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Shrimp culture in Inland Saline Waters of India: A step towards Sustainable Aquafarming

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ABSTRACT

Inland saline groundwater (ISGW) has created a huge scope for the culture of different finfish as well as shellfish resulting in expansion of commercial aquaculture in the states of Punjab and Haryana. L. *vannamei* is considered to be one of the potential candidate species for inland saline aquaculture due to possession of some special characteristics like high growth and survival rate, ability to withstand a wide range of environmental fluctuations, high disease resistance and better utilization of low protein diet. The present article focuses on the culture practices of L. *vannamei* and elaborating the best management practices (BMP) for its sustainable production in Inland Saline Water.

Salinisation of soil is a serious problem that mainly affects the agricultural output of more than 100 countries worldwide and also reflects a negative impact on the socio-economic welfare of their farming communities. The majority of inland saline zones of the world are located in arid, semi-arid, and low-lying and poorly drained regions, where high concentrations of salts accumulation has occurred within the soil. This type of salinisation is known as primary salinisation which occurs due to insufficient rainfall and poor leaching of soluble salts. Anthropogenic activities like improper agricultural practices also cause secondary salinization in areas with underground saline water. Due to ever-increasing population, demands for food products is also increasing which compels the farmers to completely rely on intensive irrigation of agricultural lands with underground saline water, with or without proper drainage facilities to supply the sufficient quantity of food. It causes a serious problem like water-logging or the rise of the underground water table, due to continuous repetition of this process over the years that has transformed the fertile/productive land into non-productive wastelands.

Status of Inland Saline waters:

In recent times, salinisation is a major concern and affects over 380 mha of land spreading over 20 countries worldwide (Lambers, 2003). This type of wasteland is being used for farming of fish, crustaceans, molluscs, etc. especially in the USA, China, India, Israel, and Australia (Allan, 2009). In India, nearly 8.62 million ha of land area is affected by soil salinity and 2.8 million hectares of salt-affected soils are present with in the Indo-Gangetic alluvial plain. Within 8.62 million ha, 40 % of the salt-affected area is concentrated in the north-western, semiarid/arid states of Haryana, Punjab, Uttar Pradesh, and Rajasthan (Allan, 2009).

Fish species cultured in Inland Saline Water:

Around the world, different fishes are being cultured in saline groundwater including euryhaline finfishes (e.g. *Lates calcarifer, Sparus auratus, Dicentrarchus labrax, Argyrosomus japonicus*), crustaceans (e.g. *Penaeus monodon, Litopenaeus vannamei, Marsupenaeus japonicus*), molluscs (e.g. *Saccostrea glomerata*), diadromous species such as salmonids (e.g. *Oncorynchus mykiss*), salt-tolerant freshwater species such as finishes (e.g. *Oreochromis niloticus, Bidyanus bidyanus*) and crustaceans (e.g. *Macrobrachium rosenbergii*) (Allan, 2009). Further, Barramundi, *Pangasianodon hypophthalmus* (Kumar *et al.,* 2016), *Chanos chanos* (Barman *et al.,* 2012), *Mugil cephalus*, *Etroplus suratensis*, Common carp are the most commonly cultured fish species in inland saline water. Apart from that different shellfishes such as *Litopenaeus vannamei* and *Macrobrachium rosenbergii* are also reared in Indian inland saline water.

In majority, of the locations throughout the world the primary candidate shrimp species for inland saline water is the Pacific white shrimp, *Litopenaeus vannamei*, which is native to the Pacific coast from Northern Peru to Mexico. *L. vannamei* was first introduced in India on pilot scale in 2009 and gained attention as one of the most potential aquaculture species. It is cultured in inland saline water mainly in two states Punjab and Haryana.

Reason for its suitability as most potential species in inland saline condition area as follows:

- ✓ High growth rate

- ✓ Tolerance to high stocking density (Stocking density- 60 no/m^2 recommended by coastal aquaculture authority).
- ✓ Utilization of low protein diet
- ✓ Tolerance to a wide range of environmental fluctuation especially temperature (15-30°C) and salinity (0.5-45 ppt).
- ✓ Attain maturity in the captive condition which enables domestication and genetic improvement of stocks
- ✓ It gives higher meat yield compared to *Penaeus monodon*
- ✓ Spawning is easy due to open thelycum in captivity.
- ✓ High disease resistance.

Pacific white shrimp (*Litopenaeus vannamei)*

Taxonomic classification

Kingdom: Animalia
Phylum: Arthropoda
Subphylum: Crustacea
Class: Malacostraca
Order: Decapoda
Suborder: Dendrobranchiata
Family: Penaeidae
Genus: Litopenaeus
Species: *L. vannamei*

Characteristics:

- ✓ Adults live in deep-sea; post-larvae and juveniles migrate to the estuaries for food and complete their life cycle.
- ✓ Females grow faster than males. Attains maximum length of 230 mm.
- ✓ Rostrum formulae are 7-10 dorsal teeth and 2-4 ventral teeth.
- ✓ They are translucent white, but they can change their colour depending on the pond bottom substratum.
- ✓ Males mature at 20 gm in size and female 28 gm.
- ✓ Fecundity ranges from 1 to 2.5 lakh, depending on the size of the berried female.
- ✓ Egg sizes are 0.2 mm in diameter.

Culture of *L. vannamei*

Pond Preparation

After every cycle, it is necessary to scrap the pond bottom to remove organic sludge present at the pond bottom. Drying of the pond is the most essential and effective method for eliminating the unwanted species. Along with drying process other activities such as repairing the pond dikes/bunds, bird netting etc are carried out. During drying the pond bottom develop cracks and ploughing is done with the help of tiller up to a depth of 10-15cm, which helps in the oxidation of obnoxious gases and releases nutrients that are locked into the soil. If drying is not possible then good quality of probiotics rich in nitrogenous bacteria should be applied for removing of obnoxious gases. Lime is applied at a rate of 200-250 kg/ha to maintain the soil pH and a further sufficient level of Ca should be provided, which will in turn help them during moulting. Shrimp culture in an improperly prepared pond may lead to difficulty in pond management during the culture period which may result in decrease in the carrying capacity of the pond.

Watering

Watering is done normally up to 1.2 - 1.5 m of depth. The water source is bore well and multiple screens are used to filter the water followed by treating it with 10 ppm chlorine and then leave it 4-5 days for dichlorination. Organic slurry is applied, which are prepared with molasses, rice polish, oil cake, and yeast. Pond water transparency should be maintained at 30-40 cm and if it is more than 40 cm organic slurry may be applied in a phased manner to maintain the proper photosynthesis level in the pond.

Seed

Specific Pathogen Free (SPF) and Specific Pathogen Resistant (SPR) shrimp seed from different shrimp hatcheries approved by Coastal Aquaculture Authority (CAA) and following best management practices (BMP) may be used. Before going for seed procurement, seed should be tested for viral and bacterial infections.

Stocking of seed

Before stocking of seed, the shrimp seed may be acclimatized to pond water temperature along with sprinkling water into the polythene bag containing seed. Artemia nauplii are added to the container containing shrimp seed to avoid cannibalism. After acclimatization, seeds may be stocked into the pond at 60 no/m^2

following the guidelines of coastal aquaculture authority (CAA).

Feed and Feeding

The use of accurate feed size is necessary according to the mouth size of shrimp such as 1mm for starter, 2mm for the grower, and 2.5 mm for the finisher. The feed should be broadcasted evenly throughout the pond and applied based on biomass. Shrimp biomass is calculated based on the following formulae

Shrimp biomass = Total number stocked × % Survival × Avg. body weight.

Check trays may be used for proper monitoring of feed consumption. For optimum growth rate, 30-35% protein is ideal in a shrimp diet.

Harvesting

Shrimps attain an average weight of 22.8-28 gm in 100-120 days culture period. For harvesting two methods are used– Firstly, by complete draining of pond and secondly by catching the shrimp using a bag net. In order to avoid damage, harvested shrimp are cleaned and stored in containers having ice. Shrimps may be then packed in Styrofoam boxes with alternate layers of crushed ice and shrimp respectively and might be transported to market effectively.

Best Management Practices (BMP)

It includes regular health monitoring of shrimp and checking for any abnormality such as antenna cut, opaqueness, white mussel, etc. It starts from site selection and pond construction, maintenance of biosecurity, SPF and SPR seed selection, optimum feed size and management, weakly water quality check-up, proper harvesting, and post-harvest management. Further, it is necessary to check the bottom of soil weekly and drag the chain at pond bottom twice in a week to eliminate obnoxious gases. During harvesting, separate cast net is required for every pond to avoid cross-contamination from one pond to the other. On a note, the optimum Ca: Mg ratio is to be maintained as 1:3 during the culture. Water Quality parameters in inland saline water of Rohtak, Haryana, India (Lakra *et al.,* 2014) are as follows:

Parameters	Acceptable range
Salinity	13-15 ppt
Dissolve oxygen	5.4-8.2 ppm
p^H	7.8-9
Alkalinity	200-230 ppm
Hardness	3200-3700 ppm
Calcium	235-270 ppm
Magnesium	610-695 ppm
Potassium	80-100 ppm

Potassium level monitoring

In case of inland saline water potassium is the most important and critical limiting factor compared to seawater which is a deficit in potassium and significantly high in calcium and magnesium so, maintain the desired level of potassium in pond water following steps are followed;

- The potassium content of the pond water should be maintained at a level of 50% of the salinity of natural seawater by fortifying the water with KCl prior to stocking. When new water is added in the pond, the potassium level needs to be monitored regularly.
- The requirement of potassium level in the pond can be calculated by using the following formulae:

Requirement of K^+ in ISGW = (10.7 x desired salinity) - available K^+ in ISGW

Conclusion and Future Prospects

Shrimp farming in inland saline water is more profitable as compared to agricultural/ horticultural crops because it fetches higher returns to farmers in a short span of 100-120 days. Further, utilizing the groundwater/seepage water for shrimp culture prevents water logging, improves soil texture and at the same time reduces secondary salinisation. Cluster Farming of a large saline area dividing into two clusters and producing two crops per year may result in increase of profit as well as employment generation. Moreover, it may reduce the production cost while on the other hand might increase the foreign export thereby improving the country's economy. So, cluster farming of shrimp is an alternative approach for aquafarming in inland saline waters of Punjab, Haryana, and Maharashtra.

Fig. 1: Components of BMP for shrimp culture in Inland Saline water A) Aeration B) Feed C) Stocking of seed and D) Water quality check-up.

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