched a high of 0.86 million tonnes, valued at $3,508.45 million (Rs 16,597 crore), in 2011-12. This translates to a year-on-year growth of six per cent in quantity, 28.6 per cent in rupee earnings and 22.8 per cent in dollar terms. Frozen shrimp, including Vannamei, formed nearly 50 per cent of the seafood shipments. It is noteworthy that the export surge in 2011-12 came about at a time when the global seafood bazaar was passing through a recession because of over-supply, which tended to persist in part of 2012-13, as well.

Debutant Indian Vannamei farmers, most of whom are small and marginal fish producers operating water bodies of 0.5 to five hectares, have managed to pocket good returns **(**Surinder Sud,2013)**.** Vannamei is essentially a prawn species found commonly in the western Pacific Ocean. Under natural conditions, its adults prefer to dwell in the sea, while the juvenile like to live in estuaries. It was successfully bred in captivity for the first time in Florida in the early 1970s. This paved the way for its commercial cultivation that began in south and central America in the late 1970s and spread rapidly to other countries. China, Taiwan and Thailand are among the largest Vannamei producing countries now. However, the Indian authorities reservations on permitting domestic farming of Vannamei, which delayed the countrys entry into the lucrative Vannamei export market, were understandable. Neither broodstock (mother shrimp) nor good quality seeds of Vannamei was locally available. Allowing their unregulated imports would have posed the risk of importation of exotic fish diseases that could prove perilous for the existing shrimp aquaculture industry. It was, therefore, good that while granting permission for the import of specific pathogen free vannamei broodstock, the government imposed stringent quarantine requirements and restricted the entry of imported shipments to only the Chennai port, which was equipped to enforce the stipulated guidelines **(**Surinder Sud, 2013)**.**

Since the success of commercial farming of Vannamei depends largely on the availability of good quality seeds, their local production was deemed imperative to reduce dependence on imports from countries like the US, Thailand and Singapore. The Rajiv Gandhi Centre of Aquaculture (RGCA), the R&D wing of the Marine Products Export Development Authority of India, has now begun producing Vannamei broodstock locally in collaboration with the Hawaii-based Oceanic Institute, a non-profit R&D body dedicated to marine aquaculture. RGCA last month offered the first batch of 20,000 mother shrimps free of pathogens of selected diseases for sale to the hatcheries to be used by them to produce good quality vannamei seeds for fish farmers. These broodstocks have been bred at RGCAs production facility at Mangamaripeta in Visakhapatnam, which has a total annual production capacity of 45,000 mother shrimps, each costing a fraction of the imported shrimp. This project is said to have the potential of helping fish farmers to produce annually 135,000 tonnes of vannamei shrimps, valued at Rs 4,000 crore in the export market, from 10,000-hectare water-spread. Given the growing interest of the local aquaculturists in Vannamei cultivation, there is need to expand the broodstock production capacity at the Visakhapatnam centre or set up more such facilities. An expansion of Vannamei farming can, evidently, augment shrimp supplies for both export and domestic markets **(**Surinder Sud,2013)**.**

SPF - SPECIFIC PATHOGEN FREE

SPF animals are special stock of animals that are kept in specific pathogen free facilities under rigorous monitoring system, which are subjected to sensitive and accurate diagnostic methods. The animals are repeatedly bred under controlled conditions to maintain their freedom from specific pathogens and the SPF designation itself is tested on a regular basis over an extended period of time. The SPF animals are not innately resistant to the specified pathogens or infections, although they can possibly be developed as specific pathogen resistant (SPR) species. They are not produced to provide either superior genetic stock or improved culturing attributes such as faster-growth. However, these characteristics can be incorporated into SPF stock to increase their commercial value. The SPF status of stock animals is lost once the animals are removed from the designated facility even if the animals are not infected or develop any other disease symptoms. The SPF animals may be referred to as “high health” stock once they are transferred to other well-established unit with history of disease surveillance.

SPF STOCKS PREVENTED PATHOGENS

The specific list of pathogens the SPF stocks are free from varies between suppliers. Principally, those pathogens must be a significant threat to the industry and possibly to international trade. All the OIE listed pathogens are normally considered. The pathogens affecting any life cycle stage of animal should be included. These pathogens must be detectable with reliable diagnostic methods that can evaluate the animal health status. Moreover, they must be physically excluded from the animal culture facility. (Anonyms, 2008)

ADVANTAGES OF SPF

SPF animals offer an advantage to a country introducing a species for the first time as it offers some assurance that the imported animals will not introduce the listed pathogens to native species. However, SPF stocks may harbor other (non-specified) pathogens, and this should be taken into an account as it can pose a risk when the animals are under stress. With regard to shrimp culture, biosecurity systems are adopted to overcome a threat of disease outbreaks. The main concepts of biosecurity systems are to exclude pathogens and aid eradication if they occur. SPF stock is one of the major components considered in any biosecurity system, since the specific pathogen can be eliminated and contamination minimized. SPF animals are extremely useful for basic and applied science research especially to immunological studies and vaccine trials since the listed interfering pathogens can be ruled out. The SPF animals are also essential for other bioassay; for instance a study of shrimp viral diseases, where the shrimp cell line is not available, the pathogen free animals are certainly needed for bioassay study. (Anonyms, 2008)

TYPICAL RISKS ON HANDLING SPF

The major concern of SPF stock is the potential problems caused by inbreeding. SPF development is reliant on inbreeding of animals to maintain consistent production. Such a production system inevitably faces the problem of genetic deterioration. This may pose problems such as reduction in disease tolerance, growth characteristics, and other developmental abnormalities of stock animals. Lacking natural immunity could be another risk to be considered. As the SPF animals are cultured under hygienic condition with minimal contact to normal micro flora, their acquired immunity is rather low. Thus, SPF stock may not perform well under non-biosecure or outdoor open culture operations.

SPF animals are only free from tested specific pathogens, however the hidden/unknown pathogen are usually overlooked. Mutation of specific pathogens commonly occurs especially in viral diseases. This means that although the monitoring program is active, the pathogenic agent may be missed out. This hidden risk can consequently pose a threat to the health status of the animal. (Anonyms, 2008)

SPF ASSURANCE

The SPF status of the shrimps is ascertained by screening of the seven pathogens which are of industrial concern. PCR technique is employed for the detection of these pathogens. Screening is done as per the OIE manual (OIE., 2003). WSSV, IHHNV, NHPB, YHV/GAV, IMNV and TSV pathogens are detected by OIE certified kit IQ 2000 Detection and Prevention System (supplied by Farming IntelliGene Tech. Corp, Thailand) and BP by PuRe Taq Ready-To-Go-PCR Beads (supplied by University of Arizona, USA). DNA extracts are prepared from the pleopod samples and faecal strands as suggested by the OIE recognized primer supplier. One half of the extracted DNA is stored for further confirmation test. Screening of RNA viruses is also done in the same manner. Amplifications of WSSV, IHHNV, NHPB, IMNV, TSV, YHV/GAV are performed in a UNI IQ programmed thermal cycler (PE Applied Biosystems). The PCR products are then separated in 2% agarose gel, stained in ethidium bromide and the results are then documented using gel documentation system (Remany, *et al*., 2010).

HISTORY OF *L.VANNAMEI* IN OVERSEAS

L. vannamei was an important species for Mexican inshore fishermen as well as for offshore trawlers during 20th century (Boone, 1931a). In 1973 in Florida the harvested *L. vannamei* was raised us aquaculture. During the warm El Niño years the culture of *L. vannamei* results exclusive production in Latin America, and reduced due to the disease during the cooler La Niña years. The susceptibility of *L. vannamei* to diseases includes white spot syndrome, Taura syndrome, infectious hypodermal and haematopoietic necrosis, baculoviral midgut gland necrosis and *Vibrio* infections. The break through production of *L. vannamei* overtakes *P. monodon* by the world wide to 1,116,000 t by 2004 (Boone, 1931b).

Greenpeace International includes whiteleg shrimp to the seafood red list in 2010. The Greenpeace International seafood red list is fishes list which is very high risk of being sourced from unsustainable fisheries which was sold in worldwide supermarkets. The Greenpeace reasoned as the destruction of plenty mangroves areas in several countries, for farms over-fishing of juvenile shrimp from the wild, and notably human rights violations. In 1973 first spawned this species in nauplii of Florida and shipped from Panama from a wild-caught mated female. With good pond results, unilateral ablation and sufficient nutrition innovation advances maturation in Panama in 1976 and the *L.*vannamei marketing raised in South and Central America.

Successive progress of intensive breeding and rearing techniques directs to its culture in Hawaii, mainland United States of America, and more in Central and South America by the early 1980s. After this, the commercial culture of this species in Latin America showed a quick rising trend (with continues 3-4 years at warm, wet 'el niño' years), interrupted by declination with concurrent disease outburst during the cold 'la niña' years. Instead these problems, the *L. vannamei* production rises from America – after decrease from its earlier 193 000 tones peak production in 1998 to 143 000 tones in 2000 had peaked to 270 000 tones by 2004. Asia shows outstanding growth of *L. vannamei* production.

Even if no production was stated to FAO in 1999, it reaches nearly 1 116 000 tones by 2004 and breakdown the *L. vannamei* production in China, Taiwan Province of China and Thailand, due to a number of favourable factors. Many Asian countries disinclined to advances cultivating *L. vannamei* due to aware of importing exotic diseases, hence its strains stay officially detained to experimental testing only in Cambodia, India, Malaysia, Myanmar and the Philippines. With legal restriction Thailand and Indonesia freely allowed its marketing culture, henceforth may be only SPF/SPR broodstocks imported. Meantime, most Latin American countries have strictly quarantine laws or abandoning importing foreign pathogens with new cultures (Briggs, 2006). Meanwhile *L. vannamei* main cultivator in the world wide extended its list as follows: China, Thailand, Indonesia, Brazil, Ecuador, Mexico, Venezuela, Honduras, Guatemala, Nicaragua, Belize, Viet Nam, Malaysia, Tawian P.C., Pacific Islands, Peru, Colombia, Costa Rica, Panama, El Salvador, the United States of America, India, Philippines, Cambodia, Suriname, Saint Kitts, Jamaica, Cuba, Dominican Republic, Bahamas (Briggs, 2006).

Table. 1 List of approved suppliers for import of SPF broodstock of *L. vannamei*

S.No.	Name of the suppliers	Prime center	Place	Country
1	Oceanic Institute		Waimanalo,	Hawaii, USA
2	Kona Bay Marine Resources		Kekaha,	Hawaii, USA
3	Shrimp Improvement Systems	SIS	Islamorada,	Florida, USA
4	SyAqua		Bangkok	Thailand
5	Vannamei 101 Co.Ltd		Phuket	Thailand
6	Charoen Pokphand Foods Public Co. Ltd	Shrimp Genetic Improvement Center	Bangkok	Thailand
7	Shrimp Improvement Systems Pte. Ltd	SIS	Lim Chu Kang Lane	Singapore
8	Shrimp Improvement Systems Pte. Ltd	SIS	Kailua-Kona	Hawaii, USA
9	High Health Aquaculture Inc.		Kailua-Kona	Hawaii, USA

Source: CAA – Govt. of India

REGULATION OF SPF *L. VANNAMEI* CULTURE IN INDIA.

The dynamics of Indian shrimp farming was always controlled by the enthusiasm of the enterprising farmers. Unlike other sectors of food production, shrimp farmers always went ahead of the scientific community in India and welcomed ideas and technology from foreign experts. The need of regulations in the sector was felt in the early 90's itself, and the supreme court verdict in 1996 in response to a public interest litigation (PIL) banned all forms aquaculture other than traditional farming within the coastal regulation zone (CRZ) and stipulated compulsory registration of all farms from Aquaculture Authority. Under the Environmental Protection Act, 1986 Aquaculture Authority was set up in 1997 to regulate the sector with its head quarters in Chennai. Considering the need for a stronger legislation to safeguard the interest of all the stakeholders of the coastal areas along with preservation of the fragile ecosystem, the Government of India passed the Coastal Aquaculture Authority (CAA) Act, 2005. The authority is empowered by the provisions of the Act, Rules and Guidelines to regulate coastal aquaculture and to ensure sustainable development without damaging the ecosystem (Pramod Kiran and Shyam S. Salim, 2012).

The Department of Animal Husbandry, Dairying & Fisheries (DAHD&F), Government of India, Notified there date on 15.10.2008, issued under the Livestock Importation Act, 1898, has sanctioned CAA to grant approval for importing broodstock of SPF *Litopenaeus vannamei* from selected suppliers. Rajiv Gandhi Centre for Aquaculture (RGCA) with funds from National Fisheries Development Board (NFDB) to function an aquatic quarantine unit at Neelankarai, Chennai. Costal Aquaculture Authority had performed a Standard Operating Procedures (SOP) for the Aquatic Quarantine. The managing and monitoring Technical Committee for performing Aquatic Quarantine was represented by the DAHD&F, Ministry of Agriculture, Govt. of India vide Order No.35029/13/2008 Fy. (T&E) dated 2.6.2009. On 30.4.2009 under the Coastal Aquaculture Authority (Amendment) Rules, 2009 issued Gazette Notification concerning Guidelines for controlling hatcheries and farms for introduction of *L. vannamei (*Anonyms, 2013).

The authority can make regulations regarding the construction and operation of farms within the coastal area, inspect the farms for ascertaining environmental impacts, register them, can order the demolition of polluting farms, etc. It will be the agency to fix standards in the sector with regard to inputs liks seeds, feed, additives, chemicals and drugs, etc. used in the farm in addition to ensuring protection of both ecologically and socially sensitive areas from being converted to aquafarms. According to the Act, all coastal aquaculture farms should be registered with the authority, usually for a period of 5 years. Construction of new farms within the 200m from the highest high tide limit is prohibited in the coastal regulation zone, however, farms constructed before the enactment of CAA and non-commercial research farms by the agencies of government are permitted to operate. The authority has a District Level Committee and State Level committee to verify applications for registration of the farms which are disposed in a time bound manner. Further, the authority can collect samples from the farms, analyze them, close down facilities for unsustainable practices and recommend for punishment of individuals involved (Pramod Kiran and Shyam S. Salim, 2012).

The authority issues guidelines for sustainable aquaculture practices. It has prohibited the use of 20 pharmacologically active substances and set residual levels for permitted substances. Management of waste water is another major concern and it is mandatory for farms with more than 5 ha area to install effluent treatment system and the authority has stipulations for different water quality parameters at discharge points in estuarine areas and coastal marine waters. Farms with more than 40 ha area need to conduct Environmental Impact Assessment at the planning stage and should have an Environment Monitoring and Management Plan (Pramod Kiran and Shyam S. Salim, 2012).

The key role of the facility is to ensure the SPF status of the imported broodstock, thus preventing the entry of any infected broodstock. The centre funded by the National Fisheries Development Board (NFDB), Ministry of Agriculture, operates on Standard Operating Procedures (SOP) framed by a team of technical experts. The member institutions involved in this effort include the Coastal Aquaculture Authority (CAA), the Aquatic Quarantine and Certification Services (AQ & CS, Ministry of Agriculture, Dept. of Animal Husbandry, Dairying & Fisheries), the National Fisheries Development Board (NFDB), the Central Institute of

Brackishwater for Aquaculture (CIBA, Indian Council of Agriculture and Research), the Marine Products Export Development Authority (MPEDA) and the Rajiv Gandhi Centre for Aquaculture (RGCA). All activities of the AQF are under the legal provision of Livestock importation Act, 1898 (Remany, *et al*., 2010).

BACKGROUND OF PACIFIC WHITE SHRIMP *L.VANNAMEI* CULTURE ACTIVITY DEVELOPED IN INDIA.

The Government of India (GOI) permitted pilot-scale introduction of the species in 2003 and subsequently permitted the culture of *L. vannamei* in the country in 2008 based on a risk analysis carried out by Central Institute of Brackishwater Aquaculture (CIBA) and National Bureau of Fish Genetics Resources (NBFGR) which recommended the pilot-scale introduction of *L.vannamei* culture in India *albeit* with strict regulatory guidelines. Accordingly the nodal research and development agencies have jointly evolved detailed guidelines for importing broodstock, seed production and culture of *L.vannamei* (Kumaran *et al*., 2012). White leg shrimp is an alien species and the extension officers and farmers are not familiar about its biology, seed production and culture practices. It is essential that the extension officers, field consultants and farmers are to be properly sensitised about pre-quarantine, quarantine and post-quarantine requirements for importing of broodstock and inspection, application procedures, production practices including bio-security, food safety, environmental and social responsibility aspects of *L.vannamei* culture. Sensitisation is a viable extension methodology to increase the awareness levels, inculcate the basic knowledge about a technology or innovation and encourages its application (Abdulsalam *et al.,* 2008*;* Mercy *et al*., 2008).

In India *L. vannamei* species was used as shrimp culture through the years. The sector increases in numbers of farms and hectares destined for shrimp culture with the improvement of culture-technology. There are totally 2961.33 hectares of land to date allocated for shrimp cultivation and was shared by seven state shrimp farmers for *L.vannamei* shrimp-farms in India. In agreement with the current position of the shrimp culture in India, the *L. vannamei* introduction made a essential options that make the shrimp culture survival activity possible in India. The productivity and economic concerns make advantage for the introduction of this new species.

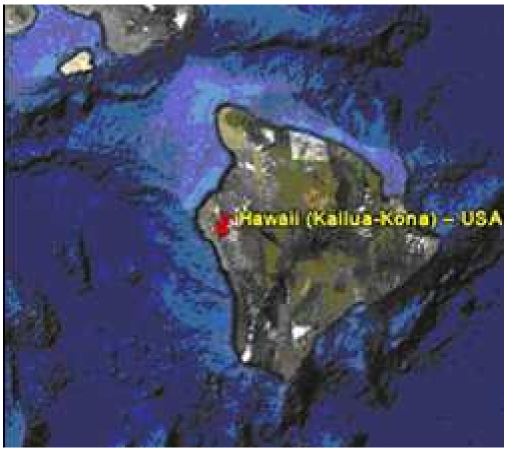
The *L. vannamei* is launched for second time in India, due to inexperience and favorable prices for *P. monodon* during the first time was tried to introduce in Andhra Pradesh during 2003. Non indigenous species (*L. vannamei*) provides with greater adaptation to Indian environmental conditions the shrimp cultivators replaced it instead of indigenous species (*P. monodon*), with the aim to improve the farms production efficiency. Hence, it makes effortless breed under conditions, but affected by the major viruses i.e., WSSV, MBV, IHHNV, YHV and TSV. Generally, penaeid shrimp can be infected by more than twenty different viruses (Haq *et al* 2012).

Henceforth, the commercial introduction must be under strict measures of sanitary and genetic conditions of foreign species, controlling the infection of new pathogens and preserving the genetic variability in originator populations. According to the Marine Products Export Development Authority (MPEDA), a government trade promotion body opined that illegal vannamei farming will be posed the threat of introducing new shrimp diseases to shrimp farms in the state of Andhra Pradesh, India. Leena Nair, Chairman of MPEDA said farmers were illegally breeding vannamei and distributing them across Andhra Pradesh Since seacaught shrimp are not tested for antibiotics, exporters were passing them (*L. vannamei*) off as sea caught shrimp (Rachel Mutter, 2011).

MAJOR IMPORTED COUNTRY OF *L. VANNAMEI*

Shrimp aquaculture productivity and the sustainability are, however, permanently making trouble all around the world by the epizootics of endemic and foreign origin. The annual losses by diseases infection on shrimp production world was estimated about 3,000 million dollars per annum, but the productivity is approximately 3,700 million dollars per annum (Lundin, pers.comm.). Most often, shrimp production affected by diseases as endemics, because the presence of pathogens in continuously cultivating shrimp hatcheries and farms reservoirs. After the introduction of infected animals into hatcheries or farms the disease may affect as outburst. Throughout the continuous supply of shrimps pathogens preserve and also the pathogenicity increases through the genetic changes such us as mutation, transduction, transposition or transformation.

Development of intensive breeding and rearing techniques led to *vannamei* culture in Hawaii, mainland United States of America, and much of Central and South America by the early 1980s. There after the commercial culture of this species in Latin America showed a rapidly increasing trend (FAO, 2006). However, many Asian countries were reluctant to promote farming of *L. vannamei* due to fears over importation of exotic diseases which may come along with the brood stock and now Asia became the top producer of L.*vannamei* among the world (Yarrakula Mahesh Babu, 2013). While nearly 20 native species of penaeid shrimp in South Pacific and Hawaii islands since 1972, nine foreign species also introduced, initially into Tahiti and New Caledonia which includes *P. monodon, P. merguiensis, P. stylirostris* and *L. vannamei* (since 1972), *Metapenaeus ensis*, *P. aztecus, P. japonicus* and *P. semisulcatus* (since 1973) and *P. indicus* (in 1981) (Eldridge, 1995; Briggs, 2005). With it, *P. stylirostris* was launched in French Polynesia (from Mexico and Panama) in 1978, from Hawaii to Fiji in the mid 1990s launched *P. stylirostris* and in 2002 *P. vannamei* was introduced (Ben Ponia, per. com.). Peru had imported the brood stock of L. *vannamei* from Mexico in the year of 1970 then among the Asian countries China had imported the broodstock from the Texas in the year of 1988 and all the way India imported the bloodstock from the Hawai in the year of 2001(Matthew *et al* , 2004)



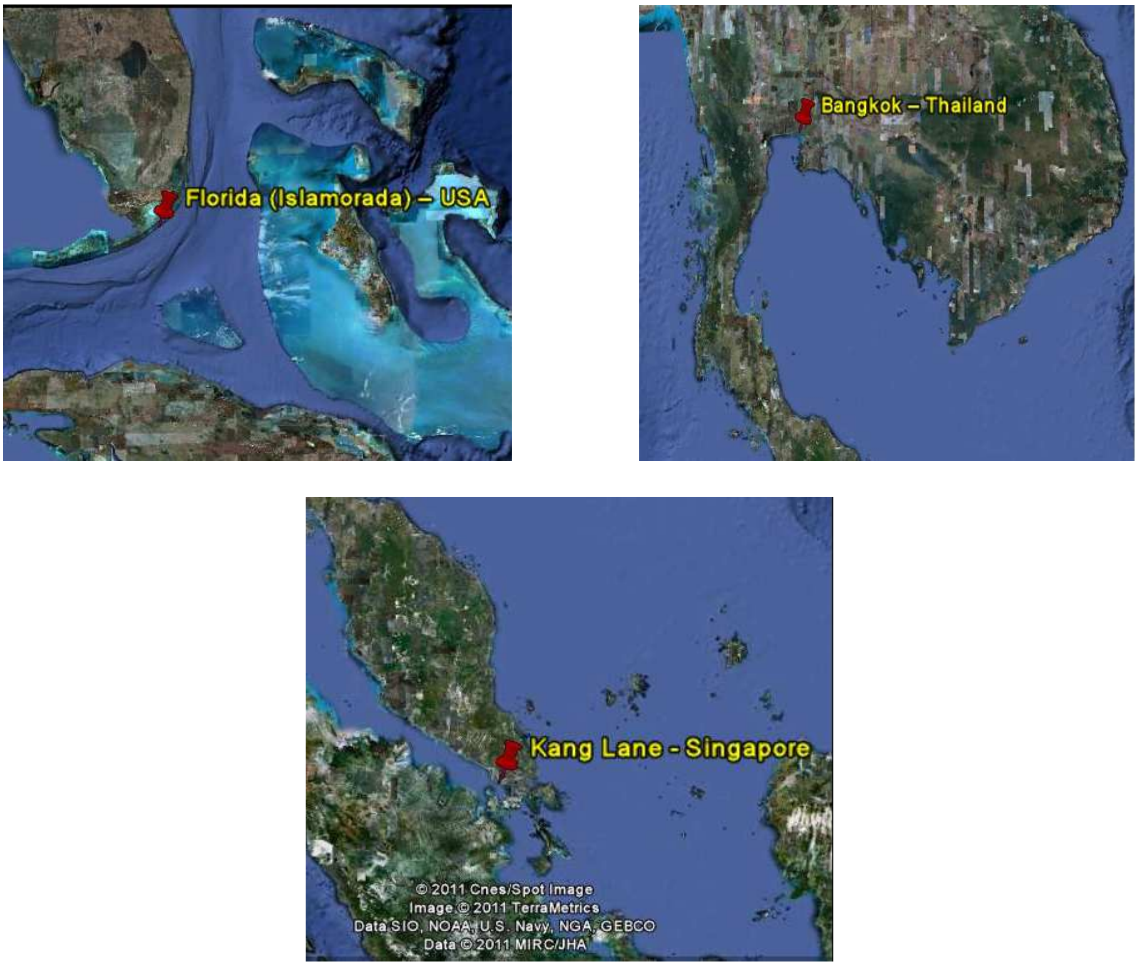


Figure 1 *L. vannamei* imported areas : Hawaii Islands (Kallua-Kona) USA, Florida (Islamorada) USA, Thailand and Singapore.

About 3,500 kilometers from North America Hawaiian Islands is located. These are world's most remote islands. Hawaii was specialized for biosecure broodstock development because of succeeding trade winds and strong ocean current. This Broodstock lines growth mingled with Hawaii's Oceanic Institution over twenty years. The manufacturing services are at Waimanalo and Kailua-Kona islands located separately distance from development of any kind. This makes us to produce fast growth broodstock and SPR broodstock in low densities resulting natural productivity which includes highly productive growth and reproductive characteristics.

In 1998 Islamorada, Florida (USA) Shrimp Improvement System (SIS) was introduced. This company performs the commercial genetic improvement program for Specific Pathogen Free (SPF) stocks of *L. Vannamei* with established techniques of selective breeding used widely in other agribusinesses. SIS is located in Florida, Singapore and Hawaii. In US market Thailand is the largest shrimp importer. The 2008 Thai DOF reports over 464,000 mt of white shrimp (*L. vannamei*) and 1,900 mt of tiger shrimp (*P. monodon*) production from nearly 25,000 active farms (DOF pers. comm., April 20, 2009). It was mostly exported to US also to Japan and the European Union. Thailand extends of 514,000 km^2 (United Nations 2009) in SE Asia.

It surrounds with Myanmar at west, Laos People's Democratic Republic at north and Cambodia at east and Malaysia at south. Thailand coastline covers 2,420 kilometers along the Gulf of Thailand

and the Andaman Sea (Indian Ocean). Its 76 provinces include North, Northeastern (Isaan), Central and South (Malay Peninsula). The capital city of each province has same name. The Central region has the Bangkok Metropolitan Region, includes the large basin of the Chao Phraya River flows north-south along Bangkok into the Bay of Bangkok, a northernmost Gulf of Thailand water body. SyAqua Broodstock lines are esteemed by world's leading broodstock suppliers. They are basically obtained from indigenous *L. vannamei*, Hawaii stock (1983) and Native Litopenaeus vannamei, Venezuela/Mexico stock (1984).

MAJOR GROUNDS OF *L.VANNAMEI* CULTURE IN INDIA*:*

India has vast natural resources suitable for the development of aquaculture in the marine, brackish water and freshwater environments. A long coast line 8118 km along with 3.5 million ha of estuaries and 3.9 million ha of backwaters, our potential for the development is immense. It is estimated that an area of 1.2 million ha are suitable for the development of brackish water aquaculture and by prolonged performance yields optimally qualified shrimps and profitable fin and shell fish species. A major share of this potential area lies in the states of West Bengal (34 per cent) and Gujarat (32 per cent) where they greatly remain under utilized. Andhra Pradesh has been leading the country with its enterprising farmers both in utilization (50 per cent) of the potential land and in quantity produced. The latest estimates places the total brackish water area developed for aquaculture at 1, 90,000 ha with a national average of 16 per cent.

Coastal aquaculture production areas for fish forming brackish water, largely in shrimp cultivation covers approximately 1.23 million ha, which indicates that nowadays about 10% area are in cultivation. In this 80% undergoes traditional farming Systems and remaining for extensive and semi extensive shrimp farming. The shrimp cultivation under business scene was established in Tamil Nadu and Andhra Pradesh coastal Waters. During 2001 and 2002, both Scampi culture and *P. monodon* culture had been come down due to severe disease outbreak in Andhra Pradesh. At that time Sharath industries and BMR in Nellore, Andhr Pradesh, India, applied to Ministry of Agriculture, GOI for introducing *L. vannamei* into the India on the year of 2002. Sharath industries and BMR got permission for *L. vannamei* into the India during 2002 (Yarrakula Mahesh Babu., *et al*., 2013). Sharath industries and BMR got permission for *L. vannamei* culture in the terms of pilot project in the year 2003. They can import brood stock and produce seed and culture only in their own farm andthey should not sell the seed to the farmers. Sharath and BMR industries started this venture in 50 acres each on experimental basis with 50 no./m2 stocking density in 2003. During the first crop, harvest size was 20 g, survival rate was 90% and their FCR was 1.5 (Aslam and Yamuna, 2011). The Government of India (GOI) permitted pilot-scale introduction of the species in 2003 and subsequently permitted the culture of *L. vannamei* in the country in 2008 based on a risk analysis carried out by Central Institute of Brackishwater Aquaculture (CIBA) and National Bureau of Fish Genetics Resources (NBFGR) which recommended the pilot-scale introduction of *L.vannamei* culture in India albeit with strict regulatory guidelines. Accordingly the nodal research and development agencies have jointly evolved detailed guidelines for importing broodstock, seed production and culture of *L.vannamei* (Kumaran, *et al*., 2012).

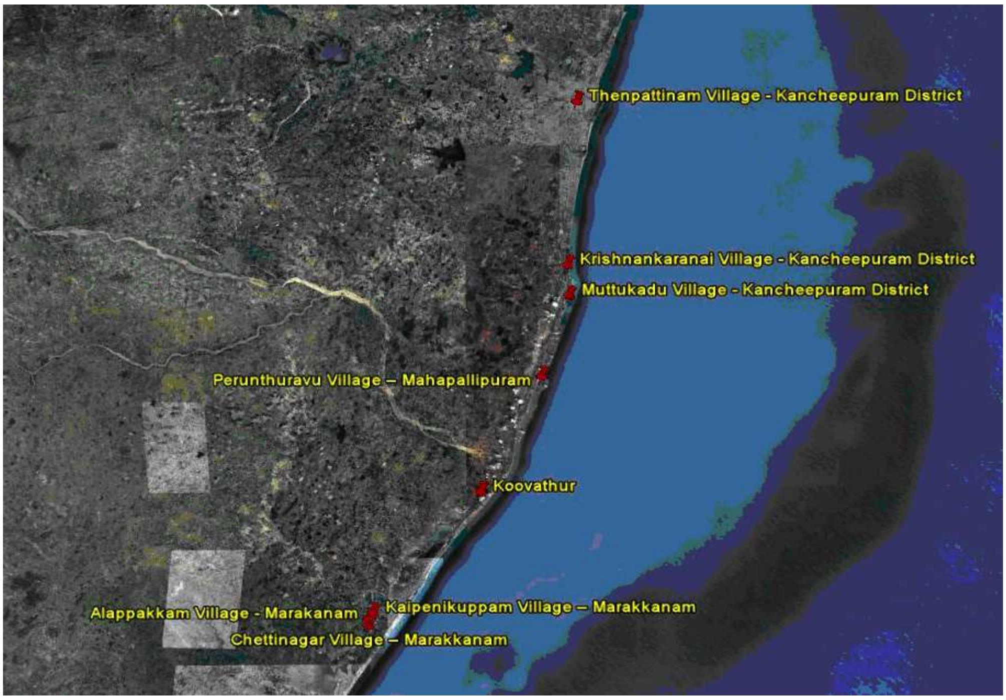


Figure 2 Locality of selected *L.vannamei* hatchery in Tamil Nadu

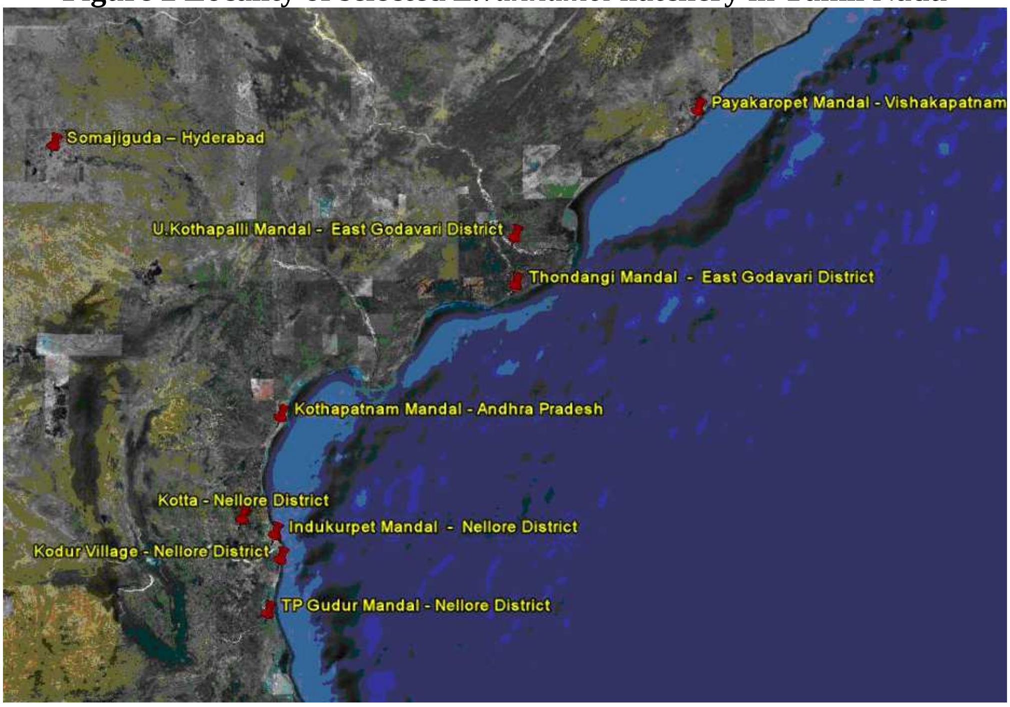


Figure 3 Locality of selected *L.vannamei* hatchery in Andhra Pradesh

Importation of Specific Pathogen Free (SPF) animals to a country provides some assurance that the imported animals will not introduce the listed pathogens to native species and it mitigates the risk associated with the movement of the exotic species. The import of SPF stocks of *L. vannamei*, is an initiative by the Government of India to provide shrimp growers and hatcheries with broodstock of known health status with regard to certain pathogens (Remany, *et al*., 2010**)**. The initiative was an offshoot of the stagnant shrimp production due to exclusive *P. monodon* culture and its associated disease problems in India. The production, predominantly black tiger prawn (*P. monodon*), has declined from 106,165 tonne in 2007-08 to 75,996 tonne in 2008-09, a fall of 28.41 per cent (Anonymous, 2009).

In India 175 shrimp hatcheries are located, 60 are located in and around Kakinada. Kakinada, a coastal city in the state of Andhra Pradesh is the centre of the shrimp hatchery industry in India (John, 2012). The newly imported candidate species of SPF *L.vannamei* infected with WSSV had been investigated in Tamil Nadu costal water was recorded by Haq *et al*., (2012a; 2012b). The following sampling areas (fig.4) are selected for the species identification was made by screenings of the WSSV infestation were made by advance molecular techniques from the culture animals.

Andhra Pradesh ranks first in aquaculture and fresh water marine aquaculture. It ranks second in fresh water fish production and overall value of fish/prawn production. Andra Pradesh contributes nearly 40 per cent of the total marine export of the country. Inland resources comprise 102 reservoirs of which 7 are large, 26 are medium and 69 are small reservoirs. There are two lakes – Kolleru Lake, a fresh water lake and Pulicat lake – a brakish water lake. 74,000 perennial, seasonal and long seasonal tanks, fish ponds and fresh water ponds for aquaculture also present in Andhra Pradesh. Brackish water resources comprise 0.78 lakh hectars for shrimp culture, a costal line of 972 Kms and 508 fishing villages. In Andhra Pradesh coastal zone has been demarcated wit CRZ development maps. The regulation and the enforcement are being over seen by the Shore Area Development Authority (SADA). The following sampling areas (fig. 5) are selected for the species identification is made by barcoding and screenings of WSSV infestation were made by advance molecular techniques from the culture animals.

White leg shrimp is an alien species and the extension officers and farmers are not familiar about its biology, seed production and culture practices. It is essential that the extension officers, field consultants and farmers are to be properly sensitised about pre-quarantine, quarantine and post-quarantine requirements for importing of broodstock and inspection, application procedures, production practices including bio-security, food safety, environmental and social responsibility aspects of *L.vannamei* culture. Sensitisation is a viable extension methodology to increase the awareness levels, inculcate the basic knowledge about a technology or innovation and encourages its application (Abdul salam *et al.*, 2008*;* Mercy *et al*., 2008).

PROBLEMS AND PROCESS OF *L. VANNAMEI* IN INDIA

Shrimp aquaculture expanded significantly during the 1980s and now represents a multi-billion dollar a year industry. In 2002, the global shrimp farming industry produced an estimated 1.6 million metric tons of shrimp, and production is projected to increase at a rate of 12-15% per year over the next several years (Rosenberry, 2000). Although farmed shrimp now represent about 50% of the global penaeid shrimp supply, farmers have suffered significant economic losses over the last decade, largely from viral diseases that have plagued the industry. In Asia, mortalities of cultured shrimp due to White Spot Syndrome Virus (WSSV) and Yellow Head Virus (YHV) have resulted in significant economic losses (Flegel and Alday-Sanz, 1998), and Taura Syndrome Virus (TSV) is now spreading throughout Asia, so this should be considered as serious issue in our country. Similarly, in the Western Hemisphere, both WSSV and TSV have caused catastrophic losses on shrimp farms (Lightner, 2003). In Ecuador alone, WSSV was responsible for an estimated 53% decline in shrimp production from 1998 to 2000, resulting in a loss of export revenue in excess of $516 million (Rosenberry, 2000). Over the last couple of decades, several diseases (e.g. luminous vibriosis, white spot syndrome, yellow head disease, Taura syndrome) have caused significant devastation in the shrimp aquaculture.

In India, even initially the government authorities issued permittable license of hatchery and grow out farm operation of *L. vannamei*, recently of about last two years, most of farms in TN and AP were developing their own *L. vannamei* broodstock from grow out ponds and producing seeds of *L. vannamei*. These seeds are sold out as SPF *L. vannamei* post larva to the shrimp farmers of TN and AP. Some of shrimp farmers were cultured native species *P. monodon* along with non-alien species of SPF *L. vannamei* in same premises, without following MPEDA and CAA regulations. This type of illegal and neighboring culture of native and non-alien species were transmitted WSSV to the *L.vannamei* and similarly RNA based viruses like YHV, GAV, TSV, MoV and IMNV were infected *P. monodon* though non-alien species.

In general, *L. vannamei* species is not easily infected DNA based viruses of WSSV, IHHNV and MBV. This cultivation makes outbreak of novel and existing viruses to the non-native species. This is major sources of RNA viruses, especially, YHV, TSV and IMNV were introduced in Indian aquaculture industries (UGC major research project data – un-published). The formers cultivate breeding of post larva *L.vannamei* illegally in areas like Marakkanam, Visakhapatnam, Kakinada, Ongole, Gudur, Kotta they were analyzed only DNA based WSSV and MBV viruses and supplying to market as SPF *L.vannamei.* Most of shrimp farmers not analyses other major viruses like HPV, IHHNV, YHV, GAV, TSV, IMNV, MoV viruses, because of lack of novel virus identification knowledge and commercial Indian manufacture kit or their primer availability of viruses, especially, RNA based viruses identification. This make elevated out break and mass mortality were occurred especially in TN - Sirkali, Paravai, Pattukottai ,Marakkanamand AP - Ongole, Gudur and Kotta. (Personal Communication). A high frequency of WSSV by RT PCR in both the brood stocks from Tamil Nadu and Andhra Pradesh.

The WSSV prevalence was also reported to be quite high in other SPF *L. vannamei* animal in native species *P. monodon* through water contamination, collected in nearby *P. monodon* shrimp farms. Furthermore, a pilot studies of *L.vannamei* from WSSV impact areas of Tamil Nadu coastal waters. These results indicated that wild broodstock and native culture shrimp *P. monodon* obtained from natural Indian waters may be infected with WSSV and bring it into the SPF *L. vannamei* farming environment. RT PCR method of detection is potential and will have widespread application in aquaculture. There is an urgent need to address and develop molecular based viral genome technique to save the aquaculture environments (Sedhuraman, *et al*., 2014).

Controlled introduction of vannamei to India in selected farms yielded impressive yields and attractive production costs (unpublished information), giving farmers a free choice on which species to culture. In the year 2010 the production was estimated at 20,000 tons mostly contributed from Andhra Pradesh. The production is expected to reach upto 40,000 tons in 2011. Short listing of more SPF vannamei suppliers based on the genetic programme and status of the SPF facility and permit to more number of hatcheries based on strict biosecurity would help more shrimp farmers to switch to vannamei culture to augment their income (Remany, *et al*., 2010).

CONCLUSION

L.vannamei as a non-native Specific Pathogen Free (SPF) shrimp it should be maintained as pathogen free measures us it had. The illegal activates made on it should be eradicated to control the outbreak of pathogens and thus the formers should have their own yielding's with their satisfied faces. The illegal cultivation should be controlled by sanitizing with precaution measurement like, farmers co-operation, amendment of MPEDA, EIA and CAA government regulations. Also the biosecurity and HACCP system should be improved and regularized. The illiterate farmer should be instructed by awaking the pathogenicity of novel viral diseases and economical declination cause due to those viral infections. The novel viral identification techniques with its primer development have to be developed in farmer sectors. This information's had also made sense to our innovation and findings of India to produce Specific Pathogen Free (SPF) shrimp of our own native shrimp species for Indian economic growth development.

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