Farm-level plans and husbandry measures for aquatic animal disease emergencies

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Summary
Disease is one of the gravest threats to the sustainability of the aquaculture industry. A good understanding of biosecurity and disease causation is essential for developing and implementing farm-level plans and husbandry measures to respond to disease emergencies. Using epidemiological approaches, it is possible to identify pond- and farm-level risk factors for disease outbreaks and develop intervention strategies. Better management practices (BMPs) should be simple, science-based, cost-effective and appropriate to their context if farmers are to adopt and implement them. As part of a regional initiative by the Network of Aquaculture Centres in Asia-Pacific (NACA) to control aquatic animal diseases, effective extension approaches to promote the widespread adoption of BMPs have been developed in India, Indonesia, Vietnam and Thailand, and have proved their worth. A highly successful programme, which addresses rising concerns about the effect of disease on the sustainability of shrimp farming in India, is now in its seventh year. In this paper, the authors present a brief insight into the details of the programme, its outcomes and impact, the lessons learned and the way forward.

Keywords
Aquatic animal disease emergencies – Better management practices – Cluster farming – Epidemiology – India – Risk factors – Shrimp farming – White spot disease.

Introduction

There are numerous threats to the sustainability of the aquaculture industry, and disease is one of the most serious. Aquatic animal diseases have caused considerable damage to aquaculture and threatened the sustainability of the sector in many parts of the world. Some of the important diseases include:

a) viral diseases , for example:

– white spot disease (WSD) in cultured shrimp

– koi herpesvirus disease in koi (*Cyprinus carpio)* and common carp

– abalone viral mortality in abalone (*Haliotis)*

b) bacterial diseases, for example:

– vibriosis in shrimp

– streptococcosis in fish

c) fungal disease, for example:

– epizootic ulcerative syndrome in fish

d) parasitic diseases, for example:

– sealice infection in salmon

– sporozoan infection in carp.

The risks associated with the international trade in live aquatic animals and their products in the global spread of aquatic animal pathogens are well documented (1, 2, 14).

The socio-economic cost of aquatic animal disease is phenomenal. For example, in Asia, first yellowhead virus (from 1992 onwards) and later white spot syndrome virus (WSSV) (from 1993 onwards) caused direct and continuing losses of approximately US$ 1 billion a year to the native cultured shrimp industry (3). Aquatic animal disease prevention and control are a shared responsibility, and stakeholders at all levels (that is, farm, province, national and international) must be aware of their obligations, and be able to respond to disease emergencies and contribute to comprehensive aquatic animal health management programmes.

Developing and implementing farm-level plans and management measures to respond to disease is not straightforward. A good understanding of biosecurity and disease causation is necessary. Such plans and measures should embrace the concept of aquatic animal health management in its entirety, while focusing attention on three crucial points:

– preventing the entry of pathogens into production systems (e.g. farms and hatcheries)

– preventing the proliferation of pathogens in the production system which could lead to an outbreak (e.g. avoiding conditions on the farm which could promote or facilitate disease)

– preventing the spread of pathogens, should an outbreak occur.

Biosecurity is a set of standard scientific measures to exclude pathogens from the production environment and host and, more broadly, to limit the establishment and spread of pathogens. The principles of biosecurity should be adopted to keep harmful pathogens not only out of the farm but also out of the country and the region, particularly where there are shared bodies of water. Once harmful pathogens enter and become established (endemic), it is practically impossible to keep them out of the farm, especially in open farming systems, such as cages.

Some concepts vital for ensuring biosecurity are:

– identifying pathogen entry routes

– quarantine and screening of potential hosts introduced onto the farm

– disinfection at defined critical control points

– identifying risk factors for disease outbreaks.

At the farm level, every producer would like to implement a biosecurity plan. However, the extent to which the principles of biosecurity can be applied depends greatly on the type of farming system used (e.g. open, closed, partially closed). Applying biosecurity principles in small-scale, extensive, open farming systems is difficult, but open farming systems with little, if any, control over pathogens or carriers entering the pond (or other body of water) still comprise much of the aquaculture in Asia.

According to epidemiological theory, a disease will occur only when there is a sufficient cause. One component of the sufficient cause is the presence of the pathogen, which is necessary for the disease to occur (necessary cause). This is particularly the case in infectious diseases. Unless the necessary cause is solely sufficient to cause the disease, the presence of the pathogen alone will not make the animal sick and cause an outbreak. Several component causes (also called risk factors), in addition to the necessary cause, are essential for the disease to occur (22).

Using epidemiological approaches, it is possible to identify pond or farm-level risk factors for disease outbreaks. Intervention strategies can then be developed to minimise or eliminate such risk factors and reduce the risk of disease. In a broad sense, better management practices (BMPs) provide measures to manage disease at the farm level. Epidemiological approaches for identifying pond or farm-level risk factors for disease outbreaks (e.g. WSD in shrimp) are becoming more popular in the development of aquatic animal disease prevention and management strategies (9, 10, 18).

Applying biosecurity and disease causation principles when developing farm-level plans

Generic plans for minimising pathogen entry, preventing disease outbreaks and formulating post-outbreak responses are well developed. Likely pathogen carriers include:

a) infected hosts, for example:

– post-larvae (PL), broodstock

– vectors

– intermediate hosts

– reservoir hosts

b) non-host biological carriers, for example:

– birds

– dogs

– insects

– other predators

– human beings

c) fomites, for example:

– water

– vehicles

– buckets

– shoes

– nets

– clothing.

Such carriers could enter the aquaculture system through water-borne, air-borne and/or overland transport routes. Several generic approaches are available to prevent the entry of pathogens and their carriers into the pond and/or the farm (5). Implementing strict biosecurity measures at the farm level can be very expensive and may not be feasible in open farming systems. Identifying and weighing the relative risks associated with different pathogen carriers and entry routes through epidemiological studies would help to target resources at the major risks, so that biosecurity measures become more cost-effective. Biosecurity measures will be adopted on the farm only if they are shown to prevent the occurrence of the disease effectively and at a cost the farmer can afford.

The mere presence of a pathogen (necessary cause) does not always lead to disease outbreaks at the farm level. Good husbandry practices and risk management measures can minimise the impact of an outbreak. Epidemiological approaches have been successfully used to identify farm-level risk factors for some diseases, e.g. WSD. Farm-level plans and improved management practices to address identified risk factors have been successful in producing good yields, despite the presence of the necessary cause.

For example, successful production has been achieved in the presence of WSSV. In fact, in some farming systems at least, a majority of ponds harvest shrimp which test positive for the presence of antibodies against WSSV (12, 23). Some possible reasons include:

– a low viral load and low prevalence in PL

– reduced contact ratio and transmission (due to such things as a lower stocking density)

– improved environmental conditions leading to less stress for the shrimp (e.g. better water quality, high-quality feed, a clean pond bottom)

– better surveillance and early diagnosis

– informed decision-making.

These considerations seem to indicate that it is possible to prevent WSD outbreaks, despite the presence of the pathogen (9).

In the case of diseases for which antimicrobial treatment is not an option (e.g. viral diseases such as WSD), a quick response and damage control should be the primary post-outbreak goals. A quick response aids in the prevention of disease spread to other ponds in the farm, or to other farms in the region, or into the natural environment. Once the outbreak occurs, the farm becomes a source of the pathogen. Isolating the farm, covering the ponds, avoiding movements onto and off the farm, removing the affected hosts and disinfection programmes can all help to contain the spread of the pathogen.

Recent experience (11) shows that well-designed BMPs can help producers to:

a) increase efficiency and productivity by reducing the risk of shrimp health problems

b) reduce or mitigate the impact of farming on the environment

c) improve food safety and the quality of the farmed shrimp product

d) improve the social benefits from shrimp farming and its social acceptability and sustainability.

However, a lack of farm-level plans and lapses in biosecurity can be seen at every stage of the aquaculture operation in many countries, especially in the low-input, extensive shrimp farming systems which are common in Asia. These problems may include:

– improper pond preparation

– a lack of water treatment

– stocking with unscreened PL

– sharing farm equipment and labour between ponds

– unrestricted access to ponds/the farm

– no disinfection programmes.

Lapses in biosecurity following an outbreak could have major negative consequences for ponds and farms in the vicinity. Such lapses include:

– the improper disposal of dead animals

– the release of contaminated pond effluents.

Priority must be given to increasing farmer awareness of farm-level plans and biosecurity concepts and building their capacity to implement them. System-specific and cost-effective BMPs incorporating the basic principles of biosecurity must be developed, tested in pilot schemes, demonstrated to farmers and prove their worth.

As part of a regional initiative to control aquatic animal diseases, NACA oversees continuing projects in India, Indonesia, Vietnam and Thailand. These programmes are developing and validating effective extension approaches (e.g. the concept of cluster farming) to promote the widespread adoption of BMPs/farm-level plans that include the concepts of biosecurity on the farm, disease causation and health management.

A case study in India

Since the early 1990s, the Indian shrimp aquaculture sector has been hard hit by viral diseases. To address rising concerns about the effect of diseases on the sustainability of the sector, the Indian government Marine Products Export Development Authority (MPEDA), with the technical assistance of NACA, and the support of the Indian Council of Agricultural Research (ICAR) and the Australian Centre for International Agricultural Research (ACIAR), initiated a programme in 2000 on 'Shrimp disease control and coastal management'. The programme began implementation in 2001, with a large epidemiological study aimed at identifying the risk factors for key shrimp diseases. It also undertook to develop and disseminate BMPs to minimise risk factors for disease outbreaks on the farm and, more broadly, to address shrimp-farming sustainability. The programme, which is now in its seventh year, was implemented phase by phase. Its progress since 2000 is illustrated in Figure 1.

Some of the key stages of the programme include:

– a baseline study of the major diseases affecting shrimp aquaculture (2000)

– a longitudinal epidemiological study of 365 ponds in Andhra Pradesh, on the east coast of India, to identify major risk factors associated with WSD and low productivity in *Penaeus monodon* aquaculture ponds (2000 to 2001)

– the development of farm-level BMPs, appropriate to the Indian context, to address the identified risk factors (2002)

– pilot-testing of BMPs on selected farms (2002)

– publishing a simple and practical shrimp-health management manual, based on the outcomes of the risk

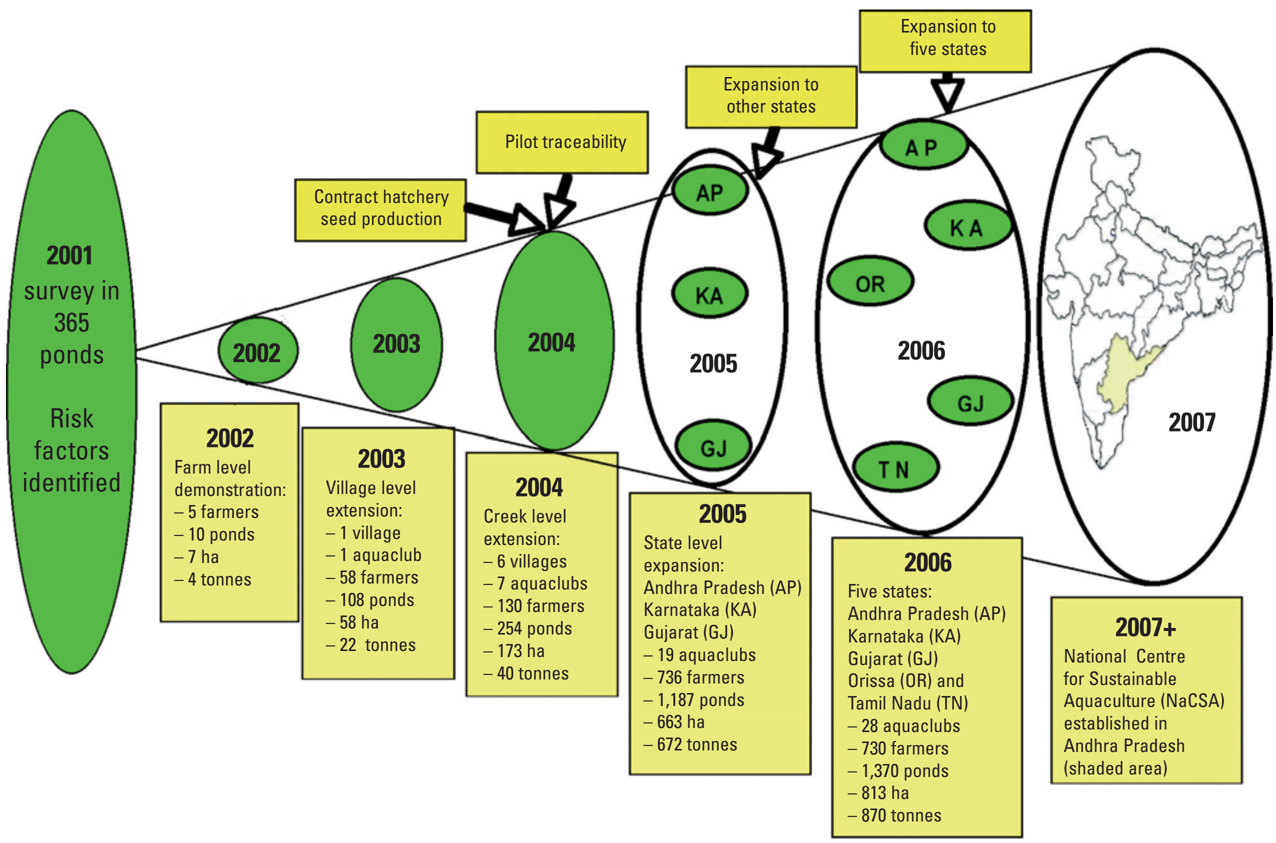

Fig. 1
Marine Products Export Development Authority/Network of Aquaculture Centres in Asia Pacific programme development in India since 2000

factor study and BMP pilot tests, to support farm and village-level extension programmes (2002)

– developing and testing the concept of cluster farming and promoting the adoption of BMPs to a large number of clusters (2003 to 2004)

– extending some BMPs to downstream operations, such as hatcheries

– reviewing and refining these BMPs, and producing BMP extension leaflets for each stage of the aquaculture operation (2005)

– expanding the BMP programme to clusters in five different states of India (2005 to 2006)

– designing an institutional framework to maintain the BMP and shrimp health extension programme (2006)

– establishing and inaugurating the National Centre for Sustainable Aquaculture (NaCSA) to carry forward the MPEDA/NACA programme (2007).

Risk factor study

Following a baseline survey of the major diseases that affect shrimp farming, and after some preliminary consultations with farming communities, a detailed longitudinal epidemiological study was conducted on shrimp disease problems during 2001. The study involved 365 ponds in the West Godavari and Nellore districts of Andhra Pradesh state. An epidemiological approach was taken to understand better the key risk factors that contribute to shrimp disease outbreaks and low pond production, with an emphasis on the economically serious WSD. The findings from this study have been published as a *Shrimp Health Management Extension Manual* (13). Some of the key findings from this risk factor study are summarised in Table I. The outcomes of the study provided a better understanding of risk factors for WSD outbreaks, as well as for unusually low pond productivity.

Towards the end of 2001, the results were discussed widely with farmers and relevant agencies in Andhra Pradesh. Consensus was reached on the study findings and their practical application to improve the performance of shrimp-farming in this state. Significant risk factors associated with disease outbreaks and low pond productivity were then used to develop locally relevant management strategies (so-called 'better management practices' or BMPs) to reduce the identified risks.

The study was unusual because, up until this time, only a limited number of field studies had been conducted on this scale. Moreover, of these, only a few used an epidemiological approach. Among the studies that were conducted, the most extensive were:

– the longitudinal epidemiological investigation, conducted in Vietnam and India from 1998 to 2000, with

Table I
Factors that reduce or increase the risk of white spot disease outbreaks in shrimp

Factors that reduce the risk	Factors that increase the risk
Disposal of removed bottom sludge away from the farm site	Ponds with a history of white spot disease (WSD) outbreaks
Ploughing of soil when wet	Ponds that are widely and randomly spread in the farming cluster
Liming the water	Dark brown coloured water at stocking
Ponds closely located within a given cluster	Transparent water with benthic algae during later stages of the grow-out phase
Water filtration using fine mesh filters (300 µm) and disinfection before stocking	Water salinity of more than 30 parts per thousand
Quick transportation of the post-larvae (within 6 hours)	Water transparency of less than 30 cm during the first month and more than 60 cm during the third month of the grow-out phase
Acclimatisation of post-larvae for less than 2 hours during stocking	Water pH of under 7.5 or over 10
Stocking of on-farm nursery-reared juveniles	Stocking of commercial nursery juveniles
Use of water disinfectants, soil treatment chemicals and soil conditioners during the grow-out phase	Stocking post-larval batches with more than 5% mortalities during transportation
	Stocking post-larvae batches with a higher prevalence of white spot syndrome virus
	Shallow water depth (less than 1 m) and water intake during the first month of the grow-out phase
	Late stocking of post-larvae
	Higher stocking densities
	Delayed start of feeding
	Raining and sudden drops of temperature (more than 5°C within a day)

funding from the UK Department for International Development (6, 7, 8, 15, 21, 24, 25)

– the MPEDA/NACA study carried out on the east coast of India during 2000 and 2001.

Both studies clearly show the value of the epidemiological approach for understanding pond and/or farm-level risk factors for important diseases, and the practical value of using such findings to develop appropriate interventions in the form of BMPs.

Testing better management practices at the farm level

During 2002, BMPs were tested on five farms, involving ten ponds, in three villages in the West Godavari and Nellore districts of Andhra Pradesh, on the east coast of India. Incidentally, Andhra Pradesh contributes about 50% of the total production of cultured shrimp in India. Technical assistance, monitoring and evaluation were provided by NACA and MPEDA. These trials or demonstrations were also used to disseminate information on risk management strategies more widely to farmers.

Although the adoption of BMPs did not completely eliminate shrimp disease, participating farmers and the MPEDA/NACA study team judged the outcomes as very promising. Adoption of risk management practices at pond level led to improvements in both profits and productivity. On demonstration farms, returns shifted from a loss in 80% of ponds in 2001 to a profit in 80% of ponds in 2002. During district-level workshops in November 2002, which were attended by over 470 farmers from the Nellore and Bhimavaram districts of Andhra Pradesh, farmers responded positively to these findings and requested support for more demonstrations, and initiatives to extend the concept of BMPs to the wider farming community. The 2002 trials further provided valuable insight into the factors influencing the adoption of BMPs by farmers, with farmer knowledge, willingness and the capacity to adapt BMPs to their on-farm conditions and financial resources all contributing to the positive results. Based on the findings from the 2001 risk factor study and the 2002 demonstrations, the BMPs were further modified and published as the *Shrimp Health Management Extension Manual* (13). The manual is freely available for download at www.enaca.org/shrimp and www.mpeda.com.

Promoting better management practices at the village level

During 2003, MPEDA and NACA responded positively to farmer requests and provided technical assistance for further demonstrations in one village in the West Godavari district of Andhra Pradesh. The objective was to promote the adoption of BMPs by a wider number of farmers to create a visible and quantifiable impact on the village community. A further objective was to support the village to organise a self-help group (the 'aquaclub') among farmers in the village to collectively address common shrimp health and farm management problems through a participatory approach. The core NACA/MPEDA team lived in the village during the early part of 2003, promoting the adoption of BMPs, supporting farmers to establish the aquaclub, facilitating weekly farmer meetings, and organising 'service provider/farmer' contacts and exchanges of information, thus trying to build up mutual trust among these parties. At the same time, the team established a monitoring programme and, at the end of the 2003 harvest, evaluated with farmers the outcomes of the village demonstration, to better understand the benefits of, and constraints to, adopting BMPs. Padiyar *et al.* (19) provide a detailed account of the 2003 programme. Some highlights were:

– 58 farmers with 108 ponds, spread over 58 hectares, volunteered to work with the study team and came together to form an 'aquaclub' to implement BMPs through a co-operative approach;

– shrimp health management practices were developed in consultation with local farmers, based on the general BMP principles derived from the 2001 risk factor studies and the outcomes of the 2002 demonstrations;

– BMPs focusing on pond bottom and water preparation, PL selection, stocking and post-stocking were widely promoted;

– data collected on corresponding harvests from non-demonstration ponds (164 ponds in 20 villages) were used to compare results and assess the impact of the village-level trials;

– BMP adoption rates in demonstration ponds were much higher than those in the non-demonstration ponds of surrounding villages. For example, in demonstration ponds the adoption rates for some key BMPs, such as sludge removal, water filtration, polymerase chain reaction (PCR) testing, stocking with PL reared in on-farm nurseries, using feed-check trays for on-demand feeding, and emergency harvesting of disease-affected stocks were 99%, 89%, 98%, 83%, 88% and 100%, respectively.

Better management practices listed in the *Shrimp Health Management Extension Manual* (13) were promoted in all the ponds under study. Some of the key BMPs used were:

a) preparation of pond bottoms and water management before stocking, i.e.:

– sludge removal and disposal away from the pond site

– ploughing on wet soil if the sludge has not been removed completely

– water filtration, using twin bag filters of 300 µm mesh size

– ensuring a water depth of at least 80 cm at the shallowest part of the pond

– water conditioning for 10 to 15 days before stocking

b) careful PL selection and stocking, i.e.:

– selecting PL of uniform size and colour, which are actively swimming against the water current

– testing (with nested PCR) PL for WSSV (using batches of 59 PL pooled together. Negative test results indicate, with 95% confidence, that the prevalence of WSSV-infected PL is less than 5% in that population)

– eliminating weak PL before stocking, using formalin (100 parts per million [ppm]) stress for 15 to 20 minutes in continuously aerated water

– on-farm nursery rearing of PL for 15 to 20 days

– stocking from the first week of February to the second week of March (early spring)

– ensuring a transportation time for PL of less than six hours from hatchery to pond site

– stocking into green water with stable algal blooms and avoiding transparent water during stocking

c) careful management after stocking, i.e.:

– filling grow-out ponds with water from reservoirs that has been left to 'age' for at least 10 to 15 days

– regular use of agricultural lime, especially after water exchange and rain

– no use of any harmful or banned chemicals, including antibiotics

– use of feed-check trays to ensure feeding based on shrimp demand

– feeding across the pond, using boats or floating devices, to avoid local waste accumulation

– regular removal of benthic algae

– exchanging water only during crucial periods (e.g. periods of low oxygen, algal bloom crash)

– weekly checking of pond bottom mud for blackish organic waste accumulation and bad smells

– regular shrimp health checks, and weekly health and growth monitoring, using a cast net

– removal and safe disposal of sick or dead shrimp

– emergency harvesting after proper decision-making

– no draining or abandoning of disease-affected stock.

Farmers and the study team judged the results of these demonstrations very favourably. Four harvest outcomes were considered:

– days of culture

– productivity

– shrimp size

– shrimp survival.

All were significantly ($p < 0.05$) better in the demonstration ponds than in the non-demonstration ponds. Many of the non-demonstration ponds 'crashed' with shrimp disease early in the season, whereas nearly 75% of demonstration ponds sustained the harvest for 80 days.

An important outcome in 2003 was the establishment of an active club, which met regularly and promoted widespread adoption of BMPs among its members, generating intense interest among neighbouring villages. At the end of the 2003 harvest, participating farmers recorded significant benefits from adopting BMPs and the aquaclub. Although shrimp disease was not eliminated, demonstration ponds had significantly increased production and achieved a better-quality product than the surrounding ponds and villages. The demonstration also provided more understanding of the constraints (e.g. financial, social) faced by farmers in adopting BMPs. The well co-ordinated collective approach and positive results evoked keen interest among farmers in surrounding villages, and the study team received several requests to bring new villages into the scheme in 2004.

The 2003 village pilot scheme showed that it is possible to reduce the risks of production losses from shrimp disease, and improve the productivity and profitability of shrimp farms, by:

– providing science-based information on BMPs

– providing technical support that enables farmers to adapt BMPs to their own circumstances

– promoting the concept of self-help groups (aquaclubs) to aid co-operation and communication among stakeholders, allowing them to address health management issues collectively.

Promoting better management practices at the cluster level and expanding the programme

Following the success of BMPs at the village level, the programme moved one step further and promoted the adoption of BMPs among clusters of farmers along a particular creek. In 2004, 130 farmers with 254 ponds were organised into seven aquaclubs (clusters) in Andhra Pradesh and BMPs were promoted to the cluster. A cluster is a group of inter-dependent shrimp ponds, situated in a specific geographic locality. Usually, all these ponds depend on the same water source. Cluster farming is collective planning, decision-making and carrying out these decisions by a group of farmers (in a 'cluster') who have chosen to take a participatory approach to accomplish a common goal (e.g. reduce risks and improve farming practices and profitability). The cluster concept also makes it easier to communicate risks and risk management more effectively to a larger group of farmers.

As a result of its success, and the acceptance of the concepts of BMPs and cluster farming, the programme was further expanded in 2005 to cover more clusters in Andhra Pradesh, and extended to limited areas of the Karnataka and Gujarat states on the west coast of India. In all, the adoption of BMPs was promoted in 19 aquaclubs, consisting of 736 farmers with 1,187 ponds. Details of the programme in Andhra Pradesh, along with harvest outcomes and lessons learned, are provided by Padiyar *et al.* (17). The results, presented in Table II, clearly indicate that, when implemented collectively by organising farmers into an aquaclub, BMPs can significantly improve the shrimp harvest and reduce the impact of disease.

In 2006, the programme was run in five coastal states:

– Andhra Pradesh

– Karnataka

– Gujarat

– Tamil Nadu

– Orissa.

By 2006, BMPs were being promoted in 28 aquaclubs, comprising 730 farmers with 1,370 ponds.

Table II
Average value of shrimp harvests during the demonstration period of better management practices on Andhra Pradesh farms in India in 2005

Harvest outcome	Study ponds	Non-study ponds
Production (kilogram/hectare)	1,366	764
Days of culture	116	98
Survival rate (%)	72	46
Planned harvest (%)	88	35

Key approaches of the programme

To enhance BMP uptake and promote their adoption in different coastal states of India, brochures on ten key thematic areas were developed in English and translated into all five state languages. Each brochure describes the field procedures for its topic in 15 simple steps, in the local language, with the aid of pictures from the field. The brochures are distributed at weekly farmer meetings and regular pond visits. BMPs are also promoted through posters, articles in local newspapers and documentaries on local television channels. All ten BMP brochures can be downloaded from www.enaca.org/shrimp, and their subjects are as follows:

– good pond/water preparation

– good quality seed selection

– water quality management

– feed management

– pond bottom monitoring

– health monitoring/biosecurity

– food safety (no use of antibiotics)

– better harvest and post-harvest practices

– record maintenance/traceability

– environmental awareness.

To facilitate farmer involvement, ensure commitment and instil confidence, the study team stayed in the study villages for the entire shrimp-harvesting season, arriving at least one month before it started. At village meetings, farmers were introduced to the 'cluster farm management' concept, the formation of aquaclubs (groups of 20 to 30 farmers) and the importance of adopting BMPs. Key farmers from other villages, where the MPEDA/NACA study team had worked previously (between 2002 and 2004), were invited to these new villages to share their experiences. Wherever possible, field visits were arranged for farmers to other villages so they could talk to the farmers already using BMPs and see their ponds at first hand. Aquaclubs were able to prioritise and contextualise the BMPs according to their local needs. A contract hatchery seed procurement system (16) was introduced, in which meetings were arranged between farmers and hatchery operators to ensure a supply of good quality seed shrimp. Under this system, cluster farmers place bulk orders to a hatchery, 45 to 60 days in advance of the planned stocking date, for the required quantity and quality of PL. Through a consultative process, initially facilitated by the project team, a mutual agreement is made between selected hatcheries and aquaclubs. This arrangement includes agreements on BMPs to be used in the hatcheries and other terms and conditions for the production and procurement of quality PL.

Impact of this regional initiative on aquaculture in India

The MPEDA/NACA programme has made significant progress, increasing from five farmers, who adopted the cluster farming approach in 2002, to 730 farmers (813 hectares) in 28 aquaclubs in five states (Andhra Pradesh, Karnataka, Orissa, Gujarat and Tamil Nadu) in 2006 (Fig. 1). In addition, several farmers and farming villages in India implemented BMPs and the shrimp-farm-cluster management approach without direct intervention from the project, which is an indirect positive impact of the programme. The production of BMP shrimp through the programme has increased from four tonnes in 2002 to 870 tonnes in 2006. The implementation of simple, science-based farm-level plans and management practices (e.g. BMPs) and adopting the cluster farming approach have significantly reduced disease risks on cluster farms. The prevalence of disease in the demonstration farms decreased from 82% in 2003 to 17% in 2006 in Andhra Pradesh; while, in non-demonstration ponds, the reduction in disease prevalence was much lower over the same period, as shown in Table III.

Another significant finding was that the efficient use of resources, such as feed, PL, fuel and finances, minimised production costs and improved farming profits, providing a strong incentive to join the programme.

Economic analysis clearly demonstrates that farmers adopting BMPs have higher profitability, lower production costs and are able to produce quality and traceable shrimp without using any banned chemicals. The concept of traceability was successfully pilot-tested in a few of the selected clusters. Preliminary findings clearly suggested that, through cluster farming and the aquaclub concept, it is possible to implement traceability schemes for small-scale farmers, to ensure market access. In the demonstration ponds in Andhra Pradesh, for every 1,000 Indian rupees (US$ 25) invested by a farmer, around 520 rupees (US$ 13) was earned as profit in 2006. This was a substantial increase, compared to the 250 rupee profit (US$ 6) made by non-demonstration farmers during the same period.

The programme also led to a reduction in other aquaculture-related risks. For example, environmental risks were reduced through the decrease in pollution, resulting from the reduced use of chemicals and antibiotics, and the limited discharge of sediments and water exchange. Food safety risks were substantially reduced by the reduction of chemical use in cluster BMP ponds. The social impacts included a reduction in risks to livelihoods and an improved awareness of biosecurity and the environment among cluster farmers. A summary of the impact of the programme is highlighted in Table IV.

Maintaining the process: the way forward

Better management practices on the farm and cluster farming are promising models for small-scale farmers to work together to reduce disease, food safety risks, environmental, financial and social risks, and earn their livelihood by helping the industry to meet customer demand, through adopting sustainable and environmentally friendly farming practices (4, 20). However, to expand and maintain the process, an institutional framework is needed, as well as the commitment of resources from the national government and private sector.

Following on from the programme, MPEDA formulated a scheme for registered 'aquaculture societies' (legal entities that are very similar in structure and function to the informal aquaclubs) at the primary producer level, which would assist these producers to adopt BMPs. To support the initiative, MPEDA has set up a separate technical service agency, called the National Centre for Sustainable Aquaculture (NaCSA), under the administrative control of MPEDA. This new agency has been operating since April 2007 and will function as an outreach organisation of MPEDA, primarily to cater to the extension needs of aquaculture farmers. The primary objective of NaCSA is to support the development of sustainable aquaculture in India, by providing science-based extension and other

Table III
Comparison of disease prevalence, by percentage, in ponds with better management practices (BMP) and ponds without, between 2003 and 2006, in India.

Year	Number of BMP ponds	Disease prevalence in BMP ponds	Number of non-BMP ponds	Disease prevalence in non-BMP ponds	Difference
2003	108	82%	164	89%	+ 7%
2004	254	37%	187	57%	+ 20%
2005	1,187	15%	517	42%	+ 27%
2006	1,370	17%	901	44%	+ 27%

Table IV
Summary of the impact of the programme of the Marine Products Export Development Authority and Network of Aquaculture Centres in Asia-Pacific to promote better management practices

Risk	Positive impacts
Disease	Reduced incidence of disease
Food safety	Reduced chemical and antibiotic use and complete traceability of the product
Market access	Increased opportunity for market access, mainly due to sizeable quantity of production from an aquaclub (as opposed to a single farm)
	Better quality produce
Financial	Improved profits
	Access to bank credit
Social	Reduced risk to small-scale farmers
	Increased communication
	Harmony among farmers
Environmental	Reduced pollution
	Increased awareness of the environment

services to the sector. Thus, NaCSA will continue to consolidate and expand the BMP implementation work initiated under the MPEDA-NACA programme through a network of aquaculture societies across the country. At present, NaCSA is working with 70 aquaculture societies and is expected to promote BMPs in 200 societies within the next year. The following steps are being taken by NaCSA to continue the process of BMP adoption and cluster farming:

– promoting BMPs to reduce disease risk and improve aquaculture productivity and profits

– building capacity and empowering primary producers

– facilitating improved service provision to the aquaculture sector

– connecting farmers to markets to realise better prices

– ensuring food security and sustainable livelihoods.

Conclusion

Although BMPs are often simple farm-level management practices to prepare for and respond to disease, their systematic adoption by farming communities to manage shrimp health problems, and to achieve widespread sustainable shrimp production, has a relatively recent history. The MPEDA/NACA programme has the distinction of being the first programme in this direction in the region. Since then, this approach towards sustainability has been adopted by several countries, and it is expected to spread to many other countries in the Asian region. During the period between 2002 and 2006, BMPs were massively promoted through demonstrations/pilot schemes. The concept of cluster farming was developed for shrimp farming through the development of farmer self-help groups, known as aquaclubs. Efforts were made to link the aquaclubs with their suppliers, such as shrimp hatcheries and feed manufacturers. The concept of producing good quality PL under contract agreements (the contract hatchery system) with aquaclubs was also introduced. A massive awareness campaign was conducted to promote BMPs through articles in local newspapers, documentaries on local television channels, posters, leaflets and farmer meetings. Finally, to maintain the process of cluster farming and BMP adoption, an institutional framework, in the form of NaCSA, has been established.

Effectively engaging with the millions of aquaculture producers in Asia and the Pacific region, and helping them to develop farm-level plans to deal with aquatic animal disease, is not a small task, and it is one that can only be achieved through the involvement and contribution of all the participants in the supply chain, from producers to consumers. The Indian example should serve as a model for developing and implementing farm-level plans that support sustainable aquaculture development and, at the same time, contribute to effective health management.

Acknowledgements

The authors gratefully acknowledge the financial and technical support provided by various national (MPEDA, ICAR, College of Fisheries, Mangalore) and international agencies (ACIAR, NACA). The commitment and co-operation extended by the shrimp farmers is highly appreciated. The untiring work of MPEDA-NACA project staff and aquaclub leaders is also gratefully acknowledged.

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Plans et mesures de gestion à l'échelle des élevages pour faire face aux urgences sanitaires affectant les animaux aquatiques

C.V. Mohan, M.J. Phillips, B.V. Bhat, N.R. Umesh & P.A. Padiyar

Résumé

Les maladies des animaux aquatiques constituent le principal danger pour la pérennité du secteur de l'aquaculture. Une bonne connaissance de la biosécurité et des facteurs à l'origine des maladies est essentielle pour concevoir et mettre en œuvre des plans et des mesures de gestion au niveau des élevages en cas d'urgence sanitaire. Les approches épidémiologiques permettent d'identifier les facteurs de risque de foyers à l'échelle du bassin ou de l'élevage et de mettre en œuvre des stratégies d'action appropriées. Pour que les éleveurs adhèrent aux pratiques optimales de gestion et les appliquent correctement, celles-ci doivent être simples, scientifiquement fondées, économiquement rentables et adaptées au contexte des élevages. Dans le cadre d'une initiative régionale de lutte contre les maladies des animaux aquatiques mise en place par le réseau des centres d'aquaculture de la région Asie-Pacifique (NACA), des dispositifs de vulgarisation ont été introduits avec succès en Inde, en Indonésie, au Vietnam et en Thaïlande. En Inde, un programme très performant s'occupe depuis sept ans d'apporter des réponses aux nouveaux problèmes que les maladies font apparaître dans les élevages de crevettes et qui menacent leur pérennité. Les auteurs présentent brièvement les caractéristiques, les résultats et les retombées de ce programme, avant d'en tirer quelques enseignements et perspectives pour l'avenir.

Mots-clés

Élevage de crevette – Épidémiologie – Facteur de risque – Grappe de production aquacole – Inde – Maladie des points blancs – Pratique optimale de gestion – Urgence sanitaire affectant les animaux aquatiques.

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Planes y medidas de gestión en cada explotación para afrontar emergencias sanitarias en animales acuáticos

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Resumen

Las enfermedades constituyen una de las más graves amenazas que hacen peligrar la continuidad del sector acuícola. Para elaborar y aplicar planes y medidas de gestión en las explotaciones que sirvan para responder a emergencias sanitarias es indispensable conocer y entender bien los fundamentos de la bioseguridad y las causas de las enfermedades. Utilizando la epidemiología es posible determinar los factores de riesgo en viveros y explotaciones que favorecen la aparición de brotes infecciosos, y elaborar estrategias de intervención en consecuencia. Para que el propietario las adopte y aplique, las prácticas óptimas de gestión deben ser sencillas, científicamente sólidas, eficaces en relación con los costos y adaptadas al contexto. Como parte de una iniciativa regional de la red de centros de acuicultura de Asia y el Pacífico (Network of Aquaculture Centres in Asia-Pacific: NACA) destinada a combatir las enfermedades de los animales acuáticos, en la India, Indonesia, Vietnam y Tailandia se han instituido mecanismos de divulgación para promover la adopción generalizada de prácticas óptimas de gestión, planteamiento que está resultando muy fructífero. En la India hay un programa sumamente eficaz, que se encuentra ya en su séptimo año de funcionamiento, para responder a la creciente inquietud que suscitan los efectos de las enfermedades y la posibilidad de que éstos hagan peligrar la continuidad a largo plazo de la cría de camarones. Los autores exponen breve pero detalladamente las características de dicho programa, sus resultados y efectos, las enseñanzas de él extraídas y el rumbo que conviene seguir.

Palabras clave
Cría de camarones – Emergencia sanitaria en animales acuáticos – Encadenamiento productivo acuícola – Enfermedad de las manchas blancas – Epidemiología – Factor de riesgo – India – Práctica óptima de gestión.

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