Diseases surveillance in brackishwater aquaculture: recent developments

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Introduction

Global wild fisheries have been enduring under pressure of continuous exploitation, and during the last many years the catches are showing a flattened curve, the trend in Indian capture fisheries also shows similar stagnation. The promotion and progress of aquaculture sector is emerging as the only viable alternative, in meeting the ever increasing valuable fish protein. The Food and Agriculture Organization (FAO, 2012) estimates show that the catch production will remain relatively the same at about 90 million tons until the year 2030, while the production of aquaculture is expected to increase approximately to about 93 million tons by 2030 from the 63.6 million tons in 2011. In India brackishwater aquaculture, especially the shrimp farming is the engine of industrial phase of aquaculture, contributing a major share in the export earnings, which crossed Rs. 30,000 crores during 2013-14. The Indian shrimp farming sector follows a bubble and bust cycle, where early nineties showed a remarkable growth with tiger shrimp farming, but later collapsed with the outbreak of white spot disease (WSSV) pandemic, even forcing a crop holiday for shrimp farming during 1995. However from 2009, with the introduction of specific pathogen free (SPF) Pacific white shrimp, India's brackishwater aquaculture saw a new dawn with productions crossing three lakh metric tons in 2013. Fisheries sector in India contributes about 0.83% of the total GDP and about 4.75% of agricultural GDP (Anon, 2014) valued at about Rs. 30213.26 crores during 2013-14. This scenario could be sustained provided aquaculture intensification progresses on a responsible aquaculture mode. Long-term sustainability of brackishwater aquaculture sector can be achieved with meticulous planning and effective management of aquaculture inputs and rearing systems, with proper use of novel biotechnologies in seed, feed and health aspects of the host and farming systems. As in the case of other rearing systems such as agriculture and animal husbandry, disease issues and related crop failures is the most significant challenge in the growth, sustainability and profitability of brackishwater aquaculture sector.

Disease problems and related crop loss are the major constraints in aquaculture production

Across the world, the aquaculture production is showing an impressive growth, and the expansion is also significant, where the introduction of new species, including exotic species is playing a major role. In the process of introduction and movements of live aquatic animals and animal products and their life stages (broodstock, seed, and feed), has become a normal activity in India and other aquaculture countries. This intensified aquaculture, along with the introduction process, is opening up new opportunities for opportunistic and exotic pathogens, ultimately resulting in the spread and incursion of diseases in shellfish and finfish rearing systems. Disease outbreaks in aquatic environment are complex and the etiology is often difficult to determine since a series of events which are involved (environmental factors, stock health condition, infectious agent, poor husbandry and management practices), in the process of disease development and outbreaks. Aquatic animal disease caused by viruses, bacteria, fungi, parasites and other undiagnosed and emerging pathogens continue to have significant impacts, as the industry expands to meet the challenges of increased production, and the unavoidable intensification.

Over the last couple of decades, diseases such as white spot syndrome caused by white spot virus (WSSV), yellowhead disease caused by yellow head virus (YHV) and Taura syndrome caused by Taura virus (TSV), heavily impacted shrimp aquaculture in the Asiatic region and in Americas and caused the collapse of the *Penaeus monodon* industry. The combined loss from shrimp diseases, at the global level from 11 shrimp farming countries for the period 1987–1994, was estimated at 3019 million USD (Israngkura and Sae-Hae, 2002). WSD alone is estimated to cause losses of over US$6 billion since its emergence in 1992. Since 2009, the newly emerging diseases such as early mortality syndrome (EMS), specifically known as Acute Hepatopancreatic Necrosis Disease (AHPND), has caused large losses among shrimp farmers in China, Vietnam, Malaysia and Thailand. Losses due to AHPND are reported to be well in excess of US$ 1 billion per year. Recently in 2013, AHPND was also detected in Mexico with more than 80% mortality in about 50% of its shrimp farms in operation and the loss was estimated to be $ 116.2 million. These case histories clearly reflect the capacity of the lethal disease causing pathogens and the damage caused by the disease outbreaks to the aquaculture sector. Considering the limited therapeutic options available for the control of viral diseases, only timely disease detection using novel diagnostic tools for disease surveillance followed by active response to adopt and practise proper health management approaches would ameliorate the magnitude of the problem.

Aquatic animal health monitoring and aquatic animal disease surveillance

The term aquatic animal health monitoring is nothing but comprehensive collection, analysis and dissemination of information about diseases that are known to occur in the population which is being monitored. It is used to evaluate the frequency and trends of diseases, the risk factors associated with it and its economic impacts. Monitoring programs are used in conjunction with disease control and eradication programs frequently. The term *surveillance* implies an active process in which data are collected, analysed, evaluated and reported to those involved with a goal of providing better control of a disease or condition. It aids in detecting an exotic or new disease within a given population. Disease surveillance programs are designed to argue freedom from specific diseases and should always elicit action in the event of an exotic disease introduction. Important questions often asked as part of the surveillance programs include: (i) is the frequency of the disease remaining constant, increasing or decreasing?; (ii) are there differences in the geographical pattern of the condition?; (iii) does the disease have any impact on productivity and / or profitability?; (iv) is the disease absent from a particular species / strain, region, or nation?; and (v) is a control or eradication program cost-effective?

Due to the wide variety of species cultured, the pathogens and management systems, is necessary to establish surveillance systems; these should be designed to demonstrate freedom of aquatic animals from infectious diseases, taking into account the definition of the population, including any sub-populations that should be targeted to improve the probability of detecting disease, clustering of disease, documentation of the methodology used, survey design and data analysis procedures, the test or test system being used, the design prevalence or minimum expected prevalence in the presence of disease, sampling approaches, and quality assurance systems. Surveillance has been recognized as one of the key elements of any animal health policy, giving priority to preventive approach, early detection and rapid response.

Approaches to Aquatic Animal Disease Surveillance

The various approaches in performing surveillance programme are General or Passive surveillance and Targeted or Active surveillance.

General or Passive Surveillance relies on the use of secondary that

is collected from disease records, sales of medicines and production records in the farms. Stakeholders play a critical role in passive surveillance and hence they should be involved in the surveillance programs. Continuous training programs and periodical feedback with results will help in motivating them in their commitment towards such initiatives.

Active surveillance is based on primary data collection encompassing steps through sample collection through data analysis. Active disease surveillance programmes (based on survey techniques which provide representative samples of the susceptible population of interest) are aimed at (i) detecting occurrence of any significant diseases; (ii) may target specific diseases; or (iii) may monitor the progress of specific disease control or eradication efforts. This kind of surveillance provides the data required to prove that the specified populations are free of a specific disease.

A third type of approach to surveillance is the ***"Risk based surveillance (RBS)",*** in which the exposure and risk assessment methods have been applied together with traditional design approaches in order to ensure appropriate and cost effective data collection" (Stärk *et al.* 2006). Risk-based surveillance is useful to support both strategic and operational decision making. The aim of risk-based surveillance is to identify surveillance needs, set priorities and allocate resources effectively and efficiently. Targeted surveillance is a part of RBS, and involves making best use of resources.

Aquatic Animal Disease Surveillance - International scenario

The diseases which are listed by OIE are a major concern at the international level. Codex Alimentarius Commission (CAC) has set standards for various diseases and aquaculture end products. The primary purposes of surveillance is to gather information on the occurrence, course and treatment of aquatic animal diseases and to provide guidelines and set standards for health regulations, including diagnostic techniques which are also applicable to international trade in aquatic animals. The Code describes internationally agreed upon scientific and technical information regarding important aquatic animal diseases, risk analysis procedures and health certification protocols. All the member countries are required to send report on the occurrence of notifiable and other diseases of which are concern to OIE. Through Disease Information System it is disseminated to member countries by OIE. India is a member country of the OIE and its participation in the aquatic disease reporting system contributes to overall aquatic disease surveillance. Many countries have surveillance system in aquatic animals. Countries like Australia and New Zealand has its own well developed aquatic disease surveillance programme. Moreover Nordic countries have surveillance programme for various fish diseases.

Implications of disease surveillance programme

Diseases surveillance and reporting is considered to be a fundamental component of any national or regional strategy on aquatic animal health programme. Disease surveillance has its own advantages. They form the source of ringing the alarm bell in any emerging disease outbreak in aquatic animal health. Planning and executing aquatic disease control programmes can be done efficiently if an efficient aquatic disease surveillance system is in place. The surveillance programme helps set guidelines / standards in assessing and managing risks of diseases associated with trade. Besides helping to identify the etiology of the disease, the proactive surveillance will also provide the data required for rapid response. The aquatic animal health surveillance directly benefits farmers and stakeholders; certification of exports; international reporting and verification of freedom from diseases of concern. The information obtained from surveillance programme can be used to support contingency planning and monitoring of diseases control measures.

Disease surveillance also helps in zoning, which is the process of delineating infected and uninfected populations within a country or group of countries, with regard to specific diseases. Further, the zones defined by appropriate surveillance mechanisms as being free of diseases may be used to facilitate trade and to protect against the introduction of pathogens. Zones defined as having the presence of a specific pathogen may also have unrestricted transfers to zones positive for the same pathogen. Thus, a zone which is positive for a disease is not, necessarily subject to cessation of trade (Subasinghe *et al.*, 2004).

India's initiative in aquatic animal disease surveillance

As the disease management is difficult proposition in the aquaculture, the best option available is to have a two pronged approach of prevention and protection against the existing and emerging pathogens through surveillance and monitoring. Better management practices (BMPs) and regulatory framework in the movement of aquatic animals across the farming areas, in par with international standards is required. Timely response and targeted actions are important in the assessment of threat and follow up contingency plans. A good surveillance programme, using novel diagnostics in place can identify the pathogen and prevent the emergence and spread of the diseases.

New national Surveillance programme initiated through a network of fisheries research institutions active in aquatic animal health, with National Bureau of Fish Genetic Resources (NBFGR) and National Fisheries Development Board (NFDB), is a way forward in the aquaculture disease monitoring in India. The project was conceived with the following objectives: (i) Investigate and detect new and exotic infectious disease outbreak in aquatic animals; (ii) Provide evidence of freedom from diseases of concern within a defined geographical area; (iii) Collect information on the distribution and occurrence of diseases of concern; (iv) Assess progress in control or eradication of selected disease pathogens; with a total budget outlay of about Rs. 32 crores hopefully would achieve desired results. About 22 leading national institutions covering fourteen states with passive and active surveillance in more than 100 districts would cover disease problems in shrimp, carp, catfish, tilapia, ornamentals, cold water species, freshwater prawn and molluscs. A Technical Advisory Committee (TAC) has been constituted to oversee the implementation of the project with NACA, Bangkok as a special invitee.

Initiatives by Central Institute of Brackishwater Aquaculture in disease surveillance

Disease monitoring in brackishwater aquaculture has been a major activity of this institute since its inception. During initial phase of brackishwater aquaculture development during late 80's, soft shell syndrome of shrimp and EUS of fin fish were plaguing our brackish water sector, where CIBA initiated disease investigation and diagnosis. Scientific shrimp farming took off in India with the DBT-Govt of India pilot project at Nellore, AP. The project with the Andhra Pradesh Shrimp seed production, supply and research centre (TASPARC) with DBT funds injected great impetus and interest on semi intensive shrimp farming. Initially sporadic occurrence of bacterial diseases such as the bacterial septicaemia in grow-out farms caused limited losses, and from 1994 the new white spot syndrome or white spot disease (WSD), caused by one of the lethal and largest DNA viruses showed and it presence causing large scale and massive mortalities, devastating the entire shrimp farming sector. Many brackishwater shrimp farmers shifted to scampi farming in brackishwater ponds considering its ability to carry higher viral load, which also suffered setbacks due to another new viral disease, the white tail disease, caused by an RNA virus, the macrobrachium nodavirus (MrNV). Since 2006, the black tiger shrimp farming continued to face challenges with WSSV, but also with other disease conditions such as loose shell syndrome (LSS), followed by the monodon slow growth syndrome. Since the introduction of the Pacific white shrimp in India in 2009,

issues of zoea syndrome in hatcheries and mortality problems during early days of stocking and continuous low level mortalities during the crop have also been reported.

Concluding remarks

Considering the complexities of the aquatic ecosystem, success of aquatic animal disease surveillance programme requires a sustained effort. Surveillance programme is really a challenge in the multifaceted aquatic animal health system. More sophisticated models of the processes underlying disease emergence have to be taken into account, inter-alia, the role of multi-host pathogens and reservoir populations and a greater understanding of the way pathogens are transmitted in aquatic systems are needed to support measures to minimize the number and impact of new diseases. The quantum of both legal and illegal trade in aquatic animals far outstrips that of land-dwelling animals, and it is one of the biggest challenges in preventing the spread of emerging aquatic diseases. In addition, coming few epochs, aquaculture is likely to expand and grow further, such legal/illegal trade is set to increase, and pressures of limited water resources and climate change effects are likely to combine to increase the rate at which diseases emerge and spread. In the face of these combined challenges, the demand for epidemiological approaches to curtail measures to protect aquatic animal health will undoubtedly increase. Sustained efforts by all stake holders in India; the institutional, corporate, farmers level and allied sectors, active in aquaculture need to come together to achieve enhanced aquaculture production, to meet the increasing demand of quality food.

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