Aquaculture - Biosecurity

The importance of biosecurity and disinfection in aquaculture

The world's demands for high quality aquaculture products make control of diseases increasingly important. Good Biosecurity measures are vital to maintaining healthy animals, to reducing the risk of acquiring diseases in aquaculture facilities and to harvest high quality good yield.

Biosecurity

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, growout 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. It touches all the bases: 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, Traffic control, 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. Spotting these areas often requires a little foresight and common sense. One of the challenges faced by aquaculturists is to offer all the life stages of their animal's proper sanitary conditions and Biosecurity. A comprehensive biosecurity programmer 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.

Different Levels of Biosecurity

Although it is important that all aquaculturists understand the concepts involved, different levels of biosecurity will be applicable depending upon the purpose of the system and the species, stocking densities, frequency of movement of animals and farm/hatchery, workers/visitors/ owners into or out of the system, 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 systems whether they be land based (farm) or flow through (hatchery).

Good Biosecurity measures reduces the exposure to disease causing organisms with:

- **External barriers** – preventing the spread of disease causing organisms onto and off an aquaculture farm or hatchery.
- **Internal barriers** – preventing the spread of disease causing organisms within an aquaculture farm or hatchery.

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 shrimp, prawn and fish from other farms.
- Total ban on movements from farm with older or poorer health.
- Restrictions on movements of shrimp, prawn and fish between farm sites of the same company.
- Restriction on visits to the aqua farm.
- Restriction on access to a farm site i.e. fence around the site.
- Strict sanitary measures for any people entering the farm.
- Protective clothing (disinfected).
- Foot dips and hand hygiene.
- Cleaning and disinfection measures.
- Pest control management.

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

Biosecurity involves following strict management protocols to prevent specific pathogens from entering a system or reducing the numbers. A good understanding of pathogen reservoirs is important. **Quarantine, sanitation and disinfection** are all important components of biosecurity.

Quarantine, defined as the isolation of an organism or group of organisms to prevent the introduction or spread of infectious disease, is a standard procedure that is extremely important in aquaculture. In practical terms, quarantine is a standard set of procedures that should be observed to prevent the introduction of pathogens or diseases into a population of fish, prawn and shrimp in aquaculture. The quarantine protocols should be strictly adhered and should follow as many of the following protocols as are practical:

- testing of a sample of shrimp, prawn and 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 upon 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 to prevent or reduce the pathogen load in a system include:

- 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 (fallow manufacturers recommendations/expiration date) of manufactured feeds to prevent loss of nutrients and build up of pathogens or toxins.

- Good overall system maintenance and cleanliness to reduce environments that will favor 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. backwash 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 sanitisation 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)

Biosecurity Programme for Shrimp Production Sector:

The major implementation of any biosecurity measures is always going to be in the hatcheries and in the growing ponds. However, besides good management practices and treatments in hatcheries and ponds there are biosecurity measures which should be put into place:

1. Identify all vectors that can transmit disease from one place to another. Man is a major source of contamination. Anybody working with shrimp in several ponds should wash his/her hands, legs and feet with proper disinfection solutions, after handling equipment or animals and before moving to work on the next pond. Other vectors of disease transmission include crabs, rodents wild birds etc. which can contaminate the water in ponds. These vectors should be kept in control completely in the vicinity of aquaculture practices.
2. Do not share equipment between ponds unless necessary. In these cases, disinfect all equipment prior to being re-used.
3. Ensure that the site is limited to one combined entrance and exit to establish a secure Biosecurity perimeter. Restrict access to the hatcheries and farms to authorized persons only.
4. Ensure that all vehicles have been cleaned and disinfected prior to arrival at site.
5. Keep clean all surrounding areas of the hatchery or farm. After cleansing disinfect all surrounding areas of the hatchery or farm.
6. Thoroughly clean all equipment such as sampling tubs, trays, nets etc., rinse with clean water and then disinfect.

Problem-Solving Approaches

Strictly adhering to the principles of biosecurity and good husbandry management will prevent many disease outbreaks. However, problems that may lead to disease will arise even in the best-managed systems and a scientific and methodical approach will help determine the best course of action, reduce losses and get the system and shrimp back to normal. Record keeping is an important tool in this approach.

Problems may or may not result in diseased shrimp or fish. The key to preventing disease and reducing losses is early detection of any abnormalities in the system or the shrimp/fish. Early detection relies on daily monitoring of water quality, general system checks and observing shrimp/fish behavior, shrimp/fish appearance and mortalities. Optimal water quality should be determined for the species being held as it may vary among species, life stages or systems.

Health Diagnosis

Some early warning signs of disease in a population of shrimp, prawn or fish include changes in behavior or appearance, reduced or absent feeding response, as well as increases in morbidity (sick once) and moribund (mortality). In many cases, two or more factors, such as changes in

water quality, handling, parasites or bacteria, will have contributed to the disease outbreak and each must be corrected.

Records of water quality and management actions should be reviewed for early warning and any problems should be corrected. Nutritional programs should be examined for completeness (this will vary depending upon the species requirements and life stage) and storage of feeds should be evaluated to ensure feeds are stored properly (cool temperatures, low humidity and for minimal periods).

Shrimp, prawn and fish should be evaluated, preferably with the assistance of a health specialist. Early warnings will include behavioral changes, lack of feeding and any obvious external signs of disease (e.g., white spots, hemorrhages, vibriosis, or presence of protozoa or fungi). A representative sample of sick shrimp, prawn and fish should be sacrificed for necropsies. Necropsies should include examination of all tissues for appearance and presence of abnormalities; search for external and internal parasites; microbiological culture of pertinent organs; histopathology; and virology, if warranted. Any necessary treatments should then be based on findings from all pertinent tests.

Knowledge of how treatments affect the system is also important. Their proper use in aquaculture systems should be understood and all relevant issues should be determined prior to their use. Work with knowledgeable aquaculture specialists prior to starting aquaculture venture. Such efforts will maximize the chances of success.

Designs and components of biosecurity systems continue to be upgraded and streamlined, but basic management principles remain unchanged. Preventative medicine is critical. Preventative medicine includes proper attention to species biology, genetics, water quality, nutrition, system design, quarantine, sanitation, disinfection and overall management. An understanding of common diseases is also important. Common infectious and non-infectious diseases will vary from one species to another.

It is of primary importance to understand the serious implications of not implementing **biosecurity strategies**, quantitative assessment of risks, constant surveillance and detailed record keeping. This is particularly important in our aquaculture operation systems where predators, scavengers and poachers can pose serious threats in the transportation of pathogenic viruses, bacteria, protozoa, fungi etc. from one site to another.

Biosecurity is the management practices that prevent non-infected, healthy animal populations from being exposed to infectious or parasitic agents. Common biosecurity measures include:

1. **Sanitation**-Sanitation includes the cleaning and disinfecting of hatcheries, holding facilities, tanks, ponds, handling and vaccination equipment, etc. Cleaning must be done before disinfecting. Disinfectants include chlorine, heat, steam, formalin, and other chemical compounds. All of the chemical disinfectants are toxic, so all equipment should be rinsed well after disinfecting.

2. **Vertical disease transmission**- Vertically transmitted diseases (from parent to offspring) can be prevented by using healthy, disease-free broodstock.

3. **Egg disinfection**- Egg disinfection with iodine or other solutions at the time of the water hardening of eggs can reduce the incidence of disease problems of eggs and larvae.

4. **Traffic**- Restricting people and equipment traffic can reduce the chance of disease transmission from one facility to another.

5. **Water treatments**- Water treatments of incoming or recirculating water decreases the chance of pathogenic organisms entering the culture system. Treatments include mechanical filtration, UV light, and ozone.

6. **Effluent treatment**- Treatment of wastewater from aquaculture facilities and processing plants reduces the release of microorganisms into the environment. This is important, because there have been problems in the past with diseases re-entering an aquaculture facility from wastewater of a processing plant. Infected water from the plant was released, and then this water was taken into the aquaculture system.

7. **Clean feed**- It is important to use clean, fresh feed. Proper handling and storage of feed can reduce food-borne disease organisms.

8. **Disposal of mortalities**- The proper disposal of mortalities by incineration, burial, or composting will reduce the risk of recycling diseases. It is also important to remove dead fish from the tank or raceway often to reduce the likelihood of spreading the infection.

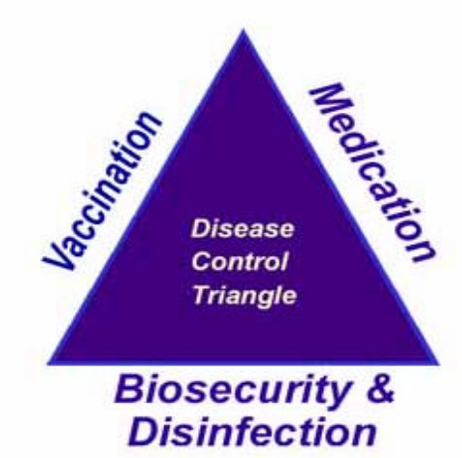
One of the challenges faced by aquaculturists is to offer all the life stages of their animal's proper sanitary conditions and Biosecurity. A comprehensive biosecurity program should be in place. This is essential in combating and preventing disease.

With the rapid increase in intensive aquaculture, 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). Disinfectants kill disease-causing organisms by releasing proper amounts of chlorine or iodine or other compounds.

A Proliferation of Pathogens

Pathogen. The word conjures up horrific thoughts of plague and death. It comes from the Greek word for 'feeling' or 'disease'. It comes from kids with snotty noses that you pick up from daycare. They got it from some other kid whose parents aren't as diligent about hygiene. Simplistic maybe, but the principle is the same whether it is people or fish: pathogens are transferable and they get that way by making copies of themselves.

Pathogens are organisms that cause disease. They can be viral, bacterial, fungal or parasitic. On the size scale, viruses can be nanometers wide (millionths of a millimeter) and only visible with an electron microscope, while bacteria are microns wide (thousandths of a millimeter) and visible with light microscopes at high power. Fungi and parasites are both macroscopic and microscopic.



The common aspect among all of these pathogens is that when present in large enough numbers, they produce toxins, disrupt cell function, or overuse resources of the host while feeding their own needs to reproduce. Not a pleasant thought.

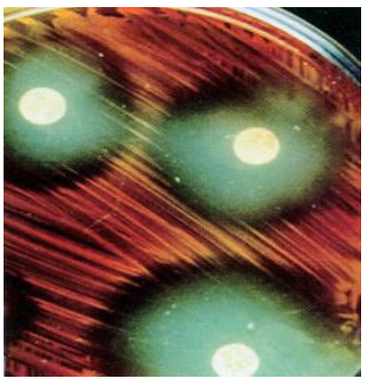
Viruses

Most viruses enter the fish by the mucosal linings of the gut or skin or by entering through gill tissue that has a thin cell membrane and a high surface area. In the gut the virus must survive acid conditions and then enter surrounding tissues to become infectious. In the fish slime, it must survive wandering macrophages (scavenger white blood cells) and at the gill sites, it must pass unrecognized by other white blood cells. If all this is done, the virus can initiate infection.

Once inside the fish the virus must then enter a host cell that permits replication. This is done by commandeering the machinery for normal DNA replication and using it for it's own evil purposes. After doing this, it makes several million copies of itself until the cell is full, bursts and spreads viral particles to other cells, either within the host or sometimes, outside the host.

The virus can relay it's disease attribute by cell lysis (disintegration), producing a toxic substance, changing host cell function or inserting a bit of it's genetic material into the cells genome. The most common observation is cell lysis as the virus multiplies in number.

Bacteria



Bacteria play the numbers game too. They enter the fish by the same methods or by open wounds suffered through trauma. Once inside, bacteria use the fishes' plumbing system, find a tissue that it likes (specific or non-specific) and sets up shop. Here the buggers multiply rapidly. The disease aspect of the bacteria is directly by tissue damage or by production of toxins. These toxins may be a result of metabolism or as a mechanism to protect the process of replication. The latter is almost a defense mechanism at the bacterial level. Either way, having too many bad bugs share your body is not a good thing.

Fungi

Fungi, like some other pathogens, are opportunistic, and are sometimes secondary infections to other fish health issues. Fungi send out hyphae (filaments) to attach themselves to nonspecific tissue that may be vulnerable or susceptible. From there they multiply spreading throughout the tissue utilizing the hosts valuable energy resources.

Parasites

Parasites may use fish as an intermediary or primary host. As an intermediate host, the fishes' chances of overt disease signs are small. However, as a primary host, the fish is the environment the parasite has been living for. Parasites don't generally kill the host, but they tend to alter behaviour and growth. The idea of having a macroscopic bug thriving to reproduce in you is not a pleasant one and it is easy to understand why the fish looks sick.

Antibiotics

Got an infection? Take a pill. But how does medication kill bugs? Antibiotics – those chemicals that kill bacteria – are also called antimicrobials and are of two general types: bacteriostatic and bacteriocidal.

Bacteriostatics prevent the bacteria from multiplying by inhibiting cell division. The fish then has time to develop an immune response and finishes off the resident bugs using its own defense system. Bacteriocidal medications kill the bacteria outright (how?). Antifungicides have similar effects on fungi by either inhibiting growth or by making changes to the cell wall and membrane of the fungus' hyphae. Poking holes in the cells of fungi causes salt and ion penetration that kills the cell and hopefully the fungus.

Parasiticides

Parasiticides are usually specific in toxicity to the target organism. The real challenge here is to kill the invader while keeping the host intact. These compounds usually focus on some particular feature of the parasites' anatomy or biology and exploit that weakness.

On the good side, pathogens don't normally live long outside a host. This is because they are dependant on a host for most of the necessities of life. Some may aestivate (go dormant) as spores or such, but generally they die. This is also the time to disinfect.

If the pathogen is outside the fish, it's much easier to kill it. Not only is the environment bad for the pathogen, there are also more tools that can be used to kill it. Selective toxicity is not necessary because you have isolated the pathogen and do not have to worry about the host. This is the principle of disinfection.

A good disinfectant will kill the pathogen and prevent growth of new pathogens. Of course, in a hatchery or farm situation, the disinfection process must be safe for humans, fish and the receiving environment otherwise some really nasty stuff could be used. Such uses would be irresponsible. The idea is to have a disinfectant that works with the efficiency of nuclear warfare, but without the aftermath. Biosecurity on fish farms has always been a challenge but there is no better time to kill a pathogen then when it is exposed, vulnerable and in search of a host.

Biosecurity - Get with the program

It is important to keep in mind the purpose of a biosecurity program and how it works to prevent disease infiltration. To help ensure an airtight program, successful farmers rely on measures developed using Hazard Analysis and Critical Control Point (HACCP) principles. These principles help identify critical control points for biosecurity hazards and are then used to set up internal and external barriers to control acknowledged risks.

Farmers can also systematically choose proper biosecurity and disinfection products to help create those barriers. This method allows all activities to be outlined in standard operating procedures (SOP's) developed and implemented by all farm staff.

In aquaculture, critical control points are areas in the production process that may present or permit biological hazards. Spotting these areas often requires a little foresight and common sense, and sometimes divine enlightenment.

Factors such as yielding capacity (compliance), holes in the current biosecurity program, accidents, and the angry of Mother Nature must always be considered when identifying critical control points and setting up barriers.

Critical control points may include: transferring pathogens on dirty boots or hands, disease spread through predation, movement of fish, eggs, people, or equipment, as well as incoming water supplies. Once critical control points have been identified, internal and external barriers are put in place to help eliminate hazards. The footbath is probably the most obvious barrier, especially for those going home with soggy feet.

As one could imagine, internal barriers are barriers that are set up to prevent disease or the spread of disease through elements inside the production cycle. These elements include controlling movement of people, fish, and equipment, as well as the disinfection procedures and so on.

Footbaths, hand wash stations, and routine disinfection are popular ways to establish internal barriers. Setting up separate secure areas on the farm and demanding high standards of hygiene may also be ways to develop good biosecurity practices.

On the other hand, external barriers are put in place for those troublesome elements outside of the production cycle. These may include treating incoming water supplies, and setting up predator nets. Though it may be difficult to predict all events in nature, it is possible to reduce their potential impacts and sometimes monitor and manipulate typical threats.

What about visitors you might ask? Both the internal and external barriers must deal with these seemingly uncontrolled beings. Although many feel they have little or no control over visitors, setting up gates, posting clear signs directing traffic, and requesting appointments are a few ways to manage those unavoidable beasts.

Once critical control points have been identified and internal and external barriers are in place, developing and implementing SOP's is the next step to biosecurity. So, make policy of the practices that will ensure that all biosecurity measures are understood, performed and documented. This will go a long way to ensuring that your fish are healthy and happy.

SOP's are often developed to ensure that recirculation pumps are turned off when well boats are downstream from processing plants. They mandate that all individuals must use footbaths and hand-wash stations and they highlight procedures for cleaning and disinfecting tanks. These SOP's should be clear and laid out step by step to avoid misunderstanding or misinterpretation.

SOP's may also provide information on how to choose proper biosecurity and disinfection products. Getting information on efficacy, solution concentration, environmental impact, contact time, and target organisms is often a good place to start. Having this kind of information will make the decision process easier.

Ask your supplier for pertinent information before purchasing. Compare the particular needs for each SOP against the specific features of the product being considered. This logical step-by-step method will almost always ensure you've made the right decision.

Developing Standard Operating Procedures is only the beginning. The process of biosecurity is ongoing and never static. SOP's have to be implemented immediately, followed constantly, reviewed periodically and amended whenever necessary. In order to be effective, biosecurity should be interactive, effective, and practical.

In many cases, the effects of pathogens and disease outbreaks can be avoided with the proper biosecurity program that identifies critical control points and sets up internal and external barriers. So, the next time someone walks away with soggy shoes, they should remember, it's not a matter of inconvenience; it's a matter of biosecurity. Besides, if they don't want to get their loafers soggy, they should leave them at home.

The Need For Biosecurity in Aquaculture

Disease challenge by viruses, bacteria, fungi and toxic algae presents a major threat to profitable aquaculture production. Biosecurity, in other words **reducing the number of infectious organisms** in the aquaculture environment, is the most effective form of protection. Biosecurity is a set of management practices, which reduce the potential for the introduction, and spread of disease-causing organisms onto and between sites. Bio-security procedures, particularly disinfection and sanitation, should be combined with selection of pathogen-free seed and strategic treatments to either eradicate or reduce these pathogens to non-infectious levels.

The Neospark Biosecurity Programme has been developed over many years with leading aquaculture producers around the nation. Neospark products and procedures have proven effective in practical farm conditions against a broad spectrum of pathogens. These include persistent and difficult to destroy immunosuppressive viruses causing WSSV, MBV and Vibriosis, which make the shrimps and other aquaculture organisms more susceptible to

additional disease challenge. Neospark disinfectants are also proven effective against bacteria casing a threat to food safety such as *E. coli, Pseudomonas, Aeromonas, Salmonella, Shigella, Edwardsiella etc.*

HACCP (Hazard Analysis and Critical Control Points) principles are increasingly being applied on all stages of aquaculture sector to control such threats. Neospark Bio-security Programmes are entirely consistent with HACCP principles.

Disease transmission

The mode of disease transmission between shrimps/prawns/fishes or between ponds or even between sites may or may not differ depending on the type of infection. For example, the occurrence of WSSV in shrimps depends on several factors. The shrimps that carry WSSV may not show any prominent symptoms or mortalities at all times. This may be due to the number of physico-chemical and microbiological factors, which triggers the stress factors causing severe mass mortalities. Therefore the management aspects should be considered for occurrence or non-occurrence of diseases in aquaculture ponds. Subsequently the virus particles through drained water spread the disease by waterborne transmission. On the other hand, the secondary infections caused my bacteria or other microbes, which are native flora, also causing the diseases and heavy mortalities. Infectious agents spread through droppings is also a major threat to the aquaculture sector.

Other diseases persist on sites through the contamination of equipment and organic matter by stubborn virus particles. Many organisms will persist outside the host, and *Vibrio, Zoothamnium, Aspergillus* and many viruses can survive in this way for a considerable time, especially in organic material.

Factors influencing biosecurity

Infection may be harboured and spread in a variety of ways. In relation to aquaculture, these may include by crustaceans, in feed, in feacal matter, by birds, by inadvertent human intervention and on equipment. These factors all influence the planning of a bio-security programme.

However, disease avoidance measures can be undertaken elsewhere. For example, use a heavy-duty broad-spectrum virucidal and bactericidal disinfectant (eg KloSant or ViraNil, Neospark), which will be capable of dealing with gross organic challenge.

People are the most important animate factor – including employees, servicemen, vehicle drivers, fishermen (cast net sampling). Staff movements should be as limited as possible, particularly where the disease situation on a particular site has deteriorated.

Control site traffic: Keep to a minimum and exclude all unauthorized persons. All visitors should enter on foot. Use regularly refilled foot dips, charged with a suitable disinfectant (eg. SparkDin, Bionex, ViraNil - Neospark).

All possible vehicles should be excluded from the site. Vehicles, which must enter, should be subject at the site entrance to spray disinfection of wheels and wheel arches. All visitors should observe standard operating procedures on vehicle cleansing and protective clothing used by vehicle crew.

All site visitors should be provided with adequate protective clothing, and should wash their hands prior to visiting ponds. Use an effective hand hygiene system, which is equally effective even when there is no available water supply (KloSant or ViraNil, Neospark). A shower in, shower out facility should also be seriously considered.

The fish or prawn or shrimp themselves can also be a cause of disease spread. Incoming seed should therefore be from high health status sources and there should be a well-defined health monitoring and audit procedure for bravids/broodrs/nauplei supply flocks. This should extend to hatchery hygiene procedures with regular microbiological/PCR monitoring. Avoid the potential spread of infection by diseased carcasses and dead once by on-site incineration.

Effective cleaning and disinfection reduces pathogen numbers and the weight of disease challenge, and enhances any biosecurity programme. It can only be achieved with sufficient turnaround/down time to allow removal of all organic matter or litter, and to satisfy required contact times for the disinfection products used prior to stocking or restocking. Cleaning and disinfection should include ponds, equipment and surroundings.

Use water with a low total viable count for better growth of fish, prawn and shrimp. It is always better to maintain a reservoir for ideal disinfection of total volume of water. At turnaround, clean and disinfect the water system with a non-tainting product (eg. KloSant or ViraNil, Neospark) to remove the greasy biofilm that will harbour and protect pathogens.

Treat feed trays and feed delivery systems. Feed delivered to the site must be of high health status and vermin protected. Finished feed and stored raw materials should be sampled regularly for its quality. "High risk" feed or raw materials or sources should not be used.

Check biosecurity procedures regularly. Use only biosecurity products with proven broad-spectrum efficacy against all viral and bacterial pathogens and use them according to manufacturers' instructions. Maintain an effective, audited biosecurity programme and prevent entry of pathogens through good farm/pond design and repair.

Biosecurity Checklist:

01. Properly implemented biosecurity measures will limit the spread of disease causing organisms.
02. When these are combined with disinfection and sanitation, vaccination and strategic treatments, many pathogens can be reduced to non-infectious levels.
03. Remember – different infectious agents spread by different methods, so use appropriate measures against each type.
04. Site location and design, and density of fish/prawn/shrimp in a given geographical area, are vital. When planning a new site, there is the opportunity for very effective biosecurity to be implemented at the design stage. However, biosecurity practices must concern themselves with practicalities, rather than a theoretically deal set-up.
05. All sites must have traffic – in personnel, feed, stock and equipment – but this should be kept to an absolute minimum.
06. Only essential vehicles should have access to a site, and these should be sanitized where possible on arrival.
07. Use protective clothing to prevent pathogen spread.
08. Priority should be given to biosecurity measures on breeding and hatching sites since errors here are magnified greatly at the commercial level.
09. Site decontamination, turnaround times and a well audited and structured cleansing and disinfection procedure should be in place for all sites.

10. Effective disease/pathogen carrier control must be maintained.
11. Only disinfectants with proven broad-spectrum efficacy against all viral and bacterial pathogens should be used and then at manufacturers' stated dilutions and directions.

Neospark - Biosecurity Programme

Terminal disinfection Programme	Continuous disinfection Programme	Specialist disinfection Programme

HACCP Principles on the Farm

HACCP strategies identify pathogen hazards and areas where they may be controlled. The production chain is audited to ensure procedures are effective.

Principle 1 Hazard Analysis

To identify hazards, both microbiological and physico-chemical, at each step in the process, from stocking to harvesting.

Principle 2 Critical Control Points (CCP's)

At CCP's action can be taken to reduce or eliminate the hazard. Within the farm there are control points at which pathogen reduction can take place as part of a biosecurity programme.

1 Site Security	Transport sanitation, wheel dips and foot dips
2 Personnel Hygiene	Protective clothing, hand hygiene and showering in and out
3 Water System	Sanitize and disinfect the water
4 Equipment	All equipment, such as feed trays, feed equipment, cast nets, sampling equipment, aerators etc
5 Organic matter	Methods should be fallowed to reduce
6 Carriers Control	Integrated Management Programme practices to control disease/pathogen carriers
7 Farms	Terminal Disinfection programme

Points 1 to 6 form part of a continuous programme with Terminal Disinfection at the end of each cycle. The Neospark Biosecurity Programme gives full details of the action to be taken at each Control Point, with Terminal Disinfection broken down into a number of stages for effective control.

Attention must be paid to personnel hygiene throughout the process, with the use of protective clothing, hand hygiene, foot dips and showering in and out where possible.

Principle 3 Critical Limits

The limits to which the hazard must be reduced. Cleaning and disinfecting in accordance with Neospark's Biosecurity Programme will ensure that microbiological hazards meet those limits. Below is a table showing suggested critical limits of disease organisms following

disinfection. Total Viable Counts are the total number of microorganisms cultured, and the presence of Vibrio specifically.

	Satisfactory	Doubtful	Un-satisfactory
TVC	0-100	100-1000	1000+
Total Vibrio	0-10	10-100	100+

TVC = Total Viable Count per ml

Principle 4 Monitoring

Observation and measurement of cleaning and disinfecting to ensure the critical limits are met at each step. From our research four key areas for control of contamination have been identified:

01. Source water - quality

02. Water exchange – improper disinfection

03. Equipment – Feeders, sampling kit

04. Moveable equipment, carriers and personnel

Principle 5 Correction

Action that must be taken if the critical limits are not met at each step.

Cleaning and Sanitizing Buildings and Equipment

Thorough washing of all surfaces is essential to achieve the best results from the subsequent disinfection.

Wash

Wash all surfaces with a pressure washer with the detergent sanitizer solution applied at 500 mls per square metre of surface area. Ensure coverage of aerators, feed trays and all other equipment, including any removed from the farm ensuring that they are all visibly clean. Use a soak tank if available for removable equipment. Include any service room in this cleaning procedure.

Principle 6 Recording

Records must be kept that the biosecurity programme is in place and implemented correctly and continuously. Records should be kept of products used, critical limits, cleaning schedules and any corrective action provide documentation for control and for monitoring. Complete sets of records are important for proper action and may form part of a current Quality Scheme.

Principle 7 Verification

Tests and procedures to ensure the Biosecurity system are working properly. Often performed by an outside person or organization, for example third party verification of bacteriology tests, calibration checks and dosing tests.

The Neospark's Farm Biosecurity Programme provides a strategy for pathogen reduction on the farm. Each of the Neospark Products included in this programme has undergone a rigorous programme of activity and safety testing by independent organizations to prove their effectiveness in practical conditions, and their safety to the user and environment. Those products, which are in contact with the fish or prawn or shrimp, have been proven to have no adverse effect even after repeated and prolonged contact.

Terminal Disinfection Programme for Farms

The following procedures should be followed for each pond to be disinfected after depopulation or harvesting to prevent the carry over of infected organisms.

Stage 1 Removal Equipment and Cleaning

The removal, cleaning, drying and disinfection of all equipment (feed trays, aerators etc) are essential to stop the further occurrence of infections.

Stage 2 Removal of dead and decaying organic matter

The removal of all dead and decaying organisms is essential because they contain high levels of contamination and are a major source of infection. Removal of surface soil will also reduce the efficiency of the cleaning and disinfection process.

Stage 3 Water System

All water systems contain some bacterial contamination. This could be a source of disease spread from one pond to the next. Sanitizing will clean the system and eliminate unwanted bacterial or fungal growth.

Continuous Biosecurity Programmes

Between applications of the Terminal Disinfection Programme there are many opportunities to prevent introduction of infection or cross infection to stock on the farm. Continuous biosecurity routines take into account the different disease problems, which occur at different stages of production. The following will help to prevent the introduction, incidence and spread of disease.

Site Security

To avoid introduction of infection onto a farm or transfer from pond to pond, the following precautions should be observed:

01. FOOT DIPS. All personnel should use foot dips on entering the site. Use ViraNil-S at 1:100 dilution (1.0%). Replenish at least weekly.
02. WHEEL DIPS/VEHICLE SPRAYS/MOBILE EQUIPMENT. Any vehicle entering the site must pass through a wheel dip or vehicle spray. Top up regularly to avoid dilution or contamination. ViraNil-S at 1:100 dilution in vehicle sprays. Wash and disinfect all equipment brought onto the site from other units. Rinse thoroughly after use.
03. HAND WASHING. Dirty or unwashed hands transfer infection. All visitors to the site should be required to wash their hands before entering using Neospark Hygiene System. All staff should wash their hands before starting work, after breaks and when changing work activities.
04. VISITORS Allow no non-essential visitors onto the site. Essential visitors should be provided with full safe guards. Pay special attention to cleaning and feeding teams, sampling and catching gangs, electricians, engineers etc. They are frequently the cause of spread of infection.

Water Sanitizing

1. Contaminated water

The source water can be a potent source and spread of infection. Reservoirs, ponds and pipelines need to be regularly cleaned and disinfected with a non-tainting disinfectant.

Continuous use of KloSant at 1-2 ppm can treat the water supply where poor quality or contaminated water has to be used.

2. Transfer of Infection

Fish, prawn or shrimp, which are infected with viruses or other disease organisms can contaminate the water and spread the disease. Add ViraNil continually to the water at a 0.02 to 0.06 ppm during the period of risk to minimize transfer of infection.

ViraNil - Virus Biosecurity Programme

01. Dry, clean and disinfect equipment.
02. Sanitize the water system. Use ViraNil at 1 to 2 ppm.

Vibriosis Programme

Vibrio's infections remain a serious problem to the aquaculture industry worldwide. *Vibrio harveyi* isolations have increased significantly in recent years and pose threats to hatcheries as well as grow-out farms. Other species are also can be resistant to antibiotics. Disinfection is a vital tool in the fight against these resistant organisms, which can persist in the environment.

For control select a disinfectant with proven activity against Vibriosis. Neospark's Biosecurity products have been proven effective against Vibrio including *Vibrio harveyi*.

Ensure that the correct dilution is used in all disinfection procedures. A number of Critical Control Points (CCP) requires particular attention in order to assure removal of these organisms from infected premises.

01. TERMINAL DISINFECTION – Follow the terminal disinfection programme. Ensure that the washing and disinfection of Critical Control Points at stages 3 & 4 are given particular attention, for example water inlets.
02. CARRIERS CONTROL – Ensure adequate control of carriers.
03. SITE SECURITY – Pay attention to all aspects of site security with particular attention to CCP's – Foot dips, Wheel dips and hand washing.
04. TRANSPORT – Ensure that all transport used for feed is disinfected with a product proven effective against pathogens.

Stage 4 Disinfection

The level of disease organisms present after cleaning is high enough to offer serious disease challenge. Using disinfectant proven to be effective against viruses, bacteria and other pathogens is essential.

For Normal Disinfection Routines

Use Neospark's ViraNil at 1-2 ppm at initial disinfection fallowed by 0.02 to 0.06 ppm.

Specialist Biosecurity Programmes

Persistent and Virulent Virus Biosecurity Programme

Outbreaks of serious diseases caused by viruses constantly face the aquaculture industry world-wide. All viruses can interfere with the efficiency of the immune response, but Immunosuppressive Viruses (ISVs) have a more specific action on the immune system. All viruses can cause disease in their own right, however their major impact on the industry has been the ability of ISVs to allow other pathogens (mainly bacteria) to cause increased or new problems.

One of the most notable in recent years has been White Spot Syndrome Virus (WSSV) Disease, which has been the cause of significant losses. Many other viruses including MBV, YHV, IHHNV, TSV Infections are also a significant threat. Although SPF/SPR stocks plays an important role in the control of some of these, disease frequently still occurs.