Culture of white legged shrimp , *Litopenaeus vannamei*

1 Introduction:

Shrimp farming in India, till 2009, was synonymous with the mono culture of tiger shrimp, *Penaeus monodon.* About 1,90,000 ha brackish water area have been developed for shrimp culture in the country. Since 1995 culture of P *monodon* is affected by White Spot Syndrome Virus (WSSV) and the development of shrimp farming has been stagnant. Most of the South East Asian countries like Thailand, Vietnam, Indonesia were also culturing *P. monodon* and since 2001-02 onwards most of them have shifted to culture of exotic Whiteleg shrimp, *Litopenaeus vannamei* because of the availability of Specific Pathogen Free (SPF) and Specific Pathogen Resistant (SPR) brood stock. In India, Pilot-scale introduction of L. *vannamei* was initiated in 2003 and after a risk analysis study large-scale introduction has been permitted in 2009.

2 Biology

L. *vannamei* is native of pacific coast of Mexico and Central and South America as far south as Peru. It is mainly found on mud bottoms, down to a depth of 75 m. It is commonly known as white legged shrimp or Mexican white shrimp. It is greyish-white in color. The maximum weight of the females in the wild is about 120 g. The males are smaller at 60-80g. It lives in the column and prefers clayey loam soil.

For L. *vannamei* the growth at 30°C is much higher than at 25°C. The optimal range of temperature for the species is between 30 and 34°C. At 20°C growth virtually stops. It can tolerate salinity levels of 0 to 50 ppt. Growth is uniform within 10-40 ppt. They can grow in freshwater also but the growth is slower below 10 ppt. pH range of 7 to 9 is tolerated with optimal growth at pH 8.0. Dissolved oxygen levels above 4.5 ppm are required for optimal growth. Turbid water with flocculated particles of more than 0.5 micron resulted in better growth than clean water mainly because of the presence of algae and bacteria. Ammonia -N and Nitrite - N levels should be less than 0.1 ppm and 1 ppm respectively.

L. *vannamei* is an omnivorous scavenger and is less aggressive and less carnivorous than P. *monodon.* Food

intake is more during evening and night. Retention time of food in the gut is 2.2 to 5 hours. Growth of L. *vannamei,* under confined culture conditions is similar to P *monodon* till they attain 20g size. Beyond that the growth rate was poor. The shrimps attained the size of 20g within a period of 100-120 days depending on the stocking density.

3 Advantages of *L. vannamei :* Culture of L. *vannamei,* is being taken up in many countries because of the following characteristics: –

1. It grows as fast as P. *monodon* upto 20 g.
2. It is easier to culture in very high stocking densities of upto 150/sqm due to their less aggressive nature.
3. It is tolerant to wide range of salinities of 0.5 to 45 ppt .
4. It is very tolerant to low temperatures of upto 15 degree centigrade
5. It requires comparatively low protein feed (20-35%).
6. It is an easy to breed species and hence domestication of the species is very successful with the production of SPF stock. Commercial availability of SPF/SPR and High-health stock is an added advantage.
7. Selective breeding work for the production of SPR brood stock is easier because of the short generation period and easier captive breeding.
8. Higher survival rates in hatchery (50-60%).
9. Has a very good market in the US, as the most preferred species with higher meat yield (66-68%).

4 Disadvantages of L. *vannamei :* The above advantages make L. *vannamei* a very important cultivable species, however, the following disadvantages create some apprehension for its introduction in the country:

1. L. *vannamei* is highly susceptible to and a carrier of TSV, WSSV, YHV, IHHNV and LOVV. Though SPF stocks are available for these viruses, the performance of these in the virus ladden environment is doubtful. WSSV is prevalent in the country and its infectivity and pathogencity for L. *vannamei* is similar to that of P. *monodon* (Tapay et al. 1997)
2. L. *vannamei* is being cultured in very high densities under intensive management, which might lead to environment problems like nutrient loading.
3. L. *vannamei* is highly susceptible to hypoxic conditions and hence there is a need for continuos aeration during high density farming.
4. Handling, processing and transporting are more difficult in L. *vannamei* compared *Penaeus monodon.*
5. There is high competition in the International market due to the world -wide production.

5 Specific pathogen Free Stock:

L. *vannamei* is highly susceptible to a number of viral pathogens. White Spot Syndrome virus (WSSV), Taura Syndrome Virus (TSV), Yellow Head Virus (YHV), Infectious Hypodermal Haematopoietic Necrosis Virus (IHHNV), Lymphoid Organ Vacuolization Virus (LOW), Reo like Viruses (REO) are some of the viruses reported in the species. In order to eliminate the presence the virus in the seed, Specific Pathogen Free (SPF) stock has been developed by producing a number of generations in highly bio-secure facility with continued surveillance of pathogen presence. Although SPF shrimp are, by definition, free of all specifically listed pathogens, SPF shrimp may be infected with a known pathogen that is not included on the SPF list of the shrimp supplier, or with an un-known pathogen that has not yet been described. Offspring of SPF shrimp are not considered SPF unless they are produced and maintained at an SPF facility. SPF status changes with the pathogen condition of the shrimp, as well as the type of environment within which they are cultured (Le. I level of biosecurity). One of the main advantages of culturing L. *vannamei* is commercially available as high health animals from Specific Pathogen Free (SPF) stocks while P. *monodon* have very limited availability from SPF stocks.

6 Bio – Security requirements of shrimp farms:

Stocking of pathogen free post larvae alone will not guarantee a disease free culture since the pathogens still enter the culture environment horizontally and infect shrimps during the culture. Viral pathogens enter the culture pond through :

1. By persisting in the soil
2. Intake water
3. Aquatic vectors introduced through intake water, by crabs and other animals
4. Contaminated land animals and birds
5. Contaminated farm inputs & farm implements

Crabs are one of the major carriers of viral pathogens and providing crab fencing in shrimp farms is considered as one of the important biosecurity measure. Carriers like crabs could also move from pond to pond over land barriers. To prevent such movements fencing made of 0.5 m plastic sheet should be put around culture pond.

Birds such as crow/ water crow pick up the dead and moribund shrimps affected with viral disease from ponds and may drop unaffected ponds, there by transmitting the virus mechanically. This could be avoided by using bird scares and bird fencing over the pond.

7 . Technical Parameters : Technical parameters of *L vannamei* culture include site selection, items of pond development, pre and post stocking operations, stocking fertilisation, feeding harvesting and post harvesting etc. are given in Annexure I

8 . Margin:

The margin money may be considered @ 5, 10 & 15% for small, medium and large farmer respectively and 25% for companies and partnership firms.

9. Subsidy

Subsidy may be available for various items like Pond Development, construction of New Ponds, first year inputs etc. under a centrally sponsored subsidy scheme implemented by majority of the State Governments through FFDA/ BFFDAs for different categories of farmers, details of which may be obtained from concerned Fisheries Departments/NFDB/MPEDA.

10. Eligible Borrowers

The following category of borrowers are eligible to avail credit.

a) An Individual.

b) A company .

c) A Partnership firm.

d) A Co-operative society.

e) A group of shrimp/fish farmers(SHGs/ JLGs)

f) Producer Companies /Organisations

Training in fish farming is being provided by the FFDA/BFFDAs to the eligible borrowers and it is essential that the borrower has prior knowledge of fish /shrimp farming before availment of bank loan.

11 . Financial Outlay :

The details of Capital Cost and Recurring Cost have been indicated in Annexure II. The capital cost for development of one hectare pond works out to be Rs 8.48 lakh and the recurring cost as Rs 15.04 lakh. However, the cost is indicative and actual assessment of the cost parameters based on the field level conditions have to be done while preparing /submitting the project to the bank.

12. Repayment

Repayment of bank loan is possible in 6-8 years in annual instalments with moratorium on repayment of principal for the first year. Annexure II

13. Financial Analysis:

As per financial analysis shown in annexure the scheme is financially viable. The financial parameters are as follows Annexure II

i). NPW @ 15% : Rs 30.03 lakh

ii). BCR @ 15% : 1.18:1

iii). IRR : > 50%

14. Rate of Refinance

NABARD provides refinance assistance for shrimp/fish culture to commercial banks, cooperative banks and Regional Rural Banks. The rate of refinance is fixed by NABARD from time to time.

15. Rate of interest

Interest rate to be charged to the ultimate borrowers would be as indicated by bank/RBI/NABARD from time to time depending on quantum of loan amount and the agency providing the loan.

16. Security

Security from the ultimate beneficiaries may be obtained as per the guidelines of RBI issued from time to time.

17. Registration of the Farm

Registration of the farm may be done as per the requirement of GoI/ State Governments .

Technical Parameters Annexure I

1. **Farm Design Requirements:**

L.vannamei lives in the column and hence increasing the depth of the pond will help in increasing density. Generally shrimp farms which were culturing P. *monodon* had a water depth of about 1 mt. But is advisable to have a depth of 1.5 to 1.8 m water column for culturing L. *vannamei.*

Since mechanical aeration is one of the major requirements for L. *vannamei* culture due to higher stocking density, constant circulation of water is expected in the pond. This will lead to the erosion of the soil in the dyke and bottom. To avoid this compacting of the pond bottom and the dykes are essential. In intensive culture ponds total lining of the pond HDPE sheets is done to avoid any type of

erosion. In high density culture systems, accumulation of sludge in the bottom is a major problem and provision of central drainage or use of sludge pumps is essential. Positioning of paddle wheel/long arm aerators should aide in bringing the sludge to the centre of the pond from where it can be removed.

Bio-security requirements like reservoir ponds, fencing, crab fencing bird fencing, and disinfection facilities are incorporated in the design. To avoid disease in most cases zero-water exchange system of farming is practiced with recirculation facilities. In such cases more than 40% of the water area in the farm is allocated for reservoirs and waste sedimentation ponds.

2 Management *of* the farm

2. 1 Drying and Liming

The sludge left in the pond, may have the remains of the earlier viral disease outbreak , containing high organic load, bacteria, viral particles and DNA as well as many other viral carriers. All these should be removed to prevent the persistence of viral disease. This could be achieved by the application of burnt lime (CaO) @100 ppm, followed by exposure of the pond bottom to sunlight until drying and cracking, removal of the top soil and compacting the bottom soil

2. 2 *Water Management :*

White spot virus has been reported to survive as a free-living form in water up to seven days. Direct use of creek or sea water carries the risk of introducing the virus into the system. Most of the aquatic crustaceans including the planktonic forms are reported to be carriers of WSSV virus. A number of other aquatic organisms could be mechanical carriers because of their filter-feeding habit. There is a need to eliminate these from water before use in culture ponds. Use of filter nets 60 micron mesh/sq cm in the delivery pipes/ inlet sluice should be strictly followed. Water should be taken in reservoir ponds and treated with calcium hypochlorite @ 30 ppm and aged up to seven days, to eliminate the viral pathogens.

Farmers should ensure that only treated water be used in the culture ponds for compensating the evaporation losses. Regular water exchange is not advised to avoid cross contamination pathogens from the source water.

2.3. *Fertilization and addition of carbon source*

Culture of L. *vannamei* can be done under two systems - with plankton as natural feed or with bacterial floc. The fertilization schedule with urea and superphosphate is followed for plankton development while provision of carbon source in the form of molasses and dolomite is used for development of bacterial floc. The volume of bio-floc was controlled at 15 ml/ litre.

2.4 . Stocking:

SPF shrimp seed from a reputed approved hatchery may be used for stocking. PL8- PL9 is normally selected after ensuring the pathogen free status of the seed. The seed acclimatization is a very important requirement before stocking. Temperature, salinity and pH of the transportation water

should gradually brought to the level of pond water by gradual mixing of both over a period of 6-12 hours depending on the difference. Stocking densities of 40 to 60 no/sq m is preferred. Higher stock densities above 60 no./sq m is not permitted.

2. 5 Feed Management:

Protein requirement varies between 25 to 40% depending on the density. Marine source protein was more effective than plant source. Lipid requirement is around 6-8% with 2% marine unsaturated fatty acids and 0.25 to 0.4% of cholesterol. Feeding rate is between 6.6 to 16% for 1 gm of shrimp which will be reduced to 2% for 15 gm shrimp. Optimal feeding frequency is between 2 and 6 in a day with maximum percentage of feed distributed in the evening and night rations. Check trays are used to monitor the feed consumption and the feeding ration is adjusted accordingly. FCR levels of 1.1 to 1.4 are expected.

2.6 Maintenance of Water Quality:

Regular monitoring of water quality is very essential. Water quality parameters like temperature, salinity, pH and alkalinity are monitored on daily basis. DO levels are recorded at least 2 times a day. Other parameters like Ammonia, Nitrite, Calcium, Magnesium are monitored on weekly basis. DO levels should be maintained above 4 ppm although and operation of paddle wheel /long arm aerators should done to maintain the level. The number of aerators required is about 1 HP per every 300 kg of mass. The location of the aerators should be adjusted in such way the sedimentation occurs at centre of the pond, which will help in its easy removal.

Removal of sludge from the pond bottom during culture is essential in case of high density. Aerators are positioned in such a way that the sludge is accumulated in the center of the pond and from there it could be removed through central drainage or using sludge pumps. To aid in the process, sludge settled in other places should be disturbed regularly. This is achieved through dragging of chains at the bottom at regular intervals on all sides of the pond

2.7. Health Management:

Weekly monitoring of shrimps for their growth and well being is essential. *L. vannamei* normally grows at the rate of 0.2gm /day after the first 30 days. Weekly growth rate will range between 1.5 to 2.0 gm depending on the stocking density. At 60 nos./m^2 the shrimps attain 20g size within 100 -120 days.

3.0 . Harvest and Post Harvest

L. vannamei is a column living shrimp and hence maximum stock can be harvested by either by cast nets or drag netting and this will help in harvesting without much overcrowding or stress. Final harvesting by draining the water should be done within 6 hours. Compared to *P. monodon*, L. *vannamei* discolours faster if there is any delay in icing the harvested stock. Hence the stock should be 'ice killed' immediately on harvest and stored in ice.

4. Cost of production:

The cost of production of L. *vannamei* in Indian conditions considering the industrial rate for electricity might work out to Rs. 150 -160 for production levels of 8 to 10 tons per ha. The average size at harvest ranges from 20 to 25 g and the sale price is more or less same for both P. *monodon and L. vannamei* of similar size at Rs. 200 to 220. The profit margin is very high and even if only 50% of the area will be utilized for grow-out, it is beneficial than P. *monodon* culture.

5. Conclusion:

L.vannamei is very suitable species for semi-intensive culture with the availability of pathogen free seed. The major issues to be considered are bio-security and maintenance of water quality through constant monitoring. It also requires higher technical knowledge to achieve higher production in sustainable manner. Strict adherence to the guidelines of Coastal Aquaculture Authority is a must to ensure environment protection.

Annexure II Unit Cost L
vannamei culture 1 ha Model

A	CAPITAL COST	Unit	Qty	Rate(Rs)	Amount in Rs
1	Earthwork for construction of ponds by machinery (using Proclaine)	ha	40 hr	1500/ hr	60000
2	Water inlet structures for pond	Nos	1	15000	15000
3	Water outlet structures for ponds	Nos	1	15000	15000
4	Main outlet sluices	No	1	35000	35000
5	Pump house	Sqft	100	300/sqft	30000
6	Office, laboratory and stores	Sqft	350	300/ sqft	105000
7	Watchman shed	sqft	100	275/sqft	27500
8	Pump	5 HP	1	65000	65000
9	Long arm Aerators	2HP	4	35000	140000
10	Electrical installations/Power Supply incl Transformer	LS	1	60000	60000
11	Reservoir	hr	40	1500/hr	60000
12	Crab Fencing	RMT	400	150	60000
13	Bird scare/ Bird net	Sq m	2000	35/sqm	70000
14	Lab and farm equipment, pH meter , salinometer , chemicals etc	LS	LS	75000	75000
15	Miscellaneous expenditure	LS	LS	30000	30000
	TOTAL --- A				**847500**
B	**Operational cost for first crop**				
1	Stocking density	Per/ha	500000	0	0
2	Cost of PL20('000)	nos	500000	0.75/ PL	375000
3	Feed	kg	14875	60/kg	892500
4	Chemicals and manures for pond preparation	LS	LS	10000	10000
5	Electricity/Power charges	LS	LS	65000	65000
6	Repairs and maintenance	LS	LS	20000	20000
7	Harvesting charges	per kg	10625 kg	1/kg	10625
8	Farm Supervisor	1	4 months	10000/ month	40000
9	Mechanic/ skilled labour	1	4 months	6500/ month	26000
10	Watchman	2	4	5000/	40000

			months	month	
11	Office expenses and misc expenses	LS	LS	25000	25000
	TOTAL --- B				**1504125**
	Grand Total (A+B)				**2351625**
	Means of Finance				
1	Total Financial outlay				2351625
2	Margin 15%				352744
3	Financial Assistance				1998881
4	Say in Rs Lakh				19.99
5	Rate of Interest				12%

Production and Income in Rs					
1	Production from 1 crop (kg) in 1 ha				10625
2	Price per kg				175
3	Total income from 2 crops from II yr				3718750
4	Operational cost one crop				1504125
Assumptions					
1	Farm size (water spread area)	ha			1
2	culture period	Months			4
3	Stocking rate 50 No / sqm	10000sqm			500000
4	survival rate				85%
5	No of pieces at harvest				425000
6	Harvest size(average)	gm			25
7	Production	kg/ha/crop			10625
8	Water exchange				pumping
9	Feed				formulated feed
10	No of crops per year				Two
11	FCR				FCR 1:1.40

Financial Analysis - *Litopeneaus vannamei* culture - 1 Ha Model

Year	**1**	**2-8 years**
Capital Cost	8.48	0
Recur ring Cost	15.04	30.08
Total Cost	23.52	30.08
Gross Benefit	18.59	37.19
Net Benefit (B-C)	-4.92	7.11
Present Worth of Costs at 15% DF	166.68	

Present Worth of Benefit at 15% DF	196.71
Net Present Worth (PW Benefit - PW Cost)	30.03
Benefit Cost Ratio (PW of Benefit / PW of Costs)	1.18
Internal Rate of Return	>50%

Repayment schedule – *Litopeneaus vannamei* 1 Ha Model

Total financial Outlay	**23.52**
Margin @ 15%	**3.53**
Financial Assistance	**19.99**

Year	B/L O/S at the beginning of the year	Net Income	Interest	Principal	Total	Bank loan O/s at the end of the year	Net surplus	DSCR
1	19.99	3.55	2.40	0.00	2.40	19.99	1.15	0.00
2	19.99	7.11	2.40	3.33	5.73	16.66	1.38	1.24
3	16.66	7.11	2.00	3.33	5.33	13.33	1.78	1.33
4	13.33	7.11	1.60	3.33	4.93	10.00	2.18	1.44
5	10.00	7.11	1.20	3.33	4.53	6.67	2.58	1.57
6	6.67	7.11	0.80	3.33	4.13	3.34	2.98	1.72
7	3.34	7.11	0.40	3.34	3.74	0.00	3.37	1.90
Repayment period 7 years with one year grace								