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SHRIMP CULTURE (*LITOPENAEUS VANNAMEI*) AND ITS MANAGEMENT

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Introduction:

India has a vast coastline, which allows for extensive exploitation of marine resource. Fishermen in India used to engage in traditional sea fishing till a few years ago. Fishermen became focused on catching shrimps in the 1970s due to the significant profit margins associated with their export value. During 1991-94, brackish water prawn farming took off in a large manner, particularly in the coastal regions of Andhra Pradesh and Tamil Nadu (Subramanian, 1994). Brackish water is most frequent in estuaries where a freshwater river meets the sea. These waters sustain only a certain type of flora and fauna that can live exclusively in these waters, making them ideal for brackish water aquaculture. Shrimp fry caught in salt beds, coastal paddy fields, or brackish water fishponds were once permitted to develop to marketable size and collected as a supplemental crop. However, in recent years, since the harvest of shrimp generates better revenue than the main crop, many farmers have transformed their rice fields, salt beds, and fishponds into shrimp farms.

Shrimp farming is one of the most rapidly expanding aquaculture sectors in Asia, Latin America, and, more recently, Africa. Until 2009, shrimp farming in India was linked with the monoculture of tiger shrimp, *Penaeus monodon* (Ramaswamy *et al.*, 2013). Because of the availability of Specific Pathogen Free (SPF) and Specific Pathogen Resistant (SPR) brood stock, most South East Asian nations, including Thailand, Vietnam, and Indonesia, have moved to culture of exotic White leg shrimp, *Litopenaeus vannamei*, since 2001-02. In 2003, the entire global output of farmed shrimp exceeded 1.6 million tonnes, with a value of approximately 9,000 million US dollars (Tourtip et al., 2009). Around 75% of farmed shrimp is produced in Asia, mostly in China and Thailand. The remaining 25% is produced mostly in Latin America, with Brazil being the leading producer. Thailand is the world's greatest exporter (Giap *et al.*, 2009).
In India, a pilot-scale introduction of *L. vannamei* began in 2003, and following a risk assessment study, a large-scale introduction was approved in 2009 (Khushbu *et al.*, 2022a).

The idea of a limitless market demand, high export prices, job creation, and increased foreign exchange profits have pushed several countries in the region rich in aquatic resources to prioritize the development of the shrimp farming business.

Types of culture:

a) Extensive culture:

Extensive shrimp farming is a traditional farming practice which requires water to be exchanged under tidal influences with the inflow bringing natural seed and feed to the culture ponds (Rosenberry, 1998). Harvesting is undertaken on a bi-monthly basis during low spring tide events, when the ponds can be completely drained (Hung *et al.,* 2013). Supplemental feeding is not used in extensive culture systems, and the shrimp rely completely on natural feed (Reis *et al.,* 2021). There are three types of culturing practices employed in India.

Extensive farming employs very low stocking densities, usually in the range of about 3,000–5,000 fry per hectare (Valenti *et al.,* 2021). The dramatic increase in area utilization for extensive prawn production in recent years can be attributed to high market demand, increased hatchery-bred fry production, minimum technical requirements, and lower production cost and risks (Kabir *et al.,* 2020). In Philippines shrimp production has been mainly characterized by the extensive system. Out of the 200,000 ha of brackish water about 25% (50,000 ha) are stocked with shrimps in monoculture or in polyculture with milkfish (Ghoshal *et al.,* 2019).

Until 10 to 15 years ago, natural seed abundance of banana prawn (*Penaeus merguiensis*) and Indian white prawn (*P. indicus*) was sufficiently high to supply the ponds with juveniles and due to a decline in naturally produced post larvae (PL), farmers have to stock black tiger shrimp (*Penaeus monodon*) PL to improve their yields (Ahmad *et al.,* 2019). The practice of stocking PL in this manner is known as the 'improved extensive system'. These two systems occupy a large proportion of the shrimp culture area globally (Hung and Huy, 2007). In 2004, extensive and improved extensive systems accounted for 68 percent and 27 percent of the shrimp farming surface area (Thunjai *et al.,* 2004).

b) Semi- intensive culture:

Food is supplemented in semi-intensive production systems with garbage fish, tiny shrimp, Jawla paste shrimp (*Acetes indicus*), and inexpensive shrimp pellets (about US$0.8/kg).

- The stocking density is between 5 and 10 shrimp/m^2.
- The age of the pond, the farmer's expertise, feed, extraneous costs, the amount of seed supplied, and skilled labor all contributed favorably to the yield.
- The average predicted production was 3937 kg/ha (Raju, 2002). The research suggested that, in order to maximize profit, stocking density and feed consumption should be reduced from current levels.
- Aeration is not employed. The farms might be run as rotating shrimp/rice farms or incorporated into mangrove regions (McGraw and Scarpa, 2003).

c) Intensive Culture:

Shrimp are stocked at 20 to 50 shrimp per m^2 in intensive production systems. Ponds are often built near the top of the tidal prism and have a surface size of 2,000 to 3,000 m^2.

- The system necessitates a high level of upkeep and care in terms of feeding, water quality monitoring, and aeration.
- Formulated feeds as well as farm-made feeds are used (McGraw and Scarpa, 2004).

Table 1: Comparison of different type of culture

	Extensive	**Semi- intensive**	**Intensive**	**Super-intensive**
Stocking density	0.2-5/m²	5-20/m²	15-50/m²	50-200/m²
Nutrition	Natural food	Supplement + Natural food	Commercial Feed	Commercial Feed
Aeration	None	Sometime	Continuous	Continuous
Water exchange Rate / day	Tidal	1-20%	5-30%	50-200 %

d) Super-intensive Culture: Aquaculture systems with low land requirements and high stocking densities. Some farmers in the Brazil's northeast are implementing super-intensive agricultural technology. Ponds have square or rectangular surfaces ranging from 2,500 to 4,000 square meters, depths ranging from 1.8 to 3.0 meters, bottoms coated with high density polyethylene (HDPE) geo membranes, and central drains (Felix *et al.,* 2020). Shrimp are fed multiple times per day through human broadcasting or feeding trays, there is a high mechanical aeration rate (20 to 30 hp/ha), initial stocking densities vary between 120 and 300 shrimp per square meter, and yields can exceed 25,000 kg/ha/crop (Hou *et al.*, 2018). The shrimp may also survive considerably greater stocking volume.

Prestocking, stocking and post stocking management in shrimp culture: The success of any shrimp culture is dependent on improved management procedures in pond preparation and pre-stocking management activities.

Pond preparation: It is one of the most significant pre-stocking management techniques required for optimal shrimp development in grow out farming systems. Several considerations must be made during the pond preparation for shrimp production (Rajendran *et al.*, 2016).

Pond Renovation: The majority of remaining traditional shrimp ponds are large (1.5–0.9 ha), irregular in shape, and somewhat shallow (70–80 cm), resulting in significant variance in water temperature and salinity (Minardi *et al.*, 2019).

These ponds might be readily enhanced via rehabilitation by making them more regular in shape, uniform in size, and deep enough to accommodate the construction of adequate inlet and outlet gates to promote water exchange through supply and drainage canals (Hasan *et al.*, 2020). Farmers are urged to carry out the following processes while renovating a pond (Rajendran *et al.*, 2016)

1. Adjust the pond's size and form for better management at a reasonable cost. The pond should be rectangular in shape and occupy an area of 0.5–1 hectares. Dig up the pond to a depth of 150–180 cm to contain more water and minimize rapid changes in water temperature during the day.
2. When installed and used properly, the paddle wheels will not stir up dregs at the pond bottom, causing the water to become murky.
3. When the water depth is high, the pond dike should be built broader and stronger by compressing the soil to prevent water leakage and dike breach. If there are any tree root fragments at the pond's bottom, remove them completely.
4. Furthermore, decaying roots can quickly degrade water quality. Farmers should smoothen the pond bottom after cleaning the roots to create a slope toward the discharge gate.
5. When we alter a pond, we must construct two independent water gates, one for allowing water in and the other for discharging and harvesting water.
6. The size of the water gates should be proportional to the size of the pond to allow for enough water exchange for shrimp harvesting in a timely manner.
7. For a 1 hectare pond, its breadth should be roughly 1 m. Farmers should build water pumps capable of pumping water into the pond at any time.
8. There must be reservoir ponds where water may be stored and treated before being pumped into the raising pond.
9. To keep shrimp predators out, the water must be filtered with a sieve or a cloth filter (Soundarapandian and Gunalan, 2008).

Figure 1: Show shrimp pond a) With Lining b) Without lining

Top soil removal: The top black soil and bottom sludge must be removed to avoid anaerobic conditions from developing during the culture phase.

The sludge must be disposed of distant from the pond site so that it does not contaminate the water. Grow out ponds with high stocking density remove the whole pond top soil, whereas modified extensive ponds remove sections of the pond where there is a large buildup of organic matter from past crops, such as the feeding zone (Roy *et al.*, 2007).

Pond Preparation: It is critical to prepare the pond before adding the seed to promote maximum output. Unwanted species are eradicated by emptying the water and drying the pond until the soil splits in the pond bottom, killing predator fishes and other competing organisms in the pond (Jayaprakashvel *et al.*, 2020). Aside from permitting the escape of harmful gases from the pond bottom, drying the pond bottom is the cheapest technique of eradicating undesirable organisms. Allow the pond bottom to dry in the sun for a length of time until the dark color and foul odor in the soil have faded. This drying process can aid in the loosening of hard bottom and mineralization of pond bottom (Zadeh *et al.*, 2010).

Liming: After the pond becomes completely dried then remove 2–4 cm of top soil from the bottom. To eradicate illness caused by the collection of dead algae, lime must be distributed throughout the pond bottom, which is moist and stinky. Lime can also aid in the decomposition of organic materials and the killing of predators and other unpleasant aquatic animals that live on the pond bottom (Qiu *et al.*, 2021**).** Plough the pond bottom horizontally and vertically to a depth of 30 cm to remove noxious gases, oxygenate the bottom soil, discolor the black soil to eliminate the hydrogen sulfide odor and boost fertility, smoothen it, and produce a slope toward the outflow gate. Repair leaks at the water gates and on the earthen dike.

Bloom Development and Probiotic Application: Fill the pond to a depth of 40–50 cm, then sprinkle tea seed cake at a rate of 150–200 kg/ha to kill common fish or other aquatic creatures that may escape into the pond when water enters (Chang *et al.*, 2018). The pond is then supplemented with organic fertilizer (dry cow dung, rice bran, and groundnut cake) at a rate of 50–100 kg/ha and inorganic fertilizer (urea, DAP, and super phosphate) at a rate of 10–15 kg/ha. The pond is left for 3–4 days to allow for natural food (plankton) development, with water mixed by paddle wheel aerators (Khushbu *et al.*, 2022). When the pond's water turns green or brown, add more fresh seawater until the necessary depth is reached.

Figure 2: Show bloom development

Figure 3: Show shrimp

Seed Selection and Stocking: Aquaculture success is largely determined by the quality of seed and feed. Shrimp maturation and reproductive performance are critical for the successful propagation of captive penaeid broodstock. The global expansion of *L.vannamei* cultivation can be attributed to fast growing and disease resistant strains created through selective breeding operations. When compared to other penaeid shrimp species, this species can be easily reproduced in captivity, has a wide tolerance to environmental factors, utilizes low-protein meals well, and develops quickly (Wyban, 2007). Adult *L. vannamei*, like all other marine penaeid shrimps, lives and spawns in the water. The larvae metamorphose in the sea, and the post larvae move to brackish water settings, but the juvenile and sub adult spend their lives in coastal estuaries or lagoons. Males mature at 20g and females at 28g in nature, according to reports. However, broodstock weighing 40-45 g is recommended in hatcheries (Anand *et al.*, 2021). Females attain sexual maturity at 8-10 months, whereas males reach sexual maturity at or after 10 months. *P. vannmei* is a species of open thelycum. It marries when both the male and female are in the hard stage, and the spermatophore may be observed as a white sperm plug adhered to thelycum after mating.

Stocking: Shrimp stocking is a critical component of any biosecurity program. Use seeds from domesticated shrimp stocks that are disease-free ("Particular Pathogen Free" or SPF) or resistant to specific disease agents (SPR) SPF broodstock from a certified Nucleus Breeding Center (NBC) (Saoud *et al.*, 2003). These are biosecurity facilities with at least two years of recorded disease testing to back up their SPF certification. Before purchase, inspect the shrimp post larvae for general condition such as activity, color, size, and so on. If any dead or abnormally colored PL is found in the stock, the entire batch should be discarded. Before stocking in the pond, PL should be treated with 100 ppm formalin.

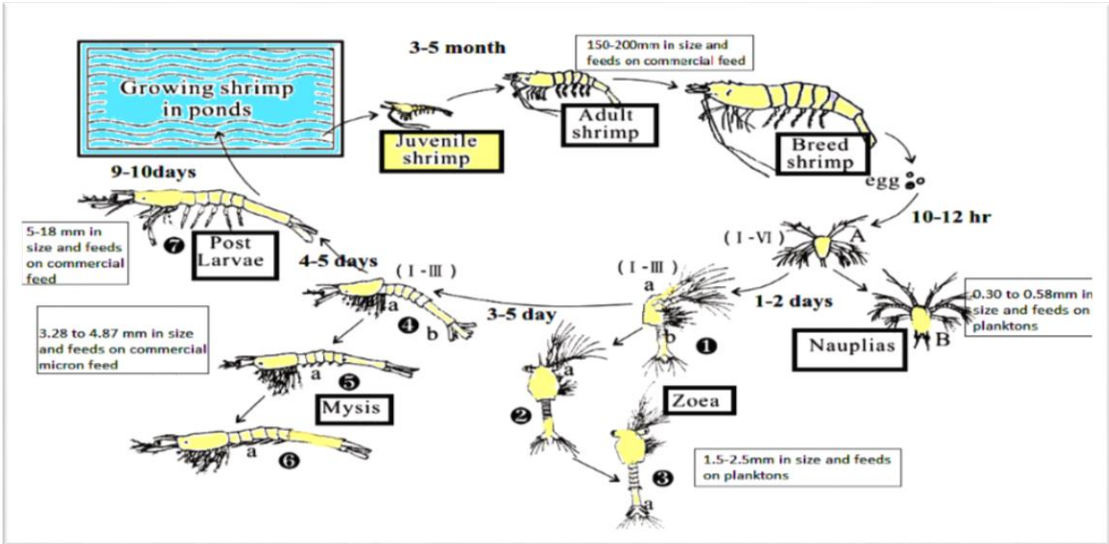

Figure 4: Show life cycle of shrimp

Maintaining a balanced or optimal stocking density is another critical aspect of shrimp production (Qiu *et al.*, 2021)

Feed management:

Management of live food and feed: Aside from hormonal modification, the quality of the maturation diet is critical in shrimp maturation. It is critical to choose an optimal diet that has a steady supply, is easy to handle, is effective in delivering immunostimulants, medicines, or hormones, has a low risk of disease transmission, and so on (Tinikul *et al.,* 2008). Fresh feeds are typically thought to be optimal for shrimp maturation because they are abundant in polyunsaturated fatty acids, particularly Arachidonic acid (ARA, 20:46), Eicosapentaenoic acid (EPA, 20:53), and Docosahexaenoic acid (DHA, 22:63), all of which are required for shrimp maturity. Currently, the shrimp business employs a wide range of fresh feeds, such as squids, bivalves, and polychetes, in conjunction with various artificial diets**.**

Improved feed management: Feeding tables are provided by all feed manufacturers in order to calculate feeding rates and avoid over- or under-feeding. The daily feed is adjusted based on shrimp size and the amount of feed left on the feeding tray from the previous feed raft (Kumar and Engle, 2016). Farmers often feed 3–4% of the daily feed ration into feeding trays (2.8, 3.0, and 3.3 percent for 5–10 g, 10–20 g, and >20 g shrimp, respectively). After two hours of feeding, the feeding trays are examined. If the amount of unfed feed left in the feeding tray exceeds 10%, the farmers cut the feed ration at the following feeding. When the feeding tray is empty, the ration size is raised**.** When the feeding tray is empty, the ration size is raised. Feed conversion rates (FCR) achieved with commercially prepared feeds varies from 1.3:1 to 1.5:1 when well-managed. FCR in poorly managed systems can reach 2.5:1. Yields of upto 7 tonnes/ha/crop can be obtained under intensive cultivation settings (Sung *et al.*, 1991).

Figure 5: Show feed and feed tray

Water quality management:

Total Hardness: A study conducted by Brown et al. (1991) on the growth and carapace mineralization of *Macrobrachium rosenbergii* found that it grows from 9 mg L^{-1} CaCO3 to 326 mg L^{-1} CaCO3 under the conditions of different water hardness. There was no significant change in growth at lower hardness levels but a decline at higher levels at 53 mg L*1 CaCO3. At the highest levels, survival was impaired.

Acidity and pH: Shrimps are able to tolerate acidity between 4.0-11.0 (Chamberlain, 1988) and pH levels 7.5-8.2 (Effendi *et al.,* 2016).

Transparency: Transparent water is one that is saturated with plankton, indicating more plankton is present. However, too much plankton density may affect the pond's pH and dissolved oxygen levels. The level of transparency must be maintained in between 30-40 cm (Flegel *et al.,* 2008).

Dissolved oxygen: Dissolved oxygen should not be less than 4 parts per million in the morning and more than 6 parts per million by late afternoon. Shrimp will rise to the surface of the water to acquire oxygen if DO concentrations are less than 4 ppm (Muralidhar et al.,2012).

Salinity: Shrimps grow best at salinities between 15 and 30 parts per thousand according to Saraswathy et al (2012). When reared in high salinity (5-15 or 25 ppt) than in lower salinity (5-15 or 25 ppt), *Litopenaeus vannamei* juveniles were affected by IHHNV (Infectious Hypodermal and Hematopoietic Necrosis Virus).

Temperature: When shrimp in a pond were exposed to temperatures exceeding 33°C for an extended period of time, the pond's production capacity was reduced. However, when shrimp in a pond were exposed to temperatures between 23.5 and 25.5°C or between 30 and 31.5°C over an extended period of time, the shrimp output in this pond increased (Abdelrahman *et al.,* 2017)**.**

Alkalinity: It is significant because it allows the pH to be maintained after the addition of acid without reducing the pH value. The alkalinity should be at or above 80 ppm (FAO, 2005).

Aeration Management: Paddle wheels are required from the first week. Use six 2-HP paddle wheels for a 1 ha pond with 15/m2 (long-arm aerator 10–12 wheels per unit engine). All paddle wheels are typically driven for 10 hours every 40 days. After the 40th day of culture, expect the aerator to need to be properly operated during feed time. Otherwise, there is a greater risk of oxygen depletion in the pond (Flegel, 2012).

In general, one horsepower is recommended for 500 kg of output and 50 PL/m. The location of aerators is critical to preventing sludge buildup in certain areas. Maintaining an adequate quantity of DO allows nitrifying bacteria to convert ammonia to harmless nitrate (CIBA, 2013).

Biosecurity Management: Biosecurity has been described as "sets of activities that limit the likelihood of a disease introduction and subsequent dissemination from one location to another ".

The following are major biosecurity objectives:

- **Animal management:** It is the process of getting healthy stock and enhancing their health and immunity via proper husbandry.
- **Pathogen management:** It is the prevention, reduction, or elimination of pathogens**.**
- **People management:** It includes educating and supervising employees and visitors**.**

Animal management includes following criteria:

Good husbandry: Avoid any environmental circumstances or procedures that stress the shrimp or may cause harm to the skin, fins, gills, or gut. This will weaken their immune systems and make them more prone to disease (Noga, 2010).

Pathogen-free stocking: Stocking pathogen-free postlarvae does not ensure a disease-free culture since pathogens can still enter the culture environment horizontally and infect the shrimps during the culture (Gunalan, 2015).

Viral pathogens can still infiltrate the culture environment via the methods listed below, and a better understanding of them can aid in the prevention of horizontal transmission. In addition to the above-mentioned carriers, viral particles can enter the farming system by remaining in the soil, *intake water, *aquatic vectors delivered by intake water, by crabs, and other animals* (Kim *et al.*, 2021).

- Land animals and birds contaminated with eagle, crow, or water crow.
- Farm inputs contaminated via live feed and semi-moist feed
- Farm equipment, nets, and automobiles, among other things, were contaminated.

Table 2: Show various chemicals used for shrimp health and disease management

Chemical name	Trade name	Form	Method of usage	Functions
Benzal Konium chloride	BKC	Liquid	Spread with water, 0.5 ppm	Control bacteria and reduce phytoplankton in water,
Chlorine	Bleaching	Powder	Spread with water; 60 ppm	Eradicate virus carrier to prevent WSSV
CaO	Rock lime	Solid	Spread with water, 10 ppm	Improve soil and water quality
$A1_2O_3.SiO_2$;	Zeolite	Powder	Spread with water 10–20 ppm	Improve soil and water quality
$A1_2SO_4$	Aluminium sulfate	Solid	Spread with water 2.5 ppm	Reduce or settle iron in water
$CaCO_3$	Agriculture lime	Powder	Spread with water; 6–10 ppm	Improve water quality
$KMnO_4$	Potassium permanganate	Granular	Spread with water, 0.1–0.2 ppm	Disinfectant
Vitamin C	Vitamin	Powder	Mix with feed, 3 gm/kg feed	Feed supplement to increase resistant powder
Urea	Fertilizer	Solid granular	Spread with water, 1–2 ppm	Improve plankton in water

Tinsen	Tinsen	Powder	Mix with feed, 3 gm/kg feed	Feed supplement to increase resistant powder
Eco-solution	Eco-solution	Liquid	Spread in water, 0.1 –0.2 ppm	Prevent viral disease
38% Formaldehyde	Formalin	Liquid	Spread with water, 1–3 ppm	Control protozoan disease also improve water quality
Sodium percarbonet	Best oxygen	Powder	Spread with water, 0.1–0.2 ppm	Increase O_2 in water
Urea	Fertilizer	Solid granular	Spread with water, 1–2 ppm	Improve plankton in water
Tetravet 200WSP	Tetravet	Powder	Mix with feed, 3 gm/kg feed	Feed supplement to increase resistant powder
Sodium thio sulfate	EDTA	Powder	Spread with water; 0.1–1 ppm	Disinfectant also reduce toxic gases

Good preventive medical practices: Quarantine, frequent monitoring, immunization, and the use of immunostimulants, probiotics, and diagnostics for illness treatment are all examples of good preventative medical practices (Yanong and Erlacher-Reid, 2012).

Shrimp Health Analysis: Shrimps should be tested once a week using cast nets and evaluated for general health concerns such as exterior appearance. A pale yellowish stomach, for example, indicated a gut infection, whereas a typical gut would be bright or golden brown in color. Probiotics, immunostimulants, and bioremediation agents can be used as preventive measures in grow out culture (Shen *et al.*, 2010).

To enhance the overall pond microbial balance, a yeast-based organic product (60 kg rice flour, 30 kg yeast, and 3 kg yeast) can be used. Antibiotics should be avoided in shrimp farming due to major concerns about their usage**.**

Sanitation and disinfection:

- Physical treatments: include heat, sunlight, and drying (dessication)
- Chemical treatments: Virkon Aquatic, Bleach, Phenol derivatives, Alcohol, and other chemical techniques are used.

People and equipment disinfection stations: utilize disinfectant footbaths, hand-washing stations or alcohol spray bottles, net disinfection stations, showers, and vehicle disinfection stations.

Table 3: Show Various disinfectant used in shrimp culture

Chemical name	Trade name	Dosage
Benzal konium chloride	BKC	Spread with water, 0.5 ppm
Sodium thiosulphate	EDTA	0.1–1 ppm
n-Alkyl dimethyl benzyl ammonium chloride + stabilized urea	Emsen	80 g/33 dec
Chlorine	Bleaching	60 ppm
Efinol	Efinol	5–8 gm/liter water
38% Formaldehyde	Formalin	1–3 ppm
Ankul benzyl dimethyl ammonium chloride + poly-2- deoxy-2 amino glucose	Lenocide	500–1000 ml/acre
Iodine 20% Nony alklohenoxypoly ethaneixide iodine complex	Microdine	2–2.5 L/acre
Benzyl ammonium chloride + urea	Omicide	200 ml/33 dec. after 24 h. 150 m
Sodium thiosulphate	Water clear	In case of 5–6 feet deep water body 2–3 L/100 dec.
n-Alkyl dimethyl benzyl ammonium chloride + stabilized urea	Timsen	20 g/33 dec. (for prevention) , 80 g/33 dec. (for treatment)

Farm Records: Records are required to detect various hazards and to correct problems as soon as possible during the production cycle. Record keeping also allows farmers to learn from past failures, lowering risk and production costs in succeeding crops (Roy *et al.,* 2007).

Control worker mobility inside and across the farm, and reduce the amount of personnel involvement in stocking, harvesting, sampling, and so on. It is critical to maintain environmental cleanliness and govern human traffic, visitors, employees, technicians, and movement across fields (Diwan, 2005).

Conclusion:

The two-pronged approach of combining pond management and health monitoring is the key for successful shrimp production. Sustainability of aquaculture depends on the maintenance of a good environment. The understanding of the ecological processes occurring in source water bodies and in *L. vannamei* shrimp culture ponds through regular monitoring will help us understand and solve some of the disease issues faced by shrimp farmers**.**

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