Codes of Practice and Better Management: A Solution for Shrimp Health Management?

FLAVIO CORSIN[1], C.V. MOHAN[1], ARUN PADIYAR[2], KOJI YAMAMOTO[1], PORNLERD CHANRATCHAKOOL[3] and MICHAEL J. PHILLIPS[1]

[1]Network of Aquaculture Centres in Asia-Pacific (NACA), Suraswadi Building, Department of Fisheries, Kasetsart University Campus, Ladyao, Jatujak, Bangkok 10900, Thailand
[2]Food and Agriculture Organization of the United Nations (FAO). Tsunami Rehabilitation Support Coordination Unit, Jl. Angsa No. 12, Ateuk Deah Tanoh, Banda Aceh, 23244, Nanggroe Aceh Darussalam, Indonesia
[3]Novozymes Biologicals

ABSTRACT

Following the development of the FAO Code of Conduct for Responsible Fisheries, international principles for the sustainable production of shrimp farming were prepared to address shrimp health, food safety and the environmental and socio-economical sustainability of the sector. Better Management Practices (BMP) to translate the principles into practice were also developed, disseminated and implemented in several Asian countries including India, Vietnam, Thailand and others. This manuscript describes how approaches towards sustainable shrimp production can effectively contribute to shrimp health management. It also highlights the need for broad stakeholder involvement and for providing the right incentives to producers such as reduced costs, improved production, access to information and diagnostic services and higher market prices for BMP products.

Corsin, F., Mohan, C.V., Padiyar, A., Yamamoto, K., Chanratchakool, P. and Phillips, M.J. 2008. Codes of practice and better management: a solution for shrimp health management?, pp. 419-432. *In* Bondad-Reantaso, M.G., Mohan, C.V., Crumlish, M. and Subasinghe, R.P. (eds.). Diseases in Asian Aquaculture VI. Fish Health Section, Asian Fisheries Society, Manila, Philippines. 505 pp.

Corresponding author: Flavio Corsin, flavio.corsin@gmail.com

INTRODUCTION

Over the last decade, shrimp farming has been one of the most rapidly growing sectors within aquaculture. From a production of less than 900 thousand tonnes in 1994, in 2004 global production from shrimp farming reached 2.5 million tonnes, with a farm gate value of US$9.7 billion. This production was largely dominated by Asian countries which in 2004 made up 88% of the total production with 2.2 million tonnes and a value of US$8.3 billion. Although impressive, these aggregated figures do not fully represent the extent of the growth experienced by some of the leading shrimp farming countries. Production in China showed a notable 5.5-fold increase over the 5 year period between 1999 and 2004, going from 171 thousand tonnes to 936 thousand tonnes. A similar 5-fold increase was experienced by Vietnam, where production increased from 55 thousand tonnes in 1999 to 276 thousand tonnes in 2004 (FAO, 2006).

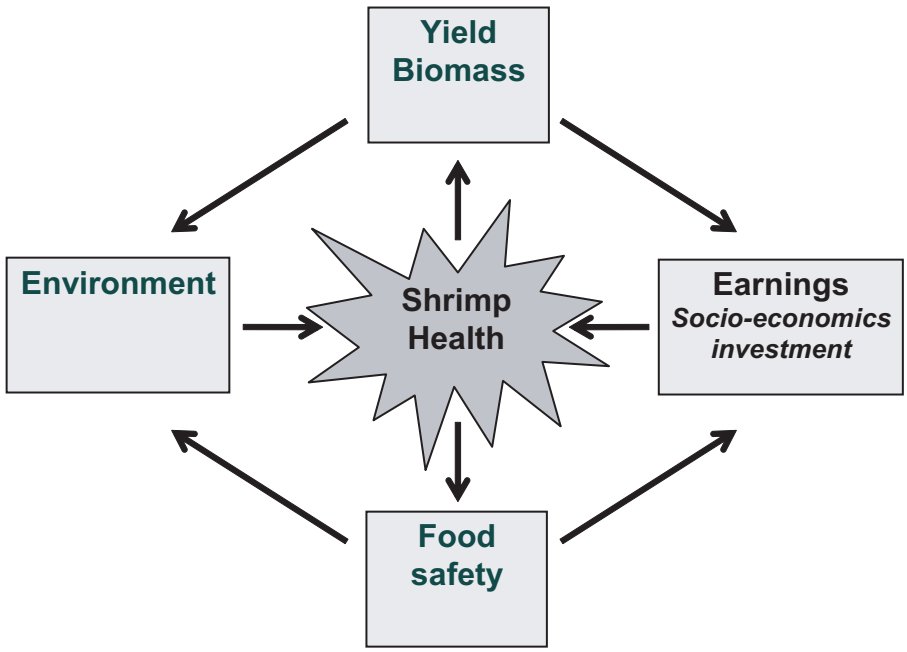

Figure 1. Diagram explaining the relation between shrimp health and other aspects of sustainability.

With this rapidly increasing production, several issues and challenges over the sustainability of the sector began to emerge (Figure 1). Outbreaks of various shrimp diseases (*i.e.* White Spot Disease, Yellow head Disease, and Taura Syndrome) have caused devastating economic damage to the sector worldwide. Increased shrimp health problems have led to the use of sometimes banned chemicals and drugs, which posed threats to the health of consumers and led to several restrictions being put in place by importing countries (Ababouch *et al.*, 2006). Major challenges included also environmental degradation and social conflicts related to the use and pollution of natural resources, sometimes leading to claims of mangrove deforestation, salination of agricultural land and eutrophication of

sensitive aquatic habitats. The sustainability of the sector was also challenged by the price in the international market, which has continued to decline, especially in the USA, in spite of the increased challenges faced by producers (Leites, 2006).

In response to these concerns, efforts were initiated to develop a more sustainable approach to shrimp farming and to the fisheries sector in general. The Food and Agriculture Organization of the United Nations (FAO) played a key role in this process. In 1995, FAO issued the Code of Conduct for Responsible Fisheries (CCRF), which set principles for the responsible development of the fisheries sector, including aquaculture. In 1999, FAO joined NACA, the World Bank, WWF and other partners to form a Consortium Programme targeted at exploring more sustainable approaches specifically for the shrimp farming sector.

This paper examines how approaches towards sustainable shrimp farming can assist shrimp health management, in particular using case studies from India, Vietnam, Thailand and Iran.

SHRIMP HEALTH MANAGEMENT AND SUSTAINABLE SHRIMP FARMING

It is increasingly being recognized that shrimp health management is strongly linked with other aspects of shrimp farming sustainability and that all those aspects should be addressed to achieve effective shrimp health management.

It is obvious that shrimp health affects yields and therefore earnings. In addition to the well known links between environment and shrimp health, the occurrence or threat of experiencing shrimp health problems, often leads farmers to use chemicals and drugs which may have been banned by importing countries. The price of rejecting batches containing such substances will also reflect on the earnings generated throughout the supply chain. As a consequence of reduced profits, farmer will have less financial resources to invest on reducing their risk of experiencing shrimp health problems, therefore increasing further the risk of diseases.

Although shrimp health is generally a major driver of the process towards sustainability, at least for producers, for the above reasons this manuscript will discuss broadly about sustainability of the shrimp farming sector, rather than only shrimp health management by itself. Sustainability of the sector is a shared responsibility and as such, will be addressed in this paper by considering the role to be played by the many stakeholders involved, and not merely by looking at shrimp farming practices. For ease of explanation, the process of achieving sustainable shrimp farming will be presented step-wise, following the diagram reported in (Figure 2).

Gather technical knowledge

There is a great deal of knowledge now available on how to successfully farm shrimp, while improving the environmental and socio-economical sustainability of farm operations and the safety of the harvested products. This knowledge should be used to address 2

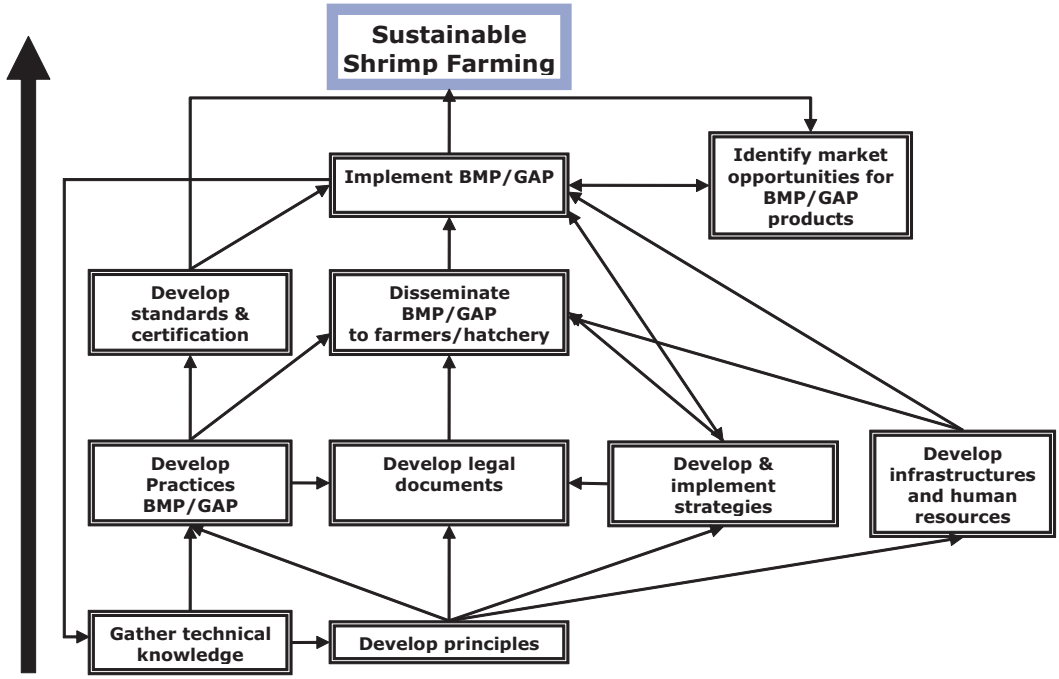

Figure 2. Diagram showing indicative steps to achieve sustainable shrimp farming, as defined by improved shrimp health management, environmental protection, food safety and socio-economical sustainability.

issues. The first concerns the development of general principles for shrimp farming sustainability, *i.e.* the identification of what concepts should be adopted to make shrimp farming sustainable. The second issue is related to the "translation" of those principles into practice, which is conducted by using technical knowledge to develop system-specific farming practices that address the sustainability of the farming operations.

The development of principles for responsible shrimp farming (see next section) was based upon several consultations which involved a broad range of stakeholders and lasted for about 7 years.

Concerning the development of practices for the implementation of the principles, this process can be assisted by the several extension documents now available. A reference manual concerning technical aspects of shrimp farming is "Health Management in Shrimp Ponds" (Chanratchakool *et al.*, 1998), a document widely used in the Asian region and around the world and which has been translated in at least 5 Asian languages. Several extension documents can also be freely downloaded from the NACA website (http://www.enaca.org/modules/wfdownloads/). The applicability of these manuals to a specific farming system however, is not straightforward and practices recommended in these documents generally require revision and amendment to fit local contexts. Knowledge on how to improve practices for the sustainability of the sector can be obtained through discussions between international and national experts and in consultation with farming communities (NACA/FSPS/MOFI, 2005). Following the development and implementation

of practices specific to a farming system, it has also proven extremely useful to review the applicability and effectiveness of these practices and to revise them if necessary. In this process, researchers often play a key role by advising and contributing to the development of Monitoring and Evaluation systems.

Develop principles

Principles, often grouped into Codes of Conduct (CoC) or Codes of Practice (CoP) if related to specific commodities, represent the "philosophical basis" for the responsible production of a product. In 1999 a Consortium Program was established with the aim of developing principles for the responsible production of shrimp, following the guidelines of the FAO CCRF and the experiences of the organizations involved. The Consortium was formed by a wide range of partners among which FAO, NACA, the World Bank and WWF were among the major, and UNEP joining it in more recent years. Benefiting from the knowledge available, from 35 complementary case studies conducted in more than 20 shrimp farming countries, and from several stakeholder consultations involving governments, private sector and non-governmental organizations, the Consortium Program developed the "International Principles for Responsible Shrimp Farming: incorporating 8 principles (FAO/NACA/UNEP/WB/WWF, 2006). In February 2006, the principles were endorsed by the 17 countries represented at the NACA Governing Council and in September 2006 they received global endorsement by the Committee on Fisheries, Sub-Committee on Aquaculture, making them the only internationally recognized set of principles for the responsible production of shrimp.

Develop Better Management Practices/Good Aquaculture Practices

The development of practices for the effective implementation of the principles is a key step towards the sustainability of the shrimp farming sector. Several names have been used to describe these practices for sustainable shrimp farming, among others Better Management Practices (BMPs) and Good Aquaculture Practices (GAP) are among the most used. Defining differences between BMP, GAP and others is beyond the scope of this review and for simplicity the most used term "BMP" will be used to define any set of practices that address broadly the sustainability of the sector.

BMP are generally specific to the system and as such they have to focus on what a farming community can effectively achieve in a cost effective way. BMP should be simple, practical and applicable with minimum effort virtually by every farmer willing to do so. In doing so, they should address especially the needs of small-scale producers, not only because of their importance in the overall supply of shrimp worldwide but also to ensure that these more vulnerable players are not excluded from these efforts towards sustainability.

BMP should be developed for every link in the supply chain, from broodstock suppliers, to hatcheries, seed middlemen and farmers. Most sets of farm-level BMP developed for different farming systems address the following: pond location and construction; pond preparation; seed selection and stocking practices; improve pond management; pond bottom monitoring, water quality and shrimp health; improve biosecurity during production; record keeping; better management of health problems (especially concerning

the responsible use of antibiotics and chemicals); better collaboration with other resource users. BMP also emphasise the advantages of establishing farmer groups and associations (in India known as aquaclubs) in order to share costs (e.g., for shrimp seed testing), improve water management, increase awareness on the health status of neighbouring farms and through the appointment of voluntary extension workers with the role of assisting BMP implementation by other farmers in the group.

Although BMPs are indeed simple, well-know practices, most often these practices are not followed by farmers because of poor awareness or lack of the necessary conducive environment.

Disseminate Better Management Practices/Good Aquaculture Practices to all links in the supply chain

Building awareness on BMP among farmers and other links in the supply chain relies on an effective extension mechanism. This mechanism can take different forms, depending on the country, institutional context, production system, economics and other factors.

Most Asian countries have capillary extension services that can be effectively involved in BMP dissemination, provided that the right support and incentives are given by national and local authorities. Input suppliers and processors also play an important role. Feed suppliers in India are for example an important channel for dissemination of technical knowledge. The involvement of such stakeholders in BMP programs is therefore essential to create synergy rather than parallel efforts or worse, contradictory messages being given to producers.

In view of the large numbers of producers involved in shrimp farming, farmer to farmer extension is essential. As mentioned above, the development of a voluntary extension system has sometimes proven key to the dissemination of BMP messages in Vietnam (NACA/FSPS/MOFI, 2005). Voluntary extension workers are generally selected by the members of a farmer group based on their experience in shrimp farming and willingness to support other farmers in BMP implementation. Voluntary extension workers generally do not get financial compensation for their work. Their incentives to provide extension services consist of: rapid access to information because they are the first to be contacted for dissemination of new information; better awareness about shrimp health in neighbouring ponds; ability to reduce disease risk in neighbouring ponds and consequently in their own pond.

Extension activities are greatly supported and standardized through the development and dissemination of extension material. Several extension documents are now freely available in many local languages. Links to several extension documents freely available on the internet can be found on the NACA website (www.enaca.org). Extension material is generally simple in language and often organized in steps that farmers can follow to improve the sustainability of their farm operations and, with it, more effective shrimp health management.

In addition to extension manuals, BMP messages are also disseminated at farmers meeting held by (voluntary) extension workers and though regular pond visits. The active participation and sharing of experiences by farmers plays a very important role in

awareness building and dissemination of BMP messages. Successful dissemination of BMP messages can also be achieved using demonstration farms (Padiyar *et al.,* 2008) and through more structured Aquaculture Farmer Field Schools, where demonstration farms are used to conduct regular pond-side training courses (NACA/FSPS/MOFI 2005).

In a context in which scientific knowledge has to reach millions of producers, it is important to emphasise the need for novel and practical extension approaches to facilitate an effective and efficient flow of information (e.g., BMP messages) to the end users.

Develop legal documents

BMP can also be disseminated through the development of legal documents. As the principles contained in the CCRF were voluntarily taken up by several countries to develop their own fisheries legislation (R. Subasinghe, pers. comm.), similarly, the principles for responsible shrimp farming and the BMP for their implementation can also be incorporated into legislation. An example of this is represented by Viet Nam, where the Ministry of Fisheries promulgated a "Regulation on safe shrimp culturing zone and shrimp farm management" (MOFI, 2006). This regulation aims at supporting the implementation of the Aquaculture Development Article (Article 9) of the FAO CCRF and the International Principles for Responsible Shrimp Farming and regulates on the adoption of sustainable farming practices (defined in the regulation as GAP and CoC).

Other examples of the development of legal documents for the implementation of BMP messages include also, but are not limited to, India and Thailand, where the Marine Product Export Development Authority (MPEDA) and the Department of Fisheries (DoF) respectively, are playing a key role in promoting the sustainability of the shrimp farming sector.

The development of legal documents is also critical to regulating the implementation of strategies and systems which are developed to allow the implementation of BMP by farmers and other links in the supply chain.

Develop and implement strategies

The process of BMP dissemination and implementation needs supporting also through the development of specific strategies and systems. The development of national aquatic animal health strategies has obvious implications for effective shrimp health management. These strategies would include the development of a surveillance system, contingency plans, accurate health certification and others. Guidelines for the development of strategies related to aquatic animal health management have been developed by FAO and NACA (FAO/NACA, 2000) and are currently assisting efforts conducted in several Asian countries.

The development of an extension strategy also plays an important role towards harmonisation of BMP messages distributed to farmers and other stakeholders. In addition, although keeping records is the responsibility of farmers and other players in the supply chain, their efforts have to be assisted through the development of a traceability system capable of managing those records and provide full product traceability in compliance with the requirement of several importing countries (FAO, 2002).

Strategies and systems should be developed through broad stakeholder consultations to achieve general agreement and maximise the chances of compliance at all levels. The implementation of the strategies can also be assisted through the development of legal documents that can regulate in a more structured way stakeholders' compliance.

Develop infrastructure and human resources

The implementation of strategies and systems often requires that infrastructures and the necessary human resources to operate them are also put in place. Diagnostic laboratories capable of assessing shrimp seed quality (including the presence of dangerous pathogens) and the occurrence of shrimp diseases have to be established. These should be located and equipped as to respond to the demand of hatcheries and farmers, being capable of providing diagnosis ranging from Level 1 (gross signs) to Level 3 (using advanced diagnostic methods) as necessary. For example, White Spot Disease (WSD) management could be assisted though the establishment of PCR laboratories capable of assessing White Spot Syndrome Virus (WSSV) presence in broodstock and seed and of laboratories for the rapid detection of clinical WSD in proximity of farms (NACA/FSPS/MOFI, 2005).

Water quality facilities could also be established in assistance to farming communities and to provide effective monitoring of aquatic resources and the identification of events that may affect shrimp farming operations (e.g. red tides).

Centres for the analysis of data collected from surveillance system and for the development of accurate and rapid responses to health emergencies should also be established and equipped with the necessary epidemiological expertise.

Infrastructure to allow the management of the data collected as part of a traceability system would also need establishing. The equipment requirements and expertise required will depend on the structure and mechanism of implementation of the system, ranging from largely paper based systems with little IT requirements, to systems with a high degree of digitalization of information.

In addition to the above, capacity on BMP development and implementation should also be built among different players involved with the shrimp farming sector, including extension workers, local authorities, policy makers and others.

Implement Better Management Practices/Good Aquaculture Practices

Although BMP are often simple practices, their systematic adoption by farming communities and countries to manage shrimp health problems and to achieve widespread sustainable shrimp production has a relatively recent history. The first project aimed at identifying BMP targeted to shrimp health management was implemented in the year 2001 in the east coast of India with the support of MPEDA, NACA and the Australian Centre for International Agricultural Research (ACIAR). Since then, this approach towards sustainability has been adopted by several countries including Viet Nam, Thailand, Indonesia and Iran and it is expected to spread to many other countries in the Asian region among which China, Sri Lanka and the Philippines have already expressed interest.

Experiences from India

Since mid-1990s, the occurrence of shrimp diseases in India has been causing severe economic losses and disruption throughout the shrimp production chain. To address the rising concerns about the sustainability of the sector, in the year 2000, the Marine Products Export Development Authority (MPEDA) of the Government of India with the technical assistance of NACA and the support of ICAR and ACIAR began a project on "Shrimp disease and coastal management". The project started in 2001 with an extensive epidemiological study aimed at identifying the risk factors for key shrimp diseases and developing and disseminating better management practices to minimize farm-level risk factors for disease outbreaks and to address more broadly shrimp farming sustainability.

During the period 2002–2006 BMP were massively promoted through village demonstrations. The concept of cluster management was developed for shrimp farming through the development of farmer self help groups known as "aquaclubs". Efforts were made to link the aquaclubs to input suppliers like shrimp hatcheries and feed manufacturers. The concept of producing good quality seed under contract agreements (contract hatchery system) with aquaclubs was also introduced. A massive awareness campaign was carried out to promote BMP by using articles on local newspapers, documentaries on local television channels, posters, leaflets and farmers meeting.

Major achievements obtained by the program were

- By 2006, 29 Aquaclubs have been established in 5 Indian States (Andhra Pradesh, Gujarat, Karnataka, Orissa and Tamil Nadu). In 2005 in Andhra Pradesh alone, 635 farmers (930 ponds) produced 482 tons of BMP shrimp.
- Compared to surrounding non-BMP ponds, BMP ponds showed a 2-fold increase in production, a 65% reduction in disease occurrence, a 34% increase in shrimp size and a 68% improvement in survival.
- Economic analysis clearly demonstrated that farmers adopting BMP gained higher profits, partially because of the lower production costs owing to better feed management, and were able to produce quality and traceable shrimp without using banned chemicals.

For more information on the Indian experiences see also Padiyar *et al.* (2008).

Experiences from Viet Nam

Following an unprecedented growth in shrimp production that saw a 4-fold increase in yield in the 5 year period between 1998 and 2003 and increasing environmental, shrimp health and food safety issues rising from the spontaneous development of the industry and the occasional use of banned substances, the government of Viet Nam recognized the need to promote a more sustainable development of the sector. In addition to supporting the development of the International Principles for Responsible Shrimp Farming, projects were initiated to translate the principles into practices, which targeted better production, product quality and environmental and socio-economic sustainability.

In 2003, NACA and the Ministry of Fisheries (MOFI) with the support of the Danida-funded Fisheries Sector Programme Support (FSPS) began implementing a project to support the promotion of responsible shrimp farming at all levels and for all links in the production chain. Simple and practical BMPs were developed for broodstock traders, hatcheries, seed traders and farmers, addressing particularly the needs of less resourced small-scale farmers involved with semi-intensive shrimp farming systems. Ten sets of extension material were developed and disseminated.

Outcomes of the project included:

- Implementation of BMP for hatcheries was supported in six hatcheries and resulted in seed production up to 1.5 times higher and a price per unit seed of about 30-40% higher than non-BMP seed.
- BMP implementation was also supported in 7 pilot farming communities (655 direct beneficiaries).
- Farmer groups were established in all communes and group activities were supported by voluntary extension workers who contributed to BMP dissemination and supported BMP implementation by neighboring farmers
- Implementation led to a remarkably lower (almost half) risk of mortality, higher production (sometimes 4 times higher) and higher probability (sometimes double) of making a profit.
- Strengthened institutions involved with aquatic animal health management at the national and local level

For more information on the above experiences see also the NACA/FSPS/MOFI report (2005), Corsin *et al.,* (2005) and Khang *et al*., (2008).

In parallel to the NACA/FSPS/MOFI project, the National Fisheries Quality Assurance and Veterinary Directorate (NAFIQAVED) of MOFI also initiated efforts towards the implementation of GAP in intensive and semi-intensive farming systems. Experiences from the NACA/FSPS/MOFI project were gradually incorporated into NAFIQAVED's efforts. NAFIQAVED's experiences on shrimp health management and improved food safety were also very positive, with shrimp yields being doubled in GAP farms and increasing interest in the GAP program being expressed by farming communities and local authorities (NAFIQAVED, 2006).

Experiences from Thailand

Thailand began adopting a BMP approach to shrimp production in 2002. The objective of BMP implementation include disease prevention, reduction in drug and chemical use and presence of residues in harvested products, reduction of environmental impact and increase overall sustainability of the sector. The Thai Department of Fisheries (DoF) developed 3 sets of standards for good quality shrimp production in both farms and hatcheries, based on the extent of compliance by farmers and hatcheries. The standards of highest level are called CoC, following FAO CCRF. CoC standard is made of 11 management criteria which need to be inspected and complied with for CoC certificates to be issued. The second-level standards (*i.e*. GAP) require compliance to 7 management criteria. The lower,

basic standard is called Food Safety level and represents the minimum standard acceptable by the DoF. Food Safety standards are made of 3 criteria, namely requiring registration of the enterprise, lack of use of banned substances and compliance to traceability.

To support this 3 level certification program, 17 coastal aquaculture research and development centers, 5 coastal aquaculture stations, 4 institutes and 22 provincial offices have been assigned to provide training programs and technical and testing services for farmers. By the end of August 2006 there were 222 farms and 176 hatcheries certified CoC, while the number of GAP certified enterprises was 17750 farms and 700 hatcheries. Although the above data are an indication of the rapid expansion of the Thai program towards sustainable shrimp farming, still a number of issues require addressing.

- Because markets often do not pay premium prices for products from CoC or GAP farms, farmers allegedly have limited incentives to comply with this voluntary program and may do so primarily because of the strong government support to the program
- Funds for the implementation of the program are contributed largely by the Thai government and not by the supply chain, posing concerns on the long-term sustainability of the program and raising the need to involve more actively other players (*e.g.*, processors, retailers, etc.).

The Thai program shows how strong government commitment can lead to large-scale improvement in the sustainability of the shrimp farming sector.

Experiences from I.R. Iran

In response to a serious outbreak of WSD that struck the largest shrimp producing province of I.R. Iran in middle 2005 (Corsin *et al*., 2006), the Iranian Fisheries Organization (IFO) requested NACA to provide an emergency support team to identify the source of the outbreak and develop a strategy to control the outbreak and future WSD occurrences. As part of these efforts, BMP focusing primarily of shrimp health management were developed for broodstock management and hatchery and farm operations. BMP implementation during the 2005 outbreak appeared to control the spread and impact of the disease (unpublished) and BMP are currently been implemented to different extents in several shrimp farming provinces of I.R. Iran.

Identify market opportunities for BMP/GAP products

BMP implementation throughout the production chain would greatly benefit from higher prices or better market access being granted for BMP products. Although not essential, premium prices and market access have been reported to provide incentives to achieve farmers' compliance to better practices in the agriculture sector (Sonn, 2005). However, contrary to organic and fair-trade products which supply niche markets, the production of BMP products has yet to create the interest necessary to lead to an increased market price for BMP products, although farmers are indeed willing to pay higher prices for BMP seed (NACA/FSPS/MOFI, 2005) and higher prices have occasionally been offered for BMP shrimp (Mr Nguyen Tu Cuong, Director of NAFIQAVED, pers. comm.).

In view of the inclusive approach adopted during BMP promotion, with a strong interest in encouraging sustainable shrimp production in as many communities as possible, it is also possible that BMP will serve to farmers to keep their share of the market and that importing countries will increasingly move towards accepting only products what have been produced in a sustainable manner.

Develop standards and certification

Whatever the direction that BMP implementation will take in respect to markets, providing insurance of BMP implementation will most likely be a key step in this process.

As explained above, BMP are "indicative" practices aimed at improving the sustainability of shrimp farming. However, these practices can also be modified into more "normative" standards. Standards are often more rigorous, and quantifiable, ways to achieve sustainability. Although standards can be developed as completely separated from the process of certification (*e.g.,* ISO standards), often standards are linked to a certification system. The objective of a certification system is to provide insurance of compliance to the standards.

There are presently several examples of standards and certification for the production of allegedly more sustainable aquaculture products, although some of these are presently available only as drafts. Standards can be produced by the private sector (either producers or retailers), governments or intergovernmental/non-governmental organizations. Examples of standards produced by private organizations are Global Aquaculture Alliance (GAA), Safe Quality Food and Global GAP. Among the standards developed by government there are the GAP/CoC standards produced in Thailand and similar efforts currently being conducted, among others, in India and Viet Nam.

A key issue to be considered while examining certification for a certain set of sustainability standards is the credibility of that certification to the importers, retailers and consumers. So far, none of the above schemes seem to have gathered extensive credibility, potentially with the exception of retailers-led schemes which naturally have a link with the consumers.

Compliance to most of the above standards requires a relatively large amount of resources. Although some provisions for certifying farmer groups sometimes exist as part of these schemes, certification is often expensive and requiring a relatively high degree of literacy to keep all the necessary records to be audited. It is however important that standards addressing sustainability broadly can be complied with also by farmers with limited resources and literacy.

CONCLUSIONS

This manuscript describes how approaches towards sustainable shrimp production can effectively contribute to shrimp health management. It also highlights the need for broad stakeholder involvement and for providing the right incentives to producers such as reduced costs, improved production, access to information and diagnostic services and, if possible, higher market prices for BMP products.

Because of the successful experiences gathered so far, a similar approach to the one described above is currently been put in place in several country to target the sustainable production of a wide range of aquaculture commodities. This approach was also endorsed by the 17 member countries represented at the NACA Governing Council, showing the commitment of the Asia-Pacific region to this process.

Effectively engaging with the millions of aquaculture producers in the Asian region will not be a small task, but it is one that can only be achieved with the involvement and contribution of the many players involved in the supply chain, from producers to consumers.

ACKNOWLEDGEMENTS

We would like to thank the Fish Health Section and Dr Rohana Subasinghe for giving us the opportunity to present our views on shrimp health management and sustainable shrimp farming. We would also like to thank Mr Pedro Bueno, NACA Director General, for allowing our attendance to the 6th Symposium on Diseases in Asian Aquaculture.

REFERENCES

Ababouch L., Gandini, G. and Ryder, J. 2006. Causes of Detentions and Rejections in International Fish Trade, FAO Fisheries Technical Paper No. 473, Rome Italy: FAO. (PDF can be downloaded from http://www.fao.org/docrep/008/y5924e/y5924e00.htm).

Chanratchakool, P., Turnbull, J.F., Funge-Smith, S.J., MacRae, I.H. and Limsuwan, C. 1998. Health management in shrimp ponds. Aquatic Animal Health Research Institute, Bangkok, Thailand. 152p.

Corsin, F., Cuong, N.T., Khang, P.V. and Phillips, M.J. 2005. Putting principles into practice: the Vietnamese experience on better management practices implementation. Presentation given at the World Aquaculture Society Conference. 9-13 May 2005, Bali, Indonesia.

Corsin, F., Mongkhon, P. and Azizzadeh, M. 2006. Outbreak investigation to identify the source of the largest White Spot Disease outbreak of I.R. Iran. Presentation given at the 11th International Symposium of Veterinary Epidemiology and Economics. 6-11 August 2006, Cairns, Australia.

FAO. 2002. Report of the Eighth Session of the Committee on Fisheries Sub-Committee on Fish Trade. Bremen, Germany, 12-16 February 2002.

FAO Fisheries Department, Fishery Information, Data and Statistics Unit (2006). Aquaculture production: quantities 1950-2004 and Aquaculture production: values 1984-2004. FISHSTAT Plus: Universal software for fishery statistical time series. Version 2.3. 2000. Food and Agriculture Organization of the United Nations.

FAO/NACA. 2000. Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals and the Beijing Consensus and Implementation Strategy. FAO Fisheries Technical Paper No. 402. FAO, Rome, Italy. 53 p.

FAO/NACA/UNEP/WB/WWF. 2006. International Principles for Responsible Shrimp Farming. Network of Aquaculture Centres in Asia-Pacific (NACA). Bangkok, Thailand. 20 p.

Khang, P.V., Corsin, F., Mohan, C.V. and Phillips, M.J. 2008. Limiting the impact of shrimp diseases through the implementation of Better Management Practices: the Vietnamese experience. pp. 433-440. *In* Bondad-Reantaso, M.G., Mohan, C.V., Crumlish, M. and Subasinghe, R.P. (eds.). Diseases in Asian Aquaculture VI. Fish Health Section, Asian Fisheries Society, Manila, Philippines.

Leites, M. 2006. Shrimp Market Report - June 2006 – US, FAO GLOBEFISH 2006. http://www.globefish.org/index.php?id=3030.

MOFI. 2006. Decision N.06/2006/QD-BTS on the issuance of the regulation on safe shrimp culturing zone and shrimp farm management. Ministry of Fisheries, Viet Nam.

NACA/FSPS/MOFI. 2005. Reducing the risk of aquatic animal disease outbreaks and improving environmental management of coastal aquaculture in Viet Nam: final report of the NACA/SUMA projects FSPS1. http://library.enaca.org/NACA-Publications/NACA-SUMA_Project_Completion_report.pdf.

NAFIQAVED. 2006. Completion report of Good Aquaculture Practice implementation task, Vietnam. NAFIQAVED, MOFI, Vietnam.

Padiyar, P.A., Phillips, M.J., Bhat, B.V., Mohan, C.V., Ravi, B.G., Mohan, A.B.C. and Sai, P. 2008. pp. 409-418. Cluster level adoption of Better Management Practices in shrimp (*P. monodon*) farming: an experience from Andhra Pradesh, India. *In* Bondad-Reantaso, M.G., Mohan, C.V., Crumlish, M. and Subasinghe, R.P. (eds.). Diseases in Asian Aquaculture VI. Fish Health Section, Asian Fisheries Society, Manila, Philippines.

Sonn, L. 2005. Good Agricultural Practices standards: a way towards safe and sustainable agriculture? Presentation given at the Wageningen Seminar on Certification and Regulations for Food Safety, 31 May 2005, Wageningen, The Netherlands. http://www.fao.org/prods/GAP/archive/GAP_Standards_towards_safe_and_sustainable_ag.ppt.