

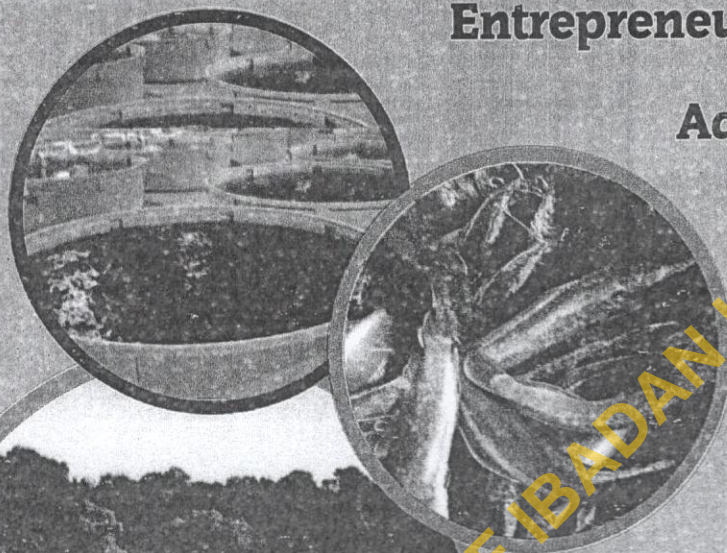


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Entrepreneurship Development Training In Aquaculture Business



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TRAINING MANUAL

Chapter Ten

Aquaculture Practice in Management of Fish Disease and Biosecurity

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1. Introduction

One of the utmost causes of financial loss in most commercial aquaculture fish farming business is incidence of fish diseases. Intensive aquaculture production systems is beset with inherent stress factors that predisposes aquatic animals to health management challenges necessitating strict adherence to routine management practices needed to circumvent incidence of diseases. All stages of development of fish including the developing embryo, hatchlings, fry, fingerlings, juveniles and the adult can be affected by disease, which can occur in all culture systems whether static culture or intensive water recirculation, and in all aquatic ecology; freshwater, brackish-water or marine environment. It is therefore important that routine management practices be developed to enhance bio-security and aid disease prevention in commercial aquaculture ventures.

Some fish pathogens are well known problems; other diseases are emerging or spreading to previously unaffected areas. Intensive fish farming provides an ideal environment in which disease-causing organisms can flourish and cause serious damage to productivity. The concentration of large number of animals within production settings can lead to the rapid spread of disease. High stocking densities also increase stress, making fish more susceptible to disease. Since treatment options are limited for most aquaculture diseases, prevention remains the best option for the fish farmer. Biosecurity is the prevention of disease causing agents entering or leaving any place where farm animals are present (or have been present recently). It involves a number of measures and protocols designed to prevent disease causing agents from entering or leaving a property and being spread. Some diseases are zoonotic, and can be transmitted between humans and animals, and therefore there are good public and occupational health reasons for having biosecurity measures.

Disease may originate from any number of sources, e.g. viruses and bacteria. By whatever means disease originates; it spreads through recognized vectors of infection. These include fish stocks, culture/ holding structures, staff and visitors, equipment, vehicles and tools, birds and animals, the aquatic environment and even the air itself. Medication and vaccination have customarily played a major role in treating diseases but it is now widely recognized that they cannot, in isolation, prevent losses due to disease.

Modern intensive farming demands a holistic approach. Unless the background challenge from disease causing organisms can be controlled, and good management practices are strictly followed, medication and vaccination alone would not adequately protect aquatic stocks (Akinwole, 2011). Cultured organisms must be provided an environment in which the level of infection is controlled to the point where vaccination and medication can accomplish positive effects. Biosecurity is the means to achieving this.

2.0 Biosecurity in Aquaculture

Biosecurity can be defined as 'the measures and methods adopted to secure a disease free environment in all phases of aquaculture practices (i.e. hatcheries, nurseries, grow out farms) for improved profitability'. Biosecurity protocols are intended to maintain the "security" of a facility (i.e., prevent entry of, or reduce overall numbers prior to entry) with respect to certain disease causing organisms (parasites, bacteria, viruses and fungi) that may not be present in a particular system. In short, food producers have consumer safety as their primary target. If the food they produce is not safe, no economic model works. The second and equally important target is economic prosperity. Part of this process is biosecurity.

Biosecurity touches all the bases of aquaculture activities such as: environmental integrity, animal welfare, food safety and economic gain. Biosecurity measures are the management practices that prevent non-infected, healthy animal populations from being exposed to infectious or parasitic agents. Common biosecurity measures are, Proper egg disinfection, Control of vertical disease transmission, strict sanitation measures, Water treatments, effluent treatment, clean feed, disposal of mortalities etc. In aquaculture, critical control points are areas in the production process that may present or permit biological hazards. Detecting these areas requires a little foresight and common sense. One of the challenges faced by aquaculturists is to offer all the life stages of their animal proper sanitary conditions and biosecurity.

A comprehensive biosecurity programme should be in place and this is essential in combating and preventing disease. With the rapid increase in aquaculture practices, the need for disinfectants has also increased. Entry and growth of pathogens must be minimized through use of disinfectants in water, on tanks and equipment and on eggs. Disinfectants used in aquaculture are aimed at all types of infectious agents (including bacteria, fungi, viruses and protozoa). The disinfectant must come into direct contact with the disease causing organism to kill them by releasing proper amounts of active compounds.

2.1 *Biosecurity basics*

The main goal of biosecurity is to reduce the risk of disease introduction or spread on a fish farm. The concentration of large number of animals within production settings can lead to the rapid spread of disease. High stocking densities also increase stress, making fish more susceptible to disease. Since treatment options are limited for most aquaculture diseases, prevention remains the best line of defense for the fish farmer. Biosecurity on commercial fish farms should be hinged on three basic principles namely;

- Reducing the threat of pathogen introduction to the culture facility. This can be addressed by incorporating biosecurity plans into culture facilities design, location and layout.
- Reduction of the possibility of pathogen spread throughout the facility by putting in place appropriate operational routines
- Minimise conditions within the facility that increase susceptibility of aquatic to infection and diseases animal health management

2.2 *Different Levels of Biosecurity*

Different levels of biosecurity will be applicable in any aquaculture venture on the purpose of the system, the species, stocking densities, frequency of movement of animals, employee, visitors in and out of the facilities, the economics involved, the potential impact of pathogens and other factors.

In the production facility, introduction of a virus, bacterium, parasite or fungus, not already present on the facility, will have greater overall impact. Vectors, such as carrier organisms, people or equipment, often spread disease causing organisms. If these vectors are properly disinfected at defined critical control points then exposure to disease causing organisms will be greatly reduced.

An effective disinfectant is chosen based on:

- **Efficacy** - Proven efficacy is of major importance against the full range of viral, bacterial and fungal disease causing organisms. Particularly in aquaculture the viruses that cause diseases are extremely persistent and difficult to destroy.
- **Environmental impact** - A good disinfectant must kill pathogenic organisms within a facility but must not harm organisms in the environment when released.
- **Operator safety** – Any products used must be safe for staff employing the product and all safety protocols must be strictly adhered to.

The principles of a good biosecurity measures apply to all system. Good biosecurity measures reduce the exposure to disease causing organisms through the following process:

(1) **Creation of External barriers** – preventing the spread of disease causing organisms onto and off a farm or hatchery by focusing on:

- Pathogen-free water source at all times for land based farms.
- Total ban on movements of fish from other farms.
- Restriction on visits and access to a farm site i.e. fence around the site.
- Strict sanitary measures for all entering the farm.
- Foot dips and hand hygiene.
- Pest control management.

(2) **Creation of Internal barriers** - preventing the spread of disease causing organisms within a farm by:

- Separation of each unit within a facility and isolation of these units from each other.
- Define sanitary units or areas on each farm site
- Define sanitary measures (i.e. cleaning & disinfection, pest control measures) inside each unit or area.
- Define sanitary measures on movements between different units or areas i.e. total ban of movements from one area to another area.
- Restrict movements of tools and culture organisms.
- Strict sanitary measures for any people entering the aqua farm.
- Protective clothing (regular disinfection)
- Foot dips and hand hygiene
- Cleaning and disinfection measures
- Pest control management

2.3 Important Components of Biosecurity

Quarantine is defined as the isolation of an organism or group of organisms to prevent the introduction or spread of infectious disease. It is a standard procedure that is extremely important in aquaculture. Quarantine protocols should be strictly adhered to and follow as many of the following protocols as are practical:

- testing of a sample of fish prior to bringing them onto the facility.
- all-in, all-out stocking procedures.
- isolation or separation from other populations for a period of time (depending on species, diseases of concern, the system)
- feeding observation and diet adjustment.
- sampling and proper treatment.
- reduction or elimination of infectious pathogens.
- disease prevention strategies.

Sanitation and Disinfection, Good sanitation and disinfection procedures reduce the numbers of disease causing organisms present within a given system and prevent or reduce the spread of disease causing organisms from one system to another.

Recommended Sanitation and Disinfection Protocols:

Proper attention to food sources:

1. Be careful with live foods, although live or fresh foods can be a good source of nutrients, these may also be a source of pathogens.
2. Ensure proper storage (in a cool, dry location) and usage (follow manufacturer's recommendations) of feeds to prevent loss of nutrients and build-up of pathogens or toxins.

Good overall system maintenance and cleanliness to reduce environments that will favour pathogens and parasites

1. Good husbandry (such as nutrition, water and soil quality etc).
2. Regular monitoring of excess organic matter and control strategies.
3. Rack wash and treatment of filters as needed to reduce organic loading in hatcheries.
4. Washing and disinfection of air and water pumps and lines in hatcheries.
5. Flush sediment out of water lines as needed and disinfect them.
6. Maintain proper sanitization disinfection strategies.
7. Keep nets and other equipment off the floor to control contamination and keep them sterile.
8. Pull dead and moribund culture organisms as soon as possible and dispose of appropriately.
9. Avoid cross contamination of equipment or water from one system to another.
10. Use disinfectants for equipment including nets and footbaths (placed at strategic locations around the facility, e.g., at the entrance and exit of quarantine buildings, hatcheries, farms and other systems)

3.0 Biosecurity and culture facility layout

During a disease event, the physical features of farm operation and local farms are vital information for helping reduce the risk of disease introduction and spread. Considerations should be given to other similar culture units in the area; other livestock sites, including processing bays, sales yards, or waste transfer stations, and hatcheries; location of stores with respect to roadways and animal transport routes; and waterways and conservation areas. The position of ventilation outlets and inlets should not be located downwind of another operation.

Facility layout

An illustration of the layout of farm operation can assist in training new employees, directing visitors, and planning future production processes and disease response. Understanding the logic of production movements and work patterns can be important to the development, implementation, and modification of a biosecurity plan.

Biosecurity considerations:

- Manage orientation of stores, buildings, and units to minimize disease introduction and transmission.
- Position facilities on the premises to minimize disease introduction and spread.
- Ensure that cleaning and disinfection areas and facilities are appropriately located.
- Designate unloading and loading point in a location that minimizes disease introduction and spread.
- Place areas for restraint, treatment, and isolation or quarantine of fish in locations that minimize the risk of disease introduction and spread.
- Keep segregated rearing areas for young, sick, and new fish.
- Surround the property with a perimeter fence or boundary.
- Establish a visibly demarcated boundary around the production area.
- Locate farm residences outside the production area, if possible.
- Make available a map of the property, including the production area.

Operation control

Vehicles and the surfaces on which they travel can be vectors for the introduction, spread, and release of disease-causing agents. Thus, it is important to control and, if necessary, restrict the movement of vehicles on farm premises.

Biosecurity considerations:

- Ensure that traffic flow routes are well defined and provide direction to staff and visitors.
- Use appropriate signs to direct visitors to parking areas, farm offices, transition areas, and delivery and drop-off points.
- Provide designated parking areas for vehicles not entering the production area.
- Ensure that the main entrance gate to the premises and production area has appropriate signs and that it can be secured.

Farm setting

Natural features, including vegetation, waterways, and topography, can benefit a biosecurity plan by providing natural barriers and drainage. These features on a farming property can provide a cheap means of implementing biosecurity measures.

Biosecurity considerations:

- Locate production areas and hatchery structure on higher ground, and/or use landscaping to assist drainage and reduce standing water in the production area.
- Minimize trees and shrubs near or within the production area.
- Use natural barriers along roadways or neighbouring farm boundaries to enhance separation.
- Manage vegetation within or around the production area.
- Use landscaping to assist drainage and to reduce standing water in the production area.

Operational routine

The arrival and movement of owners, employees, visitors, and service personnel are daily occurrences for a farm operation, and increase the risk of introduction and spread of disease and pests. Risk-reducing measures are easily incorporated into operational routines and often require little financial commitment. The success of operational routines as risk-reducing practices depends on responsibility, cooperation, diligence, flexibility, and planning.

Biosecurity Zones

Biosecurity zones are those areas that involve biosecurity measures for access, exit, and movement. Specifically, the Controlled Access Zone (CAZ), e.g. breeding and production tanks and feed, water and equipments stores, and the Restricted Access Zone (RAZ) like hatchery, indoor culture units, represent areas of increasing risk. To be effective, these zones should be visible and controlled, and their importance should be understood.

Biosecurity considerations:

- Have a CAZ (outer biosecurity zone) and one or more RAZs (inner biosecurity zones) for the production area.
- Provide appropriate and visible signs for the CAZ and RAZ.
- Define the boundaries of biosecurity zones.
- Control entry and exit points for biosecurity zones.

People, clothing, and footwear provide numerous risk factors for a biosecurity plan. Measures can be developed and implemented to reduce these risks through protocols and the strict control of access to biosecurity zones.

Biosecurity considerations:

- Communicate biosecurity measures to visitors and service sectors and ensure that they understand and comply.
- Don't forget that permission to enter the premises is ultimately the responsibility of the producer.
- Require separate outerwear and footwear (disposable or farm-dedicated) for entrance into the production area (CAZ).
- Designate farm or barn outer clothing for entrance to the animal production area – the RAZ.
- Provide handwashing facilities at the entrance and exit of a production area or unit.
- Enter and exit into or from the CAZ or RAZ by passing through a controlled entry point (transition area or anteroom) where cleaning, disinfection, handwashing, and outerwear changes occur.
- Require clean-to-dirty, healthy-to-sick, and young-to-old work patterns inside and between production units, and out of zones.
- Limit CAZ/RAZ access to accompanied essential visitors (service industry personnel, veterinarians, speciality services, utility personnel, and contractors).
- Have visitors who have had contact with other animals shower before changing into protective outerwear and footwear.
- Require the use of footbaths where provided.
- Remove, contain, and dispose of soiled disposable outerwear and footwear before departure.
- Clean and disinfect dirty boots.
- Wash hands and forearms before leaving the premises.
- Require that all visitors act as follows:

- obtain approval before their visit;
 - understand established biosecurity protocols;
 - fill out a visitor log and be accompanied;
 - limit their access to the production area; and direct access to animals, their products, feed, and water.
- Require that those employees and family members returning from other countries who have had contact there with animals and/or animal housing avoid immediate direct or indirect contact with animals until biosecurity measures have been applied. The nature of those measures and the timeframe required are dependent on the fish health status of the country visited and the potential risk of disease transmission.

Vehicles and Equipment

Just as people and clothing pose biosecurity risks, vehicles and equipment also pose high levels of risk. This risk is increased if they travel on and off the premises or have contact, direct or indirect, with fish or fish products.

Biosecurity considerations:

- Ensure that all vehicles entering a farm follow established biosecurity protocols.
- Park employee and family vehicles in a designated area outside the production area and off operational traffic patterns.
- Clean vehicles until they are free of visible organic material on tires, wheel wells, and undercarriage.
- Clean and disinfect vehicles and equipment entering a biosecurity zone in a controlled, designated area.
- Ensure that delivery and/or service areas are as distant as possible from rearing facilities.
- Have designated equipment specific to each farm. Avoid sharing farm equipments between farms.
- Clean and disinfect equipment that is in contact with mortalities, manure, or feed, according to biosecurity protocols or a risk management program,
- Clean and disinfect, as necessary, vehicles and equipment exiting a biosecurity zone.
- Properly sanitize livestock instruments and equipment before and between uses.
- Limit recreational vehicle use on the premises.
- Maintain a vehicle and equipment arrival log.

Facilities Construction and Maintenance

A well-constructed and maintained facility strengthens a biosecurity plan by aiding cleaning and disinfection processes and reducing the risks associated with visitors, services, and pests.

Biosecurity considerations:

- Put in place a routine facility/property maintenance program.
- Conduct routine inspections of equipment and buildings.
- Keep buildings and mechanical equipment in good repair.
- Have signs, fences, and boundaries in good repair.
- Require production areas to be free of water (puddles) and effluent drainage.
- Make sure that buildings are easily cleaned and disinfected.
- Design farm buildings to prevent the entry of wild birds and animals, and limit the presence of vermin (Plate 4).
- Ensure that gates and building doors can lock.
- Ensure that driveways and walkways are in good repair, and are constructed of all-weather material (concrete or asphalt) that promotes adequate drainage.

4.0 Management practices

Various management techniques are employed in commercial fish culture cutting across all production systems including brood-fish production, hatchery propagation of seeds and table fish production. Management practices applied in all these processes are usually targeted toward production efficiency and prevention of infectious and non-infectious diseases. Various bio-security measures are engaged to achieve these targets.

Selection of healthy broodstock

Brood-fish selected for breeding should be healthy and devoid of signs of infection, and should be gravid with viable eggs to ensure good hatching rates and the production of healthy seeds. Sick brood-fish may transmit disease to offspring vertically in eggs or ovarian fluid as observed with infectious pancreatic necrosis, or horizontally via contamination by bacterial or fungal organisms. Eggs that are not viable cannot be fertilized, and will form excellent growth medium for fungal and bacterial pathogens that can infect viable eggs, causing a vicious circle of infection as is the case with infection of eggs by *Saprolegnia sp.* This is the reason for the extraction of egg sample by application of slight digital pressure to check for egg viability prior to induction of ovulation. Viable eggs are either green or greenish yellow, occurring singly, discrete and usually translucent.

Disinfection of culture facilities and materials

All facilities and materials used in breeding like incubation troughs, receptacle for egg collection, towel to hold the female while stripping, the kakaband or net for egg incubation must all be disinfected using appropriate disinfectants like hypochlorite (0.25 -0.5 ml/L), formalin (5% solution) and sodium chloride (3% solution). Disinfected materials should be thoroughly rinsed before use. Earthen ponds used for fingerling grow-out and table fish production can be disinfected with nitrogen lime (0.5kg/m^3) or chlorinated lime ($0.05 -0.06 \text{kg/m}^3$), and the caustic effect of the lime allowed to wean (within 3 days) before stocking. Regarding fry rearing in earthen pond, some fry should be kept in treated (limed) pond water sample overnight to confirm safety prior to stocking.

Disinfection with chemicals like Kuprikol 50 (47.5% copper oxychloride) are also targeted against mollusks intermediate host of digeneans (worms) to break the chain of the life cycle of such parasites.

Physical methods like drying and de-siltation of earthen ponds (Plate 1) can also help to destroy the different developmental stages of some parasites including the cocoon of leech, eggs and spore forms of parasites as well as predatory larvae of water insects (e.g. dragon fly larvae).

Pond screening

Earthen ponds used for fry and sometimes table-fish rearing are usually screened (Plate 2) against predators that also double as vermin; with the capacity to spread disease agents from pond to pond. Such vermin include birds, monitor lizard (Plate 3) and frogs (Plate 4). Ponds are screened using nylon nets, wire gauze, polyethylene sheets etc, to prevent incursion by these predators. Ponds are covered on the sides and the top, and the predators are sometimes trapped in the mesh of the net. Pond screening becomes very important with the backdrop of most of the vermin being host to some fish parasites too. Birds share helminthes parasite with fish as final host to some roundworms, shedding eggs of these parasites into the ponds as they scavenge for food. It may be necessary to screen the water inlet with net to also discourage the introduction of mollusks which also constitute health risks to cultured fish as earlier mentioned.

Optimizing culture conditions

Extremes of water quality parameters like dissolved oxygen, pH, ammonia nitrogen, nitrite and algae population must be avoided. These parameters must be kept at the optimum levels hence efforts must be made to monitor them periodically. Nitrogenous waste and organic matter like uneaten food or faecal waste must be promptly removed from culture facilities, and toxic bloom of algae must be avoided in earthen pond culture.

Periodic water renewal must be encouraged in all culture systems. Furthermore, the stocking density must be optimum; overstocking and other practices that causes stress and predispose fish to infection must be avoided. Food fed to fish must be adequate in quality and quantity. Appropriate pellet size must be used to ensure accessibility and avoid malnutrition.

Preventive control of diseases

Immunostimulants are becoming popular in aquaculture and are commercially available. They are used to increase resistance to disease by modulating the immune system of fish. Immunostimulants include chemical agents, microbial components (probiotics), polysaccharides, animal and plant extracts and nutritional factors. Examples of probiotics include:

- Microalgae like *Tetraselmis spp* and *Spirulina plantesis*
- Yeast like *Debaryomyces spp*, *Phaffia spp*, and *Saccharomyces spp*
- Gram positive bacteria like *Bacillus*, *Lactococcus*, *Lactobacillus*, *Micrococcus*, *Carnobacterium*, *Enterococcus*, *Streptococcus spp* etc
- Gram negative bacteria like *Aeromonas*, *Alteromonas*, *Photobacterium*, *Pseudomonas* and *Vibrio spp*.

Commercial preparations include Diamond V Yeast that comprise of *Saccharomyces cerevisiae* used at 10g/kg of feed, and Megalo that comprise of *S. cerevisiae* and *Bacillus subtilis* and use at 1.5g/kg of feed. Other immunostimulants include Levamisole, a anthelmintes and immunostimulant used at a dosage of 225g/kg of diet, and Immunoton a multivitamin/mineral supplement applied at the rate of 1g/kg. Furthermore, vaccines have been developed against various diseases of fish, most of which are yet to be observed in Nigeria.

Provision of good feed and water

Water sources commonly used for fish farming include surface and underground water. The most suitable water source must be good quality, clear clean odourless and free of pathogens. Underground water is regarded as the most suitable though it is limited in supply. Where the use of surface water from rivers, stream and reservoir cannot be avoided, supply must be filtered using suitable means including sand filters. The use of UV radiation for incoming water is also practiced and has been found to be effective. Water sources and delivery systems have the potential to expose animals to disease-causing pathogens on a daily basis. Aquatic environments (ponds, lakes, etc.) cannot be controlled and are potential reservoirs for serious disease agents.

Biosecurity considerations:

- Production water must meet provincial and municipal standards for potable water.
- Test water regularly for safe animal consumption.
- Use municipal water sources, wherever possible.
- Filter and treat water from wells, streams, ponds, and lakes.
- Reduce or eliminate animal access to streams, rivers, lakes, or ponds.
- Use "closed" water delivery systems, wherever possible.
- Inspect and maintain systems and treatment units.
- Install alarms or other devices to notify producer when water treatment systems are not operational.

Ingestion of contaminated feed can introduce and spread disease quickly. Contamination may occur off-site at purchase or on-site as a result of inappropriate storage.

Biosecurity considerations:

- Source feed from manufacturers or suppliers that operate under a quality assurance program and that have a biosecurity component.
- Contain, seal, and/or enclose feed storage and storage areas.
- Keep feed and bedding storage outside the RAZ.
- Keep feeding systems "closed," wherever possible.
- Ensure that feed-delivery personnel have no contact with livestock.
- Source bedding from reputable suppliers.
- Store bedding in a designated area to prevent contamination.

Wastes and Mortalities Management

Daily exposure (direct or indirect) to manure is routine for animals and employees. Manure is an animal product and can easily attract insects and pests, creating the potential for high-risk situations as employees or animals move around the facility. Consider employees and equipment that have entered the RAZ to have had either direct or indirect contact with manure.

Biosecurity considerations:

- Develop a written manure management plan to address collection, storage, handling, and disposal.
- Ensure that manure management adheres to provincial and municipal waste, agriculture, and environment guidelines.
- Remove animal waste regularly from production areas.
- Store animal waste outside of the production area, if possible.
- Store animal waste away from property lines and roadways.
- Manage animal waste storage to contain runoff and to limit access to wildlife and pests.

- Require biological composting and anaerobic storage before spreading manure on fields or moving it off the property.
- Record movements, including sales, of manure and/or compost from the production area or premises.
- Ensure that neighbouring producers do not spread manure adjacent to your barns, production areas, or water sources.

Mortalities create risk situations in several ways. They may act as a reservoir of pathogens (in the case of death due to disease), attract pests, or transfer disease off-site (in the case of serviced removal). On-site considerations include movement around the facility, storage and/or containment areas, and compost or final disposal.

Biosecurity considerations:

- Develop and implement a written plan for holding and disposing of dead animals.
- Locate disposal and loading (mortality collection) areas outside the production area to prevent contamination of the site.
- Design and locate temporary containment and disposal areas in a way to prevent access by people, domestic animals, wildlife, and pests.
- Manage post mortems and diagnostic tests to prevent further contamination.
- Appropriately dispose of contaminated bedding, animal products, manure, or feed.
- Situate dead animal pickup in a location that prevents further contamination.
- Select disinfectants based on target organisms and needs.

5.0 Other measures

Cleaning and disinfection are key pillars of a strong biosecurity plan. These processes work in conjunction with zoning and other measures. Cleaning and disinfection reduces pathogen load on people, equipment, and vehicles, which mitigates the risk of pathogen movement between and within production areas. Disallow entry into culture or rearing facilities except where necessary, and after proper feet (Plate 5) and hand disinfection. Knowledge supports the control of farm operations. It also allows for future planning as situations or production processes change. Developing and implementing a training program provides employees with a sense of involvement and pride, and helps to avoid complacency. Developing, implementing, and maintaining good management practices allows a biosecurity plan to operate effectively and provides animals with an environment that is conducive to good health and maximum production. Early detection of a disease concern is vital to minimizing its impact and facilitating its containment to a premises or individual production units. Introducing new animals, or animals returning from off-site activity, has the potential to introduce disease-causing agents into a production system. Sick animals can easily transmit disease through direct or indirect contact. Initially, the

disease may be low grade; however, animals in a compromised or weakened condition are more susceptible to highly contagious and virulent disease agents. Implementing proactive measures will help reduce the risk of disease becoming established on a farm. The appropriate use of medication, for example, can improve the efficacy of treatment and help reduce the risk of future concerns. The ability to react quickly and effectively to a disease situation is vital to minimizing the impact on an operation and helps prevent disease spread. Not allowing vehicles into the farm premises, but where this is unavoidable; all vehicles entering should be made to pass through wheel-dip or sprayed with disinfectant

6.0 Conclusion

The main elements of biosecurity can be summarized as well developed culture facilities, reliable stock, adequate diagnostic and detection methods, disinfection and pathogen eradication methods and best management practices. However, climate change, growing and changing markets, consumers demands for better products and social issues associated with changing values and land-use are new factors likely to influence the pattern and spread of new and re-emerging diseases associated with commercial aquaculture. Stakeholders in the industry has no alternative than to being proactive in constantly ensuring that culture facilities are kept safe and free of diseases. The consequences of doing otherwise are best imagined than experienced.

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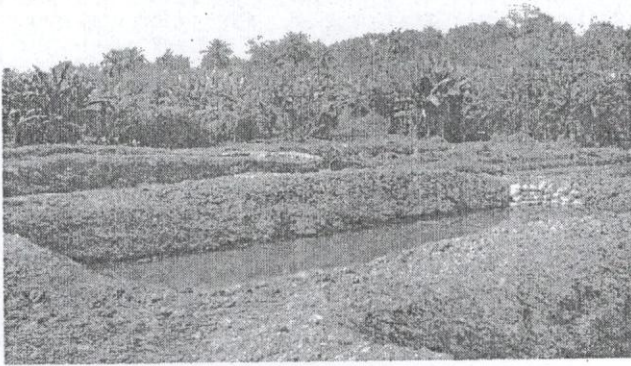


Plate 1: Pond desiltation



Plate 2: Net Screening of pond against predators/vermin



Plate 3: Monitor lizard; a predator/vermin



Plate 4: Frogs are predators of fish fry and can be vermin



Plate 5: Foot-dip at the entrance of a fish hatchery