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Better Management Practices (BMPs) for Sustainable Shrimp Farming

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ABSTRACT

Aquaculture play major role for food production and employment generation as well as economy growth of any country. Due to high production cost and low demand in global shrimp market, farmers now face lots of problem, many farmers stop culture but if we employed Better management practices (BMPs) then we can reduce these production cost. In this article we discussed about Better management practices, from Pond preparation to seed selection, water screening, biosecurity, feed management, water quality management, pond bottom management, health and disease management and better harvest practices. Along with more production we focus on sustainable aquaculture to save our environment and biodiversity for that case we should use probiotics instead of antibiotics, effluent management and also water management before releasing it into river and canals, maintains precautions for contamination and disease spread. Data was gathered and organized chronologically from a variety of secondary sources, including journals, research papers, articles, reports, and electronic media. This review's primary goal is to raise knowledge about Better management practices as well as Sustainable Aquaculture which will help students, entrepreneurs, Research scholars, others stack holders in this sector and also farmers who can directly use BMPs in their farm to minimize their production cost and maximize their profit.

KEYWORDS

Better management practices, Sustainable shrimp farming, Water quality management, sustainable Aquaculture, Feed management, Disease management, Effluent management

Introduction

Aquaculture is one of the fastest growing and most promising industry for providing animal protein and food security to the growing population. Within the aquatic food chain, fish and shrimp are regarded as the most significant group of animals fit for human consumption among the varied food items found there. Aquaculture has enormous potential for growth, but catch fisheries are nearly stagnant and have been for over ten years. Now aquaculture production mainly depends on the Culture fisheries. During the last decades, we were used excess amount of chemicals and antibiotics for disease management, discharge of effluents into the open environment and release the cultured animals in wild environment. If the process continued, aquaculture will be dropped into an unsustainable condition. BMPs are the only approach to overcoming the problems. Aquaculture can be a sustainable activity if it is carried out using good aquaculture practices in a way that is appropriate for both the environment and society. Sustainable aquaculture is defined as an aquaculture production system that uses renewable resources as much as possible, operates in balance with the environment and other living systems, and gives the animals living conditions that are as similar to those of their natural habitats. Adopting Better Management Practices (BMPs) may help to achieve sustainability.

What is Better management practices?

A Best Management Practice (BMP) is a collection of guidelines that are produced based on risk factor research and are evaluated for current concerns after collaboration with practitioners and key stakeholders. Production should be increased to meet the demand; at the same time, we should keep sustainability in mind. BMPs should be simple, science-based, cost-effective and appropriate to their context if farmers are to adopt and implement them.

“The Best management practices encompass social responsibility, legal compliance, thoughtful site selection and farm building, as well as appropriate management procedures from pond preparation to harvest and post-harvest operations. Adopting BMPs would lead to increased output, returns, and productivity while also assuming social and environmental obligations.” [MPEDA].

The main objective of BMP development is to assist farmers in managing their facilities more financially and effectively while adhering to rules regarding wastewater discharge. Environmental Protection Agency (EPA) of the United States acknowledges best management practices (BMPs) as "schedules of activities, maintenance procedures, prohibitions of practices and other management practices to prevent or reduce the pollution of water of the United States."

Adaptation of Better management practices:

1. **Pond preparation method**: The optimal conditions for shrimp and fish farming are provided by pond preparation, which is done by use of scientific approaches to reduce the danger of diseases and other outbreaks. When preparing ponds, the following should be put into practice.

    a) **Increase the water holding capacity of the pond-** The pond's water holding capacity must be raised in order to lower the risk of disease and excessive dependence on water exchange, while also maintaining a minimum water level of 1.2 meters in the middle of the pond**.**
    b) Completely drain out the water from the pond- The fish and crabs that carry disease that were present in the pond during earlier crops can be eliminated by completely removing the water. Use the wet preparation method if draining the water is not an option.
    c) **Removal of Sludge and Organic waste from pond Bottom--** Particularly in situations where there is less of gap between two crop, sludge control is equally crucial. During the culture periods uneaten feed, dead animals, dead planktons and others are settle down at the bottom

as sludge. Both organic and inorganic materials are present in this sludge, which promotes the growth of pathogens and an algal bloom.

Fig-1: Drain out the pond and sun dried

Shrimps are stressed out or even died by the toxic gases that organic matter releases into the pond, such as ammonia and hydrogen sulphide. When the soil is moist, it should be inspected for the presence of a black layer that represents organic waste. This layer can be found in feeding areas, corners, trenches, and the centre of ponds with aerators.

The following strategies can be used to remove organic matter:

- Use pond vacuums to remove this sludge, and be careful that rainwater does not re-enter the pond with the organic debris that has been removed.
- The pond should be left to dry in the hot sun for 20 to 30 days, or until the soil cracks, if it is not possible to remove all the dark black dirt. In order to help oxidize the organic matter and reduce gastropods, plough the pond two or three times, separated by two to three days. Compaction of the pond bottom following ploughing helps to decrease turbidity and leakage.
- Farmers can use the wet pond preparation method listed below if they are unable to dry off their ponds-

- Before ploughing, apply tea seed cake @ 20 kg/acre/Ft water depth means if you have an acre of 3ft depth, you must apply 60 kg /acre for perfect result (it is for salinities below 20 PPT, if salinity above 20 ppt then apply 10 kg/acre/ Ft water depth) or 20 ppm of chlorine, and remove any dead animals.

- With 15 to 20 cm of water in the pond, plough it with the tractor equipped with gauge wheels.

- Drain water from pond following the ploughing.

- Use soil probiotics like *Nitrosomonas* and *Nitrobacter* along with Rhodococcus and Rhodobacter to convert the ammonia and Nitrite into Nitrate (Less toxic for Aquatic animals).

d) **Fertilization and liming of the pond bottom-** The process of fertilizing a pond improves soil fertility, pond carrying capacity, and mineral content balance. It can be achieved through: Apply dry vermicompost 250-1000kg/ha or compost manure @ 500- 2000 kg/ha.

In moist conditions, test the pH of the soil with a soil pH meter. If soil pH is 7 then no need to apply any Lime, if soil pH less than 7 then need to apply 50 kg/Hectare of Burnt lime or quick lime (CaO) at every 0.5 pH decreasing i.e at pH 6.5 – lime 50 kg / Ha, pH 6- lime 100 kg/Ha. Similarly, we can use agricultural lime ($CaCO_3$) instead of quick lime but dose will change in that case i.e at pH 7 – no lime, pH6.5- lime 100 kg/Ha, pH 6- lime 200 kg/Ha.

Fig-2: Application of lime on the pond bottom

2. Water Screening and treatment-

- Water screening plays a critical role in preventing the spread of disease. There is no need for additional disinfectants if proper water screening is done. To stop predator larvae, eggs, and other particulate matter from entering the farm, a three-stage water filtration system is used.
- Before entering the reservoirs, the inlet water is filtered through a 150 microns mesh screen. For two to four days, the water in the reservoir is left to settle. The bottom of the reservoir is where the suspended matter, silt, etc. settles.
- After that, water is treated with 25 ppm of bleaching powder and 5 ppm potassium permanganate to eradicate any potential bacteria and virus-carrying parasites.

Fig-3: Water screening

3. Post Larvae Selection and Stocking-

One of the most crucial elements that affects the entire crop is the selection of seed selection.

- Choose good post larvae which are PCR-tested and Specific pathogen free (SPF) from recognized hatchery that are Coastal Aquaculture Authority (CAA) certified.
- Select the post larvae (PL) that are uniform in size and also Colour (Dark or light brown), which are actively swimming against the water current.
- Try to avoid wild seed because they can carry some un desirable diseases.
- For extended transportation, seed should be packed with adequate aeration and a good amount of artemia.
- One of the most things is to select proper Post Larvae (PL) size. For *P. monodon* PL 20 and PL 13 for vannamei is the ideal for stocking.

- Prepare the pond water before release seed into the pond, the pond water should be green in colour that is indicate sufficient planktons present in the water.
- Low temperature hours like early morning and late evening is the best time to stocking the seeds.
- Acclimatization of seeds should be practiced to reduce the sudden Stress.

Fig-4 Acclimatization of seed

Fig 5- Seed packed in polythene bag

4. Biosecurity-

In the field of shrimp farming, biosecurity refers to the precautions taken to keep particular pathogens out of shrimp cultures. In shrimp farming, biosecurity includes sanitation, personal hygiene, pond preparation, water screening, disease-free seed stocking, and the prevention of disease carriers from entering the area. In order to maintain a disease-free environment, biosecurity is essential to farming.

- Use LDPE and high-quality nylon crab fencing to manage carriers, or burrowing agents like crabs.
- To keep birds and their droppings away, use bird fence with ideally red and blue fiber threads.
- Farming area should be clean and maintain sanitization dip like Potassium Permanganate solution at entry and exit areas.
- To prevent cross-contamination, clean farm tools and materials on a regular basis using potassium permanganate or any hypochlorite solutions.
- Maintain personal hygiene of the farm workers.
- Regulate the movement of farm workers both inside and outside the farm as well as outsiders that might be disease carriers.

Fig-6: Potassium permanganate sol. Water for disinfect the equipment and personnels

Fig 7: Bird fencing

Fig 8: Crab fencing

5. Feed Management-

As feed management pays for 50–60% of overall operating expenses, it is an essential part of effective shrimp production.

- It is important to provide fresh, high-quality feed that is specially prepared to fulfill the needs of the species.
- The feed shouldn't be older than 120 days from the manufacturing date.
- Feeding should start from 1st day of stocking. Staring with 2 kg feed per day per 100000 PL and after that 300 gm increase every day until 30 days this is called blind feeding.
- After 30 days feed given based on body weight and check tray observation.
- Calculate the requirement of feed depending on the shrimp body size and weight to proper utilization.
- By checking the check tray, we can increase or reduce the feed.
- Lower the amount feed on overcast condition and wet days, as well as during high temperatures and plankton crashes.
- Lower the feed quantity under low DO and pre-moulting conditions.
- Regularly monitor ammonia and nitrate conditions.
- To determine the growth, survival, and FCR of the shrimp, we should focus on regular sampling.
- Avoid over feeding as it lead to accumulate uneaten feed at the bottom that causes the increase of toxic substances.

- It is recommended to store feed in locations that are well-ventilated, clean, and free of rodents. Additionally, feed should be kept in pallets.

Fig-9: Check tray

Fig-10: Feeding method

5. Water quality management –

To have a successful crop, the most crucial component is the quality of the water. This is a factor that affects the entire culture, so in order to keep the water clean, we must use the following techniques.

Fig-11: water quality checking (pH test)

- Avoid frequently exchanging or receiving water. Water exchange can begin in the third month if needed, but it should be minimized as much as possible. Releasing or receiving more than 10–20 cm (8–15%) of water daily is not recommended. When possible, it is recommended to use reservoir water for exchange.
- Maintain reservoir for water treatment before releasing into the culture pond.
- For prefiltration of intake water, use double layered 60 microns mesh filter at inlet pipe to prevent entry of pathogens, predators and unwanted organisms and use 80 microns mesh net Below the inlet for additional filtration.
- For treatment, use high-quality bleaching powder (35% or 70%), and avoid using insecticides or pesticides of any kind.
- If the pond water is clear in the early stages of culture (four to six weeks), there aren't any planktons there. Shrimp culture cannot be successful without plankton bloom. Use fermented juices made from 60 kg of paddy flour, 30 kg of molasses, and 2.5 kg of yeast or harissa to keep the plankton bloom healthy.
- If the colour of the water is too dark, replace the top 10 cm with fresh water in the afternoon, preferably during high tide, and avoid using chemicals to kill the algae. If it's possible, cut back on or cease feeding during this time.

- If the suitable water condition is not occur the it is always suggested to Dragging chain on

Fig-12: Application of Dolomite

pond bottom.

• Use high-quality minerals, particularly a combination of calcium, magnesium, and potassium, to keep the ionic balance in the water system.

For high growth of Shrimps, we need to maintain optimum water quality parameters. The optimum water quality parameters given below-

Parameter	**Ideal range**	**Analysis**	**Timing**
Dissolve oxygen concentration	4-6 ppm	Instant kit or DO meter	5 to 6 am
Temperature	28-32 °C	Thermometer	6 am and 3 pm
pH	7.5-8.3	Liquid indicator or calibrated pH meter	6 am and 3 pm
Salinity	10-25 ppt	Refractometer	Any time
Total alkalinity	100-200 ppm	Use Alkalinity instant test kit	Any time
Total ammonia	<0.5 ppm	Use ammonia instant test kit	Morning
Transparency	30-40 cm	Secchi Disc	12 noon
Water colour	Green or brown	Visual observation	Day time

Fig 13- Unfavorable water condition

6. Pond bottom Management

The quality of the pond bottom, where shrimp spend the majority of their lives, has a significant impact on the shrimp. Upholding a robust pond bottom is crucial for all kinds of culture systems.

- Every week, look for any signs of black dirt or an unpleasant odor in the bottom soil.
- Rapid consumption of feed in the check trays can be a cause of bottom sludge.
- If soil is black, exchange water and reduce feeding.
- At feeding areas, perform routine chain dragging to promote the oxidation of organic matter. Benthic algae can also be removed by chain dragging.
- Regularly remove accumulated black soil and benthic algae from the pond corners.
- In areas where the pond bottom is poor, apply more lime in addition to the regular application.
- Maintaining a clean feeding area is possible with a sufficient number of strategically placed aerators.
- Use soil probiotics contain *Nitrobacter*, *Nitrosomonas, Rhodobacter* and *Rhodococcus*.

7. Health Management practices-

Every day, check the condition of the shrimp in the feed check trays. Poor feed consumption over a three- to four-day period is indicative of health issues. Every week, assess the overall well-being and growth of the shrimp that were caught using a cast net. Samples should be taken in the early morning or late at night at various locations.

- Check water quality parameters and bacterial loads on a regular basis.
- The body colour of the shrimp should be normal in colour and the gut should be filled with feed.
- Check any infections or any colour changes of legs and antennae.
- Determine deformities and fouling. Inspect shrimp for accumulation of debris and the development of microorganisms on their exoskeletons, known as external fouling. This is a sign of poor pond health.
- Check antennal colours and also check any roughness or cutting of antenna which indicates unhealthy shrimp.

- If the tips of the antennae are black, the pond's poor bottom may have caused a bacterial infection. Shrimp gills that are black indicate that the pond's bottom is dirty. By implementing improved pond bottom management techniques, the pond bottom will be improved.
- Hepatopancreas should be brown in colour.
- Check any black or white spot on surface of the shrimp.

If found any one from above then use preventive method and treatment and also keep the feeding area clean.

- If you notice sick or dark shrimp in the surface water, look for black or dirty gills. If so, take precautions by reducing feeding and exchange of water.
- Every day in the early morning, check the pond for unhealthy or dead shrimp as well as any other indications (such as oxygen issues or any other unusual observations). Then, follow the guidelines for managing diseases and let the other farmers in the society know.
- Provide good water condition that will enhance the moulting, if need add minerals like calcium and magnesium to excelerate the moulting process.

Fig-14: Cast netting for sampling

fig-15: Health checkup of shrimp

8. Disease management-

Throughout the crop time, make sure that adequate water screening and complete biosecurity are maintained.

- Any issues that arise during the crop, such as shrimp drifting off, should be reported right away to all farmers in the society, and farmers should be contacted to deal with the problem right away.
- Use quality probiotics regularly and sterilize using trustworthy sanitizers during viral outbreaks..
- To improve the overall condition of the pond, corrective actions regarding antenna cut, fouling, or gill issues should be taken.
- Do not let water escape from shrimp that have white spots, and notify all of the community's farmers right away. In an emergency, remain calm and coordinate with other farmers.
- If any serious infectious disease is detected which has the potential to spread widely the pond should be isolated,
  a. If the shrimp are small in size, do not empty or abandon the pond; instead, use 20 ppm chlorine to disinfect it. Hold onto the water without discharging it for a week.
  b. Gather all the shrimp without removal the water if their size allows for harvesting. Use 20 ppm chlorine to disinfect the pond. Hold onto the water without discharging it for a

week. After a week, notify every farmer in the community when the disinfected water is discharged, and ensure that no water is pumped in for a minimum of two days.

- Install a bird net to stop birds from collecting dead shrimp and transporting them to other ponds. The afflicted and dead shrimp would be buried beneath the ground far from the pond.
- Collaborating and communicating with local shrimp farmers and farm workers, as well as holding frequent meetings to discuss disease issues, can help to prevent the spread of disease.
- In the event of a disease outbreak, keep feeding the regular ponds. Shrimp that are not fed grow weaker and more prone to illness. Remain on the farm during a disease outbreak and make sure that neither other personnel nor animals have contaminated you.
- Equipment from the impacted pond should not be moved to other ponds. Let farmers place KMnO4 solutions wherever they can for tasks like hand and leg washing, dipping legs, equipment washing, etc.

Fig-16: Floating of dead shrimp on water surface
Fig-17: Collecting of dead shrimp by feed boys
Fig-18: accumulation of dead shrimp in bucket

Fig 16

Fig-17

Fig-18

9. Use Probiotics instead of Antibiotics for retain sustainability of Environment-

To treat diseases and also for growth promoter of culture species Antibiotics were used from last 2 decades but it has adverse effects on aquatic species such as presence of antibiotic residue in animal tissue, generation of bacterial resistance mechanism and imbalance of intestinal microbiota. So, probiotics is only alternative way to treat the diseases and also as a growth promoter.

Probiotic is a live Microorganisms that beneficially affects the host. Probiotics is also called friendly or beneficially. Mainly gram-positive bacteria such as Lactic acid bacteria – *Lactobacillus; Bacillus, Streptococcus, Bifidobacterium, Enterococcus* etc used as probiotic strain. Some yeast like *Saccharomyces cerevisiae* and micro algae *Tetraselmis suecica* also used as probiotic strain. Beside that *Nitrobacter, Nitrosomonas, Rhodobacter, Rhodococcus* etc used as soil probiotics.

The main mechanism is that they Grow rapidly and spread their colony over the pathogenic microorganisms so they dominate the pathogenic microorganisms. Probiotics organisms compete for binding site, compete for nutrition with the pathogenic organisms and also some probiotics have Bactericidal and bacteriostatic effect on pathogenic bacteria. Some probiotic has ability to stimulate the immune system also they can activate the phagocytic cells and macrophages and they can fight against virus by secretes interferon by body's natural defence system.

Till now no documented evidence available for side effects of using probiotics in aquaculture but excess use can create some problem.

Fig 19-: Feed Probiotics mix with feed

Fig 20: Soil probiotics mix with white sand

10. Effluents management-

Pond water effluent has a big impact on environment (Eutrofication) due to the high nutrient content. To manage the effluent some techniques are used those are:

- Efficient use of fertilizer and feed. Control the nutrient leaching.
- Use of recirculation system.
- Use of high-rate algal pond system
- Before releasing the water into river or canal it should treated with chlorine that help the chemical biodegradation.
- Use sedimentation pond for settle the effluent.
- Plant mangroves on the discharge canal dike as it is use as a natural filter.
- Drain out the pond and then discard the effluents by physically or mechanically and keep it away from farm then let them to dry and dig them into the soil.

Fig-21: Direct discharge of effluents before proper treatment

11. **Better harvest and post-harvest practices:**

Use the following best practices for harvesting and post-harvest handling to enhance the freshness and quality of shrimp for export markets:

- Don't exchange water before 2-3 days from the schedule harvest date. It always advice to exchange atleast 20 % water before one week.
- Avoid of feeding to shrimp six hours before harvesting in order to extend shelf life
- Harvesting should be finished in 6–8 hours, between 6 PM and 6 AM
- Use dragnets rather than cast nets
- When cleaning the shrimp, avoid using any chemicals.
- Make sure that when harvesting and packing, high-quality ice is used (ideally straight from the processor).
- For perfect preservation, place the shrimp in transport boxes with a 2:1 ratio of crushed ice to shrimp.
- Use bleach and lime in the harvest area after harvest to prevent cross-contamination.

Fig-22: Harvesting

Fig-23: Weighing for transport

Fig-24: Temporary Preserve in crushed ice

12. Record keeping-

Maintaining accurate records is essential to running a shrimp farm effectively. Records are required to detect issues with water quality, keep an eye on daily operations, recognize and learn from previous mistakes and reduce production costs.

What are the thinks keep in record:

- Give unique name of every pond like (A1, A2, A3, C2, D1, etc.)
- Water spread area of each pond
- Stocking density
- Feeding details likes quantity of feed, feed company, feed batch number should keep in the record
- Date and percentage of Water exchange with pond details should keep in record along with every water quality parameter.
- Details of additives such as probiotics, minerals, fertilizers etc.
- Weekly sampling report with survival rate and average growth rate should be keep in record.
- Date, time and production (in quantity) of partial harvest and final harvest from each pond.
- FCR of every culture
- Economics- Cost of seed, cost of feed, cost of labour, cost of chemical, revenue, profit etc. should keep in the record.

Conclusion:

There are a lot of threats of disease, a high cost of feed, a high cost of seed, and other management costs, as well as a decrease in productivity. In these circumstances farmers are unable to continue their culture due to increase production cost so the one and only way to reduce production cost and get high production is to focus on better management practices. If we employed Better management practices from the starting of culture to the harvest of shrimp it means pond preparation and management, water screening, seed selection, biosecurity, water quality management, health and disease management etc. that would reduce the risk of getting stress to the culture animal, Reduce the feed wastage and all-over it reduce the risk of disease. Due to this, farmers can get better production and profit. Along with more production, we also have to think about protecting the environment to retain the sustainability. So, for that case we should follow BMPs such as use probiotics and management of Pond effluents and also treat water before releasing into the nature as well as stop contamination from diseased pond to spread it into another pond.

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