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International Journal of Current Research
Vol. 5, Issue, 08, pp.2118-2122, August, 2013

INTERNATIONAL JOURNAL OF CURRENT RESEARCH

ISSN: 0975-833X

RESEARCH ARTICLE

AN OVERVIEW ON LITOPENAEUS VANNAMEIFARMINGPRACTICES IN INDIA, CURRENT ISSUES, PROBLEMS AND FUTURE PERSPECTIVES

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ARTICLE INFO

Article History:
Received 19th May, 2013
Received in revised form
25th June, 2013
Accepted 28th July, 2013
Published online 23rd August, 2013

Key words:
L. vannamei,
Production,
Current issues,
Prevention measures,
Sustainability.

ABSTRACT

Litopenaeusvannamei(Pacific Ocean shrimp) is the exotic species, imported from Taiwanto India for experimental purpose. *L. vannamei*hasso many advantages than the tiger shrimp (*Penaeusmonodon*), so The Government of India (GOI) permitted pilot-scaleintroduction of the species in 2003 and subsequentlypermitted the culture of *L. vannamei* in the country in 2008based on a risk analysis carried out by Central Institute ofBrackishwater Aquaculture (CIBA) and National Bureauof Fish Genetic Resources (NBFGR) which recommendedthe pilot-scale introduction of *L.vannamei* culture in Indiawith strict regulatory guidelines (kumaran et al, 2012). Present production of vannamei is too high when compare to last two decades. Scientistsare expecting so many problems such as, diseases, unsustainability etc. All problems can overcome by importing of Specific Pathogen Free (SPF), Specific Pathogen Resistant (SPR) brood stocks from other countries, implementing biosecurity factors and practicing of Better Management Practices (BMP) in field level, will maintain the environmental sustainability.

INTRODUCTION

L. vannamei was native species of Latin America, the first spawning of this species was achieved in Florida in 1973 from nauplii spawned and shipped from a wild-caught mated female from Panama. Following good pond results and the discovery of unilateral ablation to promote maturation in Panama in 1976, commercial culture of *L.vannamei* began in South and Central America (FAO, 2006). In the year of 2001 *L. vannamei*was introduced into India for experimental purpose from Taiwan and not for commercial farming. White Spot Syndrome Virus (WSSV), Monodon Baculo Virus (MBV), Runt Deformity Syndrome (RDS) and Infectious Hypodermal Hematopoietic Necrosis Virus (IHHNV) and recently Early Mortality Syndrome (EMS) have been reported by Lightner, et al., 2012 in *L. vannamei*. These are the diseases mostly causes economic loss in shrimp farming. There are not only disease problems in India but also production cost, which includes price hikes in fish meal leads to increasing in the commercial feed cost, uncertainty in international market price less demand in local market because of its price, lack of quality seed and its high price, production cost of fuel, more chemicals usage, poor environmental management, market coordination, public relation management, illegal farming, irregular electric supply, etc. are facing by the farmers. Wide spread of diseases from one place to another place should be controlled by following strict quarantine measures to make sure the restriction of pathogens entry. Sustainable farming can be achieved only through implementation of Better Management Practices (BMP) and biosecurity protocols in field level and it can give the good production of *L. vannamei.*

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At present *L. vannamei*farming industry is inboom and its culture has somany advantages when compare to former major cultivable species (*P. monodon*) in India. Because of its raising demand in the international market all farmers are shifting from *P. monodon*to*L. vannamei.*Because of its high stocking densities and less prone to crowding stress, farmers are stocking the PL at very high rate,which leads to unsustainability. *L. vannamei*farming practicesin India and its overview, brief history, importation, major problems at field level, future perspectivesand recommendationsfor sustainable *L. vannamei* culture in India are included in this paper.

Brief history on Introduction of *L. vannamei* into India

Development of intensive breeding and rearing techniques led to *L. 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. 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) mainly for the experimental purpose and the details were presented in the table.1. 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, Andhra Pradesh, India, applied to Ministry of Agriculture, GOI for introducing *L. vannamei* into the India (2002). 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./m^2 stocking density in 2003. During the first crop, harvest size was 20 g, survival rate was 90% and their FCR was 1.5 (Aslamand Yamuna, 2011).

Table 1. Importation of *L. vannamei*to India

Importer	Year of import	Exporter
Peru	1970	Mexico
China	1988	Texas
Taiwan	1995	Hawai
Philippines	1997	Taiwan
Thailand	1998	Taiwan
Vietnam	2000	China
Indonesia	2001	Hawai
Malaysia	2001	Taiwan
India	2001	Taiwan

Source: Matthew et al, 2004

Production of *L. vannamei* in India

*L. vannamei*production of about 18247 MT from 2,930hectares 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). Andhra Pradesh led the table with a total production of 75385 MT and a productivity of 10.58 MT/ha/year, Gujarat lead in terms of productivity, with a production of 1195 MT and a productivity of 13.59 MT/ha/year. Remaining details were furnished in the Table 2.

Table 2. State wise details of *L. vannamei* farming in India 2011-12

S.No.	State	Area (ha)	Production (MT)	Productivity (MT/ha/Year)
1	Odisha	25	100	4.08
2	Andhra	7128	75385	10.58
3	Tamil Nadu	397	2863	7.21
4	Karnataka	72	232	3.21
5	Maharashtra	127	941	7.41
6	Gujarat	88	1195	13.59
	Total	7837	80717	10.30

Source: SEAI, 2013

Switching over to *L.vannamei*

There are so many reasons for introduction of *L. vannamei* into India. It has somany advantages when compare to former leading shrimp species, *P. monodon*.Some of the advantages enlisted in the following Table 3.

Table 3. Performance of *L. vannamei* over *P. monodon*

Sl. No.	Characteristics	*P. monodon*	*L. vannamei*
1.	Stocking (m^2)	40-50	60-150
2.	Crop duration (days)	110-140	105-120
3.	Harvest size (gm)	22-28	21-25
4.	Yield/ha (MT)	8	24
5.	Profit/ha	$13,000	$36,000
6.	Maximum length (mm)	363	230
7.	Hatchery survival (%)	20-30	50-60
8.	Protein requirement (%)	36-42	20-35
9.	Growth rate (gm/week)	1	1-1.5*
10.	FCR	1.6:1	1.2:1
11.	Meat yield (%)	62	66-68

*growth rate will decrease after reaching 20gm body weight.

Even though *L. vannamei* has the above said advantages the following factors may be seriously considered before allowing its commercial farming (Aslam and Yamuna, 2011).

1. A comprehensive risk analysis study by every competent agency should be carried out throughout our country from the very beginning.
2. A central quarantine facility with a large scale capacity is to be established to monitor all incoming *L.vannamei*brood stock from any or every source outside the country.
3. Only SPF certified brood stocks should be allowed in to the country only from approved and reputed suppliers.
4. A very few number of bio-secure hatcheries under strict selection procedures, should be selected as multiplication centres in order to produce SPF brood stock only.
5. Hatcheries only with complete bio-security facilities should be licenced to operate at different coastal states to produce *L.vannamei* shrimp seed.
6. For the first year of *L.vannamei* culture, only afew approved farms in different states should be selected. The selection of such farms depending on strict technical criteria should be done in consultation with the state fisheries department, regional MPEDA offices and respective farmers associations.
7. Continuous monitoring of such *L.vannamei* shrimp culture or SPF brood stocks production facilities should be carried out throughout the first culture period by a national level committee.
8. All the above effects/ activities should be completely reviewed after one crop in order to study its viability and risk potentials.
9. If the review supports *L.vannamei*shrimp culture in our country, then only it should be fully allowed to percolate down to small and medium farmers in all culture zones.
10. Then a set of suitable guidelines can be established for *L.vannamei* shrimp culture in any country, which intends to allow its forming.

Current Issues and problems in *L. vannamei*farming in India

- Limited quarantine facilities
- Diseases
- Production cost towards feed
- Demand and price fluctuations
- Seed stock quality and availability
- Feed quality and availability
- Production cost of fuel
- Banned chemicals and antibiotics used
- Environmental impact and management
- Illegal farming
- Others

Limited quarantine facilities

All *L. vannamei* broodstock must be held in quarantine and checked for diseases by the Ministry of Agriculture before it can be released to the hatcheries. The Rajiv Gandhi Centre for Aquaculture in Chennai operates the quarantine facilities, but it has limited resources to conduct tests on imported broodstock. Consequently, hatcheries can only meet 30% of the demand for *L. vannamei* seedstock. Though there are plans to open a couple of new quarantine centers, they have been slow to get up and running. LakkarajuSatyanarain, president of the All-India Shrimp Hatcheries Association, said "Non-availability of seed is forcing aqua farmers to buy the shrimp locally, which is posing a challenge of virus." Lack of testing facilities for *L.vannamei*poserisk to India's expanded shrimp production.

Diseases

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, 2003). 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, yellowhead disease, Taura syndrome) have caused significant devastation in the shrimp aquaculture.

Virus	Year of Emergence to 2001	Estimated loss
WSSV - Asia	1992	$4 – 6 billion
WSSV - Americas	1999	> $1 billion
TSV	1991 – 1992	$1 – 2 billion
YHV	1991	$0.1 – 0.5 billion
IHHNV*	1981	$0.5 – 1.0 billion

Table 4 Estimated economic losses (in US$) since the emergence of certain viral pathogens in penaeid shrimp aquaculture (Lightner, 2003), *Includes Gulf of California fishery losses for 1989 – 1994. The following diseases were reported in the India and the world, which need to be considered as serious issue to maintain the sustainability.

Table 5. Diseases reported in *L.vannamei*in India and the world

S.No.	Diseases	*L.vannamei*	Reported in India
1	TauraSyndrome (TS)	√	×
2	White Spot Disease (WSD)	√	√
3	YellowHead Disease (YHD)	√	×
4	Tetrahedral baculovirosis (BP)	√	?
5	Spherical baculovirosis (MBV)	×	√
6	Infectious Hypodermal And Haematopoitic Necrosis (IHHN)	√	?
7	Lymphoid organ vacuolization virus	√	×
8	Reo like viruses	√	×
9	Necrotising hepatopancreatitis (NHP)	√	×

Besides the above mentioned diseases, Early Mortality Syndrome (EMS)/Acute Hepatopancreatic Necrosis Syndrome (AHPNS) are can be an emerging threat in the Asian Shrimp industry (Geoff, 2012). Recently, a new/emerging disease known as Early Mortality Syndrome (EMS) in shrimp (also termed Acute Hepatopancreatic Necrosis Syndrome or AHPNS) has been reported to cause significant losses among shrimp farmers in China (2009), Vietnam (2010) and Malaysia (2011), it was also reported to affect shrimp in the eastern Gulf of Thailand (Flegel, 2012). The disease affects both *P. monodon* and *L. vannamei* and is characterized by mass mortalities (reaching up to 100% in some cases) during the first 20-30 days of culture (post-stocking in grow-out ponds). Lightner et al., (2012) described the pathological and etiological details of this disease. Similar histopathological results were obtained by Prachumwat et al., (2012) on Thai samples of *L. vannamei* collected from Chantaburi and Rayong provinces.

Production cost towards feed

Since the third week of April 2012, the price of shrimp feed has increased by a couple of cents a pound. Shrimp feed prices currently range between $1.20 and $1.52 a kilogram (Arief Fachrudin., 2012.). Cost of shrimp feed was slightly increased because of raw material and fish meal price hikes.

Demand and price fluctuations

The major market for shrimp is the United States of America, which was expected to import approximately 477, 000 tonnes worth USD 3.1 billion in 2005, 1.8 times more than the 264,000 tonnes imported in 2000. However, the rapidly increasing production of *L. vannamei* has led to serious price depression in the international markets. Similarly, farm gate value for 15–20 g size white leg shrimp has steadily decreased from USD 5/kg in 2000 to about USD 3.0–3.5/kg in 2005 (FAO,2006). Continuous price fluctuations due to depreciation of rupee value in the international market and less buying capacity of the local buyers in India, the shrimp farmers are not getting proper profit.

Recent data price declining

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. However, 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. Recent prices decline of 40 count *L. vannamei* being traded at < Rs.190 per Kg, the shrimp farmers are under severe stress physically and financially. Shrimp prices are normally low during June and July for the last couple of years, a recurring phenomenon difficult to explain logically. Many *L. vannamei* farmers (especially in Andhra) are of the opinion that either they should harvest (irrespective of counts) by 2nd week of May (during normal price) or to stock early to reach desired count by 15th May. The depreciation of Rupee, its impact on commerce and Industry is of great concern and Aquaculture (shrimp farming in particular) is not an exception. The input cost (feed & fuel) is shooting up on side and the market pricing is sliding on the other side.

Seed stock quality and availability

Shrimp hatcheries in India

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). Most of them supply *L.vannamei* seedstock, but a dearth of testing facilities to determine the disease status of imported shrimp bloodstock makes it impossible for the hatchery industry to meet the demand for post-larvae.

Enhancement of vannamei stock

Keeping in view of overwhelming response for vannamei culture, the government agencies are now gearing up to initiate action towards adequate supply of brood/seed. Rajiv Gandhi Centre for Aquaculture (RGCA) has released the tender for the expansion work of Aquatic Quarantine facility at Chennai. An additional 6 cubicles will be constructed and the facilities are expected to be ready by the end of this year.

Feed quality and availability

Feed quality and availability also a major problem in India, good quality feed is of more costly, so the cost of input will be increased, even though the farmers are ready to pay if the market price of *L. vannamei* is high. But there is lack of assured and fixed market price, so farmers are not willing to purchase high quality feed and some of them are preparing their own feed , which should not be practiced according to biosecurity protocols and if so it can cause somany disease problems in shrimp farming.

Importance of fuel

Because of irregular electrical supply, the usage of fuel has been increased,which is very necessary to run the aerators for maintaining the oxygen levels especially in *L. vannamei* farming. It causes more stress on the shrimp farmers towards production cost and leads to environmental uncertainty because greenhouse gases will be emitted from the generators.

Use of Banned chemicals and antibiotics

Using thebanned Antibiotics in shrimp aquaculture is a major concern. The final yield which consist any banned antibiotic residues will not be exported and the farmer who has used the antibiotics will face so many problems. The following are some of the actions, which were taken as serious concern towards the antibiotic residues in the final produce.

- Rejection of shrimps
- Farmers cannot sell their produce to exporters there by incurring huge loss.
- EU making further stringent measures for cross examination for the testing of antibiotics.

Environmental impact and management

Poor water quality is major stress to all aquatic animals including shrimp. Stress increases the susceptibility of the animals to the disease while decreasing their growth rate and feed conversion efficiency. It is much easier to prevent diseases than curing them after disease has been attacked. Disinfectants may help avoid some diseases, but they treat only symptoms and not the cause of disease problems. The Bacta-pur is ECOPROBIOTIC it can help improve the water quality, reduce the stress to the animals, improve the growth, feed conversion and reduce the need for expences of drugs.The Table 6 given here can show the amount of water used to produce one kilogram of whole shrimp in commercial shrimp farms that culture shrimp under intensive conditions and rely on reduced or zero-water exchange.

- Impact on the water courses in the vicinity
- Impact on ground water quality
- Impact on drinking water sources
- Impact on agricultural activity
- Impact on soil and soil salinisation
- Waste water treatment
- Green belt development (as per specifications of the local authorities)

Illegal Farming of Penaeusvannamei India

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. LeenaNair, Chairman of MPEDA said farmers were illegally breeding vannamei and distributing them across Andhra Pradesh Since sea-caught shrimp are not tested for antibiotics, exporters were passing them (*L. vannamei*) off as sea caught shrimp (Rachel Mutter, 2011).

The following are some of the highest priority recommendations for *L. vannamei* culture

- Continued development of SPR lines of *L. vannamei* for viruses including TSV, WSSV, IHHNV, BMNV and IMNV.
- Development of faster growing lines of SPF/SPR stocks.
- Continued development of biosecurity, high density and low salinity culture systems.
- Vaccination and other effective treatments for shrimp viruses.
- Replacement of non-eco friendly and costly marine meals in shrimp feeds.

Table 6.

Species	Water Exchange (%/Day)	Stocking Density (m^2) (Shrimp/m^2)	Water Use (L/kg shrimp)	Reference
L. vannamei	0	63-121	2,000	Fast&Menasveta (2000)
L. vannamei	< 0.5	100	483	Moss et al. (2002)
L. vannamei	< 0.5	200	370	Moss et al. (2002)
L. vannamei	< 0.5	300	352	Moss et al. (2002)

Effluent Treatment System (ETS)

Effluent Treatment System (ETS) is mandatory for farms above 5 ha. The pond area earmarked for the ETS may be used for secondary aquaculture, particularly for culture of mussels, oysters, seaweed, other fin fishes, etc. Such integrated culture projects would help improving the waste water quality, reducing the organic and nutrient loads and producing an additional cash crop.

Environment Impact Assessment (EIA)

- An Environment Impact Assessment (EIA) should be made even at the planning stage by all the aquaculture units above 40 ha size.
- For 10 ha and above a statement will be required to be given in the detailed plans. The District/ State Level Committees set up by the Coastal Aquaculture Authority (CAA) should ensure that such an EIA has been carried out by the aquaculture units before their proposal is recommended to the CAA for approval.

Environment Monitoring Plan and Environment Management Plan (EMMP)

The shrimp culture units with a net water area of 40 ha or more shall incorporate an Environment Monitoring Plan and Environment Management Plan (EMMP) covering the areas mentioned below:

- Efficient water treatment and management systems for closed culture systems.
- Techniques for reducing bacterial loads in shrimp culture systems.
- Effective disinfection procedures for eggs, nauplii and PL in hatcheries.
- Effective replacements (i.e. probiotics and immunostimulants) for antibiotics.

Future perspectivesin*L. vannamei* farming

Vaccines

Primary immune response of shrimp to disease appears to be innate and soconventional vaccines are not possible, so more research and development is required in this area.

Probiotics and therapeutics

Antibiotics are ineffective against viruses; probiotics appear to have some beneficial effects, at least under experimental conditions. New generation therapeutics may be useful for treatment of broodstock or as feed additives.

Selection for disease-resistance

Selection of WSSV-resistant lines not possible to date, but somehow other diseases like TSV which is the latest disease outbreak and TSV-

resistant lines of*L. vannamei*produced successfully BUT susceptible to new strains of TSV that have emerged.

Transgenic shrimp

- More durable resistance possible through transgenic strategies
- TSV resistant transgenic *L. vannamei*generated by expressing anti-sense
- RNA to the coat protein gene (Lu and Sun, 2005) has been developed.
- Transgenic *L. vannamei*expressing an anti-microbial peptide (cecropin) have been generated.
- Shrimp expressing hairpin RNA against viral genes are very likely to be resistant
- Serious issues to be addressed with respect to impacts on shrimp, the environment and human health.

Key principles for *L.vannamei* health management:

1. Pathogen exclusion practices

Manage seed selection and the pond environment to ensure stock are free of pathogenic viruses

2. Stress reduction practices

Manage stock during grow-out to ensure that, if stocks are inadvertently infected with pathogenic viruses, they do not develop disease or to reduce the stress on stocks.

3. Disease containment practices

Manage disease outbreaks to prevent spread of pathogens to the environment and other farms (horizontally or vertically)

4. Responsible trading practices

Manage the international movement of infected shrimp or shrimp products to prevent the global spread of disease

Conclusion

L.vannamei is present leading cultivableshrimp species in India and have so many advantages as earlier said, but more stocking densities may cause the viral diseases outbreak, whichaffects the shrimp farming industry. By following strict quarantine measures, importation of SPF, SPR stocks, implementing biosecurity protocols and following Better Management Practices (BMP) can reduce the disease outbreak which leads to sustainable production.There has been a slowly increasing demand for farmed shrimp in world markets, as capture fisheries stagnate and people became more affluent and conscious of healthy food choices. Despite the increased demand, the price for *L. vannamei* has been declining steadily. All shrimp farmers are to be aware of the growing need and 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. The newly developed intensive bacterial floc and super-intensive systems may have potential to address all of these concerns and should be investigated more thoroughly. In order to continue the growth of shrimp farming smoothly in the long term, domestic consumption should be promoted (as in China) to supplement the problematic export markets. Farmers should be trained well to bring awareness on different issues involved in the *L. vannamei* culture. KrishiVigyanKendras (KVK) and State Fisheries Departments (SFD) should take responsibilities to conduct different training programmes and frontline demonstrations to bring awareness among the shrimp farmers towards sustainable *L. vannamei* production.

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