Guidelines for Regulating Coastal Aquaculture

Annexure-I

(see rule 3)

Guidelines for Regulating Coastal Aquaculture

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Appendix

Guidelines for Regulating Coastal Aquaculture

1.0 Introduction

1.1 Coastal aquaculture entails managed farming or culture of organisms in saline or brackishwater areas for the purpose of enhancing production, both for domestic and export markets. Coastal aquaculture in the broader sense includes culturing of crustaceans like shrimp, prawn, lobsters, crabs and finfishes like groupers, sea bream, mullets and molluscs like clams, mussels and oysters.

1.2 These guidelines are to ensure orderly and sustainable development of shrimp aquaculture in the country. The guidelines are intended to lead to environmentally responsible and socially acceptable coastal aquaculture and also enhance the positive contributions that shrimp farming and other forms of aquaculture can make to socio-economic benefits, livelihood security and poverty alleviation in the coastal areas.

1.3 The present guidelines are to cover the entire gamut of shrimp farm management and measures to reduce the environmental impact of the wastewater discharged from shrimp farms, treatment of such wastes and mitigation of the adverse impact of such wastes on the environment as well as resolution of social conflicts, which could lead to sustainable development of shrimp aquaculture. The guidelines are intended to assist the farmers in adopting good management practices (GMP).

1.4 These guidelines are for the use of all stakeholders involved, including shrimp farmers, the coastal community, State Fisheries Departments, Pollution Control Boards and the Ministries and Departments of the Governments of India and the States.

2.0 Shrimp aquaculture

2.1 Shrimp aquaculture is one of the most common and popular farming practices in the coastal areas. By the end of 2004 out of an estimated 12 lakh ha amenable for coastal area only about 1 50 000 ha is under shrimp farming producing about 1 20 000 tonnes of shrimp every year. *Peneaus monodon* is the most commonly farmed species for which the technology is also well established. Presently, about 80 per cent of the shrimp culture activities in the country are under traditional/ extensive systems.

2.2 Shrimp aquaculture also resulted in development of several ancillary/ associated activities such as seed production, feed production and processing units as well as aquaculture machinery/ equipment production. Together, these activities have contributed to the generation of livelihood options and employment opportunities in the coastal areas.

3.0 Shrimp aquaculture practices

3.1 The technology, scale and intensity of shrimp aquaculture determine the production and productivity as well as the environmental and socio cultural impacts on the coastal environment. Presently, traditional/ improved traditional and scientific extensive shrimp farming practices are most common and adopted by the farmers in the coastal areas of the country. Traditional/ improved traditional systems are characterized by low stocking densities and limited application of supplementary feeding or fertilizers. In scientific extensive farming, supplementary seed and feed are encouraged as a means of integrating more effectively the use of land and water resources in the coastal areas.

3.2 The other technologies of shrimp farming such as semi-intensive and intensive are not recommended as they involve the use of higher stocking density of seed and larger quantities of feed and fertilizers. Such practices generally place larger demands on the natural resources and result in higher organic load leading to pollution and social impacts in the coastal areas. Therefore, only traditional/ improved traditional and scientific extensive systems of shrimp farming shall be permitted in the coastal areas.

4.0 Site selection

4.1 Site selection is an important process in aquaculture as this can often decide the success or failure of the shrimp farm, small or large. Besides technological (biological, physical and chemical) aspects of aquaculture, the environmental and socio-economic aspects covering social, economic and legal issues are important parameters to be considered while finalizing the site for setting up a shrimp farm. It is also essential to look into the previous use(s) and topography of the site to determine the adequacy of the site and cost of farm construction.

4.2 The following guidelines on site selection are to ensure that shrimp farms are harmoniously integrated into the local environment and social settings. By identifying the limitations that influence the suitability of a site, it is possible to incorporate corrective measures in the farm design and also formulate remedial measures for the negative impacts likely to arise out of these limitations.

4.3 Large-scale shrimp aquaculture may bring in excessive demand on land resources, resulting in multi-user conflicts. Construction of shrimp farms may make inroads into agricultural land. The States must undertake detailed surveys to identify lands/ areas, which are fit for different purposes and allocate suitable area for shrimp farming. They should discourage conversion of agriculture land for aquaculture. Construction of shrimp ponds on marginal land not fit for cultivation alone should be permitted. However, the competitive and cooperative activities of the different sectors concerned should also be considered while giving approval to setting up of shrimp farms.

4.4 Generally clayey loam soils are preferred. High capital and operational cost will be involved in maintaining a farm in sandy area, which is also to be avoided owing to the high water percolation through the sandy soils, and possible environmental damage which could arise from it. Further, the topography of the soil and its contour should be ascertained in relation to the water intake and drainage points as well as construction costs. A better site is the one, which involves lesser capital investment for constructing fully drainable ponds.

4.5 The quality of soil should be ascertained for soil pH, permeability, bearing capacity and heavy metal content. Soil with low pH of below 5 (example acid sulphate soils) should be avoided. Similarly, soils with high concentrations of heavy metals also should be avoided. The suitable soil characteristics ideal for construction of a shrimp farm are as follows:

pH	Organic carbon	Calcium carbonate	Available nitrogen	Available phosphorus	Electrical conductivity
7-8	1.5 – 2.5%	> 5%	50–75 mg/100 g soil	4–6 mg/100 g soil	> 4 µmhos

4.6 The hydro-meteorological data of the proposed area is very important to develop the design of the farm and to ensure the availability of acceptable water quality in the farm. The most important data required in this regard are rainfall, tidal fluctuation, wind direction and velocity, flood levels, frequency and time of occurrence of natural calamities such as storm, cyclone, hailstorm, etc. Construction of farms in cyclone prone areas and places where natural calamities such as floods occur should be avoided.

4.7 Mangroves play an important role in soil binding, as a source of nutrient cycling, as a buffer and a natural biological filter of several pollutants and as a breeding ground and

nursery area for many important fin and shellfishes. There is evidence that removal of mangroves leads to a decline in fin and shellfish recruitment to the open waters through reduced availability of post-larvae. Mangroves are now legally protected under the environment law of the country.

Large concentration of shrimp farms in mangrove areas has not proved sustainable elsewhere in the world. Mangrove soils are potential acid sulphate soils and not conducive for setting up of shrimp farms. The States should not permit shrimp farm construction within natural mangrove areas, or ecologically sensitive wetlands, swamps, etc.

4.8 The infrastructure facilities like roads, electricity, proximity to hatcheries, feed manufacturing units/ feed retailers, ice plants, processing plants should be considered while choosing the site for a shrimp farm since these play an important role in the economics of culture operations.

4.9 The following guidelines, which are mandatory, should be adopted for site selection and also to avoid subsequent social and environmental impacts.

- Mangroves, agricultural lands, saltpan lands, ecologically sensitive areas like sanctuaries, marine parks, etc, should not be used for shrimp farming.
- Shrimp farms should be located at least 100 m away from any human settlement in a village/ hamlet of less than 500 population and beyond 300 m from any village/ hamlet of over 500 population. For major towns and heritage areas it should be around 2 km.
- All shrimp farms should maintain 100 m distance from the nearest drinking water sources.
- The shrimp farms should not be located across natural drainage canals/ flood drain.
- While using common property resources like creeks, canals, sea, etc, care should be taken that the farming activity does not interfere with any other traditional activity such as fishing, etc.
- Spacing between adjacent shrimp farms may be location specific. In smaller farms, at least 20 m distance between two adjacent farms should be maintained, particularly for allowing easy public access to the fish landing centers and other common facilities. Depending upon the size of the farms, a maximum of 100 – 150 m between two farms could be fixed. In case of better soil texture, the buffer zone for the estuarine-based farms could be 20 –25 m. A gap having a width of 20 m for every 500 m distance in the case of sea based farms and a gap of 5 m width for every 300 m distance in the case of estuarine-based farms could be provided for easy access.
- Larger farms should be set up in clusters with free access provided in between clusters.
- A minimum distance of 50 – 100 metres shall be maintained between the nearest agricultural land (depending upon the soil condition), canal or any other water discharge/ drainage source and the shrimp farm.
- Water spread area of a farm shall not exceed 60 per cent of the total area of the land. The rest 40 per cent could be used appropriately for other purposes. Plantation could be done wherever possible.
- Areas where already a large number of shrimp farms are located should be avoided. Fresh farms in such areas can be permitted only after studying the carrying/ assimilation capacity of the receiving water body.

5.0 Construction and preparation of shrimp farms

5.1 Farm Design and Construction: Proper designing and construction of shrimp farm is essential for their efficient management and for promoting environmental protection. Good site selection and incorporation of mitigatory features in the farm design are the best ways to avoid problems related to flood levels, storms, erosion, seepage, water intake and discharge points. A site-specific approach to design and construction of shrimp farms is necessary, as site characteristics vary greatly from place to place. The following checklist should be considered while designing and constructing shrimp farms:

Checklist for farm design and construction
• Embankments should be designed to prevent flooding and erosion, after taking into consideration the tidal amplitude, water current, wind direction, wave action and the past histories of flooding in the area during cyclones/ storms. • In soils, which are seepage prone, design should include an inner clay core in the dykes with greater compaction and trench around the farm to reduce saline water intrusion into the neighbouring lands. • The elevation of the pond bottom, drainage canal and the outlet should be designed in such a way that the water in the farm can be drained fully and easily through gravity. • Ponds should have separate intake and outlet structures to permit control of filling and draining. • A minimum water depth of 80-100 cm should be maintained in the ponds. • Inlet and discharge canals should be separate so that water supply and wastewater are not mixed. In areas where such a provision cannot be made, it is advisable that waste treatment pond should be included in the design. • The farm design should not alter natural water flows, or impound floodwater. • The sluice gates should be watertight and provided with net filters. • Where possible, vegetative buffer zones, riparian vegetation and habitat corridors should be maintained and vegetative cover provided on exposed earthwork. • Pump intakes should be screened, vegetative buffers provided around pump stations, and containments installed to prevent fuel spills.

5.2 Construction of Intake Reservoirs and Effluent Treatment Ponds: In areas where the source water is turbid with suspended particles, an intake reservoir for settling the silt is very essential. Similarly, in areas where there is overcrowding of shrimp farms and the intake and outfall are from the same source (*i.e.* creek, estuary, backwater) the intake reservoir with provision for treatment of water is essential. In areas where the tidal current is swift and tidal amplitude is high, the wastewater from the farm can be directly let out during the low tide. But in areas where the tidal current is very low, it is essential that the wastewater be treated in an Effluent Treatment Pond (ETP) before it is released into the natural system. An ETP, as a reservoir for holding and regenerating wastewater, is mandatory for farms larger than 5 ha. A minimum of 10 percent of the total farm area should be reserved for this purpose. It is also necessary that smaller farms that are located in close proximity to each other (farm clusters) should consider setting up of common ETP to avoid self-pollution and also release of excess nutrients and suspended solids, which could lead to eutrophication of the receiving water body.

For better water management, individual culture units should be within 5 ha areas and suitable feeder channel system should be provided within the farm so that the water intake can be effectively managed in all the individual units.

5.3 Pond Preparation: Pond preparation is an essential part of culture practices during which the metabolite load and contaminants (chemical and biological) in the soil from the previous culture cycle is removed through tilling, ploughing and drying. During pond preparation, the pests and predators are removed and pH and nutrient levels in the water and soil are brought to optimal concentrations through application of lime, organic manures and inorganic fertilisers. The following checklist would assist in pond preparation and reduction of the possible environmental impacts:

- Pond sediments from the previous culture, which are likely to have accumulation of nutrient loads and other contaminants, should not be disposed off in the natural environment. In case it is necessary to remove the sediments it should be disposed off within the farm site itself, by putting such sediments in trenches made in the wide dykes. However, it should be ensured that these sediments do not leach out.
- Application of lime is useful in correcting the pH of the soil and water, as a disinfectant and for increasing the mineralisation process. If the soil pH is not below 7.5, a basal dose of 300-500 kg/ ha can be applied. However, in acid soils, where the pH is low, the quantity of lime to be applied should be calculated based on the pH and type of lime used.
- Unwanted /pest organisms should be killed and removed from the pond by drying of the pond bottom. In cases, where complete drying is not possible, organic, biodegradable piscicides such as *Mahua* oil cake (100-150 ppm), tea seed cake (15-20 ppm) and also lime *(Calcium oxide preferred)* can be used. No chemical piscicide should be used.
- After the application of the organic piscicide at least a period of 10 days should be given for its toxic effect to be removed. Chlorination can be done to remove the pests and pathogens in ponds where drying of pond bottom is not possible.
- Fertilizers and manures should be used judiciously as per the requirement, according to recommended doses (Table 1 below). Over fertilization should be avoided. Fertilizer schedule should be decided based on the phytoplankton growth in the ponds. The colour and transparency of the water can be taken as indicators of plankton growth. Optimal density of phytoplankton should be maintained throughout the culture period.
- Heavy algal bloom should never be allowed to develop since crash of algal bloom may lead to anoxic conditions in the pond thereby affecting the survival and growth of the shrimps.

Table 1. Recommended dosages of organic manures and inorganic fertilizers for improving production from traditional and extensive systems of farming

Dosage of manures in relation to organic carbon content of soil		
	Prescribed basal dose	
Organic Carbon in soil (%)	Raw cow dung (kg/ha)	Dry chicken manure (kg/ha)
1	500	175
0.5	1000	350
0.25	2000	700

Application of Urea in relation to available Nitrogen	
Available N in soil (mg/100g soil)	Urea to be applied (kg/ha)
12.5	100
25.0	50
50.0	25

Application of super phosphate in relation to available Phosphorus	
Available P in soil (mg/100g soil)	Super phosphate to be applied (kg/ha)
1.5	100
3.0	50
6.0	25

(Source: Aquaculture Authority, 1999)

6.0 Water quality and its management

6.1 Brackishwater/ seawater in adequate quantities should be available throughout the year. The water source could be from backwaters, canals/creeks, lagoons or sea. The quality of the water available in the site has a strong influence on the success of the shrimp farm. Water quality parameters like pH, salinity, dissolved oxygen (DO) and the presence of toxicants/ pollutants should be ascertained. Low pH water will pose serious problems and similarly wide fluctuation in salinity will also be detrimental to the cultured species. The water source should be free from any industrial/ agricultural pollution. The presence of contaminants and their levels should be considered in the light of the tolerance and also sub-lethal effects on the species to be cultured. The optimal levels of various water quality parameters for better survival and growth of shrimps are listed in the Table 2 below:

Table 2. Optimal levels of water quality parameters for shrimp farms

Sl. No.	Water Quality Parameters	Optimal Level
1.0	Temperature (^{o}C)	28 – 33
2.0	Transparency (cm)	25 - 45
3.0	pH	7.5 - 8.5
4.0	Dissolved oxygen (ppm)	5 – 7 (above 50% air saturation)
5.0	Salinity (ppt)	15 - 25
6.0	Total alkalinity (ppm)	200
7.0	Dissolved inorganic phosphate (ppm)	0.1 - 0.2
8.0	Nitrate - N (ppm)	< 0.03
9.0	Nitrite - N (ppm)	< 0.01
10.0	Ammonia - N (ppm)	< 0.01
11.0	Cadmium (ppm)	< 0.01
12.0	Chromium (ppm)	< 0.1
13.0	Copper (ppm)	< 0.025
14.0	Lead (ppm)	< 0.1
15.0	Mercury (ppm)	< 0.0001
16.0	Zinc (ppm)	< 0.1

6.2 Nutrients and organic wastes produced in shrimp culture ponds consist of solid matter (mainly uneaten feed, faecal matter and dead plankton) and dissolved metabolites (mainly ammonia, phosphate, carbon dioxide, nitrite and nitrate). Various management methods are followed to maintain these within the tolerable limits. Among these, the most economical is water exchange. A water exchange of 5 – 30 percent per day is usually done depending on the availability of water and the quality of pond water. A variety of chemicals and probiotics are used in improving the water and soil quality.

6.3 The following guidelines are to ensure that the harmful effects of these practices are reduced.

- Good water quality should be maintained by using water stable feed with minimal wastage.
- Water quality parameters should be monitored regularly and periodical water exchange is necessary to maintain optimal water quality conditions. While exchanging water, care should be taken to avoid wide fluctuations in water quality, so as to avoid stress to the shrimps and proper screens should be used to prevent the entry of pests and predators. Dissolved oxygen concentrations should be measured during early morning hours.
- Fertilisers and lime should be used in a responsible manner only when it is actually required.
- Use of freshwater to reduce the *salinity* of the culture water should be avoided for sustainability reasons; even though the shrimps can adapt and grow in a wide range of salinity, it is better to avoid salinity fluxes so as to avoid stress to the shrimps, which could make them more prone to diseases.
- In low density cultures, high level of water exchange is not required. In view of the complaints of nutrient loading in the open environment and the fear of viral contamination in the source water, the water exchange should be need-based. If water quality remains within optimal limits no water exchange is required for the first two months of rearing.
- Indiscriminate use of chemicals, bacteriological and enzyme preparations that supposedly enhance nutrient removal, organic matter, oxidation and removal of ammonia from water and soil should be avoided.

7.0 Seed production

7.1 All shrimp hatcheries need to be registered by MPEDA as per their norms which may be reported to the Authority at its subsequent meeting. The Authority will have the power to review the registration of hatcheries and to take appropriate decisions in tune with the requirements of the Coastl Aquaculture Sector.

7.2 Production of healthy and disease free shrimp seed is the first step towards sustainable shrimp farming. About 300 shrimp hatcheries were set up in the country by the end of 2004 with a total production capacity of 12 billion post-larvae. These hatcheries are mostly located on the East coast of the country.

7.3 Hatchery operations can be broadly classified into broodstock, larval/ post larval rearing and live feed management. Since production of healthy seed is a primary step towards disease free farming, shrimp hatcheries are required to maintain strict sanitation, quarantine and quality control management to ensure bio-security and health management. These following guidelines should be adopted by the shrimp hatchery to ensure production of standard and homogeneous quality seed, which are pathogen free.

7.4 Water quality: Hatcheries should ensure good supply of oceanic quality seawater with the following optimal water quality characteristics in its rearing systems so as to avoid any stress to the larvae. This can be achieved by selecting a good site with the required water quality.

Table 3. Recommended water quality parameters for shrimp hatcheries

Parameters	Tolerable Limit	Optimal Levels
Temperature (°C)	18 - 36	28 - 32
Salinity (ppt)	26 - 34	30 - 34
pH	7.0 - 9.0	8.0 - 8.4
Dissolved oxygen (ppm)	Above 3	Above 4
Ammonia - N (ppm)	Up to 0.1	Less than 0.01
Nitrite - N (ppm)	Up to 0.1	Less than 0.01

Further, the water should be treated to remove all the suspended solids, dissolved nutrients and bacterial and viral pathogens. This could be achieved by following a good water treatment protocol, which includes:

- Sedimentation
- Water chlorination and dechlorination
- Filtration with sand filters
- Filtration with activated carbon filter
- Cartridge filtration up to 1 micron size
- UV filtration/ Ozonation

7.5 Spawner/ broodstock quality: Vertical transmission of viral pathogens from mother shrimps to larvae through the ovarian tissue is one of the sources of introduction of viral pathogens into the hatchery system. In addition to that any stress caused to the spawners will result in spawning of poor quality eggs. The following measures should be strictly followed to obtain good quality eggs.

- Spawners/ broodstock collected from commercial trawling operations will be stressed after being caught in the trawl nets. They should be immediately transported to the hatcheries without further stress/ injuries.
- The spawners collected should be placed individually in disinfected water and immediately transported individually under oxygen packing. Maintaining the spawners individually from the time of their capture is more important to avoid cross contamination with viral pathogens.
- The broodstock should be quarantined on arrival at the hatchery to prevent the entry of pathogens.
- Spawners/ broodstock, which do not have lesions, damage to gills, loss of appendages and red colouration, should only be selected.
- Prophylactic treatment of spawners/ broodstock with formalin at 50 ppm for 1 hour under strong aeration should be done before introducing the stock into the hatchery/ maturation system.
- Spawners/ broodstock should be kept individually for acclimatization and screened for the presence of WSSV using a terminal portion of pleopods and for monodon baculo virus (MBV) from the faecal matter. Only spawners free from these pathogens should be taken into the hatchery/ maturation system.

7.6 Induced maturation under captive conditions: Healthy, pathogen free, immature, broodstock, collected from wild, after the prophylactic treatment and acclimatization

should be taken into the maturation tanks and allowed to recover from the stress of capture and transportation for 4-5 days. Then they are induced to mature through eyestalk ablation following the guidelines given below:

- Hard shelled, intermoult healthy female shrimps free from disease or injury having spermatophore in the thelycum should be selected for eyestalk ablation.
- The females should be above 100 g in size for ensuring good quality eggs.
- Eyestalk ablation is to be avoided for newly moulted and ready to moult female shrimps.
- Electrocauterisation is the best way of ablating eyestalk since it causes minimum stress.
- The ablated female shrimps are stocked in the maturation tanks along with unablated males @ 4 nos/ m^2. Stocking of females and males in the ratio of 2: 1 ensures best mating success.
- Fresh feeds such as clam (*Meritrix sp.*), mussel (*Perna viridis*) and squid (*Loligo* sp.) having similar amino acid profile as shrimps, polychaete worms, Artemia biomass rich in long chain poly-unsaturated fatty acids are used as maturation feeds. Feed should be provided in sufficient quantities by visual observation. Feeds like crabmeat, which are carriers of pathogens, should be avoided.
- In addition to live feed items, pelleted feed fortified with polyunsaturated fatty acids (PUFA) such as arachidonic acid, eicosopentaenoic acid and decasohexaenoic acid should be used to ensure good egg quality.
- Water quality should be maintained under optimal conditions with 100 percent to 200 percent water exchange per day.
- Light intensity should be maintained low and the movement of personnel near the maturation tanks should not disturb the ablated shrimps.

7.7 Spawning and hatching:

- Wild spawners/ induced matured stock should be disinfected with formalin treatment before placing them individually in spawning tanks.
- Feed should not be provided in the spawning tanks.
- Spawned eggs should be collected, washed thoroughly and disinfected by formalin dip treatment and re-suspended in fresh seawater for hatching.
- The quality of the eggs should be assessed within 2 hours after spawning when it will be easier to identify the fertilized and unfertilized eggs.
- If the quality of eggs is very poor, it is advisable to discard the eggs.
- Only active positively photo tactic nauplii should be collected for transfer to larval rearing tank.
- Nauplii should be tested for WSSV before transfer to larval rearing tank.

7.8 Larval rearing/ nursery rearing:

- Nauplii from a single spawner should be reared separately to avoid cross contamination.
- Stocking density of nauplii should be maintained at 50 no./l in larval rearing tanks.
- Algal feed should be initiated before nauplii moult to zoea 1.

- Algal feed should be given in required quantity from cultures that are in exponential stage of growth.
- Algal feed should be concentrated to avoid introduction of large quantities of algal culture water with its nutrient load.
- Water quality in the larval rearing should be monitored for ammonia, nitrite and bacterial load.
- Uniform aeration in all parts of the tanks should be provided through air diffuser stones placed @ 1 no/ sq. ft. This will keep the larvae and the algal feed uniformly distributed in the tank.
- During water exchange, appropriate mesh size nets should be used for draining the water so as to facilitate the removal of faecal matter without stressing the larvae.
- Artemia nauplii/ flake diets should essentially be used from Mysis II stage onwards along with the algal diet.
- Prophylactic use of antibiotics or other drugs should be avoided and only permitted antibiotics, chemicals, etc should be used. Probiotics should be used to the maximum extent possible.
- At PL5, the larvae should be collected from the larval rearing tanks, disinfected with formalin dip treatment and distributed in outdoor nursery tanks @ 15-20 nos/ litre.
- During later stages of nursery rearing, along with artemia nauplii, other live feed items like clam meat or balanced compounded feed can be used.
- Acclimatization to required salinity levels should be done gradually in the nursery stage of rearing.
- Only PL20 should be sold to the farmers after testing its quality with reference to presence of Monodon Baculo Virus (MBV) and White Spot Syndrome Virus (WSSV). At any stage of rearing, if WSSV is detected, the larvae from the whole tank should be discarded.
- For long distance transportation, the seed should be packed in thermocol boxes at reduced temperature.
- Supplementary feeds and raw materials should be properly handled and stored to avoid spoilage.

7.9 Algal culture:

- Algal culture should be maintained in pure form in indoor; temperature controlled rooms and used as started culture for outdoor mass culture.
- It is advisable to use UV treated water for the pure culture of the algae, to prevent contamination.
- The quality of the mass culture should be tested before feeding in larval rearing tanks.

7.10 Artemia hatching:

- Artemia cysts should be disinfected before keeping them for hatching.
- Hatched artemia nauplii should be segregated from the cyst wall and un-hatched cysts before being used as feed in larval rearing tanks.
- Only the nutritionally superior instar I nauplii should be used as feed.

7.11 General bio-security procedures:

- The quality of intake water is very important for healthy operation of a shrimp hatchery. The pollution free water drawn from natural sources should be filtered and possibly, sterilized before usage.
- Movement of men, materials and paraphernalia between different sections of the hatchery should be controlled to avoid contamination.
- Foot pits, washbasins, toilets, etc. should be provided to ensure adequate sanitation and hygiene in the hatchery premises.
- The effluent water should be properly treated in a effluent treatment system before discharge. Regular monitoring of effluents to ensure environment standards, stipulated.
- Hatchery should have adequate facilities for pathology lab like microbiology/PCR facilities to check the health condition of brooders/seeds at different stages.
- Diseased or moribund shrimps should be disposed off safely to prevent contamination of the stock.
- Bio-filters, tanks, buckets, nets, etc. should be thoroughly washed and cleaned using sanitizers and dried thereafter. Regular disinfections should be carried out to ensure bio safety.
- The hatcheries are required to monitor their effluents frequently so that the water quality standards remain within the limit stipulated in Table 5. Considering the need for maintaining effluent discharge standards, effluent treatment system shall be mandatory for all hatcheries.
- It is essential that hatcheries maintain proper records of their activities in various sections, for verification by the supervising agencies and also to ensure traceability and easy market access.

7.12 Shrimp hatcheries require large quantity of seawater for their day-to-day operations. The water used in the hatchery and let out is likely to be contaminated with dissolved or suspended organic matter, nutrients, chemicals, antibiotics, etc. When contaminated water is discharged into open, it is likely to result in environmental pollution that could be detrimental to the hatchery operation itself, since intake and discharge points are nearby. Therefore, it is necessary to properly treat the effluents so that the discharged water conforms to environmental standards.

8.0 Seed selection and stocking

8.1 Seed quality has a direct relationship with the survival and growth of the cultured shrimps and the stocking density has a strong bearing on the level of waste generated in the pond. The higher the stocking density the larger the quantity of feed that has to be used. Higher stocking densities also stress the animals leading to greater incidence of disease. In ponds with excessive stocking and feeding rates, the wastewater is generally of low quality and has a greater potential to cause water pollution than wastewater from ponds stocked at more reasonable densities. Hence, it is essential that the following guidelines be observed:

- Only healthy and pathogen-free seed from registered hatcheries should be used for stocking.

- The health status of the shrimp seed should be checked through standard testing procedures, including PCR.
- Seed collection from the natural resources should be banned by the State Governments with a view to protecting a large spectrum of fin and shellfish species from being destroyed.
- Before stocking the seed should be acclimatised to the prevailing temperature, salinity and pH in the pond conditions by gradual mixing. In areas with very low salinity, salinity adjustments are to be made over a period of 4 –5 days and hence should be done at the hatchery itself.

8.2 In view of the strong impact of stocking densities on sustainability of farming practices, low stocking densities would only be permitted in shrimp aquaculture. However, such stocking densities for different types of practices shall be as per the regulation of the Coastal Aquaculture Authority.

9.0 Feed and feed management

9.1 All shrimp feed manufacturing units need to be registered by MPEDA as per their norms which may be reported to the Authority at its subsequent meetings. The Authority will have the powers to review the registration of feed mills and to take appropriate decisions in tune with the requirements of the coastal aquaculture sector.

9.2 Feed is the basis for optimum yield levels in shrimp farming. About 33 shrimp feed mills with a production capacity of 1 50 000 metric tonnes of feed were set up in the country by the end of 2004. Besides, there are a large number of small feed manufacturing units, meeting local requirements.

9.3 However, shrimp do not eat all of the feed provided to them, and only a portion of the feed consumed is converted to shrimp flesh. Uneaten feed, feces and metabolic wastes add to the nutrient load in the wastewaters. As feeding rates increase, water quality and soil quality in ponds usually deteriorate.

9.4 Fresh diets increase nitrogen loads in shrimp ponds. Considerable amount of detritus and wastes often accumulate on the pond bottom, in areas where water circulation is slow, leading to increased BOD and release of harmful gases, which could cause stress on bottom living shrimps. On the contrary, regular feeding with pelletised diets is known to maximize the growth of shrimps and minimize the nutrient enrichment of the wastewater.

9.5 Feed quality and conversion ratio/ efficiency have considerable influence on waste levels. Reduction of phosphorus content in feed, control of dietary nitrogen in relation to metabolism and improvement in physical characteristics such as attractability, water stability, texture and appropriate size of the feed will help to reduce the nutrient loading to a large extent.

9.6 Careful feed management is essential for successful shrimp farming. By using good quality feed in reasonable quantities, water and soil quality in ponds remains in optimum conditions. This reduces stress on shrimp, there is less likelihood of disease, and they convert feed more efficiently to improve the feed conversion ratio and minimize feed costs. Better water quality in ponds allows minimum load of nutrients in wastewater and reduces the possibility of environmental impacts in receiving water bodies.

9.7 Monitoring of feed input is required to keep feed wastage to the minimum. Similarly, careful monitoring of standing stock in the ponds will also help to ensure that correct feeding levels are observed. The feeding rate prescribed by the manufacturer varies depending on the quality of the feed. The feeding rates given in Table 4 below are recommended. However, it should be regulated based on the check tray observations.

Table 4. Recommended feeding rates for different sizes of the shrimp

Shrimp size (g)	Daily Feed as Percentage of Body Weight
2 - 5	4.0 - 3.0
5 - 10	3.0
10 - 15	3.0 - 2.5
15 - 20	2.5 - 2.0
20 - 35	2.0

9.8 The following guidelines should be adopted for feed and feed management in shrimp farming:

- Feed ingredients should not contain contaminants, anti-nutritional factors, microbial toxins, banned antibiotics or other adulterating substances.
- Farm-made wet diets should not be used. However, when wet feeds are used crustaceans should be avoided as an ingredient.
- Only dry, nutritionally balanced pelleted feed with optimal water stability should be used.
- Freshly obtained feed should be used to the extent possible. In any case feed stored for more than two months should not be used. Feed should be stored in cool, dry areas to prevent mould and other contamination.
- Feeding rates should be determined from standard feed curves/charts (Table 3 above) and adjusted for shrimp biomass on a weekly basis.
- Feed check trays should be used to regulate feeding rates. Feed trays should be widely distributed in the pond.
- Both overfeeding and underfeeding should be avoided. Efforts should be directed to ensure that the shrimps consume the maximum amount of supplementary feed given, since excess feed lying uneaten would decompose and lead to poor water quality, stress to the shrimps and consequently increased vulnerability to diseases.
- Since the shrimps require about 4 hours for digestion of feed, feeding frequency should be 4 – 6 times in a day. Since shrimps are nocturnal, more than 60 percent of the feed should be fed during night.
- Feed Conversion Ratio (FCR) should be monitored. Reductions in FCR through careful feeding schedule will improve production efficiency and reduce waste loads.
- Feeds with high acceptability, high digestibility and assimilation efficiency will reduce waste generation and nutrient loading. Further this will reduce the cost of production since feed accounts for more than 50 percent of the recurring cost.

- Shrimp farmers should keep full records of daily feed schedules to enable assessment of FCR, which should be used to increase feeding efficiency and reduction in feed waste.

10.0 Health management of shrimps

10.1 Viruses, bacteria and protozoa cause the major shrimp diseases. The " White Spot Disease", caused by the White Spot Syndrome Virus (WSSV), which led to devastations in shrimp farming in India as elsewhere is the most known virus disease; the other well known virus disease is the "Yellow Head Disease", which has not been reported from India but is frequent in Thailand and other parts of Asia. Bacteria cause vibriosis. Protozoan diseases such as gill and external fouling caused by *Zoothamnium* also cause problems in shrimp farming.

10.2 Outbreak of disease in shrimp culture systems is related to the environmental factors such as deterioration of water quality, sedimentation and self-pollution. Treatment should be undertaken only when a specific disease has been diagnosed and it is known that this disease is treatable. Also, effective measures must be taken to minimize the spread of disease between farm stocks and natural stocks.

10.3 The following guidelines envisage health management as a holistic activity with disease prevention as the main objective. The approach includes reduced stocking of disease free seed, better handling, maintenance of good pond environment, and optimal feed management to reduce the stress and prevent most infectious and non-infectious diseases.

- The health of the shrimps should be monitored continuously and those with any one or more of the following conditions are diagnosed to have some disease: inactive and sluggish, empty gut, bluish/blackish coloration, body blisters, flared up gills, broken appendages, black / white spots, coloured gills and opaque muscles.
- Any disease should be diagnosed immediately with the help of trained pathologists/ microbiologists.
- Chemical treatments that can stress the animals should not be employed.
- Disease problems arising in aquaculture can be attributed primarily to the environmental degradation and most of the pathogens are facultative pathogenic in nature. Hence, management of pond environment is of utmost importance for disease prevention and control.
- For non-infectious diseases related to pond conditions, treatment of animals should be carried out or pond conditions corrected.
- For mild infectious diseases with potential to spread, the pond should be quarantined and the best options for disease treatment should be carried out.
- For serious infectious diseases that may spread widely, the pond should be isolated, remaining shrimp should be net harvested and the pond should be disinfected without discharging any water.
- Dead and diseased shrimp should be disposed off in a sanitary manner that will discourage the spread of disease.
- When disease occurs in a pond, transfer of shrimp, equipment, or water to other ponds should be avoided.

- Drug, antibiotic, and other chemical treatments should be done in accordance with recommended practices and all national and international regulations should be complied with.

11.0 Use of chemicals and drugs

11.1 Chemicals and drugs used in aquaculture include those associated with structural material, soil and water treatment, antibacterial agents, therapeutants, pesticides, feed additives, anesthetics, immuno-stimulants and hormones. Chemicals and drugs presently in use are mostly derived from agriculture/ veterinary field and have never been tested/ evaluated specifically with regard to their effects on the aquatic environment.

11.2 Some of the chemicals and antibiotics can accumulate in the flesh of shrimp and represent a potential health hazard to the consumer and also affect trade prospects. Some chemicals may also exist in effluents as residues and be harmful to natural aquatic ecosystems. Reducing the use of these agents and chemicals will improve environment performance but also reduce cost of operating shrimp farms. Shrimp health management should focus on disease prevention through good nutrition, sound pond management, and overall stress reduction rather than disease treatment.

11.3 *Use of chemicals:* Chemicals should be avoided in shrimp ponds for prevention or treatment of disease, as feed additives, disinfectants, for removal of other fish or for treatment of soil or water. However, chemicals may be required in hatcheries. The hatchery operators should carefully monitor entry of such chemicals into the natural waters from the hatcheries and they should take steps to remove such materials from the wastewaters.

11.4 *Use of fertilizers:* Both organic and inorganic fertilizers are used widely in shrimp culture for promoting the growth of fish food organisms, particularly for the early post-larval stages. This may contribute to the nutrient load in waters receiving the effluents. Therefore, as far as possible only organic manure/ fertilizers and other plant products should be used for such purposes.

11.5 *Use of piscicides:* Similarly, piscicides and molluscicides are widely used for removing predators and competitors from shrimp ponds. It would be advisable for aquaculturists to use only the biodegradable organic plant extracts for this purpose, as they are less harmful than the chemical agents. Use of chemical piscicides should be avoided.

11.6 *Use of chemotherapeutants:* Some of the chemotherapeutants such as formalin and malachite green which are commonly used as disinfectants are toxic and may affect adversely the pond ecosystem, the external waters, etc. and hence their usage in culture system should be avoided.

11.7 *Use of antibiotics/ drugs:* The use of antibiotics in shrimp culture is strictly prohibited as their use may result in development of pathogens resistant to such drugs and the transfer of these pathogens into human beings might result in development of resistance in human pathogens. The list of 20 antibiotics/ pharmacologically active substances presently banned for use in shrimp culture is given in Table 5. This ban will also apply to other substances so notified by the Government from time to time.

Table 5. List of Antibiotics and other pharmacologically active substances banned for using in shrimp aquaculture

Sl. No.	Antibiotics and other Pharmacologically Active Substances
1	Chloramphenicol
2	Nitrofurans including: Furaltadone, Furazolidone, Furylfuramide, Nifuratel, Nifuroxime, Nifurprazine, Nitrofurantoin, Nitrofurazone
3	Neomycin
4	Nalidixic acid
5	Sulphamethoxazole
6	Aristolochia spp and preparations thereof
7	Chloroform
8	Chlorpromazine
9	Colchicine
10	Dapsone
11	Dimetridazole
12	Metronidazole
13	Ronidazole
14	Ipronidazole
15	Other nitroimidazoles
16	Clenbuterol
17	Diethylstilbestrol (DES)
18	Sulfonamide drugs (except approved Sulfadimethoxine, Sulfabromomethazine and Sulfaethoxypyridazine)
19	Fluroquinolones
20	Glycopeptides

11.8 The Maximum Permissible Residual levels for various antibiotics and other pharmacologically active substances stipulated by the Government for fish and fishery products is as per appendix attached to these guidelines. Shrimp farmers and input providers should strictly follow these stipulations, which may be revised by the Government from time to time.

12.0 Harvest and post-harvest

12.1 During the harvesting maximum suspended particles are likely to be released into the open waters. Hence great care should be taken to prevent such a release. The farmers are advised to adopt the following norms while harvesting the crop:

- Harvesting can be done by completely draining the pond either by gravity or through pumping and hand picking or trapping.
- The water drained out for harvesting should be pumped into the waste stabilization ponds and kept for a few days for settlement before releasing into the open water.
- Icing should be done immediately after harvest.
- Generally, the processors/ buyers collect the harvest from farm site and transport in refrigerated vans. When such a facility is not available and the produce has to be transported over a long distance, the shrimps should be beheaded and stored in ice to prevent spoilage.

13.0 Wastewater management

13.1 The waste from shrimp ponds contain mainly suspended solids, comprising unconsumed feed, faecal matter and plankton, and dissolved nutrients such as ammonia, nitrite, phosphorus, carbon-dioxide, hydrogen sulphide. The former component is the result of physical qualities of feed and fertilizers while the nutrients are influenced by the chemical composition of the feed ingredients and the fertilisers. The nutrients and organic matter in shrimp pond wastes have potential for the following impacts:

- reduce dissolved oxygen in receiving waters, due to discharge of waste water low in dissolved oxygen and breakdown of dissolved and particulate organic matter and other waste materials (BOD and COD).
- hyper-nitrification and eutrophication of receiving waters, resulting in increased primary productivity (with potential risks of phytoplankton blooms), alteration of biological community structure and secondary productivity; and
- increased sedimentation due to organic matter, leading to changes in productivity and benthic community structure, plus possible siltation.

13.2 Such impacts depend on the quantum of wastewater outflow and the capacity of the environment to assimilate the waste materials. It is, therefore, desirable to match loads with the capacity of the environment to accept the waste materials. The following checklist will guide the shrimp farmer in responsible waste management and for protection of the water and land resources.

Checklist for wastewater management
• Proper designing of the farm with independent intake and outfall will reduce the nutrient loading. • Proper compaction of bunds with vegetative cover should be provided which will reduce erosion. • Proper pond preparation methods will reduce nutrient loads. • Proper water and soil quality management in the culture ponds will reduce the nutrient loading of wastewater • Responsible feed management will reduce feed wastage. • During harvest, water should be drained carefully avoiding re-suspension of sediment. • Shrimp pond wastewater should not be discharged into freshwater areas or onto agricultural land. • Removing of sediments from the pond bottom should be avoided. It should be corrected *in situ.*

13.3 Direct output of waste from shrimp farms and hatcheries can alter the water quality along the coastline. The dissolved and particulate nutrients and organic matters including small quantities of chemicals, micro-organisms and detritus can alter the water quality to a great extent and hence have to be properly treated before such wastes are discharged into the open waters or in the drainage canal. Such wastewater could also be used for undertaking secondary aquaculture projects, particularly for culture of mussels, oysters, seaweed, other finfishes, etc. Such integrated projects would also offer scope for

improving the wastewater quality, reducing the organic and nutrient loss and producing an additional cash crop. In addition to this biological amelioration of wastewater, settlement/ sedimentation ponds may be constructed along the drainage canals. The drainage canals may be designed in such a way that they are wide enough to slow down the flow of water from ponds, so as to allow the settlement of these suspended solids.

13.4 Effluent Treatment System (ETS) is mandatory for farms above 5 ha. At least 10 per cent of the total pond area should be earmarked for the ETS which may be used for secondary aquaculture projects, particularly for culture of mussels, oysters, seaweed, other fin fishes, etc. Such integrated projects would help improving the wastewater quality, reducing the organic and nutrient loads and producing an additional cash crop.

13.5 The standards shown in Table 6 are laid down for the wastewater discharged from the aquaculture systems, hatcheries, feed mills and processing plants. The same may, however, be modified by the Authority from time to time.

Table 6. Standards for treatment of wastewater discharged from the aquaculture farms, hatcheries, feed mills and processing units

S No	Parameters	Final Discharge Point	
		Coastal Marine Waters	Creek or estuarine courses when the same inland water courses are used as water source & disposal point
1	pH	6.0 – 8.5	6.0 – 8.5
2	Suspended solids mg/1	100	100
3	Dissolved oxygen mg/1	Not less than 3	Not less than 3
4	Free Ammonia (as NH3-N) mg/1	1.0	0.5
5	Biochemical Oxygen Demand-BOD (5 days @ 20 c) Max mg/1	50	20
6	Chemical Oxygen Demand-COD mg/1 Max	100	75
7	Dissolved Phosphate (as P) mg/1 Max	0.4	0.2
8	Total Nitrogen (as N) mg/1	2.0	2.0

13.6 It is advisable to let ponds dry between harvests rather than removing sediment accumulations from the pond bottom. This method is probably less environmentally damaging than indiscriminate discharge of bottom sediment. If shrimp stocking densities are kept low (below 15 Pl per m^2), then sediments can be kept in good condition by simply drying the pond bottom between harvests. The solid waste of the farms, including sludge and scrapped soil from the ponds should not be disposed off into the waterways. The waste shall be disposed off within the premises of the farm after adequate treatment without allowing it to get into waterways.

14.0 Farm hygiene and management

14.1 The objectives of shrimp farming practices should be to produce contaminant-free products for consumers through responsible pond operations and good management practices that prevent, eliminate, or appropriately reduce levels of chemicals, drugs and pathogens that pose human health concerns. The following guidelines should be used to achieve this goal:

- All waste materials should be disposed of in a sanitary way.
- In evaluating the suitability of a site for aquaculture, include testing for any chemicals, drugs and pathogens that might pose a human health risk and are likely to occur at the site.
- Avoid the potential for septic runoff from humans or other animals, as well as any indication of frequent use of pesticides, herbicides, and drugs; and past contamination with fuel oil or any other chemical contaminants.
- Feed should not contain chemical or microbial contaminants. Feeding of uncooked organisms or any nutrient source derived from uncooked organisms is discouraged.
- The shrimp industry and individual producers should work with the government to prepare lists of pathogens, drugs and chemical contaminants that pose existing or potential human health concerns and takes effective measures to control these risks.
- When using any chemical products at or near shrimp-farming sites, shrimp farmers should be attentive to the information on product labels that regards human health concerns.
- Approved drugs, or other chemicals should be used only when necessary to control identified disease problems.

15.0 Environment impact assessment

15.1 An Environment Impact Assessment (EIA) should be made even at the planning stage by all the aquaculture units above 40 ha size. For 10 ha and above a statement will be required to be given in the detailed plans. The District/ State Level Committees set up by the Coastal Aquaculture Authority should ensure that such an EIA has been carried out by the aquaculture units before their proposal is recommended to the Coastal Aquaculture Authority for approval.

16.0 Environment monitoring and management plans

16.1 The shrimp culture units with a net water area of 40 ha or more shall incorporate an Environment Monitoring Plan and Environment Management Plan (EMMP) covering the areas mentioned below:

- Impact on the water courses in the vicinity;
- Impact on ground water quality;
- Impact on drinking water sources;
- Impact on agricultural activity;
- Impact on soil and soil salinisation;
- Waste water treatment;
- Green belt development (as per specifications of the local authorities) and
- All farms of 10 ha and more but less than 40 ha shall furnish detailed information on the aforesaid aspects.

17.0 Cluster management, record maintenance and networking

17.1 There should be an awareness of avoiding social conflicts and the stakeholders together should discuss common problems and adopt appropriate management measures to avoid conflicts and increase sustainability of the farming systems.

17.2 Farmers' Associations and Self-Help Groups: Shrimp farmers should form co-operatives, associations or self-help groups in order to exchange technology and to achieve co-operation in water use and waste management. Shrimp culture techniques are also constantly improving, and it is important that shrimp farmers continue to increase their knowledge of sustainable farming techniques.

Small farmers should gain benefit by forming such co-operatives or self-help groups/ associations for facilitating supply of inputs, synchronised farming operations, common necessities for monitoring seed and feed quality, shrimp health management and water quality, sale of product and also in organising credit and crop insurance. Formation of an Apex body of Shrimp Farmers associations in the State/ District would be helpful, especially in negotiations with credit agencies and other major organisational activities.

17.3 Facilities for regular extension work and different aspects of training should be made available to the farmers. Individual farmers and self-help groups/ Associations should arrange to interact with the extension staff in the State Department of Fisheries, MPEDA, ICAR institutions, Agricultural Universities, and NGOs, as the case may be to assist the small farmers.

Appropriate awareness programmes through extension work and training of shrimp farmers and officials should be initiated for enhancing the technical knowledge and environmental awareness among the fisheries personnel, extension workers, aquaculturists and all those involved in related activities for planning and operation of sustainable aquaculture.

17.4 For facilitating data collection on the practices and farm accounts shrimp farmers/self-help groups should co-operate with the State Department of Fisheries to collect, organize, and evaluate data to demonstrate the adoption of the guidelines and document the benefits of their use and also for other statistical purposes.

17.5 Farmers should be encouraged to join shrimp farmers information network at the local, national and regional levels. The shrimp farmers should also see the various developments in shrimp farming in the country and elsewhere. The aquaculture networks available should be made use by shrimp farmers/Groups for improving their knowledge and skills and also for obtaining latest developments and market trends.

18.0 Integrated coastal zone management

18.1 Integrated coastal zone management plans should be prepared for each coastal State by the States concerned with zoning for different activities and with buffer zones. This could at best be only a rolling plan (dynamic) in the initial stages so that improvements can be effected annually or biannually, with improved databases and knowledge on site-specific interactions of aquaculture with other sectors.

18.2 Detailed master plans for development of aquaculture through macro and micro-level surveys of the potential areas and zonation of coastal area delineating the land suitable and unsuitable for aquaculture using the remote sensing data, ground truth verification, Geographical Information System (GIS) and socio-economic aspects should be considered. In areas where pond density or water surface area (WSA) of shrimp ponds are in excess of the carrying capacity (CC) of the eco-system, which can also be defined as the assimilation capacity of the receiving waters, a reduction in pond density and thus a reduction in the overall WSA should be effected.

19.0 Protecting the livelihood of various coastal communities

19.1 Coastal aquaculture, which is now confined mainly to shrimp farming, is one among the several activities in the coastal area involving the coastal communities. Much of the social conflicts in coastal areas are due to the larger demands on the limited resources, resulting in competition amongst the various stakeholders. There are also instances where through harmonious use of resources coastal communities have set up excellent examples of integrated coastal development.

19.2 Badly planned and unregulated operation of shrimp farms, as already indicated can cause considerable level of avoidable conflicts with the community and other sectoral activities in the vicinity of the farms. Conflicts could arise between shrimp farmers and others who either live in the coastal zone or depend on coastal zone resources for their livelihood, as also between shrimp farm owners/ managers and employees, especially in the case of larger farms. Some of the more serious inter-sectoral problems would be addressed in the overall governance and regulation by adopting the following guidelines.

- Shrimp farm owners/managers should respect the community rights and needs and in case of any conflicts arising always attempt to solve the problems in amicable ways for ensuring harmony in the community and sustainability of the shrimp farms. They should cooperate with the community and other sectoral users of the coastal resources, in common efforts for improving environmental conditions and community welfare.
- Farmers, especially with larger holdings should employ local workers as far as possible.
- Workers should be provided with good working conditions and should also be trained for their skill upgradation.
- Access to the sea front and other common resources to the coastal communities by the aquaculture units should be ensured. The interests of the communities and organisations in the area should be safeguarded.
- Care should be taken to see that the natural drainage canals which are used as water source for aquaculture units are not blocked so as to avoid flooding of low lying areas and villages.
- Salinisation of land and drinking water should be avoided by providing suitable buffer zones between agricultural land, villages and shrimp farms.
- Use of common property resources like the creeks, canals, etc should be carried out in a harmonious manner and the traditional rights of the coastal communities should not be affected in any way.
- To avoid problems of ground water salinisation, drawal of ground water is strictly prohibited for shrimp aquaculture. It must be ensured that piezometers/groundwater monitoring bore wells preferably 4/ha (along the periphery of the pond) are installed to monitor salinity ingress. In case of salinity ingress the Coastal Aquaculture Authority should ensure immediate closure of the farms.

Appendix

Maximum Permissible Residual Levels for Fish and Fishery Products

	Substance	Maximum Permissible Residual Levels (in ppm)
A	**Antibiotics and other Pharmacologically Active Substances**	
	1. Chloramphenicol	Nil
	2. Nitrofurans including: Furaltadone, Furazolidone, Furylfuramide, Nifuratel, Nifuroxime, Nifurprazine, Nitrofurantoin, Nitrofurazone	Nil
	3. Neomycin	Nil
	4. Nalidixic acid	Nil
	5. Sulphamethoxazole	Nil
	6. Aristolochia spp. and preparations thereof	Nil
	7. Chloroform	Nil
	8. Chlorpromazine	Nil
	9. Colchicine	Nil
	10. Dapsone	Nil
	11. Dimetridazole	Nil
	12. Metronidazole	Nil
	13. Ronidazole	Nil
	14. Ipronidazole	Nil
	15. Other nitroimidazoles	Nil
	16. Clenbuterol	Nil
	17. Diethylstilbestrol (DES)	Nil
	18. Sulfonamide drugs (except approved Sulfadimethoxine, Sulfabromomethazine and Sulfaethoxypyridazine)	Nil
	19. Fluroquinolones	Nil
	20. Glycopeptides	Nil
	21. Tetracycline	0.1
	22. Oxytetracycline	0.1
	23. Trimethoprim	0.05
	24. Oxolinic acid	0.3

B.	**Substances having anabolic effect and unauthorised substances**	
	1. Stilbenes, stilbene derivatives and their salts and esters.	Nil
	2. Steroids	Nil
C.	**Veterinary drugs**	
	1. Antibacterial substances, including quinolones	Nil
	2. Ante helminitic	Nil
D.	**Other substances and environmental contaminants**	
	1. Organochlorone compounds including PcBs	Nil
	2. Mycotoxins	Nil
	3. Dyes	Nil
	4. Dioxins	4 picogram per gram, fresh weight
E.	**Pesticides**	
	1. BHC	0.3
	2. Aldrin	0.3
	3. Dieldrin	0.3
	4. Endrin	0.3
	5. DDT	5.0
F.	**Heavy Metals**	
	1. Mercury	1.0
	2. Cadmium	3.0
	3. Arsenic	75
	4. Lead	1.5
	5. Tin	250
	6. Nickel	80
	7. Chromium	12