Disease in shrimp farming may be defined as a biotic or abiotic condition or factor that adversely affects culture performance (Lightner 1996). Biotic diseases of shrimp are those that have living agents as the cause, while abiotic diseases may be caused by environmental or physical extremes (temperature, hypoxic conditions, nitrogen super saturation, extremes of pH, etc.), chemical toxicants, pesticides, etc., nutritional deficiencies or imbalances, improper handing, etc. Within biotic diseases are diseases of infectious and non-infectious etiologies. The list of biotic diseases affecting shrimp is not too different from the list of diseases that affect other animals. Many of the major groups or major causes of disease in vertebrates are represented among the causes of disease in penaeid shrimp. Shrimp have infectious diseases caused by viruses, rickettsia, true bacteria, protozoan and helminth parasites, etc. They have benign and neoplastic tumors, and they develop nutritional diseases when fed inadequate diets (Lightner 1988, 1993a, 1993b, 1996).

Some diseases of shrimp show no clinical signs other than death, which can make it difficult to identify the cause and decide on preventative management through examination of shrimp alone. Most diseases or health problems have a number of contributing causes: that is, the shrimp succumb to an infection by an opportunistic pathogen after becoming weakened by stress from an environmental or other cause. For this reason, farmer must keep proper records for each pond, so that he can identify possible causes of stress in the preceding days or weeks. In some cases, even when identified the cause, it will be too late for corrective action to prevent significant losses, but farmer will be forewarned in relation to subsequent crops.
<table>
<thead>
<tr>
<th>Sr No</th>
<th>Feature</th>
<th>Identifying clinical signs</th>
<th>Causes</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>Shrimp with abnormal body colour or markings</td>
<td>Reddening of the legs and body (Plate - 53)</td>
<td>Cause 1: GAV-related disease Cause 2: Vibriosis</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Black marks or lesions (Plate - 54)</td>
<td>Cause 1: Healed wound Cause 2: Bacterial shell disease Cause 3: Blank Splint disease</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Black marks or lesions</td>
<td>Cause 3: Black splint disease</td>
</tr>
<tr>
<td></td>
<td></td>
<td>White spots in the cuticle</td>
<td>Cause 1: Non-viral conditions Cause 2: Exotic viral disease White Spot Syndrome Virus (WSSV) (Plate - 59)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>White muscle (Plate - 55)</td>
<td>Cause 1: White Cotton Disease Cause 2: Extreme pond temperatures (heat stress)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Red midgut</td>
<td>Cause: Haemocytic enteritis (gut infection)</td>
</tr>
<tr>
<td>2</td>
<td>Shrimp with abnormal gill colour</td>
<td>Red gills</td>
<td>Cause: Stress</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Black gills (Plate - 56)</td>
<td>Cause: various</td>
</tr>
<tr>
<td>3</td>
<td>Shrimp with deformities and external problems</td>
<td>Tail cramping</td>
<td>Cause: Assumed to be caused by effects of high temperatures and/or salinities</td>
</tr>
<tr>
<td></td>
<td></td>
<td>External fouling</td>
<td>external fouling (Plate - 57)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Abnormal appearance</td>
<td>Various</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Runtsin the crop</td>
<td>Disease (haemocytic enteritis) or genetic growth variation</td>
</tr>
</tbody>
</table>
Reddening of leg and body

**Identifying clinical signs**

Sick shrimp often show red discoloration, usually involving the legs and tail fan. In severe cases, the entire body surface, including appendages, is red.

Cause: Reddening of the legs and/or body is associated with a number of diseases (described below) and therefore cannot be used in isolation to identify a disease.

*Cause 1: Gill Associated Virus (GAV)- related disease (virus)*

**Identifying clinical signs**

Shrimp affected with GAV-related disease are typically lethargic or moribund, and congregate at pond edges during the second half of the growout period. Often their bodies and appendages are red, and some appendages, usually antennae or pereiopods, are partially amputated (Plate - 53).

**Treatment**

There are no treatments for viral diseases of shrimp, including GAV-related disease. Implementation of better management practices, as part of a biosecurity program for the farm, is the best means of reducing the risk of outbreaks. For GAV, these should focus on keeping the viral load in the pond low and, maintaining optimum pond conditions during grow out.
Prevention

Recent research in Australia (OIE, 2005) suggests that the risk of GAV-related disease outbreaks in ponds can be significantly reduced by stocking postlarvae with a low prevalence of GAV infection, and maintaining an optimum pond environment (that is, minimising stress to shrimp) during growout. At present, PCR tests for GAV infection status of postlarvae before stocking are not generally available, and cheaper, simpler tests (ELISA and dipstick) are still under development. Until these tests are commercially available, try to source postlarvae from broodstock collectors and hatchery operators who use best management practices to minimise the viral load in broodstock (Cowley et al. 1999). This will help minimise the viral load in the postlarvae.

Cause 2: Vibriosis

The term 'vibriosis' refers to infections of shrimp caused by species of bacteria within the genus Vibrio. In general, Vibrio spp. are opportunist pathogens that occur commonly in the pond environment. Their pathogenicity (ability to cause disease) varies between species and even between strains within a species. They are usually associated with disease in shrimp stressed for a wide range of reasons. Vibriosis in an individual prawn can be either a localised or systemic (generalised) infection. Systemic vibriosis is often associated with poor environmental conditions or is superimposed on another disease as the shrimp’s condition deteriorates.

Identifying clinical signs

Acutely affected shrimp with systemic vibriosis can be lethargic and gathered at pond edges; in some cases they will be red-coloured. Shrimp with localised vibriosis will usually be not red.

Treatment

Treatment of vibriosis requires improving the pond environment to reduce poor water quality conditions and allow natural conditions to prevail.
Failure to improve pond conditions will cause the problem to continue and will spoil the overall quality of the crop. Improvement in water quality may involve reductions in feed, pond water flushing and more aeration.

Black marks or lesions

Identifying clinical signs

Brown to black marks on the shell of shrimp (Plate - 54). Legs may be shortened with blackened tips. Parts of appendages, such as antennae or eye stalks, can be absent, again with blackened tips. Erosion of legs and body parts, often starting on tail first. Multiple brown to black shell lesions can develop to a point where the entire thickness of the shell is eroded. In these shrimp underlying muscle, gills and organs (with or without blackening) may be visible. Shows as distinct black marking or edging when shrimp are cooked.

Melanin is a black pigment that is produced by the prawn in response to an injury, foreign body or invasion by bacteria or parasites. As melanin is produced, chemicals toxic to bacteria and other micro-organisms are released at that site. Melanin hardens the shell and makes it more impervious.

Cause 1: Healed wound

Any type of damage to the outer layer of the shell allows normal environmental bacteria to proliferate and grow in the damaged shell. One of the common injuries is the black 'scratches' seen on the tail caused by bird capture. Underfeeding will cause shrimp to chew the appendages of other shrimp. For those shrimp that live on the pond bottom, pond bottom fouling will cause erosion and blackening of the tips of the tail, legs and antennae. The erosion of the legs and tail follows exposure to low pH and other toxic chemicals in the anoxic sediment and exposure to bacteria.

Shell necrosis (deep infections) caused by Bacterial Shell Disease (cause 2) may recover and show melanin scarring (persistent blackening) of cuticle.
Treatment

Improve water quality in the pond through water exchange, reduce pond bottom fouling and make sure the shrimp are all being fed. The black marks will be lost at the next moult.

Prevention

Manage the ponds to avoid pond bottom fouling. Minimise abrasive injuries to shrimp from barnacles or other sharp objects on screens, aerators and walls, or from partial harvesting. Control bird activity that may lead to injuries.

Cause 2: Bacterial shell disease

A more severe form of bacterial disease can occur on the shell of shrimp. Some of the bacteria that begin to grow on the damaged outer layer of the shell can produce enzymes that eat away the deeper shell layers. This is more likely if the shell is cracked. Once the haemolymph (blood) begins to leak into the site of shell injury the bacterial growth becomes even more abundant, producing deep, erosive lesions. If the shrimp’s immune system cannot wall off this proliferation of bacteria, the bacteria can spread internally into the shrimp’s body to cause multisite haemocytic granulomas. If pond conditions are not corrected, many shrimp may succumb to opportunistic bacterial septicaemia (such as *Vibrio harveyi*) with significant die-offs. Bacterial shell disease is a consequence of very poor pond conditions. It follows high bacterial loads in the water and pond bottom, and poor water quality. This may be a reflection of the stocking density and indicate excessive feeding or previous algal bloom crashes in the pond.

Treatment

No chemical treatment is effective but to reduce stocking densities by partial harvesting to improve water quality and reduce pond bottom fouling.
Prevention

It is important to remove built-up organic waste sediments in the pond between cycles of production. Liming with quicklime (or other disinfecting lime) and effective drying of the pond bottom is important to prevent the build-up of pathogenic bacteria, such as *Vibrio harveyi*, in the pond. Establish a balanced pond environment with desirable algae during pond preparation. Manage the pond to avoid pond bottom fouling. Control feeding rates and water exchange to avoid excessive bloom development and bloom crashes. Do not over feed the shrimp.

Cause 3: Black splint disease

Occasionally a disease is seen where there are internal black lines or large black nodules in the centre of the tail muscles. It is assumed that black splint disease develops from an infection of bacterial shell disease because lesions develop in the shell where adjacent tail segments rub on one another. These become progressively deeper and are not lost at moulting. It seems that the bacteria cannot be controlled and a deep tunnel-like lesion in the tail muscle develops, with proliferating bacteria at the centre surrounded by melanised haemocytes. It has been suggested that low salinities and specific bacteria such as *Vibrio alginolyticus* that proliferate in the lower salinities can cause black splint disease. It is likely that a specific set of pond conditions and any proliferation of bacteria in the pond water can lead to black splint disease. Affected shrimp must be removed at processing.

Treatment

No treatment is effective. However remove the affected shrimp at processing.

Prevention

Follow the principles described above for the other black mark syndromes. Manage the pond to avoid pond bottom fouling. Control feeding rates. Avoid sudden salinity changes.
White spots in the cuticle

**Identifying clinical signs**

White spots in the cuticle, particularly in the head.

**Cause 1: Non-viral conditions**

White spots in the cuticle of black tiger shrimp, similar to those in WSSV but caused by bacterial infection, have been seen occasionally. Exposure of shrimp to high alkalinity has also been associated with formation of white spots unrelated to WSSV or bacterial infection. These non-viral white spot conditions do not cause significant mortalities in affected shrimp.

**Treatment**

Correct alkalinity as necessary; maintain optimum pond conditions. Keep a close watch on the pond; if mortalities continue, contact fisheries officials authorities.

**Prevention:** Maintain optimum pond conditions.

**Cause 2: Potential for exotic viral disease White Spot Syndrome Virus (WSSV)**

The clinical signs and appearance of shrimp affected with WSSV are often found high and rapid mortality of infected populations, shortly after the first appearance of the clinical signs. Diseased shrimps develop anorexia, lethargy, and characteristic white spots on the inside surface of the carapace. Moribund shrimp may also show a pink to red discoloration. There may be drastic reduction in feeding levels. Therefore, farmers should consider any rapidly increasing mortality event in a shrimp pond as potentially being due to WSSV (Plate - 59).

White Spot Disease has had catastrophic effects on shrimp farming industries in many countries including Japan, China, India, Indonesia, Korea, Malaysia, Thailand, Vietnam, USA and South America countries. White Spot Syndrome Virus (WSSV) infects many species of penaeid shrimp including
the black tiger prawn *Penaeus monodon*, banana prawn *Ferropeneaus merguiensis*, *P. vannamei*, *P. setiferus*, *P. stylirostris*, *P. indicus*, *P. chinensis*, kuruma prawn *P. japonicus*, *P. semisulcatus*, and the freshwater prawn *Macrobrachium rosenbergii*. White Spot Disease also infects other crustaceans such as crabs, lobsters and copepods. These crustaceans can carry the virus and act as vectors for the virus. To avoid similar problems, it would be wise to exclude these crustacean species from ponds if possible. WSSV causes mass mortalities of mainly juvenile shrimp, with up to 90 per cent of shrimp dying in two to four days. Rapid fluctuations in pond water quality that may stress shrimp, such as a sudden change in water temperature, salinity, alkalinity, pH, or dissolved oxygen levels dropping lower than 2 ppm, can make an outbreak worse.

**Treatment**

No chemical treatment is effective. Occurrence of WSSV should control measures to prevent the spread of this disease.

**Prevention**

Biosecurity management and control at farm.

**White muscle**

Identifying clinical signs of white opaque textured muscle (Plate - 55).

**Cause 1: White Coton Disease**

Caused by the microsporidian parasite *Agmasoma penaei*.

**Treatment**

Effective treatment has so far been not established. Discard the affected stocks. Dry and lime affected ponds.

**Prevention**

This condition is a common disease in wild shrimp and has caused a 20 percent loss in captive wild broodstock. The prevalence reported has been 1-
10 percent in some wild populations. Transmission occurs via spores, which are ingested, and the parasite enters the host by the gut. The parasite multiplies in the muscle. Fish that eat infected shrimp may spread the spores in the aquatic environment. There is no current evidence to suggest that the parasite is infectious for humans, but with such a heavy infection of the muscle and muscle damage the shrimp would be of poor quality. These animals are often discarded by processing plants. It is advisable to use inlet and outlet screens to exclude wild shrimp and fish from farmed stocks of banana shrimp.

**Cause 2: Extreme pond temperatures (heat stress)**

The muscle is opaque or white with muscle necrosis, may occur with tail cramping in response to handling during high temperatures and/or salinity.

**Treatment**

Provide water exchange to reduce temperatures and/or salinities, avoid handling or harvesting at this time.

**Prevention**

None, wait for cooler temperatures.

**Red midgut**

**Identifying clinical signs:**

Red colour in midgut. Reduced growth rate and increased variation in sizes in the crop. Stunting of individual shrimp, weak shrimp in shallows, may have fouling on shell.

**Cause: Haemocytic enteritis (gut infection)**

Assumed to be caused by shrimp eating toxic algae (such as blue-green algae) occurring on the bottom where it can be mixed with the feed; algal toxicity causes damage to the gut lining. Phosphate-rich fertilisers that are used to start phytoplankton blooms enhance blue-green algae growth, so
fertilisers like ammonium nitrate tend to minimise blue-green algal blooms, but allow eukaryotic algae to grow.

**Treatment**

None.

**Prevention**

Minimise the growth of blue-green algae species such as *Oscillatoria spp.* by encouraging a micro-algal bloom to shade the bottom. Pay particular attention to feed-monitoring trays and underfeed slightly if possible. Certainly do not overfeed. The preventative pond management procedures described in ‘Black gills’ will also help reduce the proliferation of blue-green algae on the pond bottom. Healthy shrimp regularly groom their gills, but stressed or sick shrimp often have abnormally coloured gills.

**Red gills**

**Identifying clinical signs**

Pink to red gills.

**Cause: Stress**

For example, from low dissolved oxygen or high toxin (such as ammonia or hydrogen sulfide) concentrations.

**Treatment**

Examine pond records; identify and correct any environmental problem. Examine the pond environment, particularly the condition of the pond bottom, and correct as necessary.

**Prevention**

Maintain optimum pond environment.
Black gills

Identifying clinical signs

Shrimp gills clogged with brown to black material, gives a dirty or muddy look. Melanisation of gills produces a blackening discolouration. Check the fouling of gills under a microscope to confirm (Plate - 56).

Causes:

Several possible causes include:

- Significant organic fouling in the pond bottom or algae die-off
- Blue-green algae growing on gill filaments
- Infectious damage to the filaments and melanisation
- Exposure to iron salts.

As shrimp like to burrow or hide in the pond bottom, they can be more susceptible to black gill disease.

Treatment

Water exchange to improve water quality. Reduction in feed rates. Adjustment to reduce stocking densities. No chemical treatment effective.

Prevention

Deterioration of the pond environment, unstable algal plankton population and excessive stocking densities are areas of pond management that need improvement so that optimal water quality is maintained for the shrimp. The following checklist may be used to improve the pond environment:

1. Check for acid sulphate soil in ponds.

2. If it is acid sulphate free, drain and clean out the pond bottom by scraping and then liming, otherwise the filamentous algae
will tend to regrow. If acid sulphate soils are present, do not scrape the pond - use wet cleaning method to flush bottom well before filling and liming.

3. Seed pond water with phytoplankton from a good pond.

4. Use secchi depth to evaluate and manage the health of algal blooms.

5. Aerate the pond as for high stocking densities (>30 shrimp/m²) for a 1hectare pond.


**Shrimp with deformities or external problems**

**Tail cramping**

Identifying clinical signs

Shrimp tail is cramped up and will not relax, usually after handling, such as cast net sampling. Some may show white muscle from stress (could be same problem as in ‘White muscle’ above).

**Cause**

Assumed to be caused by effects of high temperatures and/or salinities when combined with the stress of handling (may not occur without handling).

**Treatment**

Provide water exchange to reduce temperatures and/or salinities, avoid handling or harvesting at this time.

**Prevention**

Minimise handling or delay harvesting until the problem is solved.
External fouling

Identifying clinical signs

Commensal organisms such as barnacles, protozoa, worms or algae in the pond attach to the cuticle of the body (or gills, see below), giving the shrimp a fuzzy appearance. These organisms live in the pond environment, and will attach to shrimp if they fail to groom or moult (Plate - 57).

Cause: Failure to groom or moult

Failure to groom or moult indicates illness or stress. Shell fouling is usually associated with high nutrient loads in the water column, a drop in temperature or a heavy biomass (for example, towards the end of a crop). Excessive growth of commensal organisms on the cuticle, such as filamentous blue-green algae, diatoms, and various species of protozoa (Vorticella, Epistylis, Zoothamnium and others) (Plate - 60).

Treatment

Reduce feeding rates to reduce nutrient loading in ponds. It may be better to conduct an early harvest and treat the product with citric acid before sale.

Prevention

Improvement in water quality of the pond by changing or reducing feeds, increasing water exchange and/or aeration and increasing water circulation. Changing pond salinity may help to reduce the problem if conducted slowly to minimise stress on shrimp.

Abnormal appearance

Abnormal appearance of the head, bent rostrum, tail or appendages can result from disease, trauma, cannibalism or genetic mutation. Runts in the crop

Identifying clinical signs

Shrimp smaller than average crop size.
Calise Disease (haemocytic enteritis), genetic growth variation. Sometimes a bimodal growth distribution (a larger group of shrimp and a smaller group of shrimp in the same crop) can occur if shrimp have been chronically infected with haemocytic enteritis.

Treatment

None. Submit runt shrimp to the laboratory for histological analysis.

Prevention

Ensure when stocking postlarvae that they are of same age and size. Ensure that adequate feed, space and growth conditions are provided (do not overstock ponds). Ensure that ponds do not have blue-green algal blooms, as shrimp ingesting blue-green algae have been known to develop a disease of the gut known as haemocytic enteritis.

Shrimp with tumours/abnormal growths

Identifying clinical signs

Tumours or abnormal growth(s) anywhere on the body.

Cause

Genetic disease, chemical pollution.

Treatment

None — remove affected shrimp, preserve and send to laboratory for histological analysis.

Prevention

None, if multiple shrimp in many ponds are affected, then possibilities of further disease and more extensive water quality investigations including chemical analysis should be considered.
Abnormal shrimp behaviour

Identifying clinical signs

Abnormal swimming, burrowing (cool pond water), shrimp congregating at edge of pond.

Causes

Extreme pond temperatures (too cool or too hot), heat stress, low dissolved oxygen, sudden drop in pH, high salinity, thick algal bloom, shell or gill fouling, disease.

Treatment

Check all pond water conditions and correct or improve any abnormalities as necessary: lower salinity, reduce thickness of algal bloom by water exchange, increase aeration to improve dissolved oxygen levels, sample shrimp at edge of pond for signs of disease and send to laboratory.

Prevention

Constant daily monitoring of shrimp behaviour and pond water quality including the pond temperature, pH, thickness and type of algal bloom, dissolved oxygen, salinity; regular examination of shrimp on feeding trays for abnormal behaviour and signs of disease.

Shrimp fail to moult

Identifying clinical signs

Moulted skin still attached or soft shell (for example, dead shrimp with a skin hanging off the carcass) or shrimp with heavily fouled shell that has not moulted.
Causes

Disease, pollution, stress, shell fouling, poor water quality with low alkalinity or low salinity. Accumulation of sediments and organic matter in the pond can result in shell fouling and failure of shrimp to moult.

Treatment

Water exchange can help to stimulate a moult. Alkalinity can be corrected by adding carbonated lime. Add high-salinity water to increase salinity. Submit a sample of shrimp to the laboratory for disease analysis.

Prevention

Ensure good-quality feed and good water quality with adequate oxygen, pH, salinity, alkalinity as well as a good algal bloom and temperatures all within normal ranges for farmed prawn species. Improve the water quality of the pond by changing or reducing feeding, increase in water exchange or aeration and increase water circulation. Changing pond salinity may help reduce the problem if conducted slowly to minimise stress on shrimp.

Empty gut

Identifying clinical signs

Empty gut, anorexia.

Cause

Anorexia (not feeding) can be associated with disease, stress, rancid or poor-quality feed, lack of feed, poor water quality.

Yellowhead Disease

Yellowhead Disease (YHD) is a viral disease of shrimp that attacks the blood cells (haemocytes), blood-forming organs (haematopoietic organs), gills, muscles and internal organs, causing widespread cell death. YHD occurs in China, India, Thailand and the Philippines and in Texas, USA. YHD is exotic to Australia, but has the potential to affect black tiger shrimp and
banana shrimp. YHD has also been shown in laboratory experiments to affect other prawn species including the red endeavour prawn *Metapenaeus ensis* (Herfort and Rawlin 1999). YHD is transmitted from prawn to prawn, and survivors of an outbreak may carry the virus. Several crustaceans are suspected of transmitting the virus to farmed shrimp, including the brackish water shrimp *Acestes sp.* and *Palaemon styliferus* (Bondad-Reantaso et al. 2001). Environmental factors associated with outbreaks include rapid pH change and prolonged periods of low dissolved oxygen (<2 ppm). YHD causes mass mortalities, with up to 100 per cent mortalities in three to five days from the time clinical signs are first noticed. YHD most commonly affects postlarvae from 20 days old to subadult shrimp.

**Identifying clinical signs**

Clinical signs include a yellow head (from a swollen hepatopancreas), yellow, pink or brown gills, and a pale body (Plate – 58). However, these signs are not always present in diseased shrimp. Affected shrimp feed at an unusually higher rate than normal for several days then cease feeding altogether. Infected shrimp aggregate at the edge of the pond or at the surface (Bondad-Reantaso et al. 2001). Factors associated with disease outbreaks include high stocking densities in ponds and poor water quality. The disease can be diagnosed by clinical pathology (haemocyte and gill smears), histology, molecular tests (PCR) and transmission electron microscopy (OIE 2005).

“Loose shell syndrome” reported by farmers in Diu is probably a result of chronic bacterial infection. The affected shrimps usually are bigger in size and have a paper like carapace with a gap in between muscle tissue and carapace. The primary cause of this chronic problem is likely toxic pond bottom conditions.

Vibriosis is a bacterial disease caused by *Vibrio* bacteria. The acute infection usually occurs when shrimps are one month old and therefore some farmers call it one month mortality syndrome. However, chronic *Vibrio* bacterial infections can occur during the later stages of culture till the harvest due to poor water and pond bottom quality conditions. When the problem occurs
later in the crop cycle, it is usually associated with loose shell syndrome. In higher salinity the severity is usually greater and is caused by luminous species. In this case the farmers may identify the problem as luminescent vibriosis.

**Diseases management**

Observed that any drastic change in the pond water and bottom quality, that means there was a change in the environment of the shrimp. The shrimp are very susceptible to disease if this happens. The root cause of disease is deviation in the health management of the pond water or soil. The viral diseases have come common in shrimp culture. These viral diseases are transferred to the pond through infected sea, or by cross contamination from neighbouring farms, through water or by bird droppings or predatory organisms in the waters. The selected study site farmer were careful in the selection of seed, and maintaining good water quality by chlorination intake water in reservoirs and avoiding the cross contamination.

To prevent the diseases, farmers take precautions to ensure that the shrimps were not exposed to undue stress. Bacterial, fungal, algal and protozoan diseases can be observed at a very early stage and they can be cured by proper treatment within a few days. Diseases caused by nutritional deficiency can be prevented by using quality feed, feed probiotics, immunostimulants, vitamin supplements and digestive enzymes.