2-Starvation •

- Chronic starvation will result in weight loss, and manifest as thinning of the body and concave abdomen. Growth will effectively cease and reproductive potential may be curtailed. Disease problems relating to a lack of certain essential nutrients may also arise following chronic starvation, notably vitamin deficiency symptoms such as anemia, eye cataracts, and skin and gill haemorrhaging. Brief periods of starvation may be normal in some circumstances.

3- **Nutritional toxicity disorders** •

- In aquaculture, plant-derived proteins are often incorporated into foodstuffs for economic reasons. However, some of these ingredients contain toxins that must be inactivated during food processing. For example, toxins in certain oilseeds including soybean, cottonseed, and rapeseed can reduce the growth rate of fish.

Mycotoxins

- Dry feeds that are stored at high temperature and/or high humidity can become colonised by various moulds (fungi). Certain species of filamentous fungi notably those belonging to the genera *Aspergillus*, *Fusarium*, and *Penicillium* produce substances known as mycotoxins which are highly toxic to fish even at very low concentrations. One type of mycotoxin produced by *Aspergillus* spp. is known as aflatoxin . Although mycotoxin poisoning is uncommon, it is nevertheless prudent for fish culturists to store dry foods under cool, dry conditions so as to minimize the likelihood of mould spoilage.

Aflatoxicosis

- Aflatoxicosis is a disease that can affect many species of fish, and results when feed contaminated with aflatoxins is eaten by the fish . Aflatoxins are chemicals produced by some species of naturally occurring fungi (*Aspergillus flavus* and *Aspergillus parasiticus*) commonly known as molds. Aflatoxins are common contaminants of oilseed crops such as cottonseed, peanut meal, and corn. Wheat, sunflower, soybean, fish meal, and nutritionally complete feeds can also be contaminated with aflatoxins.

- Four major aflatoxins (AFB1, AFB2, AFG1 and AFG2) are direct contaminants of grains and finished feeds.
- Factors that increase the production of aflatoxins in feeds include environmental temperatures above 27°C (80°F), humidity levels greater than 62%, and moisture levels in the feed above 14%. The extent of contamination will vary with geographic location, feed storage practices and processing methods. Improper storage is one of the most important factors favoring the growth of aflatoxin-producing molds, and it is a major element that can be controlled by the fish producer.

- In tropical and subtropical conditions, this potential is further increased due to storage under humid and hot conditions. The extent of disease, caused by consumption of aflatoxins, depends upon the age and species of the fish. Fry are more susceptible to aflatoxicosis than adults and some species of fish are more sensitive to aflatoxins than others.

Signs of Aflatoxicosis in Fish

- Initial findings associated with aflatoxicosis include pale gills, impaired blood clotting, anemia, poor growth rates or lack of weight gain. Prolonged feeding of low concentrations of AFB1 causes liver tumors, which appear as pale yellow lesions and which can spread to the kidney. Increases in mortality (higher numbers of dead fish) may also be observed.

- Aflatoxins can cause disease indirectly through their effects on essential nutrients in the diet. For example, fat soluble antioxidants, such as vitamin A, and water soluble antioxidants and vitamins, such as vitamin C (necessary for immune function) and thiamin (necessary for metabolic and nervous function), in feeds can be destroyed by these toxins. Hence, it is not surprising that aflatoxins depress the immune system, making fish more susceptible to bacterial, viral or parasitic diseases. These subtle effects often go unnoticed and profits are lost due to decreased efficiency in production, such as slow growth, reduced weights of the finished product, an increase in the amount of feed needed to reach market weight, and increased medical costs.

Management and Control

- Purchase of feeds that have been recently prepared and properly stored is recommended. Debris must be removed from feed ingredients and grains should be stored in clean bins or buildings. Where possible, complete fish feeds should be stored in an air-conditioned building for temperature and humidity control. Otherwise, feed should be stored off the ground, on pallets and at least one foot away from any walls (to avoid condensation) in a cool, dry area and for no longer than three months. If feed is held in bins outside, storage for longer than two weeks is not recommended.

- When feeds are stored for long periods or under poor conditions, fish health problems may arise, not only from molds, but also from loss of vitamins and rancidity of oils in the feed. Control of rodents and insects is also important in maintaining nutrient quality and aflatoxin-free feeds.

- Feeds stored for a long time and probably contaminated with molds appear stale, are discolored, lump together and smell musty. Stale foods are often saturated with moisture and appear to ‘sweat’.

- Regular testing for aflatoxins is a good idea. Simple on-farm inspection can be done visually (look for the presence of blue/grey mold on feed) or with a black light which may cause a bright greenish/yellow fluorescence if *A. flavus* is present. While the black light method is a rapid procedure, it is only a potential indicator of the presence of *A. flavus*, and it may not work in all cases. Commercial kits for detecting concentrations of aflatoxins in feeds are highly recommended if aflatoxicosis is suspected.

- A possible remedy for feeds that do contain small amounts of mold is to add a toxin inactivator to the stored feeds. A toxin inactivator controls mold development by binding with aflatoxins in the feed, making them inactive and preventing further growth of the mold in feeds. If all the feed is heavily contaminated, new feed should be purchased.

4- **Overfeeding** •

- Feeding excessive amounts of food is the most common cause of death in captive fish, particularly those held at high stocking densities in relatively confined quarters, such as aquaria. Although rarely causing direct harm to the fish, the ingestion of excess food will result in increased ammonia excretion, and any uneaten food will also contribute to the accumulation of this nitrogenous waste. Even if biological filtration is installed, this may not be able to cope with a rapid surge in ammonia production, and hence the fish may be exposed to toxic levels of ammonia.

- Obesity would rarely be expected in wild fish, and is uncommon in cultured food fish since feed ratios are carefully calculated for economic purposes: overfeeding causes unnecessary production costs.

- Obesity is sometimes observed in aquarium fish that have been chronically and frequently overfed. It is also observed in goldfish