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Coping with competition

Even at the best of times farming isn't easy. The vagaries of climate, gyrating markets, endlessly changing government regulations and disease outbreaks that can strike like lightning all combine to make life on the farm a little more 'exciting' than most people would like. Farming is a risky business.

Small scale farmers with a small plot of land and little or no financial reserves to back them up just have to live with an uncertain future. Banks and insurance companies do not see much profit in writing loans and policies for small farms due to the small premiums and high transaction costs involved. Farmers in need of a loan to buy feed, seed and other inputs frequently have to borrow money from "unofficial lenders", often at extortionate rates. A crop failure can often drive farmers into a debt trap from which it may be difficult or impossible to escape.

Agriculture is the foundation technology of human civilisation; it is the keystone on which our whole way of life is built. Yet our farmers consistently rank amongst the poorest and most marginalised members of our society. Our traditional institutions, both public and private sector, have not served aquaculture well, and they have dismally failed to meet the needs of small scale producers.

Globalisation is another steadily growing threat to small scale producers. While it offers new opportunities as market access opens up, small scale producers now find themselves in a position where they are competing with producers from other nations, including large industrialised operations with economies of scale that are not available to small producers. We have seen the implications of this in other industries: The least competitive operations are forced out, their properties are bought up and the industry consolidates into a smaller number of larger operations. There is no doubt that small scale farmers must adapt to the changing business environment and increase their own competitiveness. The question is, how?

We have seen several different models emerging. One is contract farming, where small scale producers enter into a contract with a commercial body, often a large corporation, a situation that is becoming common in Thailand, particularly in tilapia farming. The farmer buys their seed and often other inputs from the company and sells the fish back, usually with some kind of minimum price guarantee. There are mixed reports on the benefits of this approach to the farmers; on one hand it does help them benefit from the economies of scale available to the company and may alleviate some of the risk (depending on the conditions of the contract), but some also argue that it curtails the potential profit and inhibits growth.

An alternative approach is for small scale farmers to form their own collectives. Working together, farmers can also achieve economies of scale, negotiate more favourable prices for inputs and sale of the crop, and specify how seed is produced and screened for disease or obtain a loan. The collective can serve as a mechanism for sharing experience, gives the group a better voice with government authorities and does not require farmers to share their scarce income with a third party. Perhaps most significant of all, the farmers remain working for themselves and gain increased control over their own future.

Simon Wilkinson

AQUACULTURE ASIA

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Peter Edwards writes on

Rural Aquaculture

Dr Edwards is a consultant and Emeritus Professor at the Asian Institute of Technology in Thailand where he founded the aquaculture programme. He has over 30 years experience in aquaculture education, research and development in the Asian region. Email: pedwards1943@gmail.com.

Seaweed farming in Sulawesi, Indonesia

I was surprised to be invited by the Australian Centre for International Agricultural Research (ACIAR) to lead a review of a smallholder shrimp aquaculture project in South Sulawesi and Central Java, Indonesia in April this year. Although my earlier professional career was in seaweed ecology and I continue to maintain an interest in coastal aquaculture, my initial reaction was to decline as I'm not 'up to speed' on the major issues in shrimp farming. However, I accepted the task after it was explained to me that a broad systems view appraisal of the livelihoods of the shrimp farming households was sought rather than a narrow focus only on shrimp culture.

Mike Rimmer who is leading a project in the same areas on possible alternative aquaculture systems for smallholder shrimp farming households kindly guided me on a two day field trip in South Sulawesi. The highlight of the trip was a visit to Laikang village in Takalar district where most households are involved in seaweed culture. The visit was especially interesting for me as my first involvement with aquaculture in Asia when I took up a post at AIT 35 years ago was an exploration of the feasibility of seaweed farming in Thailand. I was unable to obtain project support and thus was not able to make much progress with trying to promote seaweed farming in Thailand so I turned my attention to wastewater-fed

Seaweed drying in Laikang Village Sulawesi.

Drying seaweeds along the margin of the sea.

aquaculture and later integrated farming and small-scale inland aquaculture, the topics of my previous columns to date. Mike also kindly sent me recent papers on the culture and use of tropical seaweeds which helped to put my visit into context.

Seaweeds are also dried on platforms over the edge of the sea.

Farming tropical carrageenan-producing seaweeds

The major types of seaweeds farmed in Indonesia are *Kappaphycus* and *Eucheuma* species for production of carrageenan, a gel-forming polysaccharide used especially in the food industry. Farming of these tropical seaweeds was the brain child of the late Professor Maxwell Doty of the University of Hawaii. Although I never met Professor Doty he kindly put me in touch with Hank Parker when I was teaching at Rutgers in the USA in the early 70's. Hank managed the first experimental farm of these seaweeds in the southern Philippines and kindly shared his experiences and slides with me. Following an aquaculture engineering meeting at SEAFDEC, Iloilo, Philippines in the late 70's, Herminio Rabanal, a doyen of Philippino aquaculture, kindly arranged for me to visit an experimental seaweed farm on the nearby island of Guimaras. That was my last visit to a seaweed farm until the visit described below so I was very pleased to see poor fishers successfully farming seaweed after so many years.

Farming seaweeds for carrageenan is a popular alternative livelihood approach that has been introduced into several tropical developing countries to provide extra income for poor coastal fishing households. Initially developed in the Philippines as mentioned above, the Philippines was the major global producer of *Kappaphycus* and *Eucheuma* species for many years but has now been overtaken by Indonesia. Although seaweed farming has not always been successful, the global

A grandmother helping to dry seaweeeds.

Below: Kappaphycus alvarezii is the main species farmed in the village.


Mother and young daughter tying 'seed' onto long lines.


Many young girls were tying 'seed'.

demand for carrageenan is increasing at 5-7% annually, so it should have a good future.

Seaweed farming in Laikang village

There had been days of torrential rain prior to my visit but by a stroke of luck the sun came out just as we arrived in the village. As the rain had curtailed seaweed farming activities, almost the whole village appeared to come out to make up for lost time so I was able to observe many steps in seaweed farming. As well as working age men and women, grandmothers, mothers with infants and children were all involved in various activities

According to villagers who I interviewed, seaweed farming started in 1987, almost 25 years ago, introduced by the local fisheries department. Curiously

Long lines with seed being transported to the sea.

the villagers call the seaweed 'agar agar' although they know that it is *Kappaphycus alvarezii* (formerly *Eucheuma cottonii*), trade name 'cottonii', and not the agar-producing *Gracilaria*. Today about 800 households, 90% of the village, farm the seaweed. The seaweeds are grown attached to long lines kept afloat by discarded plastic bottles in the sea adjacent to the village. While men carry out farming activities on the sea installing long lines and harvesting the seaweed, women work on the land tying small pieces of seaweed and plastic bottles to nylon ropes and sun-drying harvested seaweed. The villagers are traditional fishers but they reported that farming seaweeds is more profitable than fishing. The local fishery resources have declined and they now have to travel far involving an overnight trip of 4-5 hours to catch sufficient fish. Furthermore, the costs of fuel for the fishing boats and fishing gear have gone up.

A pile of plastic bottles and long lines.

The smallest farm has 100 lines, the largest 10,000 lines although divided up and distributed among several sites.

Villagers showing 'seed' attached to a long line.

Two to three hundred small pieces of vegetative seaweed ‘seed’ are attached to each line at 15 cm intervals, giving a total line length of 30-45 m. One person can attach seed to 15 lines in a day from 8 am to 4 pm; and one person can install 50 lines in the sea in a single day.

Close up of attached 'seed' and a plastic bottle float.

The seaweed seed is allowed to grow until it reaches the width of a coconut i.e. 15 cm width by 30 cm depth. This takes from 40-60 days. The average harvest from a line is 50 kg wet weight with maximum weights of 70-100 kg/line. The harvested seaweed is sun dried on the ground around the houses, on the village road and along the edge of the sea, as well as on specially made wooden and bamboo platforms over the edge of the sea. The ‘dry’ seaweed with a 30 % moisture content is sold for Rupias10 -12,000/kg (about US 1.2 - 1.4).

Close up of Caulerpa sp.

Small quantities of agar-producing *Gracilaria* sp. and a green seaweed, *Caulerpa* sp. are also grown in smaller quantities in ponds in the area. The former is used locally mainly to produce a gel for deserts while the latter is eaten fresh as a vegetable. Due to flooded ponds I was only able to see a sample of each seaweed kindly collected by a local villager.

Gracilaria and Caulerpa are grown in small quantities in brackishwater ponds.

Close up of Gracilaria sp.

Scaling up better management practices: Empowering small scale farmers

Mohan, C.V., and De Silva, S. NACA

Asian aquaculture is dominated by small scale farms, a working definition of which we consider to be farmer owned/leased, operated and managed operations. Small scale farmers, irrespective of country and production system, face numerous challenges in a globalised market place, amongst which are:

- Access to technical knowledge.
- Lack of enabling government policies and programs.
- Access to credit and insurance.
- Compliance to food safety standards.
- Minimising disease related losses.
- Meeting stringent market requirements, including certification.
- Meeting environmental and ethical standards, meeting wildlife and biodiversity requirements.

At the same time, the demand for quality and responsibly produced and certified aquaculture products is predicted to increase substantially in coming years. It is very important that small scale farmers are better prepared to meet these challenges in order to sustain their livelihoods, and indeed to continue to provide seafood to consumers. Past experiences have shown, particularly in the Asia-Pacific region, that small scale farmers are more adaptable to change and are resilient. The way to meet the above challenges and the most rational, practical and technically and economically feasible option is to implement better management practices through a cluster management approach, in a given locality.

Development and adoption of better management practices (BMPs) for key aquaculture commodities is gradually gaining momentum and is increasing in the region. However, there appears to be lot of confusion in the minds of farmers, policy makers and other stakeholders about the concept and approaches. Often, BMPs are confused with standards and certification, which are separate issues.

NACA has been involved on BMP development and adoption since 2000, working in several countries in the Asia-Pacific region in conjunction with country partners, donors, and international organisations. The lessons learned and experience gained strongly suggest that BMPs are the gateway to ensuring sustainability of small scale aquaculture and meeting modern day market challenges and opportunities.

What are better management practices?

Better management practices in the aquaculture context outline norms for responsible farming of aquatic animals that address environmental, social and production issues. BMP’s are management practices, implementation of which is voluntary. BMPs are not a standard for certification. However, implementation of better management practices can improve the quantity, safety and quality of products taking into consideration animal health and welfare, food safety, environmental and socio-economical sustainability, as well as the profitability of the farmer. Implementation of BMPs can assist farmers to achieve compliance with quantifiable standards and indicators set by international agencies and third party certification bodies.

Standards are usually set from a consumer view point, taking into consideration issues that may include social equity and well being, environment, food safety and quality, national regulations and other criteria. BMPs, on the other hand, are commodity specific and location specific management practices that have been developed to meet the norms of responsible farming and at the same time reduce risks to culture operations and maximise returns, the adoption of which by and large satisfies by implication the standards set from a consumer view point. Development of BMPs begins with the existing farmer practices, and is not a top-down theoretical approach to a problem but a pragmatic bottom-up one.

BMPs have most of the ingredients that are required to meet independent standards. Most standards use the principles of responsible farming which takes into account both mandatory and voluntary standards. It is important to note that BMPs are not a one-time solution, they are subjected to gradual evolution, improvement and revision – in other words a dynamic protocol. BMPs can be tailor made and contextualised to meet some of the quantifiable standards, where and if necessary. In simple terms, standards tell us what is expected while BMPs tell us how farmers can reduce risks to their culture operations, maximise returns, reduce losses and at the same time achieve compliance to quantifiable standards.

How are BMPs developed and validated?

As emphasised earlier, BMPs are commodity specific and location specific and have to follow the generic principles of responsible aquaculture. It is generally agreed that for all cultured commodities it is necessary to underpin the general principles for responsible farming that would cover environmental, social, ethical, food safety and husbandry issues. The first step in developing BMPs is gaining an in depth understanding of the culture system(s) and cultured species and the practices thereof. This should be done at the population level and not in one or two ponds. Population based approaches to understand the problems and issues confronting a cultured commodity in a specific farming area are gaining importance. Identifying risk factors (e.g. environment, disease, food safety, market access, etc) for the long term sustainability of the farming system, at the population level using epidemiological principles (e.g. risk analysis) is fundamental to developing BMPs[1].

Once risk factors are identified, new management interventions are either developed or existing management methods revised/modified to address the identified risk factors, but always done in consultation with the practitioners and other stakeholders. Once a set of science based interventions are developed, through farm surveys, stakeholder consultations and scrutiny of existing scientific knowledge, it is necessary to test the interventions and validate them. This is normally carried out through farm trials, where BMP demonstration farms are set up for scrutiny by the community. Interventions validated through pilot testing, demonstrations and farmer consultations are referred to as better management practices. These have to be rational, practical and technically and economically feasible for small scale farmers to implement. BMPs are constantly evolving and changing and it is necessary to consider approaches to continuously evaluate and improve BMPs.

Promotion of BMP adoption among small scale farmers

Promoting the adoption of BMPs by small scale farmers is not simple. Dedicated teams of field workers need to work with farmers day in and day out to bring about changes in behaviour and attitude and wean them from preconceived ideas and conventional practices that may not be conducive to the environment, sustainability and food safety. This is a slow process and takes lot of time and resources, but is vital for successful adoption of BMPs. A critical aspect of the introduction of BMPs has been the role of farmer groups or “clusters”. Provision of science based information to farmer groups through effective networking and communication is one important key to success. The best example of this model is the modus operandi of the National Centre for Sustainable Aquaculture (NaCSA), India[2].

What is cluster/group management?

In aquaculture there is a high degree of interaction between farms, e.g. use of a common water supply and common discharge channel among adjacent farms. Therefore, if a group of farms sharing these common resources are implementing BMPs their efforts may be negated if some farmers do not. An "all or none principle" is often applicable to local aquaculture practices with respect to BMP adoption. Adoption of BMPs is best done using a cluster or group approach, with all farms in a given locality acting collectively and in unison, rather than individually.

Cluster management in simple terms can be defined as collective planning, decision making and implementation of crop activities by a group of farmers sharing common resources, through a participatory approach in order to address the common risk factors, to accomplish a common goal (e.g. maximise returns, reduce disease risks, increase market access, procure quality seed). The benefits of promoting BMP adoption by clusters of small-scale farmers include:

- More farmers become involved, generating synergies in the community.
- Economies of scale allowing forward and backward integration of culture operations with processors and hatcheries, respectively.
- Collective bargaining power is greater and assists farmers to source quality inputs at better prices.
- Certification, which is generally prohibitive for individual farmers, can be accomplished through certification of clusters.
- Easier access to credit and insurance compared to an individual farmer.
- The principle of sharing costs in a cluster approach ensures that common facilities (e.g. feeder canal, roads, power) and infrastructure can be developed and maintained properly. Peer pressure prevents fellow farmers from resorting to irresponsible culture practices (e.g. use of banned antibiotics, release of water from disease affected ponds).
- Above all, cluster farming brings social harmony in a community, fundamental to the progress of society.

BMPs at work in the Asia-Pacific

NACA's experience with BMP promotion in India, Indonesia, Thailand and Vietnam clearly suggests that BMPs improve yields, safety and improve quality of products taking into consideration animal health and welfare, food safety, environmental and socio-economical sustainability. Key BMP and cluster management work carried out in the region includes:

- Improvement of management practices in shrimp farming in India, in collaboration with MPEDA/NaCSA and CIBA (ICAR) since t 2000 and ongoing.
- Shrimp farming in Aceh, Indonesia under the ADB-ETESP project (2005-2009) in collaboration with FAO and IFC.
- Catfish farming in the Mekong Delta, Vietnam under the CARD program supported by AusAid (2008-2010) in collaboration with DPI, Victoria and RIA2 and CTU, Vietnam.
- WWF supported work on shrimp farming in Thailand and India.
- ACIAR supported work of strengthening networking and information sharing amongst BMP project implementers in the region.

India shrimp BMP work

Since the early 1990s, the Indian shrimp aquaculture sector was been hard hit by viral diseases. To address rising concerns about the effect of diseases on the sustainability of the sector, the Government of India's 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 started in 2001 with a large epidemiological study aimed at identifying the risk factors for key shrimp diseases. It also undertook to develop and disseminate better management practices to minimise farm-level risk factors for disease outbreaks and to address shrimp farming sustainability more broadly. The programme, which is now in its 10th year, was implemented in a phased manner. Some of the key stages of the programme included:

- A baseline study of the major diseases affecting the shrimp aquaculture operations (2000).
- A longitudinal epidemiological study in 365 ponds in Andhra Pradesh, east coast of India, to identify major risk factors associated with WSD (white spot disease) and low productivity in *Penaeus monodon* culture ponds (2000-2001).
- Development of farm level contextualised BMPs to address the identified risk factors (2002).
- Pilot testing of BMPs in selected farms (2002).
- Production of a simple and practical shrimp health management manual based on the outcomes of the risk factor study and piloting of BMPs, to support farm and village level extension programmes (2002).
- Development and testing of the concept of cluster farming for effective BMP adoption amongst farmers in a cluster, and expansion of BMP promotion to a large number of clusters (2003-2004).
- Extension of some of the BMPs to downstream activities like hatcheries.
- Review and refinement of BMPs, and production of BMP extension leaflets for each stage of the culture operation (2005).
- Expansion of the BMP programme to clusters in five different states in India (2005-2006).

- Conceptualisation of an institutional framework for maintaining the BMP and shrimp health extension programme (2006).
- Establishment and inauguration of the National Centre for Sustainable Aquaculture (NaCSA) to carry forward the MPEDA/NACA programme activities (2007).
- 2008-2010 and ongoing: consolidation of the program in the state of Andhra Pradesh and expansion to neighbouring states, supporting clusters to access markets through certification programs on a pilot scale.

As of September 2010, NaCSA has formed 700 societies (clusters) involving 15,753 farmers and 16,126 ha with sustainable production of around 15,000 tonnes of shrimp.

NACA convened a national workshop on scaling up BMPs in the Indian context at the Central Institute of Brackishwater Aquaculture in Chennai, 16-18 May 2011, as an activity under the ASEM Aquaculture Platform. An account of the workshop is given in the July-September edition of the NACA Newsletter. Audio recordings of technical presentations made at the workshop are also available for download or streaming from the NACA website at the link below:

http://www.enaca.org/modules/podcast/programme.php

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Right: Participants in the National Workshop on Scaling up BMPs in the Indian Context. See page 38 for the full story.

Animal welfare (for farmed fish)…is Asia-Pacific ready?

Leaño, E.M. and Mohan, C.V.

Network of Aquaculture Centres in Asia-Pacific

"Catfish: A little boy was so shocked in Bali. We were at the market and he was admiring the live catfish when, suddenly, the vendor took them out one by one from the basin and started hitting the head with a hammer and emptying the stomach in front of the little boy. He hugged me and hid his crying face in my shirt... (J. Advincula, 1 August 2011; Facebook post)"

Is handling/killing of farmed aquatic animals inhumane? This will be the question that every farmer, processor and vendor needs to ask whenever they harvest or process their produce, or during eradication of stocks when there is a disease outbreak. According to the World Organisation for Animal Health (OIE), animal welfare in general is a complex subject with scientific, ethical, economic, cultural and political dimensions. It is currently considered as one of the standards of quality of animal products. And with the growing consumer interest on animal welfare worldwide, it is just appropriate to spend some insights on this aspect with regard to farmed aquatic animals, especially in the Asia-Pacific region.

In the past, animal welfare legislation tended to focus on the protection of animals used for research or teaching, for exhibition and for commercial transport. Additionally, controlled use of chemicals during aquaculture operations and disease prevention and treatment are also dealt with in fish welfare. The use of animals in basic and applied research is governed by both scientific objectives and ethical considerations (Olson et al., 1991). Heightened concern over the humane treatment of experimental animals by the scientific community and the public has led to the development of guidelines and regulations concerning animal care and use. In aquaculture research for example, overwhelming emphasis is given on keeping fish in the best possible low stress conditions to promote rapid growth and natural reproduction (Allan and Heasman, 2001). In all cases, the ultimate goal is to protect and manage fisheries resources for the benefit of current and future generations. Of equal importance is the need to reassure the community that ethics are given prime consideration before any animal experimentation commences.

With regard to the controlled use of chemicals in aquaculture in response to public concerns about human food safety, human health, and environmental effects, fish farmers must have access to a range of properly authorised medicines to safeguard animal health and welfare (Costello et al., 2001). The lack or limited availability of approved drugs and chemicals has dramatically reduced the effectiveness and increased the cost of fish production for natural resource management agencies (Schnick et al., 1996). Moreover, there is still a need to standardise and to harmonise guidelines on responsible use of chemicals in aquaculture, especially in the less-developed countries in the region.

Current fish welfare legislation

Animal health is an essential component of animal welfare (OIE, 2010a). At present, the Aquatic Animal Health Code (Aquatic Code; OIE, 2010b) includes one section that deals with welfare of farmed fish (Section 7) containing an introductory chapter (Chapter 7.1) and two chapters dealing with fish welfare during transport (Chapter 7.2) and killing of fish for human consumption (Chapter 7.3). Chapter 7.3 is the most recent addition, which was unanimously adopted by the 176 OIE Members during the OIE 78th General Assembly Meeting in 2010. In preparation is the chapter on emergency killing for disease control purposes not intended for human consumption (Chapter 7.4).

Chapter 7.2 (Welfare of farmed fish during transport) provides information to minimise the effect of transport on the welfare of farmed fish by air, sea or land, within a country and between countries. It lists the responsibilities of the personnel handling fish throughout the transportation process to ensure that consideration is given to the potential impact on the welfare of the fish. Competence (of the transport personnel) is also given importance which requires all parties supervising transport activities should have appropriate knowledge and understanding to ensure that the welfare of the fish is maintained throughout the process. Competence may be gained through formal training and/or practical experience. The chapter also enumerates some guidelines on transport planning which include vehicle design and maintenance, water quality, conditioning of fish for transport, species-specific recommendations and contingency plans.

Chapter 7.3 (welfare aspects of stunning and killing of farmed fish for human consumption) address the need to ensure welfare of farmed fish, intended for human consumption, during stunning and killing including transport and holding immediately prior to stunning. This chapter describes general principles that should be applied and is guided by the principle that fish should be stunned before killing, and the stunning method should ensure immediate and irreversible loss of consciousness. If the stunning is not irreversible, fish should be killed before consciousness is recovered. Stunning and killing methods by mechanical and electrical means are described in details, while other methods such as chilling, asphyxiation, exsanguinations without stunning are considered to result in poor fish welfare.

Overall, the section lists recommendations (on a general level) for the welfare of farmed fish (excluding ornamental species) during transport, slaughter, and destruction for disease control purposes. The following principles will apply:

- The use of fish carries with it an ethical responsibility to ensure the welfare of such animals to the greatest extent practicable.
- The scientific assessment of fish welfare involves both scientifically derived data and value-based assumptions that need to be considered together, and the process of making assessments should be made explicit as possible.

Feeding time on a catfish farm in the Mekong Delta.

Asia-Pacific aquaculture and fish welfare legislation

Asia has the longest history of aquaculture in the world. It is believed that the first record of fish culture was in China, as reported in a Chinese ancient booklet in carp culture by Fan Li dating back more than 2,500 years ago (Liao, 2009). It was not until the 1940's, however, when the landmark of systematic fish culture was established thru the breakthrough works of Hudinaga (1942) on artificial propagation of kuruma prawn (*Penaeus japonicus*). Since then, mass propagation and culture technologies have been developed among many fish and crustacean species that has contributed to the success of the aquaculture industry in the region and the world. In 2008, Asia-Pacific countries produced almost 90% of the total world aquaculture production and remain to be the top aquaculture-producing countries in the world, with eight countries (China, India, Vietnam, Indonesia, Thailand, Bangladesh, Philippines and Japan) included in the top 10 list (FAO, 2010).

Looking at the existing animal welfare regulations involving (farmed) fish (Table 1), however, none came from Asia-Pacific countries. This scenario can be due to the fact that majority of aquafarmers in the region are small scale, especially in rural/coastal communities. This means that most of the farms are farmer-owned/leased, managed and operated (De Silva, 2010). With the long history of aquaculture in Asia, and considering the aquaculture traditions handed down from one generation to the next and modified by modern technologies, it will surely be a great challenge to implement any fish welfare act that might directly or indirectly affect the overall perceptions of small scale aquafarmers. China as example – the top aquaculture producer in the world, with the longest history of aquaculture practices, and one of the largest consumers of seafoods (fish and crustaceans) – does not have any existing fish welfare regulation. The same goes with most of the Asian countries where transport, handling and killing of fish usually does not conform to the fish welfare guidelines drafted by OIE. The thought that fish are raised (cultured) solely for human consumption, humane or inhumane handling and killing of fish stocks will be the least of the concerns by most aquafarmers in the region, especially so with the many small producers that culture fish mostly for domestic consumption or for local markets.

Table 1. National and international welfare acts in relation to fish (http://www.nal.usda.gov/awic/pubs/ Fishwelfare/reg.htm).

State	Name of Act(s)
Austria	Bundesgesetz vom 27 September 1989 über Versuche an lebenden Tieren (Tierversuchgesetz 1988).
Belgium	Arrêté Royal du 14 novembre 1993 relatif à la protection des animaux d'expérience.
European Union	EU-Directive (86/609/EEC).
France	Décret 87-848 du 19 octobre 1987 pris pour l'application de l'article 454 du code pénal et du troisième alinéa de l'article 276 du code rural et relatif aux expériences pratiquées sur les animaux.
Finland	Eläinsuojelulaki 247/1996 (Law On Animal Protection). Eläinsuojeluasetus 396/1996 (Act On Animal Protection). Asetus koe-eläintoiminnasta 1076/1985. (Act on Animal Experimentation, changed partially by Act 395/1996). Maa- ja metsätalousministeriön päätös tieteellisten eläinkokeiden luokituksesta 447/1986 (Decree of Veterinary Division in Ministry of Forestry and Agriculture on classification of animal experiments). Asetus kokeellisiin ja muihin tieteellisiin tarkoituksiin käytettävien selkärankaisten eläinten suojelemiseksi tehdyn eurooppalaisen yleissopimuksen voimaansaattamisesta 1360/1990 (Introductory Act on European Convention for the Protection of Vertebrate Animals Used for Experimental and Other Scientific Purposes).
Greece	Décret présidentiel du 12-04-1991, FEK A numéro 64 du 03-05-1991 Page 1061.
Germany	Erste Gesetz zur Ænderung des Tierschutzgesetzes vom 12-08-1986. Bundesgesetzblatt Teil I vom 22-08-1986 Seite 1309.
Ireland	The Cruelty to Animals Act of 15-08-1876. EC (Amendment of the Cruelty to Animals Acts of 1976) Regulations of 1994, Statutory Instruments Number 17 of 1994.
Italy	DM 27/01/1992 - Attuazione della Direttiva n. 86/609/CEE in materia di protezione degli animali utilizzati a fini sperimentali o ad altri fini scientifici. Circolare 05/05/1993 - Decreto Legislativo 27 gennaio 1992, n. 116, articoli 8 e 9, concernenti deroghe agli articoli 3 e 4. Circolare 22/04/1994 n. 8 - Applicazione del Decreto Legislativo 27 gennaio 1992, n. 116, in materia di protezione degli animali utilizzati a fini sperimentali o ad altri fini scientifici.
Norway	The 1974 Animal Welfare Act (in addition supplemented by EU Directive 86/609/CEE).
Portugal	Decreto-lei numero 129/92 de 15-06-1992, Diario da Republica I Série A, numero 153 de 06-07-1992 Pagina 3197.
Spain	Real Decreto numero 223/88 de 14-103-1988 relativo a la protection de los animales utilizados para experimentacion y otros fines científicos, Boletín Oficial del Estado numero 67 de 18-03-1988 Pagina 8509.
United Kingdom	The Animals (Scientific Procedures) Act 1986 (subsequently amended by three Statutory Instruments).
Sweden	Djurskyddslag', no. 1988/534, amended 25 February 1998 (no. 1998/56).
USA	The Animal Welfare Act of 1966 (subsequently amended in 1970, 1976, 1985, 1990, and 2002).

The challenge

In the Asia-Pacific region, the challenge will remain in the implementation of fish welfare regulations as the perception of what does or does not constitute an act of cruelty to animals differs from one region and culture to another (OIE, 2010a). Fish welfare acts should also consider the extent to which the regulations should be applied, whether it will be limited to big producers and processors that produce fish for export, or will include even the small producers that only target local markets. If it will include the latter, the culture/tradition-rich Asia-Pacific countries will surely find it hard to abide on whatever fish welfare acts that will be promulgated, especially if it is more inclined or intended for fulfilling international certification system for exported aquaculture products. As such, small (scale) producers and local consumers in the region might not partake at all on these fish welfare acts, as their main concern is just to produce and consume fish.

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Better management practices for tilapia cage farming in Tien Giang, Vietnam

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Tilapia cage farming

The aquaculture sector has increasingly played a vital role in meeting the growing global demand for food. This role has internationally widely recognised in recent years. Freshwater aquaculture has been commonly practiced in the Mekong Delta region for centuries, providing livelihoods to poor rural people as well as food supplies, employment and income[1]. Cultivation of fish in cages is a dominant type of freshwater aquaculture in the southern provinces of Vietnam and the Mekong Delta. Due to limited land availability, cage culture of fish in Tien Giang has expanded by effectively taking full advantage of the available water resources.

Tilapia cage farms are the most popular freshwater cultivation practice in Tien Giang which has contributed substantially to livelihoods, food demand and poverty alleviation. However, this type of floating fish cultivation is increasingly facing difficult challenges, including a deterioration in water quality and fish mortalities. Safe environments and clean water are required to underpin the sustainability of tilapia cage farming in Tien Giang.

Study location and methodology

Tien Giang is about 70 km from Ho Chi Minh City and has a total area of about 2,482 km^2. It is situated in the northeastern Mekong Delta and stretches about 120 km along the north bank of the Tien River (one of the tributary ends of the Mekong River) and has a 32 km border with the East Sea.

Tien Giang is the fifth largest producing province in the Mekong Delta, and the fourth in terms of total culture area. The total area under fish cultivation (mainly catfish) was 400 ha and fish production was 27,000 tonnes in 2005[2].

Thoi Son Islet is located in the Tien River, close to My Tho City, and is one of the major tilapia (*Oreochromis niloticus*) cage farming areas of Tien Giang. The location of Tien Giang and Thoi Son Islet are shown in the satellite view on the adjacent page.

On-site sampling, laboratory analysis and questionnaire surveys were deployed to collect data from the local cage farmers. Surveys and sampling were conducted over three seasons in 2009 (dry, rainy and transitional seasons). Information collected using semi-structured checklists in questionnaire sets included:

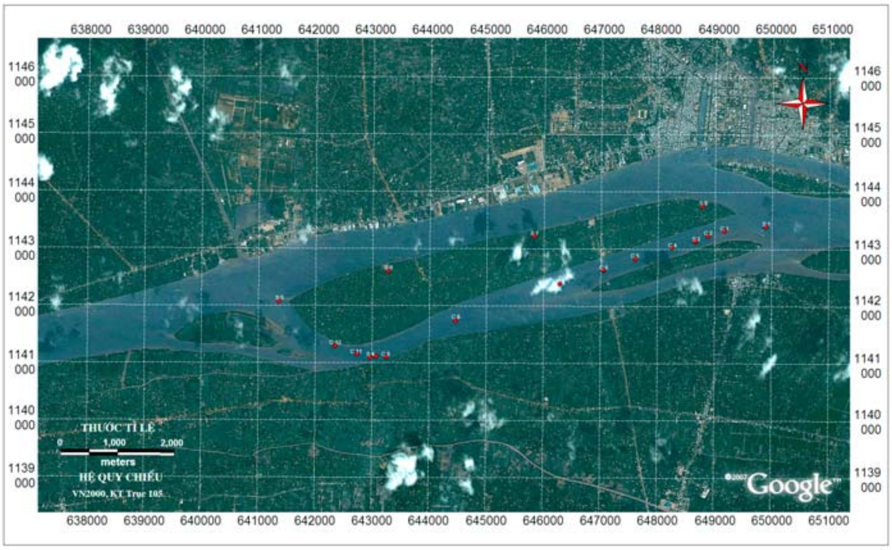


Figure 1. Location of Thoi Son Islet - Tien Giang, sampling sites and floating cages.

- Data on socio-economic aspects such as age, education level, investment costs and stakeholders' concerns regarding the long-term environmental sustainability of intensive farming systems; and
- Data relating to farming activities such as seed supply, water use, stocking density, feeds, feed management, disease issues and health management.

SPSS 13.0 for WINDOWS and Excel software were used to analyse frequencies, case summaries, and to conduct T-test, one-way ANOVA and linear regression in order to understand the socio-economic situation, environmental issues and improve production of farming in fish cages.

Tilapia cultivation practices and emerging issues

The practice of farming fish in floating cages has been underway in Tien Giang for ten years and is the predominant fishery activity along the Tien River. Not surprisingly, the Tien Giang aquaculture sector has annually provided around 18,000 tonnes of fish meat and substantially created job for more than 3,000 people and 10,000 workers relating to services and household levels.

About 145,000 m^3 of total area of water surface is being used for fish cage farms. There were approximately 1,573 floating cages throughout four major districts, comprising: Chau Thanh, My Tho, Cai Lay and Cai Be. In the first five months of 2009 alone, 128 new floating cages were constructed and 1,046 tonnes of fish were harvested (Table 1)[3].

Presently, farmers culture tilapia year around and are using more pellet feed and chemicals than previously due to higher stocking densities, water quality deterioration and consequently disease during off-seasons, especially during the floods.

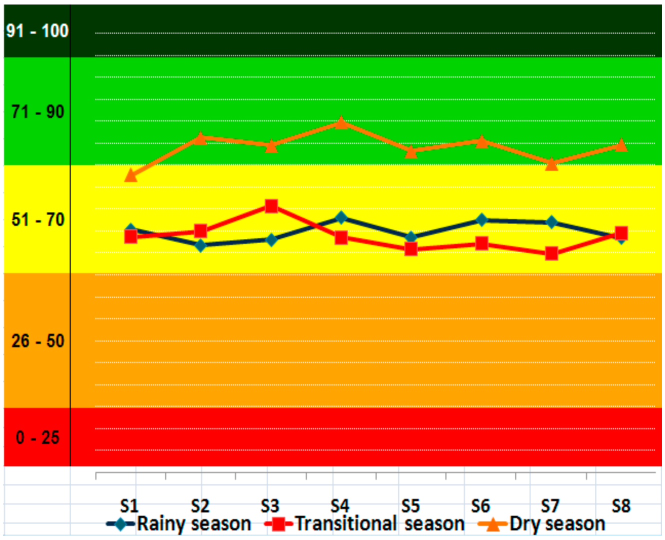
Most cages are topped with wooden frames which are also home for the farmers. Cage components consist of a frame, mesh or netting, feeding ring, lid and flotation. Cage shapes may be square or rectangular. The most common cage size is: 4 x 8 x 3 m (length x width x depth). Cages may be categorised as small (less than 100 m^3) and medium (from 100 to 500 m^3). About 74% of the cages are small and this influences the method of harvest and the cage farmers' finances in Thoi Son Islet.

Water quality

Cages are floated in clusters along the banks of the Tien River and concentrated in My Tho City. However, there are a number of emerging problems with self-pollution due to ineffective cultivation practices and unplanned farm development. First of all, wastes from the fish and uneaten feed are discharged directly into river, yet water quality monitoring has not been conducted adequately. Farmers do not have any tools for checking water quality (oxygen, pH and temperature), which are essential aquaculture practices. Secondly, floating cages are densely and spontaneously set by farmers themselves, without planning. This is the most critical survey finding as cage systems are located nearby industrial effluents and sometimes block the navigation of the river by local vehicles. More importantly, My Tho City and the My Tho industrial park are not far from production sites, being only 500 m away from some cage clusters. Industrial and domestic wastewater is ultimately diffused along the river's banks and through the cage culture system.

Industrial activities can affect water quality in the area.

Figure 2. Seasonal Water Quality at Thoi Son Islet, Tien River based on NSF-WQI.



NSF-WQI Water Quality Index: 0-25: Very bad; 26-50: Bad; 51-70: Medium; 71-90: Good; 91-100: Excellent.

Although farmers are aware of environmental pollution and take it seriously (78%), they cannot point out the main reason of the deteriorating water quality systematically (42%). The majority of interviewees argued that the industrial development may cause water pollution (58%). Unfortunately, there is no regulation or document on environmental issues relating to cage aquaculture at the local level.

Water quality in the Thoi Son Islet Tilapia cage farming was assessed over three seasons: dry, rainy and transitional seasons. During the dry season, the water quality of Tien River is better than in the wet and transitional seasons. Most importantly, water quality in the wet season has significantly impacted cage culture production, causing pH, dissolved oxygen, chemical oxygen demand, nitrite, nitrate and phosphate to fall within undesirable levels. The seasonal water quality in the Tien River (Thoi Son Islet section) can be expressed based on Water Quality Index (WQI) and is depicted in Figure 2.

Seed supply

Seed quality is the most vital concern of farmers, especially for the systems with higher level of intensification. In Thoi Son Islet, fingerlings are purchased from private hatchery providers (Cai Lay, Cai Be and Phu Tuc districts) without the inspection of local Department of Fisheries. There is no evidence to certify that fingerlings are good quality, fully ripe or free from restricted chemicals/drugs. Hence nursery owners do not bear the responsibility for the final products. As a result, the loss rate in the nursery stage of cultivation is very high.

The stocking density of cage farmed tilapia is a significant factor that impacts on the survival, growth and food conversion ratio (FCR)[4]. The research survey and findings showed that the average density in Thoi Son Islet cage farms is 8.48 ± 1.83 kg/m^3 with average weight of seed is 20.52 ± 8.38 g/fish. Importantly, there is a linear correlation between stocking density and loss rate and food conversion ratio as shown in Figure 3a and 3b. Practically, high density is not a good practice for caged tilapia to survive and develop. The research findings reveal that there is a relation between the stocking density and: (i) the FCR ($r = 0.89$, $P < 0.01$) ; (ii) the loss rate ($r = 0.61$, $P < 0.01$).

Feeds and feed management

There are three major components of investment costs for caged tilapia cultivation, including: (i) feed; (ii) seed or fingerlings; and (iii) veterinary including chemicals and drugs. Of these, feed is the highest cost in tilapia cage culture in Thoi Son Islet. Two kinds of feed used for this system are: (i) manufactured feed; and (ii) home-made feed. The ingredients of home-made feed are various such as rice bran, broken rice and trash fish. Although that kind of feed helps to reduce costs, its protein level is quite low and FCR is rather high.

Feeding practices vary from farmer to farmer. Interestingly, the frequency of feeding may be 3 or 4 times a day depending on fish age and farmers' experience. This leads to overfeeding, and in turn it causes pollution from residue, especially home-made feed. This becomes a critical problem for cage culture as the uneaten feed cannot accumulate on the bottom like in the pond culture to be removed later.

At the study area, feed ratio and FCR cannot be accurately calculated by most of the farmers, who simply feed based on their experience and observed behaviour of the fish. This results in waste and inefficient feeding practices. However, feed input was recorded by a few farmers which the owners themselves did not manage these farms (pointing to financial control rather than good farming practices). In Thoi Son Islet, the research results show that there is a relation between the FCR and: (i) the loss rate ($r = 0.65$, $P < 0.01$); (ii) the productivity ($r = -0.54$, $P < 0.01$) as shown in Figure 3. The higher FCR the lower the productivity and higher the loss rate.

Disease issues and health management

Drugs and chemicals are used in most of the steps of the cage culture, such as: hatchery, transportation, cage preparation, stocking, nursing, fingerling and grow-out. There is no residue control on fingerlings, hence the private nurseries do not bear the responsibility for final products. This raises an issue on food quality and safety. Furthermore, most of the farms do not have drug and chemical usage-notes.

The addition of vitamins, amino-acids and probiotic-enzymes are common practices of most farmers in Thoi Son Islet. Moreover, most farmers do not know either the composition of these products nor the concept of withdrawal period. In many cases, products are not in their original packaging and sold in a hand-labelled transparent plastic bag.

Environmental assessment and management

In the tilapia cage farm systems, most cages are located along river banks. The distance between cages is quite close, i.e. typically 2-3 m if the cages belong to one owner or 5-10 m if the cages belong to different owners. On the other hand, cage locations do not follow the zoning which is encouraged by the government agencies for aquaculture. Thus, their wastes and discharges cause concerns on water quality, diseases, navigation hazards and landscape of the area. These systems also have received negative impacts from other upstream farming activities of the Tien River. Due to the open culture system, the risk of disease and parasite transfer to wild stocks would be possible.

Furthermore, the practice of farm management is poor. While management standards do not exist or have to be voluntarily implemented by farmers, training and competence of the staff are low and limited. More importantly, no records of monitoring or activities are kept.

Figure 3a. Correlation between stocking density, loss rate and food conversion ratio.

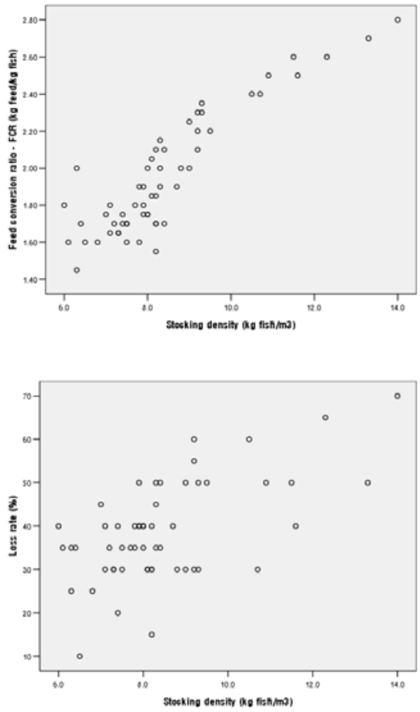


Figure 3b. Correlation between productivity, loss rate and food conversion ratio.

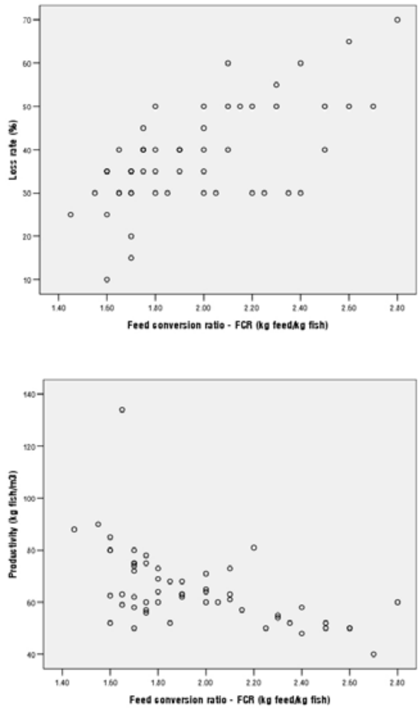
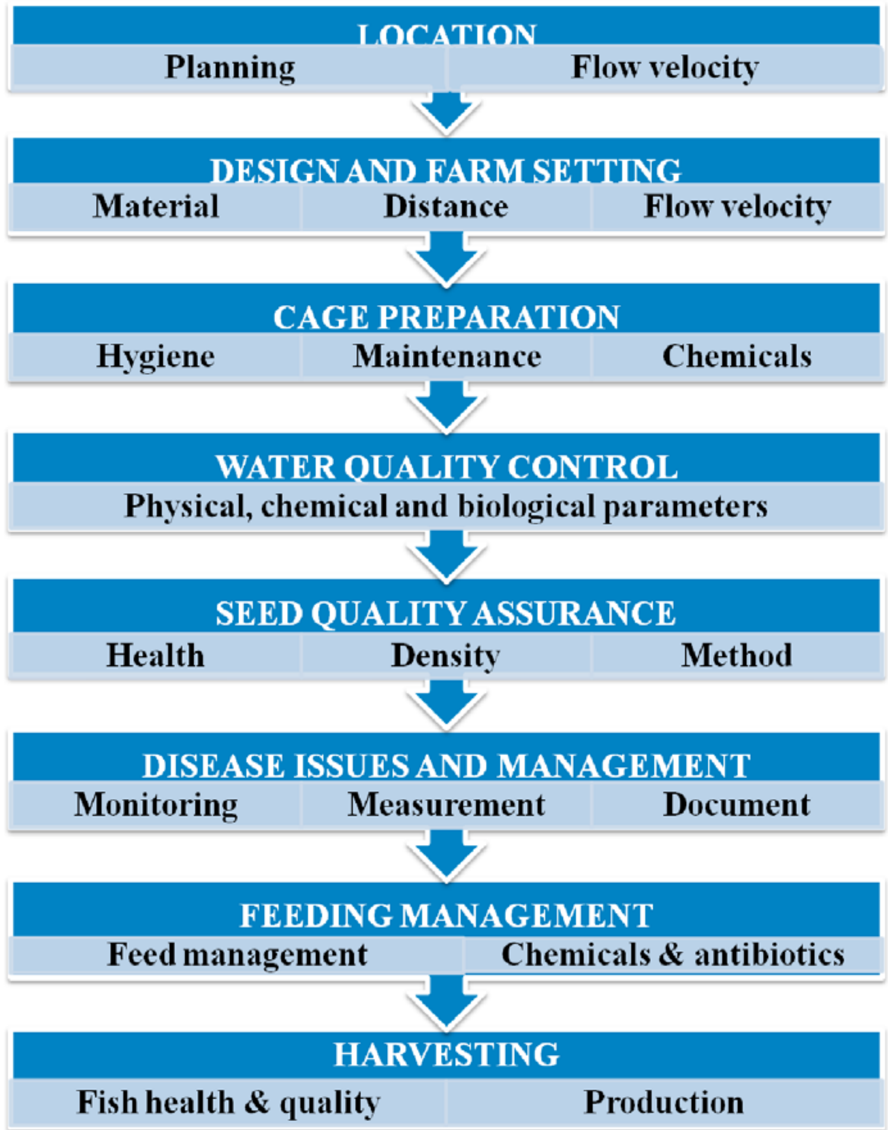


Table 1. Aquaculture Industry in Tien Giang

	Total (ha)	May 2009	Increase (%)
Freshwater aquaculture area	10,765*	5,996	108.5
Floating farm (cage)	1,573	128	-
Production (tonnes)	46,570	10,500	74

110,000 m³

Figure 4. The proposed BMPs at Thoi Son Islet.



Better management practices

Given above context, a spectrum of management practices is required to improve the situation. The practices must be flexible and suitable for small-scale farms to implement. A ‘better management practice’ approach supports fish farmers to limit fish losses, reduce environmental pollution, meet standard requirements of the aquaculture sector, and manage the whole cultivation process through: location planning => cage setting => seed quality assurance => feeding method => water quality and disease control.

Better management practices can include improvements to the cage designs, checking seed quality at stocking, monitoring water quality and fish health, improving bio-security during production, keeping records and a proactive approach to health management. Figure 4 shows the proposed BMPs at Thoi Son Islet.

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Aquaculture field schools as an extension methodology

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Fisheries extension activities were initiated in India just after independence in 1949. With the advancement of fisheries and aquaculture technologies, through the constant effort of scientists, aquaculture extension is now being emphasised as a priority. In agriculture, diversified extension methodologies are in vogue but not all of them are suitable for aquaculture. Therefore it is felt necessary to develop enterprise-specific extension methodologies for cost effective efficient aquaculture extension services. In view of this an endeavour is underway to demonstrate the effectiveness of an additional approach to aquaculture extension, through the use of aquaculture field schools in the rural matrix of the country.

What are aquaculture field schools?

Aquaculture field schools are “schools without walls” for improving the decision making capacity of the fish farming community. It is participatory approach, where by fish farmers are given opportunity to make choice in aquaculture production methods through a discovery-based learning approach. The field schools are typically composed of a group of farmers who regularly have a gathering for shared problem solving and interaction. A suitable group strength is ideally around 20-25 farmers. The basic premises of the field schools are that the farmers are experts, their fish farm is a learning place, the aquaculture extension worker serves as facilitator but not as teacher, scientists and technical specialists work with the farmers rather than lecture them and learning materials are learner-centred. The field schools provide a venue where entrepreneurial farmers with particular expertise or who may have received training from a research institute can train other small farmers in that area about science-based aquaculture practices. The major objective of aquaculture field schools is to build farmers capacity to analyse their production systems, identify problems, test possible solutions and make progressive improvements to their farming practices. In summary, the field schools objectives are to:

- Empower farmers with knowledge and skills to make them experts in their own fields.

A view of the broodstock pond AFS, Banpur.

- Sharpen the fish farmer's ability to make critical and informed decisions that render their farming profitable and sustainable.
- Sensitise fish farmers in new ways of thinking and problem solving.
- Help fish farmers learn how to organise themselves and their communities.

Global scenario

The first farmer field school, which was for agriculture, was established in an FAO assisted project on integrated pest management in Java in 1989. Thereafter farmer field schools spread to other countries in Africa, Latin America. Two technical support programmes, namely the Greater Noakhali Aquaculture Extension Project for prawn farming, and the Regional Fisheries and Livestock Development for promotion of pond aquaculture were implemented through the principle of farmer field schools in Bangladesh in 2006. The Governments of Guyana and Suriname received awards from FAO in 2004 for the implementation of integrated rice fish farming via farmer field schools. A small scale rural aquaculture project was implemented in China for sustainable fish seed production in 2006 with the involvement of women. By the end of 2005 as many as 75 countries had implemented farmer field schools to facilitate various developmental works.

Involvement of the Central Institute of Freshwater Aquaculture

The Central Institute of Freshwater Aquaculture (CIFA) has developed two field schools in the state of Orissa. The field schools were developed by the experts from the Institute. One field school was established at the Maharatha's Aquavariant Estate, Bhatapadagarh, Banpur, Khurda District in the farm of Shri Manabendra Maharatha. The resources available to him are approximately 10 ha of water comprised of 27 fish ponds of different size. He also has one commercial carp hatchery. He has been in this commercial carp seed business since 2003.

University students learning common carp breeding at AFS, Sarakhana.

Mr Manabendra Maharatha, a facilitator farmer, explaining the importance of stocking large sized fingerlings in community ponds to 27 community leaders from different districts of Orissa.

The other field school was established at Sarakana Khurda district in the farm of Shri Batakrishna Sahoo and Shri Nrusingh Charan Panda. He owns a fish farm of 6 ha with 23 ponds. There are two commercial carp hatcheries and one freshwater prawn hatchery, in addition to one ornamental fish breeding unit on the property. The pond embankments are used for horticultural crop production including floriculture. Shri Sahoo has been engaged in the fish seed production business since 1986.

The need to establish aquaculture field schools

The vision inherent in aquaculture field schools is that the trainers work alongside farmers as advisors and facilitators, encouraging independence, analysis and organisation. This method promotes exploration, discovery and adaptation under local conditions. The researcher and workers are looking

Defence personnel learning aquaculture management at the Sarakhana aquaculture field school, from a facilitator fish farmer.

to help them where they are unable to solve a specific problem amongst themselves.

The field schools aim to increase the capacity of groups of farmers to test new technologies in their own fields and to assess the relevance of results to their particular circumstances[1]. There is a need to integrate the curriculum of different steps through a scientific approach to aquaculture, such as where to rear, when to rear, how to rear, how to harvest, how to market the product etc. The field schools cover a wide range of topics and provide an additional mechanism whereby technologies and practices such as the culture and seed production of carp, catfish, air breathing fish, ornamental fish etc can be disseminated, providing new livelihood options for rural people, including rural women who can also get income from the small scale fish culture practices like seed rearing, ornamental fish culture in house and its breeding, mussel culture, seaweed culture etc which can improve their lifestyle.

The major steps in establishing and operating an aquaculture field school are summarised in the adjacent figure. These are:

- **Conduct groundwork activities**: This includes the identification of the venues through which experts can meet a large number of farmers, the identification of participants, their practices and problems.
- **Training of the facilitators**: The facilitators who guide the farmers should properly be trained by non formal education methods about the basic principles of aquaculture and should be knowledgeable about cost effective ways of production and supporting large numbers of farmers simultaneously.
- **Establishment and running of the field school**: Technology packages should properly be delivered at the farm site to the farmers and strengthen them to work as whole and mobilise the other farmers to do utilise improved practices by conveying to them the factors affecting the profitability of aquaculture.
- **Evaluating participatory technology development**: Technology employed or improvements proposed in the field school should be carefully be analysed by experts applying research methodology to develop new training resources and region specific techniques that are suitable for the aquaculture in the field, and which may be of benefit to others.
- **Aquaculture field days**: During the operation of the aquaculture field school field days can be organised where other farmers and people from other farming communities are invited to share what the group has learned and improved upon.
- **Graduation**: This programme marks the end of the aquaculture activities for the particular season. How much the farmers have learnt from the programme and also what the facilitators learnt from the field school activities which may be suitable for further research should be taken into mind.
- **Farmer run aquaculture field schools**: The aquaculture field schools are meant to give an account of knowledge to the farmer in the field itself and make them confident about their culture practices. The farmers should feel the need of

Yearling production demonstration at the Banpur aquaculture field school.

such aquaculture school as a tool to improve their farming practices and thereby their income.

- **Follow up by facilitators**: Occasionally the core facilitators will follow-up on farmers that have graduated periodical basis. The core facilitators also backstop farmers running the AFS.

Observations regarding the facilitators, their role and lessons learned

- There are difficulties in demonstrating some farming techniques in aquatic systems. For example, in agriculture it is often possible to see the results of fertiliser application within a few days time, while in aquaculture the benefit takes longer to realise.

- It takes several years to become a successful aquaculture entrepreneur. One has to learn different aspects of aquaculture under the guidance of experts. The facilitator farmers involved in the field schools have been mentored by Dr Radheyshyam, Principal Scientist, Bhubaneswar for the last 10 years at Bhataparagarha, Banapur and 27 years in Sarakhan, Balianta.

- The facilitator farmers are constantly trying new things such as the breeding of new species, establishing new aquaculture ventures or experimenting with management practices proposed by CIFA.

- The level of experience and education of the facilitators and their family members are generally high. Higher educational attainment and a great deal of experience have contributed to their being innovative.

- The facilitators enjoy positive relations with and the respect of the farming community. They are regarded as guides and mentors by the fish farmers of the village as well as by neighbouring villages.

- The facilitators have been honoured with many awards and recognition at both state and national level as a mark of their contribution

Carp seed being distributed to a farmer by the Dr Ambekar Eknath, Director of CIFA [recently elected as the next Director General of NACA - ed.].

Major steps in operating aquaculture field school (adopted from Nweri, et al 2001).

1.Foundation activities and infrastructure development

↓

2. Capacity building of facilitators

↓

3. AFS establishment and operation

↓

4. Participatory technology development evaluation

↓

5. Aquaculture field days

↓

6. Analysis and aquaculture graduations

↓

7. Aqua-farmer run AFS

↓

8. Follow up

to aquaculture. They regularly participate in the phone in/gram set programme of Prasar Bharati Corporation of India, the public broadcaster.

- In addition to imparting training to farmers in the school the facilitators provide guidance in establishing hatcheries in distant villages. At times they go beyond their home district to offer guidance and help in various aquaculture-related ventures.

- Facilitators also have an important role in obtaining essential farm inputs at a reasonable price.

Some other activities organised at the aquaculture field school

Training: Several training programmes have been organised at field schools in Bantu and Saracen. Neighbouring farmers have been trained in the selection of brood fish, hormone injection, hatchery operation, pond management seed rearing, feeding and also in various steps of carp polyculture.

Field days: Field days are being organised regularly in the two aquaculture field schools in order to create awareness about the various aquaculture related ventures and opportunities available to rural people. A large number of farmers and farm women from Chattisgarh, Tamil Nadu, Orissa, Andhra Pradesh, Manipur and Nagaland have participated in the field days. The facilitators took active interest in demonstrating various aspects of carp breeding and culture for the benefit of the visitors.

Workshops: Two workshops have been held in these field schools where experts from the institute, line department officials, facilitators, farmers and, farm women took part.

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Marine Finfish Aquaculture Network

Successful seed production of Cobia, *Rachycentron canadum*, in India

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The availability of the required quantities of high value marine finfish seed is the major prerequisite for the initiation and expansion of finfish mariculture. The breeding and seed production of high value marine finfishes has been expanding in recent years internationally.

Large quantities of hatchery produced seeds meet the need for sea cage farming in many countries (Hong and Zhang, 2003). It is well understood that the first step towards seed production technology is the development of broodstock. Prior to the 1980s, broodstock of finfishes were grown mainly in indoor concrete tanks. Since then, wild-caught broodstock have been developed either in outdoor earthen ponds or in sea cages. It has been proved that broodstock development in sea cages was highly effective in improving gonadal development for most species like cobia, groupers, pompano, red seabream, Japanese flounder and yellow croaker.

The development of hatchery technology for commercial level seed production of marine finfishes is still in its infancy in India, except for the seabass, *Lates calcarifer*. Hence, research and development need to be focused in evolving technologies for the seed production and farming of high value marine food fishes.

In recent years the seed production and farming of cobia (*Rachycentron canadum*) has been rapidly gaining momentum in many Asian countries (Liao and Leano, 2007). Cobia is distributed worldwide in warm marine waters. They are found throughout the water column and are caught in

Broodstock cages for cobia at Mandapam.

both coastal and continental shelf waters, although they are typically considered to be an offshore species. Wild-caught cobia does not support a major commercial fishery and generally considered as incidental catch. Sexual maturity is reported in males at 1-2 years and in females 2-3 years, with females growing both larger and faster with maximum sizes upto 60 kg. (Shaffer and Nakamura, 1989).

Fast growth rate, adaptability for captive breeding, lowest cost of production, good meat quality and high market demand especially for sashimi industry are some of the attributes that makes cobia an excellent species for aquaculture. Under culture conditions, cobia can reach 3-4 kg in body weight in one year and 8-10 kg in two years. The species has protracted spawning season and it can spawn in captivity. The fecundity is very high. Aquaculture research with cobia was first reported in 1975 with the collection of wild caught cobia eggs off the coast of North Carolina. Larval development was described and after the termination of 131 day rearing trial it was concluded that cobia had good aquaculture potential because of its rapid growth and good flesh quality. Additional research on cobia was conducted in the late 1980s and early 1990s in the USA and Taiwan, Province of China. Research continued and by 1997 the technology to raise large quantities of cobia fry had been developed and Taiwan Province of China was producing cobia juveniles for grow out mostly in nearshore cage systems (Yeh, 2000; Su et al., 2000; Liao et al., 2004; Liao and Leano, 2005). Cobia production is also reported in the United States, Puerto Rico, Bahamas, Martinique, Belize, Brazil and Panama (Bennetti et al., 2008). Envisaging the prospects of cobia farming in India, broodstock development was initiated at the Mandapam Regional Centre of Central Marine Fisheries Research Institute in sea cages during 2008 and the first successful induced breeding and seed production was achieved in March – April 2010.

Cobia broodstock in cage.

Administration of hormones for final oocyte maturation and spawning.

Broodstock development and captive breeding at Mandapam

The broodstock at Mandapam were developed in sea cages of 6 m diameter and 3.5 m depth (Gopakumar, 2008). Wild collected cobia brood fish in the size ranging from 2- 10 kgs of weight were stocked during December 2008 to February 2009. The fish were stocked without separating sexes. All the fish were collected by commercial hook and line fishers. After transporting to hatchery the fish were treated with 100 ppm formalin for 2-5 minutes and conditioned for two to three days in 10 tonne FRP tanks before transferring to cages. These fishes were fed twice daily at 0900 and 1530 hrs with sardines and other species such as *Pellona* and *Ilisha* , and occasionally with squids and portunid crabs @ 5 % of their body weight. Vitamin and mineral supplements were also given twice in a week along with feed in order to

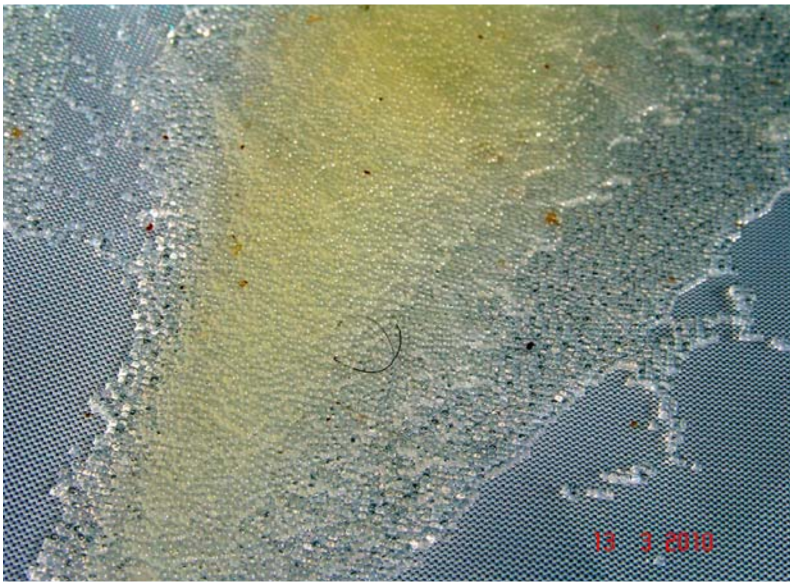
Cannulated intra-ovarian eggs.

complement any possible nutritional deficiencies in their diet. A total of 40 fishes were stocked in four cages. The length range and corresponding weight range of the brood fishes recorded during April 2009 ranged from 80-127 cm and 4-20 kg, respectively. The sexes were separated by cannulation using a flexible catheter (2 mm inner diameter) in June 2009 and stocked in separate cages. Thereafter the females were cannulated every fortnight to assess the diameter of the intra-ovarian eggs.

In March 2010, one of the female with intra-ovarian eggs of around 700 µ size, was selected for induced breeding. The size of the female was 120 cm in total length and 23 kg in weight. Two males were also selected from the male cage. The males were 100 cm and 103 cm in total length and weighed 11 kg and 13.5 kg, respectively. The selected brooders were introduced in a 100 tonne roofed cement tank with about 60 tonnes of sea water on the same day. At around 1300 hours, the brooders were induced for spawning with HCG at doses of 500 IU per kg body weight for female and 250 IU per kg body weight for males. Spawning was noted at 0430 hours on 13.03.2010. The total eggs spawned were estimated as 2.1 million. About 90% fertilisation was recorded (fertilised eggs amounted to 1.9 million). The eggs were collected by a 500 µ mesh and stocked in incubation tanks with varying densities.

The eggs hatched after 22 hours of incubation at a temperature range of 28-30º C. The percentage hatching was 80 % and the total number of newly hatched larvae was estimated at 1.5 million. The newly hatched larvae measured in total length from 2.2-2.7 mm. The mouth opening was formed on the third day post hatch and was measured at around 200 µ. The environmental conditions during the larviculture period were DO2: > 5mg / l , NH3: < 0.1mg / l, pH: 7.8 – 8.4, Salinity: 25-35 ppt, water temperature : 24-33° C (Liao et al., 2004).

Spawning behaviour inside the spawning tank.



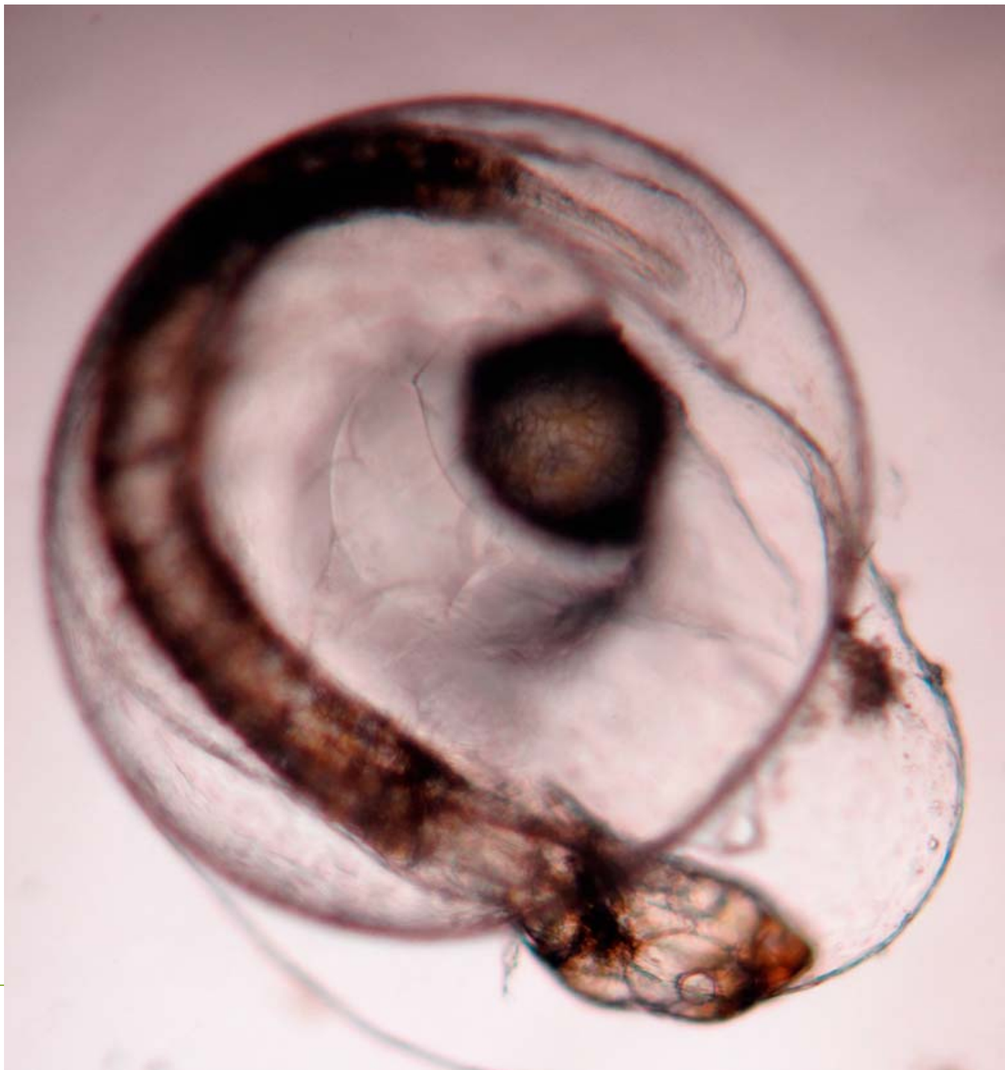
Fertilised eggs collected on 500 micron mesh.

Below: Development of the embryo.

Larviculture protocols followed at Mandapam

Larviculture protocols were developed by appropriate management of live feeds in suitable quantities and also taking into consideration the nutritional requirements of the larvae. The larvae were stocked in FRP tanks of 5 ton capacity for larviculture. The intensive larviculture tanks were provided with green water at a density of about 1x105 cells per ml and rotifers enriched with DHA SELCO at a density of 6-8 per ml from 3 to 9 days post hatching. The critical stage for the larvae was days 5 to 7 post hatching when they entirely resorted to exogenous feeding from yolk sac feeding. During this period, large scale mortality (about 80%) was noted. Thereafter, the mortality rate was moderate. From days 9 to 21 post hatching the larvae were fed four times daily with enriched *Artemia* nauplii by maintaining a nauplii concentration of 2-3 individuals per ml.

Above: Newly hatched cobia larvae. Below: A larva in the process of hatching.



During this period, co-feeding with rotifers was also continued due to the presence of different size groups of larvae. Green water was also maintained in appropriate densities in the larval tanks. From 18 days post hatching onwards, the larvae were fed with newly hatched *Artemia* nauplii and weaning to larval inert feeds was also started as per the details given in the table.

From 25 days post hatching, grading of larvae was started. The shooters were fed exclusively with the artificial feed of the size 500-800 µ and 800-1200 µ. At 30 days post hatching, three size groups of juveniles were noted with mean sizes of 10 cm (10%), 6 cm (25%) and 4 cm (65%). The juveniles measuring 10 cm length were ready for stocking in hapas and the other two size groups would be ready after rearing for another two to three weeks. All the fingerlings of 10 cm length and above were stocked in hapas in the sea for nursery rearing for about a month before transferring them to the grow out cages.

Larvae in the rearing tank.

Table 1. Age and feed size in weaning of cobia fingerlings.

Stage of larvae (days post hatch)	Size of larvae (cm)	Size of feed (µ)
18 – 19	2.3 – 2.6	100-200
20 – 23	2.5 – 3.5	300-500
23 – 30	3.5 – 8.0	500-800
31 onwards	> 4.0	800-1200

Cobia fingerlings 42 days post-hatch.

Prospects

Cobia is recognised as a finfish with emerging global potential for mariculture. Following successful development of cobia culture in Taiwan Province of China, this activity expanded fast in Southeast Asia, the Americas and the Caribbean regions. Cobia has all the qualities needed for a successful species for aquaculture. The global aquaculture production of cobia has been increasing from 2003 onwards and the major contributors are China (including the Province of Taiwan) and it has been noted that rapid growth rate and good flesh quality of cobia make it one of the best species for future expansion of production. Increasing the supplies from aquaculture combined with effective marketing can substantially enhance cobia production in the near future. The present success in the captive breeding and seed production in India can be considered as a milestone towards the development of lucrative cobia farming in the country. However, this is only a first step and standardisation of technologies for seed production and farming of cobia to suit our environmental conditions have to be further pursued on a priority basis so that India can also emerge as a contributor for cobia production in the near future.

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NACA has begun making audio recordings of technical presentations given at aquaculture workshops, meetings and projects in which we are involved. We are doing this to allow people throughout NACA member states to access these materials. Only a handful of people can ever physically attend a workshop, but now anyone can listen to the proceedings, wherever they may be.

The recordings are made available in the podcasting section of the NACA website (link below). The recordings may be freely downloaded or you can listen to them online (stream) from our server:

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The recordings are also available as podcasts. If you have podcasting client software installed on your computer, or use an online service such as Google Reader, we encourage you to sign up for our 'recent podcasts' feed. This will ensure that you receive new recordings as they are released. The feed URL is:

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Lastly, the software we use to distribute podcasts has been developed in-house and is available as an open source module for the ImpressCMS content management system. Download it from:

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- 2011 progress reports of the NACA Regional Lead Centres
- National Training Workshop for Cluster Certification Trainers
- Global Conference on Aquaculture 2010
- Expert Workshop on Inland Fisheries Resource Enhancement and Conservation in Asia

We have recordings from a couple more workshops under edit, to be posted soon. Keep an eye on our recent podcasts feed!

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22nd Governing Council Meeting and a new Director General

The Government of India hosted the 22nd NACA Governing Council Meeting in Cochi, Kerala, from 9-11 May. Delegates from NACA member governments, regional lead centres and international partner organisations were welcomed by Dr B. Meenakumari, Deputy Director General (Fisheries) of the Indian Council of Agricultural Research. Opening remarks were delivered by Dr Nantiya Unprasert, Deputy Director General of the Thai Department of Fisheries and by the Director General of NACA, Prof. Sena De Silva. The inaugural ceremony was marked by a special address from Dr E.G. Silas, former Director of the Central Marine Fisheries Research Institute and founding Director of the Central Institute of Brackish Water Aquaculture, Indian Council for Agricultural Research (ICAR), which follows below.

The Governing Council is NACA's peak policy body, which meets annually to review the organisation's activities and set priorities for the year ahead. Collectively NACA's 18 member states produce more than 90% of global aquaculture by volume, which now represents around 50% of the global food fish supply.

The Secretariat and the Regional Lead Centres for China, India, Thailand and the Philippines gave progress reports on their activities over the past year (audio recordings of these presentations are available for download / streaming), leading into a discussion and proposals for the year ahead. While many issues were raised at the meeting, key points included the following:

From left to right: Incoming NACA DG Dr Ambekar Eknath, Dr B. Meenakumari, Deputy DG (Fisheries) ICAR and outgoing NACA DG Prof. Sena De Silva.

- The need to improving the sustainability and productivity of aquaculture through promotion of group-based implementation of science-based better management practices by small scale farmers will continue to be a key focus of the work programme, expanding into new commodities.

Delegates and staff participating in the 22nd NACA Governing Council Meeting.

- The impacts of climate change are a universal and increasing concern to member governments, not only in terms of environmental damage but also on the livelihoods of rural communities and potentially severe implications for food security.

- Many members are placing increasing emphasis on freshwater aquaculture production, particularly with regards to culture-based fisheries and improved utilisation of dams and reservoirs.

- NACA's food safety and quality programme, currently focusing on on-farm issues will be expanded to include the processing sector, which form a large component of exports. Organic aquaculture will also be included in the work programme.

- NACA will facilitate group-based approaches to certification of aquaculture products to enable small scale farmers to access such schemes.

This year the Governing Council also had the task of electing the next Director General of NACA. Following a highly competitive selection process, we are pleased to announce that the Governing Council has chosen Dr Ambekar E. Eknath to serve as the next Director General of NACA. He will serve a five year term commencing on 1 September 2011.

Dr Eknath is well known throughout NACA. A graduate from the Mangalore College of Fisheries/Dalhousie University, he has served as the Director of the Central Institute for Freshwater Aquaculture, the NACA regional lead centre for India, since 2008. He spent the decade previous conducting fish breeding research at BioSoft/GenoMar at the University of Oslo Research Park using both classical approaches and molecular genetic tools on tilapia and other tropical fish species. However, he is undoubtedly best known for his pioneering work in development of the genetically improved farmed tilapia (GIFT) strain with the WoldFish Center (formerly ICLARM), where he worked for ten years.

The Governing Council also expressed their appreciation to the outgoing Director General, Prof. Sena De Silva for his substantial contribution to regional aquaculture development and for the personal commitment he has displayed to aquaculture development in the region. Prof. De Silva will resume his post with Deakin University in Australia, where he plans to continue developing and implementing projects in collaboration with the network. Prof. De Silva was present at the inaugural meeting of NACA more than twenty years ago and has been one of the most long-standing and prolific contributors to the network. Member governments wished him well and looked forward to his continuing support.

NACA receives the Margarita Lizárraga Medal

NACA is very pleased to have been awarded the Margarita Lizárraga Medal for the biennium 2010-2011 at the Thirty-seventh Session of the FAO Conference. The award was presented by Dr Jacques Diouf, Director-General of the FAO, in a ceremony at the FAO Headquarters in Rome on 27 June.

The Margarita Lizárraga Medal Award was established by the FAO Conference in 1997 to honour the memory of Dr Magarita Lizárraga, former Senior Fishery Liaison Officer, for her decisive role in promoting the Code of Conduct for Responsible Fisheries and for her productive work in the field of fisheries for almost forty years, particularly in developing countries. The Award is presented to a person who, or an organisation which, has served with distinction in the application of the Code of Conduct for Responsible Fisheries.

The award was presented to NACA "in recognition of its significant contribution to the development of sustainable aquaculture in the Asia and Pacific Region. NACA continues to serve as a cohesive intergovernmental forum for the formulation of regional policies as well as cooperation and coordination in aquaculture research, development and training. In particular, NACA has noteworthy achievements in the areas of environmental and aquatic animal health, support to small-scale fish farming, promotion of better management practices (BMPs) and aquaculture certification. The contribution of NACA to application of the Code is therefore outstanding, practical, tangible and sustainable as well as catalytic for other regions to follow".

Speaking at the Award ceremony, Prof. Sena De Silva, Director General of NACA said "I am deeply honoured and privileged to accept the Margarita Lizarraga Medal on behalf of the Network of Aquaculture Centres in Asia-Pacific, its 18 Member Governments, Governing Council, collaborating centres and scientists, past and present staff and many friends of the organisation."

"We at NACA are humbled by the recognition bestowed on us by this award", he said. "To our understanding this is the first time ever that this award has been made in recognition of endeavours in the aquaculture sector, which in turn is also a recognition of the sector's gaining importance as a contributor to the global food basket, provider of critically important livelihoods, in particular to the rural poor, and an ever increasing contributor to food security and poverty alleviation."

Prof. De Silva highlighted the catalytic role FAO had played in NACA's development, with the network having originated as an FAO project before becoming an intergovernmental organisation in its own right twenty-two years ago. "The first ever Aquaculture Ministerial Conference will be held jointly with FAO and the Government of Sri Lanka in July 2011", he noted. "This will be the first time such a high level policy dialogue is held and this is a good example of the type of collaboration that NACA and FAO have developed over the years".

Prof. De Silva noted that "NACA will continue to work to contribute to the application of the Code of Conduct for Responsible Fisheries in its endeavours, particularly to safeguard and improve the well being of small farming communities, and to play a catalytic role to assist other regions in the sustainable growth of aquaculture development".

He closed by noting that "NACA wishes to dedicate this award to the millions of small-scale farmers, their resilience, adaptability, determination and endurance, which have enabled them to keep pace with globalised community."

On behalf of the network, the NACA Secretariat wishes to offer its sincere thanks to FAO for its support and ongoing partnership towards our common goals in pursuit of rural development throughout both the region and globally.

Mr Jacques Diouf, FAO Director General (right) and NACA DG Prof. Sena De Silva. Photo credit: FAO/Giulio Napolitano.

NACA receives Gold Medal Award from the Asian Fisheries Society

We are pleased to announce that the Asian Fisheries Society presented a Gold Medal Award to NACA "in recognition of its distinguished contribution to regional aquaculture education, training and development".

The Asian Fisheries Society is a non-profit scientific society founded in 1984 by fisheries professionals in Asia. The society aims to promote networking and cooperation between scientists, technicians and all stakeholders involved in fisheries and aquaculture production, research and development in Asia.

The award was presented on 21 April 2011 at the 9th Asian Fisheries and Aquaculture Forum in Shanghai, China. It was received on behalf of the organisation by Prof. Sena De Silva, Director General of NACA.

On behalf of the network, we would like to extend our thanks to AFS and also to the thousands of people who participate in NACA and who have made it what it is today.

Special address by Dr E.G. Silas at the inaugural session of the 22rd Governing Council Meeting 9-12 May, Kochi, India

Welcome to the beautiful city of Cochin in “God's own country”. We feel privileged to have this important meeting in Cochin which is the hub of fisheries activities in this country. I feel honoured for being invited by Dr S. Ayyappan, Secretary, DARE and Director General, ICAR and Dr Sena De Silva, DG, NACA as the chief guest to deliver a special address at this inaugural session.

The vision and mission oriented approach of the late Dr T.V.R. Pillay has today seen the growth of regional aquaculture networks, with global coverage in Asia-Pacific (NACA), Africa (ARAC), Latin America (CERLA), Mediterranean (MEDRAP), Central and Eastern Europe (NACEE) and the Americas (NACEA). His goal was to achieve food, nutritional and livelihood security for the fishers and rural poor. No doubt, this global networking aided by the UNDP and FAO has strengthened and expanded aquaculture development globally. There has been an emphasis on inter-regional cooperation which is evident from the joint projects with institutions and countries, undertaken as direct partnership or jointly with international organisations for imparting training and developing sustainable aquaculture. NACA's response to the restoration and developmental needs of the coastal communities so badly affected by the devastating 2004 tsunami is an example of its commitment to societal concerns.

I have admired Dr Pillay's ability to mobilise financial support from donors for the successful working of the global networking programmes in aquaculture that he initiated. So also, my friend Dr Chen Foo Yan emulating the same. The requirement and conditions vary from country to country and regionally also. The focus of Dr Pillay was on the use of locally available fish species and development of appropriate technologies for food production and supply; and prevention and treatment of diseases of locally important species under culture. The integration of aquaculture with area development plans especially in the inland and coastal areas with allied sectors such as agriculture and forestry was one of the underlying principles of his approach to aquaculture development.

Enlarging the area of operations, NACA today functions from 18 states in the Asia-Pacific with considerable diversity in life style, socio-economics and food habits. Coordination of activities under such diversity is a major task. So also, the effective monitoring of a widespread network. The reports of the regional and lead centres to be presented here should bring out how effective this coordination has been and how best this can be streamlined.

Aquaculture is increasing in importance throughout most of Asia and is likely to continue expanding. The global population is predicted to increase by about 50% to almost 9 billion people with the largest share in this region before it stabilises towards the end of the century. A 70% increase in food production will be required to support and increasingly affluent population; and as income rises people diversify and improve their diet habits demanding healthier, tasty and value-added food. Asia produced 92% of global aquaculture and Asian aquaculture is characterised by small scale, family operated farms that are typically less than 1 ha in area and the sector is a major source of income and employment for rural communities. With Asia's rapidly expanding and increasingly affluent populations, the greatest demand for fish will be for domestic rather than the export market.

Traditional aquaculture still has relevance for the poor seeking to diversify their small farms. Its principles when compared to intensive aquaculture practices have relevance for lowering the cost of production and also improving environmental sustainability. NACA has played a vital role in improving the traditional aquaculture practices and development of better management practices (BMPs) for culture based fisheries development in Asia, for culture of the striped catfish (*Pangasianodon hypophthalmus*) in the Mekong River Delta in Vietnam, implemented through groups of small-scale farmers to improve their efficiency and profitability. This has resulted in a massive expansion of striped catfish production over the past decade in Vietnam with an annual production now exceeding 1 million metric tonnes. NACA was also instrumental in developing culture-based fisheries in eleven seasonal reservoirs in Sri Lanka, stocking common carp, tilapia and *Labeo dussumieri* with the financial support of the Australian Centre for International Agricultural Research (ACIAR). This has provided a means of increasing food supply in rural areas of Sri Lanka. I hope NACA will extend such activities in other member countries.

Hill stream / cold water fishes form an important component in the aquaculture practices in the Himalayan region of countries such as Nepal, China, India, Myanmar and Pakistan. NACA may consider assisting cold water aquaculture practices as it has no ongoing activities in this field.

Climate change is affecting farming systems worldwide. It is expected that the impacts will be disproportionately felt by small scale farmers who are already amongst the most poor and vulnerable members of the society. NACA's efforts to map farmers' perceptions and attitude towards climate change impacts and adaptive capacities to address these impacts in four Asian countries including the shrimp culture practices in India (CIBA-NACSA/MPEDA-NACA project) through the ‘Aquaclimate’ project is highly admirable. I hope the project will provide farmers with strategies to maintain their resilience in the face of climate change.

The Aquatic Animal Health Programme of NACA is helping member states to reduce the risk of aquatic animal diseases. One of the ACIAR projects aims to improve the capability of shrimp virus PCR laboratories in Vietnam with well developed plans for PCR lab registration and accreditation. I recall such a practice successfully developed and applied in India in a NACA-ACIAR-CIBA-MPEDA project in 2005-2006 and I expect that NACA will extend further assistance to combat the challenges of newly emerging diseases not only in shrimp but also in freshwater prawns, finfish and molluscs in all member states. The Shrimp Health Management Extension Manual prepared during the joint technical assistance programme of NACA and MPEDA at the time of the white spot syndrome outbreak in 2002 and translated into Indian regional languages, namely Tamil, Telugu and Oriya was well-received by the shrimp farmers of the region. The detailed proforma of crop and shrimp pond management and daily record sheets developed by NACA and MPEDA have been adopted by over 700 shrimp farmer societies and are currently in practice in the Indian states of Andhra Pradesh, Tamil Nadu, Karnataka and Orissa.

Incorporating the latest technologies such as molecular genetic tools in aquaculture and fisheries management will help to reduce negative impacts on biodiversity. NACA's programme on artificial propagation of indigenous mahseer species in Malaysia through scientifically based enhancement programmes and the development of conservation strategies for Mekong giant catfish has been successful. However, such an important programme has not identified any component or activity in a biodiversity rich country such as India. I urge the DG and office bearers of NACA to initiate propagation assisted rehabilitation of regionally important and endangered freshwater food species of the Western Ghats and North Eastern region of India jointly with the National Bureau of Fish Genetic Resources (NBFGR, Lucknow) and the regional lead centre, CIFA, at Bhubaneswar.

Semen banks form the backbone in animal husbandry programmes that revolutionised the entire sector. NACA may initiate establishment of cost effective milt banks for aquaculture species that would reduce the cost of broodstock maintenance, help in multiple breeding, avoid sacrificing males as in catfishes and in producing superior strains. China has made considerable progress in selective breeding of its native shrimp, *Fenneropenaeus chinensis* which may even compete with *Litopenaeus vannamei* in the coming years. Similar efforts may be initiated in Indian white shrimp, *Fenneropenaeus indicus* for faster growth rate in South Asian countries under the leadership of NACA in a collaborative mode with organisations such as the Central Institute of Brackishwater Aquaculture (CIBA), Chennai.

Dr E.G. Silas, former Director of the Central Marine Fisheries Research Institute and founding Director of the Central Institute of Brackish Water Aquaculture, Indian Council for Agricultural Research (ICAR) and former Vice-Chancellor, Kerala Agricultural University.

Grouper culture has led to a significant contribution to fish production and rural economy in coastal communities in Asia and also played an important role in conservation of the fragile coral reef fishes which are increasingly being threatened with overfishing and habitat destruction. One of the major constraints to furthering grouper culture is seed supply. The hands-on training course on grouper hatchery production offered by NACA and the practical guides on feeds and feed management and hatchery management have been immensely helpful in producing commercial quantities of grouper seed and enhancing skills in grouper culture in the Southeast Asian coral triangle. The Rajiv Ghandi Center for Aquaculture, in its programme on cage culture of groupers in the Andamans, benefited greatly from the advice of Dr Mike Rimmer, who was one of the founders of the Asia-Pacific Marine Finfish Aquaculture Network. Other candidate species such as pomfret, cobia, yellow-fin tuna and snappers can be included to widen the scope of seed production, stock enhancement and mariculture in the region. Another area of interest is coastal zoning and management with a view to identify appropriate hassle free sites for mariculture and coastal aquaculture with the help of GIS and land based surveys. The possibilities of developing aquaculture practices for non-conventional species such as ornamental fishes and sea cucumbers can be attempted by NACA to increase the revenue of the fishers as well as to curb over exploitation of resources from the wild. Experimental small volume, high density farming of locally important food fish such as the pearl spot (*Etroplus suratensis*) in floating net cages (1.0-2.0 m^3) in South India was found to be highly rewarding; such species may be prioritised in other member states to develop appropriate region-specific aquaculture technologies for rural areas.

Today there is need for certification in aquaculture, based on the chain of custody and value-chain systems. The modalities of the formulation of guidelines and execution of the same would be major tasks. I am sure NACA could function as a catalyst to promote this activity aimed at good aquaculture practices and best management practices for assuring quality products.

Through well-organised networks, extension activities and publications, the role played by inter-governmental organisations such as the Bay of Bengal Programme has great visibility in India and other member nations and they also disseminate information in several regional languages. Likewise, NACA with more linkages, extension and developmental activities in the region could play a pivotal role. Sharing the fruits of research with countries in the network should strengthen linkages. NACA may organise more training programmes, enhance technology dissemination and promote visits of professionals among the countries for the overall development of aquaculture in the region. At the same time, it may also strengthen its interaction with other similar international networks (ARAC, CERLA, MEDRAP, NACEE and NACEA) for better utilisation of appropriate technologies and expertise.

Talking of networks, it reminds me of the webbing in fishing nets and fortunately we have in our midst our greatest expert in nets, Dr Meenakumari. Through the ages, fishing nets have evolved from weakness to strength and durability through the use of successive improved netting material, culminating now in the use of ultra high molecular weight polyethelene, popularly known as Dyneema. Its characteristics such as low weight, resistance to weathering and high durability strengthen its webbing to last longer and function efficaciously. NACA may similarly strengthen its networking in member states as well as with other international organisations to increase its visibility, improve the livelihood of rural communities to contribute towards fish food security and aquaculture sustainability.

Today you also have assembled here for the governing Council Meeting, which will elect a new Director General to head this august body. The world is slowly recovering from a devastating economic recession. In this scenario, the new Director General will have a formidable task in generating resources for the various activities of the organisation. I am sure, wisdom will prevail in the selection of the new DG. Once again, I think Dr Sena De Silva, DG NACA, and Dr S. Ayyappan, Secretary, DARE, GOI, for giving me the opportunity to participate in this inaugural function. I wish NACA a very bright future.

Thank you.

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Striped catfish farming in the Mekong Delta: A tumultuous path to a global success

De Silva, S. and Phuong, N.T. (2011). Striped catfish farming in the Mekong Delta, Vietnam: a tumultuous path to a global success. Reviews in Aquaculture 3: 45-73.

Abstract

The striped catfish (*Pangasianodon hypophthalmus*) (Sauvage), also referred to as tra catfish or sutchi catfish, farming sector is an icon of aquaculture development in Vietnam and globally. Over a decade it has developed from a humble backyard operation to one that currently accounts for the production of over one million tonnes, employing over 180 000 rural poor, and generating an export income exceeding US$ 1.4 billion (2010). It accounts for the highest average production, ranging from 200 to 400 t ha?1 crop, ever recorded for the primary production sector. The system is integrated and incorporates seed production, fry to fingerling rearing and grow-out, and is concentrated in a few provinces in the Mekong Delta (8°33'–10°55'N, 104°30'–106°50'E), along two branches of the Mekong River. In essence, perhaps, the initial trade restrictions on catfish exports to the USA provided the impetus and then the associated developments from 2002 to 2005 of the sector to a great extent in seeking new markets. The explosion of tra catfish farming has resulted in many competitive sectors challenging this 'tra catfish' invasion into a globalised market. These confrontations still exist with many instances of attempts to discredit the sector and discourage international consumers. However, the Vietnamese catfish sector is resilient and has managed to withstand such pressures and continues to thrive. This paper reviews the development of catfish farming in the Mekong Delta, its current status and what is required to sustain it as a major food source and livelihood provider.

Download from:

http://dx.doi.org/10.1111/j.1753-5131.2011.01046.x

Diseases in Asian Aquaculture VIII: Registration and abstract submission open

The Symposium on Diseases in Asian Aquaculture VIII (DAA-VIII) will be hosted by the College of Fisheries, Mangalore, India, 21-25 November, 2011.

Registrations and abstracts can be submitted on-line via the DAA-VIII website. Early registration opens on 1st June and closes on 31st August, 2011. Participants are requested to register early so that the organisers may facilitate the visa application process:

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Food safety and biosecurity

During the recently held 9th Meeting of the Asia Regional Advisory Group on Aquatic Animal Health (AG) (download report), one issue that was discussed was to broaden the scope of the group to address emerging issues related to aquatic animal health such as food safety, certification and biosecurity. There is an ongoing need to strengthen aquatic animal health management in the Asia-Pacific region driven by increasing production and trade in aquatic animal commodities, the need to meet sanitary requirements for international trade, the importance of preventing the spread of transboundary diseases, and recognition of the significance of aquatic animal production for food security. Effective coordination and communication of capacity building initiatives across the region are important to ensure that, wherever possible, available resources are applied for maximum benefit.

According to World Organisation for Animal Health (OIE), food safety and quality are best assured by an integrated, multidisciplinary approach, considering the whole of the food chain. Eliminating or controlling food hazards at source, i.e. a preventive approach, is more effective in reducing or eliminating the risk of unwanted health effects than relying on control of the final product, traditionally applied via a final 'quality check' approach. Approaches to food safety have evolved in recent decades, from traditional controls based on good practices (Good Aquaculture Practices [GAPs] and Better Management Practices [BMPs]), via more targeted food safety systems based on hazard analysis and critical control points (HACCP) to risk-based approaches using food safety risk analysis.

To ensure food safety of animal products, action is needed at the farm level during the production cycle, where many sanitary risks may be present and can be avoided through proper disease prevention policies and good practices recommended international organisations (e.g. NACA, OIE, SEAFDEC AQD, FAO and Codex Alimentarius Commission). Globalisation in aquaculture should ensure healthy and hazard-free food products for international trade.

Concerns on drug and chemical residues among internationally traded aquatic products have resulted in more stringent standards being imposed by many importing countries around the world. In the Asia-Pacific region, the use of chemicals in aquaculture still needs to be standardised and several projects/workshops have been implemented in this regard many years back. These include withdrawal periods of antibiotics among cultured species, surveillance of chemical contaminants in aquaculture products and feeds, status of antibiotics/chemicals usage and regulations in aquaculture, and dissemination of food safety awareness. Despite of these activities, however, harmonised guidelines on responsible use of chemicals in aquaculture, especially in less-developed countries in the region, still needs to be formulated.

Food safety of aquaculture in the Asia-Pacific region needs proper implementation of the following (Azuma 2010):

- Establishment of guidelines for the proper usage of antibiotics and other drugs in aquaculture.
- Clarification of chemical contaminants in aquaculture products and feeds.
- Investigations on the status of antibiotics/chemicals usage and regulation in aquaculture.
- Promotion of food safety awareness from farm to fork following the established guidelines.

On the other hand, biosecurity in aquaculture, as discussed during the Global Conference on Aquaculture 2010 (Phuket, Thailand), is taking a broader perspective to include aquatic animal health, invasive species, genetic risks, public health and climate change impacts. The following messages were conveyed after the discussion by panel experts:

- International and national efforts to promote biosecurity need to better reach the grassroots levels of the industry and the community stakeholders.
- Biosecurity frameworks need to keep pace with the unprecedented level of aquaculture development in terms of species, systems and technology.
- Standards on aquatic animal health for known pathogens, aquatic pests and food safety are already available, but greater commitment by governments is needed to implement these standards.

International standards need to be developed to address the high incidence of emerging diseases of aquatic animals and aquatic pests compared to the terrestrial scenario – there is a need to complement the pathogen/pest specific approach to biosecurity with standards that deter high risk practices.

On the different certification schemes which are creating confusion for many stakeholders, globally accepted guidelines are needed, which can serve as basis for a more harmonised and acceptable certification. At present, the proposed FAO aquaculture certification guidelines have been approved in the recent COFI (Committee on Fisheries) meeting. A range of issues relevant to certification schemes in aquaculture has been included in the certification guidelines including: animal health and welfare; food safety; environmental integrity; and socio-economic aspects.

By and large, food safety and biosecurity in aquaculture still need to be strengthened, and awareness programmes should be implemented and proper information disseminated especially for small-scale aquafarmers which are common in the region.

As a last note, the updated list of diseases for QAAD reporting starting January 2011 is enclosed in this report. This was revised by the 9th AG based on current OIE list and other diseases of importance to the region.

Ramping up adoption of catfish BMPs

A new project funded by the European Commission will help Vietnamese catfish farmers improve their efficiency and profitability. The project will assist farmers to implement better management practices (BMPs), working in cooperative groups formed from 'clusters' of nearby farms.

Vietnamese catfish aquaculture has expanded massively over the past decade, with annual production now exceeding one million tonnes. Production is extremely intensive, with average yields of around 400 tonnes per hectare. However, the profit margin is very low - just a few cents per kilogram - and farmers are under intense pressure to reduce their production costs.

Scientifically-based better management practices for catfish aquaculture have been developed by a recently completed NACA project. These improved practices increase farm resource-use efficiency, improving crop performance while reducing production costs and environmental impact. The BMPs were developed through extensive surveys of industry practices, consultations with farmers and on-farm trials.

The new project, *Development and validation of commodity-specific Better Management Practices for smallholder farmers in the Asia-Pacific region* is an activity of the ASEM Aquaculture Platform. The project aims to promote wider adoption of BMPs for key aquaculture commodities, including tra catfish in Vietnam, work on which is being implemented by Can Tho University.

Project team discussing BMP implementation with a farmer cluster.

Workshop with Vietnamese catfish farmers on better management practices and cluster formation.

The project held a workshop to discuss BMP implementation in Can Tho, Vietnam, on 16 April 2011. The workshop was attended by 60 farmers and officials from the four participating provinces of An Giang, Don Thap, Vinh Long and Can Tho and organised by Can Tho University. Discussions centred around the formation of collaborative groups to implement BMPs, mechanisms for group operation and governance, requirements for record keeping and standard operating procedures and arrangements for evaluation.

Eleven collaborative farmer groups were agreed to be established by participants, each of which consists of farmers whose properties are clustered within a small geographic area and share a common water supply. Eight of the groups are engaged in catfish growout and three are nurseries that produce fingerlings for sale to growout farms. Each group selected a Chair and Vice-chair and agreed on standard operating procedures and governance arrangements, including the development of crop and water calendars, organisation of meetings, record keeping and liaison with input suppliers and processors.

Participants suggested that there should be regular meetings between groups, including between nursery and grow out clusters. This will assist both types of group coordinate their activities better. For example, growout clusters will develop a crop calendars and then discuss their needs with nursery clusters to ensure that the required quantities and size/quality of seed will be available at the desired stocking time. Participants also expressed interest in inviting processors to attend their cluster meetings to observe improvements in farming practices and encourage them to buy BMP product.

The project will be implemented over two crop cycles, with staff from Can Tho University providing technical support to farmer groups on implementation of BMPs, monitoring compliance and outcomes. At the request of participants, Can Tho University will also provide a technical training programme for one person from each farmer group and two technical staff from each provincial government.

For more information about the project please visit the ASEM Aquaculture Platform section of the website (link below). The ASEM Aquaculture Platform is funded by the European Commission's 7th Framework project.

http://www.enaca.org/modules/asem/index.php?content_id=1

Scaling up BMPs: A national workshop

Better management practices have proved to be a highly effective tool for the Indian shrimp farming industry. Work to extend adoption of the practices is ongoing, and in this view a national workshop was held in Chennai, India, 16-18 May 2011 to discuss scaling up strategies, to extend the concept to new areas and involve more farmers, and identify lessons learned that can be applied elsewhere. The aims of the workshop were to:

- Build awareness and capacity of relevant stakeholders on BMPs, cluster management, standards and certification, cluster/group certification, internal control systems and market access issues.
- Share lessons from BMP and cluster management projects in India, Vietnam, Thailand and Indonesia.
- Perform a thorough assessment of the impact of shrimp BMP and cluster management programs in India, including technical, social, economic and environmental concerns.
- Identify factors for success and constraints to adoption.
- Identify opportunities and challenges for scaling up.
- Provide projections on the impact of scaling up at the national level.
- Develop scaling up strategies for use by national institutions, regional organisations and potential donors.

Participation

The workshop brought together key stakeholders from all over India. These included representatives from MPEDA/NaCSA, ICAR (CIBA, CIFA, CMFRI), state fisheries departments, NFDB, CAA, fisheries colleges of state agricultural universities, farmer leaders, hatchery operators and processors, certification and standard setting bodies. In addition, experts from various regional and international organisations (e.g. NACA, FAO, WFC, INFOFISH)

Participants in the workshop on scaling up BMPs at the national level.

with expertise on aquaculture development, small-scale aquaculture, BMPs and cluster management attended the workshop.

Process

The workshop had three sessions that were integrated in a logical fashion to ensure continuity, facilitate discussion and enhance uptake:

- The first session included expert presentations on opportunities and challenges for small scale aquaculture in Asia, development and implementation of commodity specific BMPs, cluster management, innovative networking and communication channels in support of small scale farmers, group/cluster certification, and linking small scale farmers to markets.
- The second session focussed on sharing of experiences from India, Thailand, Indonesia and Vietnam.
- The third session will focussed on impact analysis and strategies for scaling up, including working group discussions, development of action plans and recommendations and presentation back to the workshop.

Outputs

Outputs from the workshop were discussed with a view to adoption as policy by institutional stakeholders supporting small scale farmers to remain competitive, profitable, responsible and sustainable. Key outputs included:

- Better understanding of opportunities and challenges facing small scale farmers in India.
- Increased awareness and capacity in development and implementation of BMPs for key aquaculture commodities.
- Increased awareness and capacity on cluster formation, cluster management.
- Increased awareness and capacity on certification, cluster certification and market access.
- Strategies for scaling up BMP and cluster management programs at the national level for key aquaculture commodities.
- Recommendations in support of small scale farmers to remain competitive and sustainable.
- Recognition of inter- country benefits and ways to enhance such collaboration.
- Definition of next steps and an action plan.
- Preparation of a workshop report summarising the above.

The report of the meeting is available for download from the NACA website, please visit the project web page for more information about the ASEM Aquaculture Platform:

http://www.enaca.org/modules/asem/index.php?content_id=1

Audio recordings

Audio recordings of the technical presentations made at the workshop are available for download from the NACA website at the link below. If you prefer you can also stream them online, or subscribe to the NACA podcast feed:

http://www.enaca.org/modules/podcast/programme.php?programme_id=6

The available recordings are as follows:

- Opening ceremony
- BMPs and cluster management: Way forward for small scale farmers to remain competitive and sustainable
- Aquaculture certification and market access: Opportunity or bottleneck for small scale farmers?
- Fair trade certification: Enabling mechanism for small scale farmer groups
- Shrimp BMP adoption through cluster management approach in India
- Lessons learned from ACIAR shrimp BMP programmes in Indonesia
- Invisible hand in BMP adoption: Malaysian experience
- Theory and practice of scaling up and scaling out
- BMP and cluster management in India: Impact assessment and ideas for potential scaling up strategies
- Role of institutions in scaling up: MPEDA
- Role of institutions in scaling up: CIBA
- Role of institutions in scaling up: CIFA
- Role of institutions in scaling up: Central Aquaculture Authority
- Role of institutions in scaling up: National Fisheries Development Board
- Role of institutions in scaling up: Kerala Fisheries Department
- Scaling up BMPs in India: Opportunities for Professional Fisheries Educational Institutions
- Role of industry in scaling up: Farm cluster leaders
- Role of industry in scaling up: Hatchery operators
- Role of industry in scaling up: Mobiaqua
- Role of industry in scaling up: Certification bodies

2nd Aquaclimate project meeting

Aquaclimate is a three year project funded by the Ministry of Foreign Affairs, Norway, through the Royal Norwegian Embassy in Thailand, which supports scientific research in selected vulnerable farming communities in the Asian region.

The second annual meeting of the project, convened by NACA, was held at the Inland Fisheries and Aquaculture Training Institute, Kalawewa, Sri Lanka from 7-9 March 2011. The meeting brought together 22 professionals from all partner countries and created a platform for the partners to present their year's progress and to hold in-depth discussions about the way forward.

The technical presentation sessions portrayed that the project has generated a large quantum of information and data, perhaps most of which are for the first time on climate change impacts on aquatic farming systems per se. The meeting agreed that there is a need to consolidate such information and subject these to scientific scrutiny prior to disseminating to stakeholder groups and employing in preparation of policy briefs.

The team also agreed upon on a work plan for the next project year (March 2011 – March 2012) of which more emphasis has been given to the consolidation of available data, preparation of manuscripts for peer reviewed international journals and preparation of policy briefs. Furthermore, the meeting identified prospective initiatives such as climate change impacts on fry and fry to fingerling rearing farming systems, culture-based fisheries in non-perennial reservoirs in Sri Lanka, captive breeding of major carps of Sri Lanka and value chain/market chains of commodities.

The meeting also comprised of a project evaluation session, which facilitated synthesis of the mid-term evaluation report. According to the report all project activities appear to be on track, however the option for seeking a six month extension from Norad for final report submission was considered appropriate, considering the complexity and scale of the various case studies presently underway. The report also pointed out the necessity of extrapolating the key findings beyond the scope of the case studies to different sectors and regions in order to achieve maximum impact.

Phase 2 of the project is comprised of two salient activities: the development of a broodstock management plan for salinity tolerant strain of tra catfish and better management practices for selected farming systems to mitigate some potential impacts of climate change. It was agreed that these components could be initiated independent of the current project activities. The report of the meeting is available for available for download. For more information, please see the Aquaclimate project webpage.

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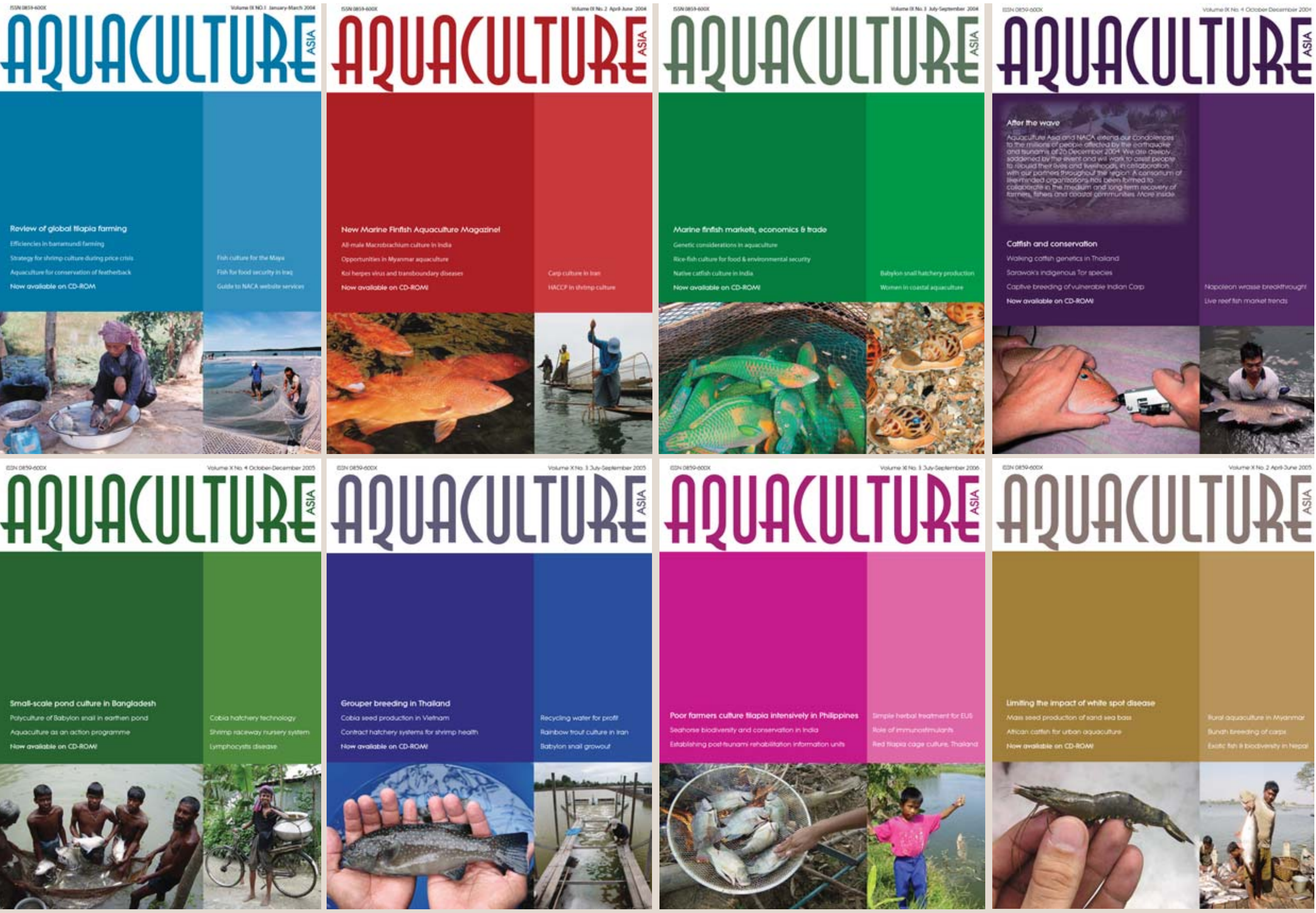
NACA is a network composed of 18 member governments in the Asia-Pacific region.

Participants in the 2nd Aquaclimate project meeting.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AQUACULTURE 2010 Global Conference

All slides and audio recordings now published on conference website!

Have your say on the future of aquaculture development

With aquaculture now providing nearly 50% of global food fish supplies, FAO in partnership with NACA and the Thai Department of Fisheries, organised the *Global Conference on Aquaculture 2010*, to evaluate where the sector stands today and prepare for the challenges ahead. The objectives of the conference were to:

- Review the present status and trends in aquaculture development.
- Evaluate progress against the 2000 Bangkok Declaration & Strategy.
- Address emerging issues in aquaculture development.
- Assess opportunities and challenges for future aquaculture development.
- Build consensus on advancing aquaculture as a global, sustainable and competitive food production sector.

The presentations and complete audio soundtracks from the conference are now available for download from the conference website at the link below.

Enquiries and further information

Please visit website for more information, or feel free to contact the conference secretariat:

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