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Production of White Leg Shrimp (*Litopenaeus vannamei*) in Inland Saline Waters of India

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Abstract

The increasing demand for the white leg shrimp, *Litopenaeus vannamei* has led to the development of new production systems for this fast growing shrimp. One of the recent development in this line is farming of this shrimps in ponds excavated in saline soils, i.e. the soils that have become totally unproductive due to excessive irrigation and unrestricted application of chemical fertilizers. Initial attempts to cultivate these shrimps in such locations in Haryana, Punjab and Maharashtra with technical assistance from CIFE, CIBA, GADVASU, MPEDA and SV Aquafarm Consultants showed encouraging results. In India, about 1.7 million ha agricultural land is turned into saline soils, which is lying fallow and is not of any use for agriculture purpose. Some of the affected saline land states are Punjab, Haryana, Uttar Pradesh, Rajasthan and Maharashtra. The ground water salinity in these areas varies from 2 to 8 ppt. In this situation conversion of affected agricultural lands into aquacultural farms may be promoted as practical option. Pilot scale farming and also commercial farming of the shrimp in Haryana, Punjab and Maharashtra could produce shrimps to the tune of 10 to 13 tonnes ha^{-1} in a timespan ranging from 97 to 140 days. In future more area needs to be brought under shrimp culture in these fallow lands. Continual trainings for successful farming, encouraging cluster farming and following of Best Management Practices (BMP) needs to be encouraged for increased production. The possibilities of sustainable culture, the special cautions to be taken during such culture, and the advantages and disadvantages of new production system have been discussed in detail.

Keywords : Inland saline water, *L. vannamei*, bird nest, cluster farming.

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Introduction

Inland saline water defined as "Land based aquaculture using saline ground water". Such saline water occurs in several countries, to name a few, USA, Israel, Australia and India. (Applebaum *et al* 2009) The introduction of irrigated agricultural arid and semi-arid region of India has resulted in twin problems of salinisation and water logging. These lands are lying fallow and are now not of any use for agriculture purpose. Some of the affected saline states are Punjab, Haryana, UP, Rajasthan and Maharashtra. To enhance the declined financial state of farmers, such fallow lands needs to be utilized for getting some other cash crop. In Western Maharashtra these lands are fallow since last 25 years. However, recently farming *of Litopenaeus vannamei was* found to be profitable owing to high density stocking and more adaptability of this shrimp to saline conditions. At present the shrimp culture is in vogue in Punjab (with technical guidance of GADVASU and CIFE), In Haryana (with technical support from CIBA and CIFE) and in Maharashtra (with technical support from SV Aquafarm Consultants). Encouraging growth have been reported from these different parts of India and it has proved beyond doubt that the vannamei cultivation is commercially feasible provided the farmers are trained, strict bio-security measures followed and Best Management Practices (BMP) adopted. In saline lands of Western Maharashtra there are fair chances for cluster farming, as fallow saline lands are available in long stretches and the farmers are hard working and ready to adopt new culture practices. However, for successful and sustainable cluster farming, continual trainings to the farmers, a strong technical support from scientists, an attractive subsidy from government and simplified government permission procedure are the pre-requisite.

Results and Discussion

These saline lands are lying fallow since last many years some parts of Kolhapur and Sangli districts of Western Maharashtra the sugar cane producing lands are unutilized since last 25 years. Here the cultivation

Table 1. The water quality characters of ground water from western Punjab

Parameter	Range
Water salinity	5.3 ± 0.3 ppt
pH	8.3 ± 0.4
Total alkalinity	370.5 ± 10.2 ppm
Hardness	1270 ± 22.8 ppm
Sodium	1312 ± 17.3 ppm
Potassium	24.4 ± 1.2 ppm
Magnesium	210.3 ± 4.5 ppm.
Calcium	165 ± 7.4 ppm

of IMC, Fresh water prawn, tiger prawn was attempted, but all these were found to be uneconomical. However, the farming of the white leg shrimp *Litopenaeus vannamei* was found to have great promise, not only in Maharashtra, but also in Punjab and Haryana. The reasons are as follows:

- Fast Growing shrimp. Crop period is only 3 to 4 months
- High density culture possible.
- Tolerate wide salinity range (0.5 to 45 ppt)
- More matching to inland saline waters, than *Penaeus monodon*.
- Grows on lower protein feed than *P. monodon.*
- Shrimp matures under captive conditions.
- Shrimp gives higher meat yield as compared to *P. monodon* (66% against 62%)
- Open Thelycum species ,so mating and spawning under captive conditions
- Higher larval survival compared to *P. monodon.*
- Better temperature tolerance.

At present the shrimp culture is in practice in the states of Punjab, Haryana and Maharashtra.

Punjab Scenario

In western Punjab around 1.5 lakh ha area is affected by ground water salinity and water logging (Singh *et al.* 2019) and is having potential for *L. vannamei* farming. CIBA and GADVASU jointly studied the ground characteristics of these saline soil and successfully improvised the water parameters to make them suitable for shrimp culture (Table 1).

The Potassium and Magnesium level was less than the required, the level of both was enhanced to desired level by addition of Muriate of Potash and Magnesium Chloride flakes. The higher level of Total Alkalinity was brought down by addition of table sugar, yeast and fermented juice in specific dose from 30 DOC. With this the total alkalinity was lowered to 290 ± 10.2 ppm. With these improvisations, the shrimp, Post-Larvae (PL-13) were stocked @ 30 m^{-3} in two ponds of 1 acre each (@ 1.2 lakh PL $acre^{-1}$). The shrimp harvested on 120 DOC, getting average weight of 26 and 27.2 g weight and 2.5 t of shrimp production $acre^{-1}$. The FCR was 1.2 and the net profit of 2.0 lakh $acre^{-1}crop^{-1}$ was obtained. This trial and two other trials indicated that white leg shrimp cultivation can be a profitable venture if BMP is followed.

At present the area under shrimp farming is about 200 acres in four districts of Punjab (Sing *et al.* 2019a). According to very recent reports from Punjab the area under shrimp culture is 500 acres. Punjab government has launched a pilot project on shrimp farming in Fazilka district, extending 50% subsidy, to 16 *vannamei* ponds, set up in 32 acres of seepage hit land. In Punjab, CIFE, CIBA and GADVASU have extended the most needed technical support to the fresh shrimp farmers. It was reported that shrimp culture, though done only for 97 days, was also found commercially viable, with a yield of 1.2 tonnes of shrimp and a net profit of ₹ 97000. When the *L. vannamei* culture was attempted in saline water pond of Mansa, Punjab, the shrimp PL (PL-15) were stocked @ 50 m^{-3} in a 2.5 acre pond, a crop of 8.36 tonnes was harvested, earning a receipt of ₹ 23.5 lakhs. The FCR was 1.25 and average weight of shrimp at harvest was 25 g (Singh *et al.* 2019).

Haryana Scenario

In Haryana state about 5 lakh ha of inland saline water logged area is available, which is potential area for shrimp culture. Haryana government provides 50% subsidy to shrimp farmers for developing infrastructure and input. Here 128 ha of salinity affected area in Rohtak, Hissar, Bhivani, Jind, Sonepat and Jhajjar district has been already brought under shrimp culture. (Singh and Singh 2018). Considering the problem of desalinization and water logging, conversion of agricultural fields

Table 2. Water Parameters *Litopenaeus vannamei* Pond of Haryana

Parameter	Values
Salinity	13 - 15 ppt
pH	7.8 - 9.0
Dissolved Oxygen	5.4 - 8.2 ppm
Hardness	3200 - 3700 ppm
Ca	235 - 270 ppm
Mg	610 - 695 ppm
Alkalinity	200 - 230 ppm
K	80 - 100 ppm

into saline aquacultural farms is being promoted as a practical solution here. Shrimp farming is giving high profit to the farmers, as the crop period is only 100 to 120 days, with farmers getting a high production of 13 t ha^{-1} 120 $days^{-1}$. The water parameters of Haryana pond (Table 2) are quite suitable for the shrimp culture.

Overall the water parameters are suitable for the shrimp farming. Moreover, the Ca:Mg ratio and Potassium is maintained by adding commercial grade Magnesium Chloride and murate of Potash.

Maharashtra Scenario

So far 1.77 lakh ha inland saline soil and 0.42 lakh ha alkali soil is available in Maharashtra. This was mainly sugarcane growing area, turned into saline land. This land was lying fallow since last 25 years. Since year 2004, with the joint effort of MPEDA and state Fisheries department, the culture of Indian Major Carp (IMC) was attempted, but the culture duration was one complete year and the fish did not get price in local market, so this culture was a failure. After this the Scampi culture was attempted but uneven growth, cannibalism and slow growth of the giant fresh water prawn, made the culture commercially non viable. Recently government is promoting drip irrigation and white leg shrimp culture in these fallow stretches. With the financial assistance from MPEDA and technical guidance from SV Aquafarm Consultants, Ratnagiri pilot scale project on growing white leg shrimp at Akiwat village in Shirol taluka of Kolhapur district was taken up during 2017 and 2018 by the progressive farmer Mr. Arun Sripal Alase. The water parameters (Table 3) in the pond were suitable for shrimp growth.

The ponds were 2 meters in depth, with a central drainage to remove sludge. The Post-larvae (PL-10)

Table 3. Water Parameters of the *Litopenaeus vannamei* pond at Akiwat village of Maharashtra

Parameter	Value
Salinity	0.50 - 2.0
pH	7.5 - 8.0
Dissolved Oxygen	6.0 - 9.4
Total hardness	560 - 680 ppm
Chlorides	330 - 390 ppm
Ca	88 - 152 ppm
K	6.5 - 18 ppm
Mg	73 - 88 ppm
Na	257 - 401 ppm

were thoroughly acclimated to pond water. About 1.7 lakhs PL were stocked in a 0.20 ha pond (42 m^{-3}). The BMPs were followed during complete culture period. The shrimps harvested on 140 DOC, getting average weight of 28 g and a production of 4.0 t shrimp $acre^{-1}$140 $days^{-1}$. So shrimp @ 4.0 t $acre^{-1}$ could be produced. The farming results are encouraging. The positive aspects that came out of this pilot scale farming were –

- A shrimp production @ 10 t ha^{-1} was obtained, with a farm gate price of ₹ 4.0 lakh t^{-1} of produce
- The shrimps grew to weight of 25 to 30 g weight in 140 days period
- The local youths could get employment
- The saline land that was lying fallow for last 25 years was utilized and a cash crop could be yielded
- The water parameters are optimal, specially the pH was found to be in desirable range and there is no need of lime addition

Ways to sustainable and successful white leg shrimp farming in inland saline waters in India

The pilot scale and commercial farming of this shrimp in Punjab, Haryana and Maharashtra indicates that for successful and sustainable farming of this shrimp, below mentioned points needs to be remembered.

1. **(BMP) adoption** – BMP includes correct site selection for the farm, careful pond construction, strict bio-security measures during culture, manuring at proper time and of appropriate doses careful seed selection and careful seed transportation and acclimation, proper sized feed for shrimp at each growing phase ,precise feed management, pre-

set arrangement for sludge removal, regular growth and health checkup, daily water quality monitoring, all pre-arrangements for harvesting, and careful harvesting and post-harvest management. Skipping any one point of these may lead to failure in culture.

2. **Special Precautions**: The white leg shrimp farming in inland saline ponds is quite different from the same in marine or brackish waters. Therefore, certain special precautions needs to be taken during culture in inland saline ponds, these are :

- Maintaining K level: Inland saline waters have low levels of K. To maintain optimal K level, the K level of water is to be found out. Then murate of Potassium is added till the desired K level reaches in the pond, this desired level needs to be maintained till end of culture

- Maintaining Ca and Mg levels: The shrimp is sensitive to Ca and Mg ratio in culture medium. ISW has high levels of Ca hardness ,compared to Mg.For better growth and survival percentage the Ca:Mg ratio to be maintained as 1:3 (Pasvan 2015) By adding Magnesium Chloride (Mg Cl_2) the Ca:Mg ratio is to be maintained @ 1:3 .

- Removing Pond Sludge : During the culture ,the sludge needs to be removed from time to time ,and for this precise pre-arrangement is must, as non-removal of sludge may affect adversely the next shrimp crop. The removed sludge should be used as manure in agriculture.

3. **Advantages of shrimp farming in ISW** : This novel shrimp farming has following advantages –

- Lowering of ground water table by withdrawing saline ground water/seepage water for shrimp culture helps to reduce water logging, and thereby improves soil and reduces secondary salinisation.

- High profit to farmers in a short span, as the crop can be harvested in 100 to 140 days. No agricultural/ horticultural crop would earn such a high profit in such short span.

- More reliable income due to healthier aquaculture crop by using ground water, that is free from pathogens.

- Utilization of waste land that was lying fallow for years together.

4. **Don'ts for Successful Shrimp Farming:** For getting successful production of the shrimp ,following don'ts must be followed scrupulously (Lakra *et al*. 2014)

- Don't allow sludge to remain at pond bottom.
- Don't use heavy doses of lime
- Don't leave wide spaces while fixing the bird nets
- Don't apply heavy doses of bleaching.
- Don't use unfiltered water in culture ponds.
- Don't allow light to penetrate beyond 40 cm.
- Don't stock poor quality seed.
- Don't release seed in pond ,before acclimation.
- Don't use poor quality seed.
- Don't avoid the routine health check up.
- Don't avoid chaining.Don't start harvesting, before making full pre-arrangement.

5. **Need for Cluster Farming in ISW in western Maharashtra**

The pilot scale project on *L. vannamei*, though on small scale indicates that it can be a highly lucrative preposition. About 12000 ha of saline land, which is lying fallow and no agriculture crop could be taken on this land since last 25 years is available in Shirol taluka of Kolhapur district. In this area if a farming cluster of 40 hectares each is made and two crops in a year are taken, then a shrimp production of 640 t (@ 8.0 t ha^{-1}, and 2 crops $year^{-1}$) earning a revenue of ₹ 2560 lakhs (with a moderate selling rate of ₹ 4.0 lakh t^{-1}) could be earned. With BMP (Best Management Practices) the total recurring expenditure for one cluster will be ₹ 1280 lakhs (@ ₹ 2.0 lakhs t^{-1} of shrimp). Thus a profit of ₹ 1280 lakhs per cluster could be achieved. A human force of 4 persons ha^{-1} of pond is required, thus providing direct employment to 160 persons per cluster will be available. Moreover, indirect employment to nearly 1000 persons per cluster will be available.

If such 10 clusters are formed in Shirol taluka of Kolhapur district, then a shrimp production of 2560 lakh tonnes, earning a revenue of ₹ 256 crores, this will improvise the whole economy of Maharashtra, specially Western Maharashtra, as direct employment to 1600 persons and indirect employment to 800 persons

will be available. The Cluster farming will bring down the shrimp seed, feed, medicine and management cost, as all this is predicted to be done on mass scale. An experienced aquaculture consultant would be hired since the activity is on large scale. The bargaining power for getting higher shrimp selling cost of the farmers will increase, as now they will be in cluster.

In short Cluster Farming is bound to result in following benefits:

- The Unutilised fallow land could be used meaningfully and profitably.
- The local youths will get a permanent source of income.
- A nutritious food will be available for the local community.
- The country will get the much needed foreign currency through shrimp export.
- The overall economy of the region will boost up.

Therefore Cluster Shrimp Farming is strongly recommended on inland saline lands of western Maharashtra. Cluster farming can be a useful preposition in the other saline states namely Punjab and Haryana.

Possible Threats of shrimp farming in ISW

Though the shrimp farming in ISW is advantageous in many ways, certain risks also have been predicted by (Singh and Singh 2018) based on their observations in Haryana, upcourse these apply to shrimp farming in other states also. The possible risks are :

- The large volume of saline water for 8 to 9 months brings a risk of increased salinity of the soil and underlying aquifiers.
- The dissolved fertilizers, unused shrimp feed, fecal matter, probiotics and other additives may leach out in soil and ground water.

Therefore, treatment and management of waste water from the shrimp farms, needs to be channelized and the farmers need to make appropriate arrangements for sewage water treatment. The government also needs to have vigilance squad to inspect that water is being released only after proper treatment. Though some risk is there, the white leg shrimp culture in inland saline waters has a more advantages and so has great potential in inland saline lands of India.

Summary

In some parts of India, the soil has become saline and so unproductive, due to excessive irrigation and overuse of chemical fertilizer. Such lands are not of any use for agricultural crop. In such areas, the culture of white leg shrimp, *Litopenaeus vannamei* in inland saline ponds has been found as a practical and profitable venture. Productions of L. *vannamei* on commercial scale have been attempted in such locations in the states of Punjab, Haryana and Maharashtra. This shrimp is a fast growing species, with all the suitable characters for farming in low saline waters. Moreover, it is a cash crop and is harvested in 3 to 4 months. In Punjab, with the technical support from GADVASU and CIBA and subsidy from Punjab government this shrimp is being cultivated in 200 acres area. In Haryana with the technical guidance of CIFE, 128 ha of saline land have been brought under this shrimp culture. In Maharashtra pilot scale project with the finance from MPEDA is in vogue in Akivat village of Western Maharashtra. In all the three states the pond water quality is suitable for *L. vannamei* culture, except that, the K level and Ca:Mg ratio needs to be maintained in the pond. The shrimp production in these different states varied from 8.36 to 10 tonnes ha^{-1} and the farming duration ranged from 120 to 140 days.

For successful and sustainable production of the shrimp BMP adoption and the K level and Ca:Mg ratio maintenance are the most vital factors. Also Don'ts during shrimp cultivation needs to be taken into consideration. Cluster Farming containing 100 acres pond area in each cluster can be a key to success in saline lands of Western Maharashtra. The advantages of the same have been discussed. Possible threats of continuous shrimp culture also have been reported.

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