Aquaculture Health Issues
The Role of Biosecurity and Biotechnology

Disease outbreaks are being increasingly recognized as a significant constraint to aquaculture production, trade and are affecting economic development of the sector in many countries of the world. Disease is now considered to be the most limiting factor in the shrimp culture sub-sector. Some figures are available on direct economic losses which indicate the significance of the problem, although social and other related impact, such as trade and employment issues, drug use and environmental costs, has never been properly quantified. Estimates of economic losses suggest that developing countries in Asia lost at least Rs. 7000 crores (App. US $ 1.55 Billions) due to diseases in 1990 alone. Since then, losses have increased. Reports from China suggest losses in 1993 of Rs. 4500 crores (App. US $ 1.0 Billions) due to shrimp viral disease outbreaks. A 1995 estimate suggests that aquatic animal disease and environment-related problems may cause annual losses to aquaculture production in Asian countries have more than Rs. 13500 crores (App. US $ 3.0 Billions) per year. According to recent reports, global losses due to shrimp disease are more than Rs. 18000 crores (App. US $ 4.0 Billions) and the World Bank investing of Rs. 1240 crores (App. US $ 0.28 Billions) in shrimp disease research.

The above figures provide an indication of the overall economic significance of aquatic animal diseases. However, there is need for a much more systematic review and analysis of information on their social and economic impact and on the cost-benefits of alternative control strategies. There is also a need to develop a better framework or methodology for routine data collection and reporting on the incidence and socio-economic impact of aquatic animal diseases.

Major diseases and epizootics:

Epizootic Ulcerative Syndrome (EUS) is one of the most severe fish diseases in Asia, it has a complex infectious etiology and causes a seasonal epizootic condition in over 100 species of wild and farmed freshwater and brackishwater fish. The disease has caused severe economic losses in Asia and is now endemic to Southeast and South Asia and has extended to West Asia. Control of EUS in natural waters is probably impossible, although various preventative measures can be used to reduce the risk of spread of EUS to some natural water bodies. The causative agent of EUS is the fungus *Aphanomyces* variably termed *A. piscicida* and *A. invaderis*. From the little epidemiological data available, it appears that the disease is spread by movement of water or, in certain cases, movement of fish without adequate quarantine and health certification.

Monodon Baculo Virus (MBV) outbreak in Taiwan Province of China in 1988, followed by a series of shrimp viral disease outbreaks--Yellow-Head Virus (YHV) in 1992 in Thailand, Taura Syndrome Virus (TSV) in 1992 in Ecuador, white spot virus (WSV) in 1993-1994 in China, Thailand and India, and the same virus in a number of other Asian countries since 1994--have caused severe production losses to the global shrimp culture industry. At present over 20 viruses have been identified as important to shrimp, the most threatening being WSV in Asia and TSV in the Americas. Many more disease outbreaks have been reported in other parts of the world, under culture and in the wild. Notable are furunculosis in salmonids, sea lice infections in European cage-cultured marine fish, and Noda virus epizootic in seabass.

Besides reported losses at epizootic levels, day-to-day loss of production due to infectious and non-infectious diseases, both at commercial and subsistent production levels and in the wild, is probably highly significant.

Need for a new approach to health management:

Environmental factors and poor water quality resulting from increased effluent discharge, movement of aquatic animals, inadequate farm management, rapid proliferation of farms, etc., have been implicated in major disease outbreaks occurring in epizootic conditions. However, the underlying causes of such epizootics are highly complex and difficult to pinpoint. An understanding of the relationship between **Host, Pathogen and Environment** is important in this regard. Since aquatic animal disease is the end result of a series of linked events, treatment of disease should go beyond consideration of the pathogen alone. Conventional approaches have so far had limited success in the prevention or cure of aquatic disease. Recent experience in trying to control disease outbreaks clearly demonstrates the importance of the linkage with other components of the production system, including the need for broader ecosystem management approaches to control farm-level environmental deterioration and to take preventative measures against the introduction of pathogens -- the "**Systems Management Approach**" (SMA) through **Biosecurity and Biotechnology** approaches to aquatic animal health.

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.

Biotechnology:

"Biotechnology means any technological application that uses biological systems, living organisms, or derivatives thereof, to make or modify products or processes for specific use".

In response to growing pressures on air, water and land resources, global attention has focused in recent years on finding new ways to sustain and manage the environment. Biotechnology is an essential tool in this endeavor because it can provide new approaches for understanding, managing, preserving and restoring the environment.

Biotechnology can be used to assess the well being of aquaculture ponds ecosystem, transform pollutants into benign substances, generate biodegradable materials from renewable sources and develop environmentally safe disposal processes.

The emphasis of **SMA, Biosecurity and Biotechnology** should be on better management for prevention, which is likely to be more cost effective than cure, involving both on-farm management and the management of the environment where farms are located.

In addition, research, training programs, extension and information exchange can be more effective and responsive to farmers' needs if based on SMA. The FAO's Code of Conduct for Responsible Aquaculture is an ideal platform to link SMA and aquaculturists cooperation in harmonizing aquatic animal health management activities.

Recent developments in disease control:

Over the years, significant achievements have been made through **Biotechnology and Biosecurity** approaches in finding tools

to combat or control diseases in aquaculture. However, there is still considerable scope for further improvement of such approaches in developing new tools and perfecting existing ones.

Major areas include:

- quality control and more efficient and cost-effective use of inputs, such as water, seed, feed and others;
- the role of good nutrition in improving aquatic animal health;
- harnessing the host's specific and non-specific defense mechanisms in controlling aquatic animal diseases;
- development of affordable yet efficient vaccines for economically important tropical fish;
- use of immunostimulants and non-specific immune-enhancers to reduce susceptibility to disease;
- use of biosecurity and biotechnology products;
- use of probiotics and bioaugmentation for the improvement of aquatic environmental quality.

The findings of these inputs will undoubtedly not only contribute towards reducing negative environmental impact and will also make aquaculture products more acceptable to consumers.

Immunological assays, including fluorescent antibody techniques (FAT) and enzyme linked immunosorbent assays (ELISA) are used previously for detection of various fish pathogens. Innovations of new assays from genetic engineering using nucleic acid probes are evolving from medical diagnostics. The most advanced bio-molecular technique, the Polymerase Chain Reaction (PCR) --which can greatly multiply minute quantities of DNA -- are effective in detecting the presence of nucleic acid sequences of fish, prawn and shrimp pathogens from infected tissues. The development of a PCR for the detection of WSV is a major breakthrough in combating the shrimp viral epizootic. There are two trends: (a) kits are becoming available for farmers to use on location to obtain information quickly about the presence of pathogens; and (b) laboratories with trained staff are being organized to receive fresh and preserved samples from distant locations for processing and identification of unusual or difficult-to-detect antigens or nucleic acid sequences. Over the next decade, there is chances for development of cost-effective, affordable, yet sensitive and effective rapid diagnostic tools and these will increase the use for disease diagnosis.

The application of genetic technologies in aquaculture should be streamlined as part of biosecurity to fish health, to increase disease resistance and to act as diagnostic tools to confirm the presence or absence of specific pathogens.

Health certification:

Health certification programs form part of a first line of defense against possible adverse effects resulting from the pathogens of finfish and shellfish. As such, they must be developed within the context of larger regional and national (Quarantine) plans addressing this problem. To succeed, such efforts must be accompanied by the development of regionally agreed-upon lists of certifiable pathogens, the standardization of diagnostic techniques and the production of health certificates of unambiguous meaning. Establishment of intra- and inter-regional health information systems which could be linked with those of relevant regional and national agencies would be highly desirable for the success of such efforts. Strong commitment by national and local governments, and the cooperation of farmers, technical staff are keys to the success of these programs. Successful disease prevention will also be directly related to the ability of countries to reduce their dependence on imported broodstock and fry for aquaculture.

The main objective of the above strategy is to develop practical and effective regional and national health certification and

biosecurity guidelines that will minimize the negative impact of aquatic animal diseases on production from inland and coastal aquaculture, as well as increase the income of aquaculturists in the region, the majority being small-scale farmers.

Use of drugs and other chemicals

Many chemicals are being used in aquaculture. Some are essential for successful and efficient farm and hatchery management, and some have been widely used without adverse impacts. Most chemicals used do not appear to carry any significant potential for adverse effects on human health or environment, provided that they are applied in a technically appropriate manner. Although, in general, use of antimicrobial drugs in aquaculture is rapidly decreasing in major producing countries and there are considerable constraints to the promotion of safe and effective use of drugs in aquaculture in developing countries. They include:

- lack of trained manpower and support services to disseminate information on aquatic animal health management;
- the misapplication of some drugs (e.g. the excessive prophylactic use of antibacterials);
- insufficient understanding of mode of action and efficacy of certain drugs, especially under tropical aquaculture conditions; and
- uncertainties with regard to legal and institutional frameworks to govern drugs use in aquaculture.

Implications for international trade:

The screening of aquatic animals and animal products for human pathogens have become significant issues in international trade following the General Agreement on Tariffs and Trade (GATT) and the "international agreement on application of sanitary and phytosanitary measures" (SPS Agreement). The SPS Agreement recognizes international agencies such as FAO, WHO and OIE as reference points in solving trade disputes over such issues. Over the next decade, these agencies will play significant roles not only in solving trade disputes, but also in developing relevant technical guidelines and providing technical assistance to their member countries.

Global awareness

During the last decade, issues such as sustainable development, environmental interactions and long-term sustainability of aquaculture received increasing attention at local, national and international levels. One of the most widely accepted criteria for sustainable development is that development activities should not exceed the carrying capacity of the environment. Creating an "enabling environment" for sustainable aquaculture development can be achieved through **Biosecurity** and **Biotechnology** approaches.