The future of mariculture

A regional approach for responsible development of marine farming in the Asia-Pacific region

Regional review on existing and potential mechanisms for technology transfer

Introduction

Applied research activities on existing and potential mariculture species are being carried out throughout the region by specialised national research facilities. Many of the commercial marine species are farmed regionally and rarely confined to the industry of any given country. The transfer of farming technologies and better practices in the region through a strengthened collaborative mechanisms may further support the development of the sector and ensure that lessons learnt may be shared to the advantage of all concerned. The objectives of this review are to:

1. Review existing mechanisms for technology transfer and propose alternatives for effective dissemination of R&D to farmers and other stakeholders.
2. Identify present training activities and likely future training requirements for the sustainable development of mariculture.
3. Identify centres of excellence in various forms of mariculture.

The information summarised below on regional mariculture research, training activities and future needs has been compiled from a variety of sources including:

- Country review papers for this workshop.
- Report of the Expert Workshop and Regional Aquaculture Review for Asia (November 2005).
- Report of the 8th NACA Technical Advisory Committee (November 2005).
- Report of the 17th NACA Governing Council, (23-28 February 2006).
- NACA publications (reviewed content from 2001-2006).
- Asia-Pacific Marine Finfish eNewsletter (reviewed content from 2001-2006).
- Institutional websites (content reviewed as of February 2006).
- Profile of NACA Centres (December 2001).

Existing and alternative mechanisms for technology transfer

Existing mechanisms

Most of the existing mechanisms used to transfer mariculture technology are largely standard practices that are commonly used throughout fisheries and aquaculture (or more broadly, in agriculture) in general. They may be loosely broken down into:

Hands-on training - short courses, study tours, training schools and on-the-job experience
Due to the highly technical nature of some aspects of mariculture, particularly hatchery technology, hands-on training in its various forms is often the most practical mechanism by which technology transfer can occur. Short, intensive courses on specific aspects of mariculture (such as the Regional Grouper Hatchery Production Training Course offered annually by Indonesian research centres in collaboration with NACA) are among the most common technology transfer mechanism cited by countries. Hands-on mariculture training opportunities are also provided through vocational training schools (Australia, Malaysia) and on-the-job in some research centers where farmers may work on a government station for a period to gain experience in the practical and/or technical aspects (Indonesia). Demonstration farms and exchange visits to exceptionally good private farms are used in some countries to raise awareness and encourage the private sector to enter into new industries or to adopt new practices (India, Indonesia, Thailand).

While hands-on training can provide practical and effective learning opportunities for transferring technology between all kinds of stakeholder groups, there is a shortage of specialised facilities where such training can take place and the number of opportunities / placements are generally not sufficient to meet demand. Participants often have to travel a great distance at considerable expense and so such training is often only accessible to people that are relatively wealthy or that have a sponsor (government, research and industrial-scale farmers).

Extension services, seminars and discussion groups
The accessibility issues that small-scale producers and rural communities face in centralised training opportunities are widely recognised. Most governments therefore employ a range of 'mobile' mechanisms to bridge the gap with rural communities and take training opportunities to the producer.

Extension officers are a traditional technology transfer mechanism providing technical support to producers through on-farm advice, local seminars distribution of publications and other information, and even provision of mobile laboratory services on water quality or health (Thailand). Extension officers can also play an important role in the social cohesion of local producers. The scale on which extension officers are deployed varies widely between countries, with officers serving individual communities (China) to entire states (Australia). While the provision of a decentralised extension network can improve accessibility to information for rural communities, it is expensive. In most countries it is generally accepted that extension services are in decline and do not have sufficient staff or resources to meet demand. They may function most effectively where there are organised groups of producers with which they can interface. The role of NGOs involved in rural development as an alternative avenue for the delivery of extension service is well recognised by some governments, which may provide training, or work in partnership with appropriate groups (India, Thailand).

A common issue with regard to mariculture is that existing extension staff may not have sufficient technical training to adequately support farmers (Cambodia, China, India, Thailand), particularly with regards to emerging technologies.

While most extension services are funded by the public sector, farmer groups may employ their own extension staff to provide specialist services (notably in aquatic animal health), although this is seldom seen outside of industrial-scale producer groups (Australia).

Publications
Printed publications are a mainstay of technology transfer employed by virtually all governments as a (relatively) cheap mechanism for reaching large numbers of producers, although cost is still often a significant issue both for the publisher and for the end user where cost-recovery policies are pursued. As standalone products the usefulness of publications is constrained by many factors including the literacy and technical ability of the target stakeholders and so they need to be prepared with due consideration of the needs of the target group and often play a supporting role to training courses and other ways of learning. An issue that remains understated is that the accessibility of printed matter is often a significant issue for people in rural communities, just as distribution can be an issue for the publisher - producing a publication is relatively simple but ensuring that it is widely available, accessible and affordable to the people that actually need it is far more difficult. In many ways, the problems that rural communities face in accessing printed media are not dissimilar to those they face in accessing the web.

Mass media
Regular television and radio programmes are utilised by both government authorities and the private sector as a mechanism to keep farmers informed of developments, emerging issues and improved practices. These range from current affairs segments in broader agricultural programmes (Australia) to dedicated documentary segments (Thailand) and talk back programs on where farmers may 'call in' (Cambodia). Clearly such devices have enormous potential, although agricultural programs to be broadcast outside of peak hours.

Alternative mechanisms

In a climate of increasing demand for knowledge and diminishing extension resources the transfer of technology to a large decentralised stakeholder base will become increasingly difficult and require fresh approaches. Some promising alternative approaches to technology transfer are described below.

Information access surveys

An Information Access Survey (IAS) is not a mechanism for technology transfer in itself, but it is a tool that can help make sensible decisions about the best ways to communicate with different groups of stakeholders. The purpose of an IAS is to conduct an objective assessment to:

- Identify key issues about people and what information needs they have.
- Identify what media sources are available, what strategies people use to get their information and how cost-effective these are.
- Suggest the most appropriate methods of communication that are useful for different groups of people.

An IAS should:

- Take into consideration the needs of the target group.
- Involve as many people as possible.
- Be socially and culturally acceptable.
- Be flexible, so that it can be modified to suit different circumstances.
- Provide recommendations that are easy to put into practice.

For each stakeholder group, issues to consider include in preparation of an IAS include:

- What is the geographical area of the survey?
- What are the existing communications networks available to target stakeholders?
- What are their needs?
- What kinds of information would be useful to them?
- How would it help them?
- How do people prefer to get this kind of information?
- Mitigating social, political or cultural factors?
- What techniques work well, and why?

An IAS provides an indication of how effective different media are to reach target stakeholders and forms the basis for developing an integrated communication strategy. Some approaches are likely to be more useful than others, or may only be useful to part of the target group. It is quite likely that an IAS will reveal that an integrated or mixed approach using multiple strategies may be most effective. Information Access Surveys have been conducted by the NACA STREAM Initiative for Cambodia, Vietnam and the Philippines. These and guidelines on conducting IAS are available for download from the STREAM website at:
http://www.streaminitiative.org/Library/Communications/communications.html.

Farmer associations (aquaclubs)

The formation of farmer associations is an approach that has demonstrated excellent potential as a mechanism to facilitate technology transfer both between stakeholder groups and within farmer communities. In India, MPEDA in cooperation with ICAR, ACIAR and FAO, has provided support to bring clusters of shrimp farmers together into cooperative associations to implement better management practices (BMPs), as part of a project on shrimp health and coastal zone management. The groups, locally known as ‘aquaclubs’, were initially established to engage farmers in the development of locally appropriate BMPs and to demonstrate and promote the advantages of working as a group to plan their crops. The group collectively manages common resources such as the water supply, thus reducing inter-farm interference, reducing the impact of disease and substantially increasing survival, size, yield and price received for the crop. Similar approaches have been applied in Vietnam with equal success.

The benefits of aquaclubs include that they:

- Serve as a focal point for extension services, leveraging the accessibility and impact of better farmers and available extension staff among small-scale producers as well as providing good opportunities for farmer-to-farmer learning.
- Provide a mechanism for rapid implementation of new technologies or better management practices across the group, such as food safety directives from export markets or traceability systems.
- Provide economies of scale in purchasing technical services, such as the testing of seed for health problems, which in turn facilitates the access of small-scale farmers to these services.
- Provide a mechanism for self-regulation as there is considerable economic incentive and peer pressure for farmers to participate and comply with the groups' management principles.
- Provide increased market power in negotiating prices for inputs and for the sale of the harvest.
- Are self-sustaining – as they are economically viable they may also be independent of government support and maintained by the farmers themselves.

Farmer associations have good potential in situations where farmers have a strong common interest and can benefit from working together, for example in the procurement of inputs or the management of shared natural resources.

One-stop aqua shops

Farmer groups can also be linked to structures that facilitate sharing of experience or access to outside knowledge. Research reported in academic journals, often in English, is an important step to sharing new aquaculture knowledge and technology but has little development impact in itself. As a consequence there is increasing interest in 'Research into Use' programmes. A particular communications and learning challenge is the exchange of learning with and amongst poor people who farm in rural areas. The evolution of local level institutions, which facilitate learning and planning and the availability of accessible local language media are helping farmers to draw down the information and other support services they need and even beginning to provide a platform for policy debate and monitoring and evaluation from farmer's perspectives.

NACA has established nine 'One Stop Aqua Shops' (OAS) in Eastern India to provide local level support and several are operational in Vietnam. The OAS function under the guiding principle of a single-point, under-one-roof provision of services, but are managed by different groups such as NGOs and Federations of SHGs, farmer groups and local community management officials. The OAS provide a variety of services according to local demand including provision of information, training, fish fingerlings, access to sources of micro-credit and loans necessary to enter and pursue farming activities. Previously farmers had struggled and engaged in considerable travel to gain access to resources such as quality fish seed and market information and had often been unaware of government, inter-governmental and NGO support, and rural banking services.

To support these facilities, in particular with the media required to fulfil their communications role, NACA responded with the launch of OASIS (the 'One-Stop Aqua Shop Information Service'). OASIS, like the OAS concept, intends to support changes to the way that information is made available to farmers and through the OAS network offer the following services, to:

- Offer farmers aquaculture and improved service delivery orientated Better-Practice Guidelines.
- Enable farmers to learn from each other's experiences and share these with other primary stakeholders throughout Asia-Pacific through publications made available in local languages at OASs.
- Find out who is who from a 'Contacts' database including details of One-stop Aqua Shops, Banks, Departments of Fisheries, NGOs, self-help groups, I\insurance providers and input suppliers.
- Enable farmers to gain access to information and facilitated access to web resources such as the STREAM and NACA Virtual Libraries.

- Enable farmers to ask aquaculture related questions and receive feedback via the NACA web-based 'discussion forum'.
- Offer awareness raising in aquaculture through documentaries, videos and drama.
- Offer exchange visits with successful aquaculture operations within the local area.

OASIS aims to make available information from farmers and fishers, service providers, news agencies, the internet, academia including databases of research and outputs from specific research programs, on-line communities of shared-interest groups, as well as learning from other countries.

The OAS has became a focus of improved service provision in an age where previously unprecedented levels of communication are possible, it has changed the way that information is being made available. The OAS enables service providers to get "closer" to communities through the development of information and service focal points.

Cooperative research networks
Cooperative research networks have gained favour over the last decade as an effective mechanism to leverage limited scientific resources against common problems, fast-tracking technological development while reducing duplication of effort. NACA coordinates one such network, the Asia-Pacific Marine Finfish Aquaculture Network (MFAN).

MFAN links researchers and institutions working on marine finfish aquaculture throughout the NACA network. The primary mechanism for information exchange is a regular email newsletter and digital magazine (PDF format), which carries a summary of the latest research findings contributed by participants or collated by the secretariat, links to relevant websites and downloadable publications and contact information. The network conducts periodic workshops and also serves as a vehicle for convening training courses such as the Regional Grouper Hatchery Production Training Course offered by Indonesian research centres and the development of proposals for regional research projects.

Factors contributing to the success of MFAN have been its focus on a suite of technical problems common to region (ie. bottlenecks in reproduction, larviculture, nutrition and health management of marine fish), a regular and common means of communication and exchange, and the presence of a dedicated coordinator to drive network activities.

As many of the scientists and institutions participating in the Marine Finfish Aquaculture Network are also engaged in other forms of mariculture, there may be scope to expand the focus of the network onto other mariculture activities.

The internet
The internet is the most powerful network for exchanging information that has ever existed in human society. Its scope of coverage, accessibility and influence grow every day. With recent advances in personal web publishing technology and content management systems, it is now possible even for a small organization with a shoe-string budget and limited IT capabilities to establish an effective website with a global reach. With careful planning, web publishing offers:

- Massively improved accessibility and circulation of information and publications. The sheer scale and worldwide nature of the internet means that even the simplest of web pages can be a highly effective communication tool.
- Low publishing costs. Good web publishing tools are available for free and most of the costs are fixed. The web offers the opportunity to publish information that may not otherwise be able to be made available in any form.
- Fast publishing. It is often possible to publish a new document and inform people of its availability in only a few minutes, making 'real time' reporting possible, as well as the provision of time-sensitive services such as market information.
- Community participation. Many web-based digital publishing tools designed to be interactive, allowing groups of people to communicate and collaborate in the process of

creating and publishing information via the internet. This allows the publishing process can be decentralized, giving the creators of the content more ownership of the process.

There are, of course, limitations to using the internet as a mechanism for technology transfer:

- The internet is not accessible to everyone. In most cases it is useful only to the sub-set of people that have access to the internet and/or computers, which tends to be relatively low in rural areas and among farming communities, although in terms of absolute numbers this group can be very large. Internet usage tends to be better in the public/research sectors.
- Some degree of computer literacy is required to make effective use of a digital publishing system and deal with daily security issues such as viruses, and a somewhat higher level to plan, install and administer such a system. These skills are often limited or unavailable in public-sector organizations involved in aquaculture.

The value of digital publishing as a mechanism for technology transfer depends to a large extent on the nature of target stakeholder groups. In most situations it is best seen as a suite of *additional* tools for communicating with people that should be used in concert with other media, preferably through an integrated communications strategy tailored to meet their needs (for example, as determined through and information access survey).

Email newsletters

Email is probably the simplest, most ubiquitous and widely understood internet technology, and email newsletters can provide a personal and highly effective way to link relevant stakeholder groups. The Asia-Pacific Marine Finfish Aquaculture Network has published a regular email newsletter since 1998, as a mechanism for researchers to publish their research findings and share experience. The newsletter contains hyperlinks to relevant webpages, publications and other information resources.

Online communities

Community websites take the web publishing concept one step further by allowing members of the public to participate as well. Instead of merely presenting information to people, community websites allow their members to communicate and exchange information among themselves. The most common form of community website is a 'discussion forum', but the community concept can be applied to nearly any form of website.

Online communities are a unique tool that in that they allow an individual to access the collective knowledge of a large group of people that may be scattered all over the world. They provide a 'venue' where people with similar interests can 'meet' each other, share experiences and solve common problems. One of the most powerful applications of online communities is as 'self-help' groups. In a highly decentralised environment, empowering stakeholders to help each other through a community website may be more practical than trying to provide direct assistance to them on an individual basis.

As with other internet technologies, online communities are only useful to a subset of most stakeholder groups. They must reach a critical mass of participants in order to become effective tools for technical exchange. Once activity reaches a certain level the feedback and mutual interaction among members becomes largely self-sustaining. Achieving the critical mass of members needed to initiate an ongoing 'conversation' can be difficult. The most important aspect is to identify an area of common interest to target stakeholders that will bind them together as a social group.

NACA is piloting the development of an online community on the NACA website, www.enaca.org. The community is still in the early stages of formation, although it has attracted more than 2,000 members to date. The community is open to public participation, but there is considerable potential to make use of the facilities to support research networks (a dedicated marine finfish aquaculture forum is available). NACA is also engaged in training staff from network institutions in website administration and management, with a view to building the capacity of member countries to provide online services, and to train their own staff.

Present mariculture training activities and likely future requirements

Regular training activities

There are currently few short-term mariculture training activities that are held on a regular basis, and most are aimed at the national or local level. The available courses are summarised below (refer to the country reports for more detail on national-level training activities):

- *Regional grouper hatchery production training course.* A three-week course organised annually since 2002 by Indonesia and NACA, it has been hosted at both the Gondol Research Institute for Mariculture and the Brackish Water Aquaculture Development Center at Situbondo. The course covers all aspects of broodstock management, captive reproduction, larviculture, nutrition, health management and growout. It is a paid course.
- *Principles of health management in aquaculture.* A 19-week online training course convened by the SEAFDEC Aquaculture Department in the Philippines. The course covers disease prevention, diagnosis and management for finfish and crustaceans. It is a paid course.
- The Malaysian Department of Fisheries offers six training courses relevant to mariculture through the Institute of Marine Aquaculture (Kedah) and the Marine Finfish Production and Research Centre (Terangganu). These are aimed at the national level, but may be open to international participation through the Malaysia Government Technical Cooperation Programme. The courses are:
    - *Fundamental aquaculture practice* (7 days).
    - *Seed production and management of marine finfish* (30 days).
    - *Cage culture of brackish water finfish* (5 days).
    - *Feed formulation and preparation at farm scale* (3 days).
    - *Seed production and culture of oysters* (30 days).
    - *Seed production and culture of mussel* (14 days).
- *Marine Hatchery Management*. A one-year vocational course offered by the Fremantle Maritime Centre (Australia). The course covers general management of recirculating hatchery systems, live food production and health management. It is a paid course.

Other ongoing training initiatives include:

- The Yellow Sea Fisheries Research Institute plans to conduct training courses on the introduction of HACCP management systems, EU Food Safety and Sanitation Regulations and Directives on the mariculture of shellfish (particularly on assessing water quality and safety), the implementation of harvesting area classification systems and implementation of marine biotoxin/algal bloom monitoring systems and information on EU markets and entry requirements for Chinese products.
- Thailand has established a programme on food safety for fisheries production aimed at assisting producers to meet requirements for domestic and export markets, the programme targets farmers, government officers and other stakeholders.
- Thailand provides training to around 25,000 farmers and other interested people each year through short courses on aquaculture, breeding and nursing, home made feeds, health management and value-adding of fisheries products. Demonstration sites are also established in selected fishing communities that provide technical assistance in water analysis and health management.
- The Marine Aquaculture Development Centre at Lombok, Indonesia, is conducting training on abalone culture for vocational school teachers from seven provinces, to accelerate spat production and support industry development.
- The Republic of Korea has introduced programmes to assist people to study mariculture (in particular youth) and to establish aquaculture businesses, to encourage new entrants into the industry.
- The Buan Fisheries Technology Institute, R. O. Korea, has established test farms for the clam *Meretrix lusoria* in four locations around Buan. This included resource management and development of value-added products.
- The Indian Central Marine Fisheries Research Institute has established open sea cage demonstration farms at four sites, two on the east coast and two on the west coast of India.

Potential training activities / training providers

Some research centres in the region have indicated that they have either recently held, or have the *capability to provide* ad-hoc training courses in particular aspects of mariculture in response to requests as summarised below:

Fremantle Maritime Centre (Australia)

- Culture of specific temperate species of marine finfish through short course training programmes.
- Aquaculture mechanics.
- Water quality analysis and environmental impact assessment of aquaculture.

Central Marine Fisheries Research Insitute (India)

- Pearl production.
- Bivalve hatchery design and management.
- Mussel culture.
- Edible oyster culture.
- Live feed and phytoplankton culture.
- Seaweed culture.

National Bureau of Fish Genetic Resources (India)

- Cryopreservation of fish milt.
- Genetic characterisation using isozyme and isoelectric focussing markers.

Brackish Water Aquaculture Development Center (Jepara, Indonesia)

- Milkfish hatchery production.
- Nutrition.

Center for Marine Aquaculture Development (Lampung, Indonesia)

- Breeding and culture of marine finfish (Asian seabass, various groupers, seahorse).
- Breeding and culture of sea cucumber.
- Breeding and culture of pearl oyster.
- Seaweed culture.
- Fish health management.
- Live food production.

Wando Maritime and Fisheries Office (R.O. Korea)

- Laver reproduction.

Pohang Regional Maritime Affairs and Fisheries Office (R. O. Korea)

- Polyculture of Japanese flounder and abalone in land-based tanks.
- Production of the sea squirt (ascidian) *Halocynthia roretzi*.

National Aquaculture Development Authority (Sri Lanka)

- Community-oriented shellfish farming.

Thailand (institute not identified)

- Babylon snail production.
- Development of information technology for fisheries.

Future training needs

Recent requests for training related to mariculture as identified in the country review papers, the 8th NACA Technical Advisory Committee Meeting in Iran (November 2005) and the 17th NACA Governing Council (February 2006) and by a range of other stakeholders were:

- Training opportunities for extension officers in mariculture technology (Cambodia, China, India, Thailand) including in livelihoods approaches and communications skills (Cambodia) so as to more effectively support the industry.
- Training of extension officers in Better Management Practices in various fields of mariculture.
- Extension of broodstock management programmes and improved nursery techniques to prevent genetic deterioration of broodstock, to lay the foundation for future genetic improvement programs, and to assist in providing high quality seed to farmers (China, Malaysia).
- Good handling and storage of fisheries products (China).
- Depuration and traceability of shellfish products and enforcement of EU hygiene regulations (China).
- Fish health management (Iran), disease surveillance and reporting (India).
- Marine ornamental fish culture (Sri Lanka).
- Seaweed culture (Cambodia, Indonesia, I.R. Iran).
- Aquaculture project development and management.
- Economic and financial planning of aquaculture (Secretariat of the Pacific Community). Future efforts by SPC will provide tools and training, such as software tools to assist businesses to address these areas.

Although some of these issues may be addressed by existing training programmes, further emphasis may be warranted in these areas.

Other common issues were:

- Poor linkage between research institutes, extension stations and farmers. It is often the interface between different classes of stakeholders that are the most serious problems (for example, between farmers and researchers).
- A shortage of training opportunities / facilities for youth (new entrants to the industry), farmers and entrepreneurs (India, I.R. Iran, Republic of Korea).

Conclusion

Mariculture is, in general, both at an earlier stage of development than freshwater aquaculture and technically more complex. The weakest links in the transfer of technology are often the interface between different classes of stakeholder, for example between researchers and farmers, leading to a considerable delay in the implementation of technological advances by producers and a shortage of skilled labour at the farm level, particularly among small-scale farmers. Development of a whole-of-chain approach to technology transfer will require a hybrid approach that takes into account the needs and behaviour of different stakeholder groups, and mechanisms to facilitate interaction between them.

Given the ongoing decline of traditional extension services there is a need to investigate alternative approaches to technology transfer, including the role of the private sector. Approaches that encourage networking both between and within stakeholder groups may offer effective solutions. Collaborative research networks communicating via email and the internet are an effective mechanism for leveraging research resources and exchanging experience in the international context. Collaborative farmer associations and locally owned/maintained information centres can offer an excellent and sustainable mechanism for facilitating rapid technology transfer at the local level.