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AQUACULTURE ASIA

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NACA
An intergovernmental organization that promotes rural development through sustainable aquaculture. NACA seeks to improve rural income, increase food production and foreign exchange earnings and to diversify farm production. The ultimate beneficiaries of NACA activities are farmers and rural communities.

Contact
The Editor, Aquaculture Asia
PO Box 1040
Kasetsart Post Office
Bangkok 10903, Thailand
Tel +66-2 561 1728
Fax +66-2 561 1727
Email naca@enaca.org
Website http://www.enaca.org

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From the Editor's desk

An update on eNACA

In 2002 the focus of NACA's Information Programme (eNACA) was on developing a website and electronic communications infrastructure that could be used to support online networking and collaboration. The major components of this – the website, electronic publishing and email newsletter are largely complete, with the addition of a searchable electronic library database undergoing finalization. Now that these communications tools have been 'switched on' our focus in 2003 will be on building a community of users to exploit them.

As part of this community building we will be seeking to establish a network of volunteers to provide local information from around the region to feed back into the network. So if you have some local news, a training course, workshop, meeting, publication or just an experience that you would like to advertise or share with the network, feel free to send it in. Relevant material will be published in Aquaculture Asia, on the website or elsewhere. Anyone can contribute.

We are also be seeking to formalize the participation of organizations involved in aquaculture or aquatic resource management in the eNACA network, as part of a regular information exchange programme. Its free and easy – all your organisation has to do is to nominate a person we can contact on a regular basis for information on your local news, events and publications - preferably someone in a good position to inform us of your local activities, such as an information officer. Participating organizations may be eligible for free publications and other incentives. We would particularly like to hear from farmer's organizations. If you would like more information please contact me directly at simon.wilkinson@enaca.org, or write in.

On the subject of electronic publishing, last year NACA undertook to make all our new publications available for free download from the NACA website as they are produced. The aim of this policy was to increase the distribution and circulation of publications, particularly in developing countries. I am pleased to report that this service has proved to be very popular with some individual titles downloaded more than 5,000 times !

NACA's electronic publishing service continues to grow in leaps and bounds with new titles added nearly every week. If you'd like to be informed of new publications please consider subscribing to the NACA email newsletter – available for free through our website www.enaca.org. We are also happy to publicize relevant articles or publications from other organizations or individuals in this forum – so send them in or send us a link.

Lastly, I would like to draw your attention to the newly-released Marine Finfish Aquaculture Network website, available from www.enaca.org/grouper. The site has been redesigned and now offers a number of new and useful tools, including weekly average wholesale prices for live fish in Hong Kong, a discussion forum where you can chat with other farmers and traders, a photo gallery and a collection of resource publications and articles. Need advice or want to share a revelation with others ? Check it out !

Simon Wilkinson

AQUACULTURE ASIA

In this issue

Sustainable Aquaculture

Peter Edwards writes on rural aquaculture: Peri-urban aquaculture in Kolkata 4

A case of informal shrimp farmers association and its role in sustainable shrimp farming in Tamil Nadu, India 10
M. Kumaran, N. Kalaimani, K. Ponnusamy, V.S. Chandrasekaran, D. Deboral Vimala

Diffusion and adoption of shrimp farming technologies 20
M. Kumaran, K. Ponnusamy and N. Kalaimani

Farmers as Scientists: Aquaculture education in India - opportunities for global partnership 26
M.C. Nandeesha

Information system of fish germplasm resources in China 41
Yang Ningsheng, Ge Chanshui, Ouyang Haiying, Yuan Yongming

Status and development needs of freshwater crustacean aquaculture in China 46
Xu Pao

Page 4

Page 10

Research and Farming Techniques

Aquaculture fundamentals: Getting the most out of your feed Part II: The role of macronutrients 6
Simon Wilkinson

Fish breeding in captivity - some innovative adaptations of technology by Bengal farmers 13
N.R. Chattopadhyay

Scientific guidelines for farmers engaged in freshwater prawn farming in India 17
Vishal Saxena

Page 13

Marine Finfish Section

News and publications 32

Status and development of mariculture in Indonesia 35
Ketut Sugama

Page 26

Aquatic Animal Health

Use of probiotics in larval rearing of new candidate species 15
Rehana Abidi

Advice on aquatic animal health care: Problems in shrimp culture during the wet season (Thai/English languages) 38
Pornlerd Chanratchakool

What's new in Aquaculture

What's new on the web 19

Aquaculture Calendar 24

News 43

Page 32

Landmark Council Decision Expands NACA Further

Pedro B, Bueno, Director-General of NACA, conceived of and was Editor of Aquaculture Asia for six years. He now writes from the vantage view of the Publisher.

NACA has just held its 14th Governing Council Meeting (28 March-1 April 2003), which decided on accepting the application of the Secretariat of the Pacific Community, an organization representing a very important group of nations, as Associate Member of NACA. We have since received confirmation of acceptance of the responsibilities ad obligations provided in the NACA Agreement (as amended) from SPC's Director General Lourdes Pangelinan.

The Council also approved reciprocal associate membership with the Asia-Pacific Association of Agricultural Research Institutes (APAARI). The significance of this move, as articulated by FAO's representative to the Governing Council, lies in the fact that APAARI's member institutes are very strong in crops and livestock R&D, and that integration of aquaculture and aquatic resource management with agriculture has been strongly emphasized in the Sub-committee on Aquaculture of FAO's Committee on Fisheries. Reciprocal membership would thus place NACA in a strong position to advocate aquaculture and aquatic resource management issues at APAARI deliberations.that NACA's

The Islamic Republic of Iran, was welcomed by the Governing Council as the latest member-government of NACA on the strength of advice from the Government that they have before the Council Meeting deposited their instrument of accession to the NACA Agreement, with the depositary the Office of the Director General of FAO.

An Aquaculture Development Seminar and Workshop was again organized, this time focused on Myanmar. It was attended by representatives of farmer groups, civil society operating in Myanmar, private industry, national and regional R and D organizations, members of the Governing Council, donor and development assistance agencies, and government workers in fishery. Resource speakers included experts from the fisheries departments of Myanmar and Thailand, SEAFDEC Aquaculture Department, CP Indonesia, NACA, and universities in Myanmar. The workshop also served as a forum for further inputs and comments to the Report of the Mission on Coastal Aquaculture and Inland Fisheries and Aquatic Resources Management organized by NACA in December 2002 and composed of experts from ACIAR and other Australian scientific institutions, namely AIM and DEAKIN University; FAO RAPA, STREAM, DOF Thailand, and NACA.

Finally, we excerpt herewith the welcoming speech of the Immediate Past Chairman of the Governing Council, Mr Junaidi Che Ayub of Malaysia, to provide a context to the 14th Governing Council Meeting:

"NACA's programs address poverty, hunger, lack of rural jobs, education, haring, allocation and management of resources, and development of the rural areas. It promotes technical cooperation among governments, and it encourages exchange and sharing of views and information so that governments can – as the Honorable Minister emphasized — benefit from each other's experiences and help each other. I am very pleased to say that the Governing Council in its previous meetings has extended the spirit of technical cooperation even further. They have agreed that in the NACA organization, the members with more resources and with stronger capacities will take responsibility to help the others.

During my term as Chairman of the Council, I have been a happy witness to and participant in an increasing number of cooperative activities. We have attracted and established strong cooperation with more partners. And, very importantly, the family is expanding. In this regard, please join me in welcoming the latest member of the Organization – the Islamic Republic of Iran.

I am also informed that the Government of Indonesia is about to officially become a member, and I would like to extend my appreciation to the leadership and the staff of the Aquaculture Department of the Republic for Indonesia for its vigorous efforts at bringing Indonesia into the NACA family. Having said that, I know that both Iran and Indonesia have long been taking part very actively in and contributing very well to the regional activities of NACA.

I am also delighted to announce that we shall be deliberating during this meeting another measure aimed at expanding participation in the Network, that of associate membership. This measure – in the form of an amendment to the NACA charter - is sponsored by the Government of Malaysia. I am pleased to announce that a very important group of nations – represented by the Secretariat of the Pacific Community – has expressed its intent to become the first associate member of NACA. I am happy to note their participation and welcome the delegate from the South Pacific Community.

Honorable Minister, Your Excellencies, much has been said about the limited resources and diminishing development assistance. As you have pointed out, Mr. Minister, cooperation among nations complement limited national resources, and extend the benefits to more governments and more people. I cannot agree more. NACA's strength is in the cooperation among members, and their cohesiveness. It is for this reason that external assistance goes a longer way and makes a stronger impact on development. In this regard, I would like to express the NACA Governments' appreciation to the development agencies and organizations who have partnered NACA in its various programs.

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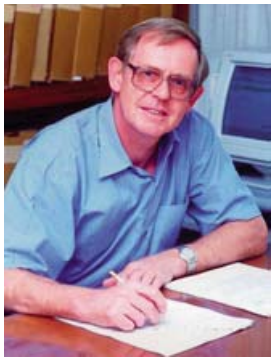


Peter Edwards is Professor of Aquaculture at the AIT in Bangkok where he founded the aquaculture program. He has 25 years of experience in education and research relating to small-scale, inland aquaculture based on extensive travel throughout the region.
Email: pedwards@ait.ac.th

Peter Edwards writes on

Rural Aquaculture

Peri-urban aquaculture in Kolkata

This issue's column requires two explanations regarding subject matter content: How does "peri-urban aquaculture" possibly justify inclusion in a column on "rural aquaculture? And Dr. Nandeesha recently wrote on the Calcutta (or Kolkata as it's now known) wastewater-fed aquaculture system in his column in the April-June, Volume VII, No. 2 issue (Sewage-fed aquaculture systems of Kolkata, a century-old innovation of farmers) so why write another piece on the same subject?

While most would agree that rural aquaculture is part of the overall strategy of rural development to address widespread poverty in developing countries through contributing to the livelihoods of the poor by providing a better diet, employment and income, urban aquaculture remains to be adequately defined. Clearly it takes place in peri-urban and urban areas but there is considerable on-going debate about its characteristics for developed as well as developing countries. Most wastewater-fed aquaculture, at least that involving conventional wastewater or sewage, takes place in peri-urban and urban areas and contributes to the welfare of poor producers as well as poor urban consumers. Thus, it qualifies as rural as well as urban aquaculture. The two definitions overlap because rural aquaculture is primarily characterized by developmental objectives relating to poverty and food security, whereas urban aquaculture at present is tentatively defined only in relation to taking place in peri-urban and urban space.

Transporting fish harvested from a wastewater fed pond to a nearby wholesale market in the East Kolkata Wetlands

Nandeesha described the history, characteristics, operation and management of the almost 4,000 ha of wastewater-fed ponds in the East Kolkata Wetlands, the largest system of its type in the world. My recent involvement with Kolkata has been through the DFID Natural Resources Systems Programme funded project, Land-water Interface Production Systems in Peri-urban Kolkata, involving institutions in India and the UK. The purpose of the project is to address the most pressing issues threatening the livelihoods of significant numbers of poor people who depend on peri-urban farming systems in Kolkata (see the project's web site for more details: http://www.dfid.stir.ac.uk/dfid/nrsp/kolkata.htm.

I was asked to meet key actors or stakeholders to discuss management and planning for Kolkata peri-urban production systems (fish, vegetables, rice) because of my long association with the East Kolkata Wetlands. I made my first visit there in 1978. Ten years later I was technical consultant to the International Seminar on Wastewater Reclamation and Reuse for Aquaculture held in Kolkata in 1988. It was organized by the UNDP-World Bank Water and Sanitation Program, ESCAP and the Government of India as an activity under the International Water Supply and Sanitation Decade which aimed to promote low-cost and non-conventional methods to alleviate poverty and safeguard public health. The major recommendation of the Seminar was that the Kolkata system should be studied as a possible model for appropriate sewage treatment and reuse systems in India and elsewhere. I was also a member of two unsuccessful project identification missions funded by DFID to examine the role of wastewater-fed aquaculture in the development of alternative low-cost sewage treatment in 1990 and 1993. And "out of the blue", when I'd almost given up on

Fish transporters showing their wares

wastewater-fed aquaculture, I was asked to give a keynote on the subject at the meeting of the International Ecological Engineering Society in Kolkata in 1998. The latest DFID funded project on wastewater reuse started in 2000, and I made two visits in 2001 and 2002 to carry out "senior stakeholder interviews". So here we are, 25 years and 7 visits to Kolkata later!

I was privileged to interview a wide range of persons from the West Bengal Government, including the Major of Kolkata, the Ministers of Fisheries and Housing, the Chairman of the West Bengal Industrial Development Corporation; technical specialists from line agencies such as Environment, Fisheries, Irrigation and Drainage, and Sanitation; NGOs; and of course the ultimate beneficiaries - fish pond workers, fish farm owners, fish traders and fish consumers.

Several key issues came up repeatedly in the interviews:

- Polarized views between urban / industrial and rural - peri-urban / agricultural - natural resource use development. A key issue is how to resolve what are often erroneously referred to a "pro-environment/pro-aquaculture / pro-poor" and "pro-development" goals with a balance between the two
- Definition of wetlands, with the overly restrictive definition used by the Departments of Environment and Fisheries in the view of the urban / industrial development lobby likely to be exacerbated by the recent declaration of the wastewater-fed fisheries as a Ramsar site
- The role of wastewater-fed aquaculture as a low-cost wastewater treatment system for Kolkata
- Limited sharing of knowledge among individuals, especially from different sectors, leading to misunderstanding and polarization of views
- Poor governance with an inter-sectoral planning and management body yet to be established
- A range of technical and social issues that affect and are affected by wastewater-fed aquaculture

The existing system, as developed by local farmers as described by Nandeesha, works extremely well on the better-managed farms with an adequate supply of sewage. Average yields approaching 4 tonnes / ha for the entire area are probably maximal in the large ponds which can exceed 100 ha in area. There is scope for intensification through better management of current technology, which would lead to increased output per unit of current resources. The benefits to the livelihoods of thousands of poor producers, input suppliers and traders, and consumers have been documented by the project.

Three main "win-win situations were identified for groups of stakeholders currently in conflict:

- Balanced development of indigenous wastewater use through aquaculture and urban and industrial development in areas selected by all stakeholders. Economic growth would create increased opportunities for the poor as well as the better off. Some displaced fishers could be employed in improved fisheries requiring increased levels of employment
- Lack of financial resources, which is exacerbated by insecure tenure, has limited desilting of ponds for decades, which limits fish production. The development of new towns outside the main wastewater-fed fishpond complex has created a market demand for silt for landfill, providing a mechanism to restore the fish ponds. Experience at the Mudialy Fishermen's Cooperative Society in the south of Kolkata has shown that it is economically feasible to desilt

Fish from the wastewater fed ponds being sold in a retail market in Kolkata city

ponds; and also that larger dikes can be used to cultivate vegetables irrigated with pond water, a far safer practice for both producers and consumers than irrigation with raw sewage.
- As an increased supply of wastewater to ponds would lead to higher fish production, farmers should be willing to pay for wastewater, thereby providing cost recovery to the city.

The single largest threat to the system, filling in the ponds for urban / industrial development, is likely to be reduced by the recent listing of the complex as a Ramsar site as it carries a Government obligation to ensure conservation and wise use. The latter is defined as sustainable utilization for human benefit compatible with maintaining the natural properties of the ecosystem, in this case wastewater-fed (agro) ecosystem. On-going wastewater development projects do not threaten the wastewater supply from the core area of the city to the fishponds. A World Bank project is renovating the sewers; and a project to desilt the main sewage canal that feeds the fishponds will increase the flow of sewage to the ponds. Kolkata sanitary engineers recognize the value of the ponds as a low-cost sewage treatment system; in the words of a local engineer "if at any time the city authorities think of introducing conventional technology, it will be a very very foolish step".

Cultivating vegetables on a wastewater fed fishpond dike at Mudialy Fishermen's Co-operative Society

Aquaculture Fundamentals

Getting the most out of your feed Part II: The role of macronutrients

Simon Wilkinson, NACA

The role of energy in nutrition

All animals require energy in order to perform a variety of biochemical, physiological and mechanical activities that are essential to their survival, growth and reproduction. In any animal, the costs of these activities place competing demands on the available supply of energy[1]. Ultimately it is the availability of energy that determines the capacity of an animal for growth and this has a substantial influence on the way in which fish utilise and respond to feed. The energy budget in fish may be considered in the following terms[2]:

$$C = F + U + R + G$$

Where C is energy intake through food consumption, F is loss of energy in faeces, U is energy lost in nitrogenous excretory products, R is energy lost through metabolism and G is energy stored in tissues (growth). Growth can be regarded as the difference between food consumption and other components of the energy budget, ie. Growth = C - F - U – R[3]. The proportion of energy expended on growth varies widely according to the behaviour and physiology of the species.

Ration size and growth

The relationship between ration size and growth rate has been summarised by De Silva and Anderson[4]. Weight loss occurs until the ration meets the minimum energy demands of the fish. This level is known as the maintenance ration. At feed levels below the maintenance ration, assimilated nutrients are fully utilised to provide energy and fish catabolise their own fat reserves and tissues to compensate for the energy shortfall[5,6].

Growth rate increases with ration in excess of the maintenance level, although the rate of increase diminishes towards the maximum ration. The utilisation efficiency (feed conversion ratio) also improves to an optimum point, and then decreases towards the maximum ration due to a reduction in absorption efficiency[4,7]. This decline may also be partially caused by increased heat of activity at high ration[4] as fish have more energy to allocate to discretionary activities. For example, the Roach *Rutilus rutilus* has been shown to adjusts its level of swimming activity in response to changes in energy demand associated with gonad development[1].

Digestible energy content

The gross (potential) energy value of a food to a fish depends on its heat of combustion as determined by its

chemical composition. However, the realised energy value of a food is also dependent on its digestibility and this will vary between species[2,8,9]. This is because part of any particular nutrient may be present in an indigestible form and its energy value unavailable to the fish[8]. Undigested components of feed pass through the digestive tract to be voided as faeces[5].

Digestibility may also vary with life stage since some fishes do not have fully developed stomachs during the larval phase or may have different dietary requirements. Therefore it is of critical importance to consider the relative digestibility of feed components to a species and / or age class when formulating a diet[10]. A measure of digestibility, the coefficient of digestion, can be calculated from the following equation[8]: Coefficient of digestion = (nutrient intake - nutrient in faeces X 100) / nutrient intake.

Digestible energy content and essential nutrient concentration of feed and feeding frequency

A negative correlation has been reported between the rate of consumption and digestible energy content of feed, indicating that fish feed primarily to satisfy their demand for energy. However, this also means that the quantity of essential nutrients that are consumed will also be negatively correlated to the energy content of the feed[5]. More frequent feeding over the course of a day can enhance the growth rate of some species. However, this is not always the case and the effect varies with species[4], meal size and feeding time[12].

Growth and dietary composition

Fish obtain energy principally through the digestion, absorption and catabolism of proteins, fats and carbohydrates in their diet. However, in addition to providing an energy source, these materials are also required as structural components for the formation of new tissues[5]. The relative proportions and quality of proteins, fats and carbohydrates affect the allocation of these dietary components between catabolism for energy and use in the formation of tissues.

Effect of dietary protein levels on growth

The growth rate in juvenile Tilapia has been reported to increase as dietary protein content is raised until a plateau is reached at around 30-34%. Further increases in protein dietary protein content past this optimum point led to a decline in growth rate thereafter[13]. Similar trends in the mussel *Mytilus edulis*[6]. In both cases the rate at which growth rate increases slows as dietary protein content approaches the maximum, such that there is little difference in growth rate across a wide range of dietary protein levels.

Essential amino acid balance and protein synthesis

Protein synthesis is dependent on the presence of the correct ratio of essential amino acids required for the formation of complete protein molecules. When a shortfall in one amino acid occurs the rest are rendered unavailable for growth and are deaminated to provide energy instead[4]. This indicates that the potential utilisation efficiency of ingested proteins is limited by their quality in terms of meeting the essential amino acid requirements of the animal[5]. Therefore the concentration of protein in the diet needed for maximum growth is not, it itself, an indication of protein requirement in fish[13].

Protein sparing

In the absence of a non-protein source of energy in the diet, some of the protein consumed will have to be degraded in order to support the energy demands for tissue synthesis and metabolism[1,4,6]. This will obviously reduce the quantity of protein that is available for growth. Carbohydrates and lipids serve as alternative sources of dietary energy, thereby reducing the proportion of dietary protein that must be catabolised in order to meet energy demand[4]. This is known as the protein sparing effect. Lipids have a greater energy content than carbohydrates and exert a greater protein sparing effect than carbohydrates[11], which are often of limited digestibility to fish[4].

Protein : Energy ratio

The effectiveness of the protein sparing effect of carbohydrates and lipid is related to the ratio of protein to energy in the diet (P/E ratio). The optimum ratio varies with species and with protein source[10]. Variation away from the optimum ratio will result in either the catabolism of protein for energy, or the production of fatty animals[4]. Both scenarios result in suboptimal feed efficiency[14].

Hajra et al.[14] investigated the optimum dietary protein : energy ratio of the tiger prawn Penaeus monodon by manipulating carbohydrate content. Under constant protein levels growth rate, feed efficiency and protein utilisation all increased with energy content up to an optimum. Protein efficiency ratio remained negatively correlated to P/E ratio up to the optimum dietary energy level. This was attributed to a protein sparing effect associated with increasing levels of carbohydrate in the test diets.

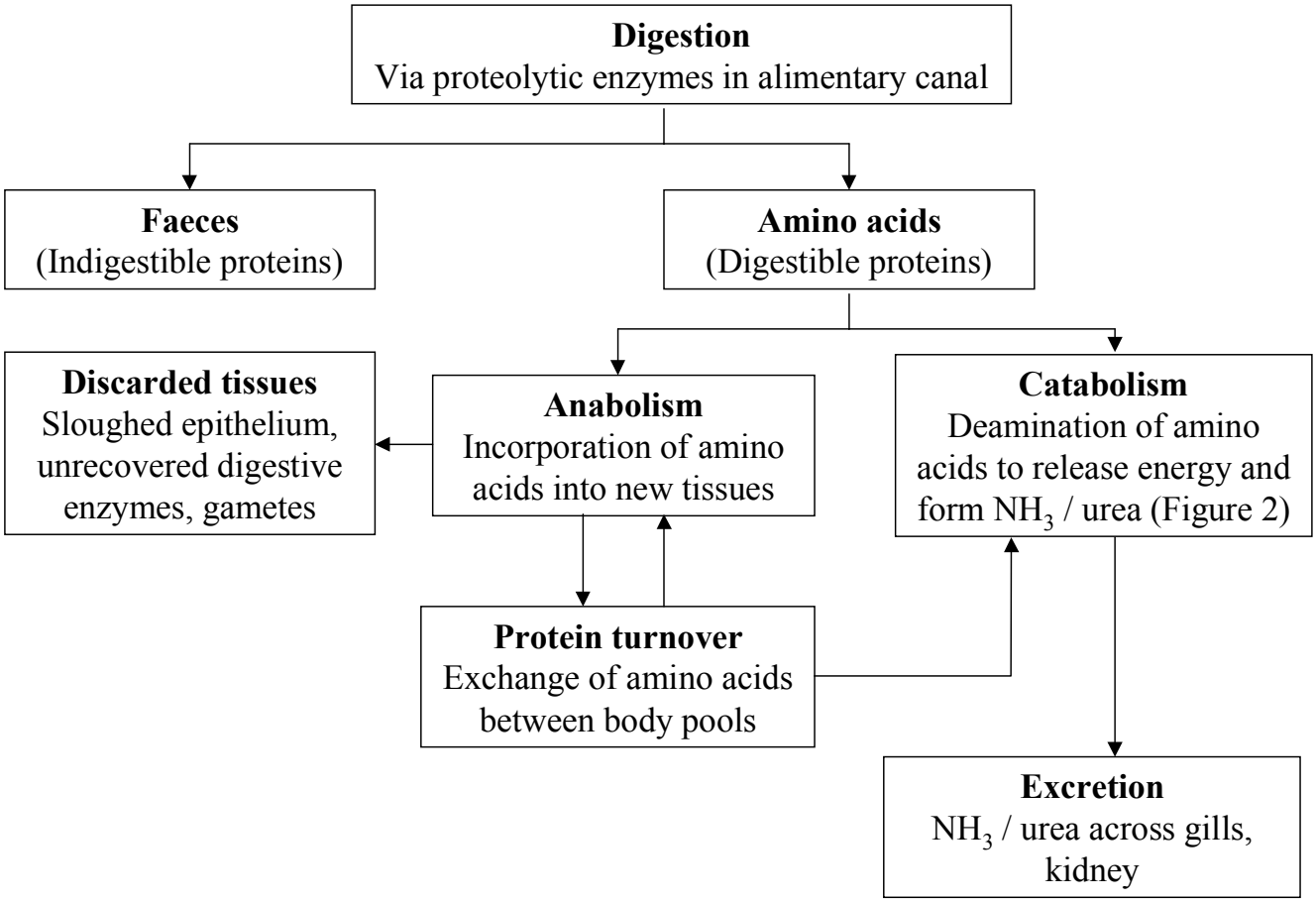
Similarly, De Silva et al.[11] reported that per cent average daily growth, food conversion ratio and protein efficiency ratio increased with dietary lipid content up to a maximum of 18% in the Red tilapia hybrid *Oreochromis mossambicus* x *niloticus*. The optimum lipid level that enhanced growth increased with increasing dietary protein level. Carcass lipid content was positively correlated to dietary lipid content, but the effect diminished with increasing dietary protein level.

Both studies found that increases in dietary energy content past the optimum level had no further beneficial effects, and resulted in reduced growth rates, feed conversion efficiency and protein efficiency ratio.

The fate of ingested protein

The fate of an ingested protein varies with the energy needs of the fish at the time of digestion, its digestibility and quality in terms of meeting essential amino acid requirements and the rate of protein/tissue turnover. Protein may also be lost or shed in tissues and reproductive material. These possibilities are summarised in Figure 1 and those not already dealt with are explored in more detail below.

Fate of ingested protein



Digestion of proteins

Digestible proteins are broken down to release their free amino acids which are then used either for the synthesis of new proteins in body tissues or for energy[10]. The digestion of proteins is catalysed by proteolytic enzymes, principally pepsin and trypsin, that are secreted into the lumen of the alimentary canal[8]. Amino acids suffer one of three fates in an organism, they are either degraded for energy, modified to form another compound, or they are used in protein synthesis[10].

Catabolism and formation of nitrogenous excretory products

The metabolism of amino acids is summarised in Figure 2[10]. There are three stages, the third of which occurs only in elasmobranchs. These are:

1. deamination, where amino groups of amino acids are removed from the carbon skeleton and converted to either ammonia or aspartate;
2. conversion of amino acid carbon skeletons to common metabolic intermediates; and
3. incorporation of ammonia and aspartate nitrogen atoms into urea.

Amino acids are principally deaminated through the transfer of their amino group to an alpha-keto acid through reaction 1, catalysed by transaminases. The amino group of glutamate is transferred to oxaloacetate in a second transamination reaction yielding aspartate in reaction 2. Net deamination principally occurs through the breakdown of glutamate, as per reaction 3 which notably results in the production of ammonia. The regulation of deamination reactions is probably most likely occurs in response to the concentrations of substrates and products.

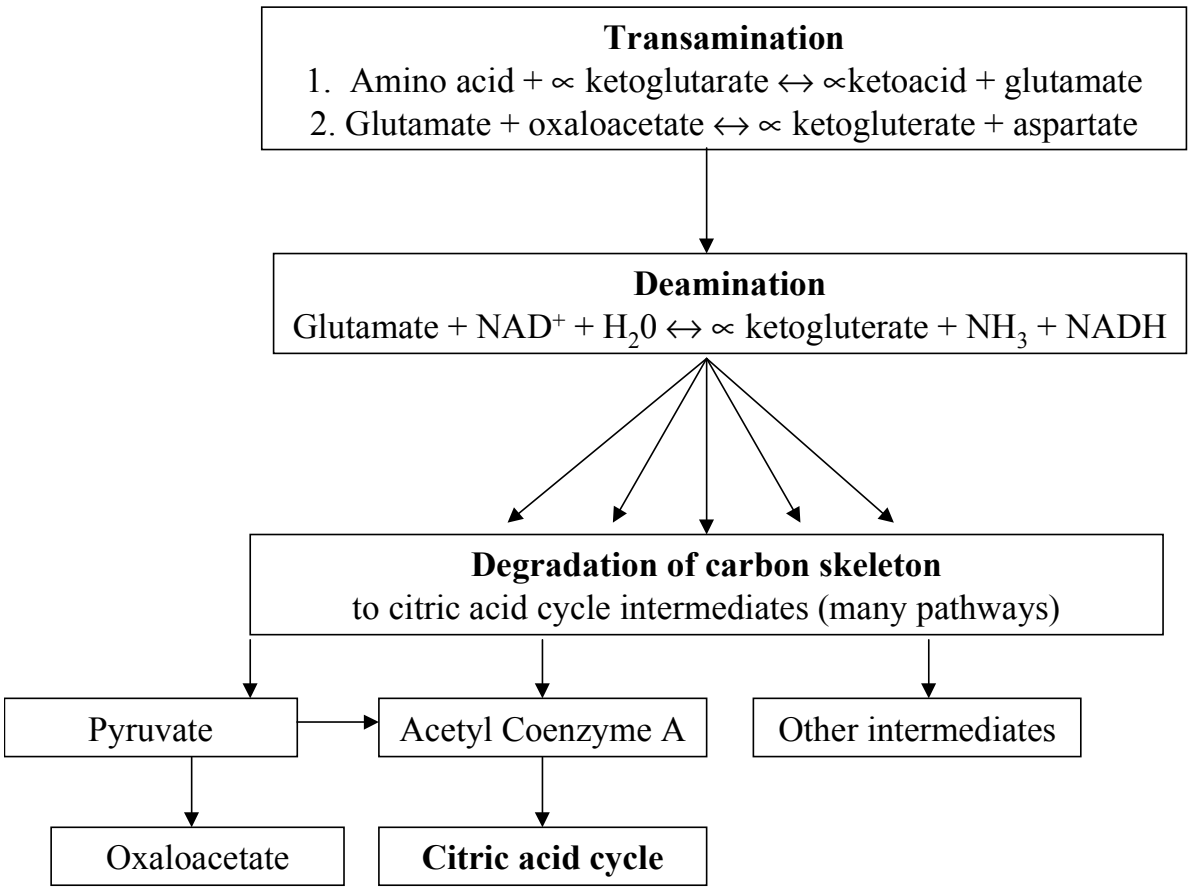
Energy from amino acids is obtained through the degradation of the carbon skeleton following deamination. The carbon skeletons are converted to pyruvic acid, acetyl coenzyme A or intermediates of the citric acid cycle[15] where they are metabolised or used in gluconeogenesis[10].

The nitrogenous end product of protein catabolism in fishes, except for elasmobranchs, is the toxic waste product ammonia, which is excreted across the gills or urine. The provision of a diet of an inappropriate amino acid balance can therefore cause an excessive loss of nitrogen through the gills or urine pathways[5,6]. The catabolism of body proteins during periods of starvation will similarly result in elevated excretion of ammonia[6].

Anabolism and shedding of tissue

Assimilated amino acids that are not catabolised for energy are available for use in growth. Amino acids are linked to form linear polymers of amino acids joined by peptide bonds between the amino group of one amino acid and the carboxyl group of the next. The structure

Metabolism of amino acids



Derived from Anon. (1999)

of the protein determined by the sequence of amino acids and this is under genetic control[4]. Assimilated protein may be shed or released as sloughed structural components, for example epithelial cells or in gametes, or as unrecovered digestive enzymes lost in the faeces[10].

Protein turnover

Tissue proteins are constantly undergoing synthesis and degradation with continual exchange of amino acids between those that are incorporated into protein, free in tissues and free in blood[4]. Amino acids deposited in protein are therefore not 'locked up' but may renter circulation for catabolism as an energy source or be recycled directly into protein synthesis[6].

Conclusion

An understanding of the bioenergetics of a cultured animal and the interaction of dietary components is essential to the provision of an adequate and cost effective diet. From a nutritional point of view, the digestibility of feed components to the target species is a key consideration since this dictates the realised energy and nutrient value of the feed to the animals. The availability of dietary protein for growth is also contingent on the provision of adequate energy levels and on its quality in terms of meeting the essential amino acid profile of the fish. Protein sources that more closely meet the essential amino acid requirements of the animal will promote more effective growth. From an economic point of view the protein-sparing action of fat and carbohydrate energy sources offers the aquaculturist an opportunity to significantly reduce feed costs.

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A case of informal shrimp farmers association and its role in sustainable shrimp farming in Tamil Nadu, India

Kumaran. M, Kalaimani. N, Ponnusamy. K, Chandrasekaran V.S. and D. Deboral Vimala

Central Institute of Brackishwater Aquaculture (CIBA), 75 Santhome High Road, Chennai –600 028, India.

The sustainability of shrimp aquaculture is widely debated in many international fora owing to difficulties that arose during the early expansion of the industry. One of the contributing factors to localized failure of shrimp farming was 'self pollution' arising out of poor or inexperienced management and lack of cooperation among the neighboring farmers.

Many aquaculture experts are of the view that Small Farmers Groups (SFG) can play a very important role in managing the shrimp farms and environment. During a farm survey conducted to study the adoption of shrimp farming practices in Tamil Nadu, the authors came across a unique farmers association, at Tambikottai-vadakadu farm cluster in Pattukottai taluk of Thanjavur district, Tamil Nadu which manages a group of farms successfully. The experiences of this association contain many useful lessons that may benefit farmers elsewhere, and the functioning of the association is described below.

Tamil Nadu is blessed with 56,000 ha of potential area for development of brackish water aquaculture. However, the area under shrimp aquaculture during 2001-02 was only 9.5% and the total shrimp production was also very low.

Shrimp farmers and their expectations for the growth of shrimp farming

Shrimp farmers in Tambikottai-Vadakadu are basically agriculturists. However, shrimp farming is the main occupation for most (87%). The literacy status of farmers varies from Primary (20%), Middle (27%), Secondary school (33%) to Graduation levels (20%). Farm size and farming experience ranges from 1 to 30 ha and 2 to 10 years, respectively. Most of the farms were of improved extensive nature (87%). All the farmers were active members of the shrimp farmers association. Most of them (80%) have not availed any credit assistance. Even though excellent access to mass media was available, they were of the view that aquaculture was given very limited attention except covering the anti-shrimp farming activists. Consultants, feed technicians and experienced fellow farmers were their technical advisors. The extension machinery of the Government departments was not influential among the farmers.

Shrimp farming and the role of Farmers' Association

Shrimp farming made it's beginning in this area during 1990s with the initiative and active support from the Marine Products Export Development Authority (MPEDA). Due to its unmatched profitability, this enterprise has attracted many local farmers towards shrimp farming since then and the area under cultivation has increased considerably. This shrimp farm cluster has 160 ha of water-spread area owned by 26 managements. Most of the farms were small in size with less than 4 ha area and growing only one crop per year during the summer.

Most shrimp farms in the area are managed by farm technicians (graduates in zoology with some training in shrimp culture and/or postgraduates with diploma in aquaculture) who stay on the farm around the clock. In addition to technicians all the farms employ Consultants alias Doctors (who had doctorate in marine biology or Zoology and/or proven experience in shrimp culture in their locality) who visit their clients' farms periodically (once in a week) to monitor the pond/farm parameters and counsel the farm technicians.

This farm cluster has a unique Farmers Association, which coordinates the entire shrimp culture operations including marketing. The association was formed by some of its more active members during the mid-nineties to counter the anti-shrimp lobby. When the farmers suffered crop failures due to disease outbreaks they became convinced that successful culture is possible only if all the farmers cooperate and adopt appropriate management practices together. Hence, they resolved

Some of the shrimp farmers

to strengthen the association so that it can supervise and control each and every operation in all farms and enforce necessary regulations. The association has self-regulated shrimp culture in the cluster since 1998.

Pond preparation and stocking

The association meets well ahead of pond preparation and form teams to supervise preparatory works. The Association forms teams for seed procurement. The stocking density and number of ponds to be stocked depending on the availability of water were decided in the meeting. Based on the requirements a team was deputed to book seed in bulk from one or two reputable hatcheries (near Marakkanam). The team was responsible for screening the seed for disease and transporting it to farm sites. The association does not permit stocking wild seed. When the number of shrimp ponds increased, more than one team was formed to procure quality seed. The supply of other inputs like feed is arranged on credit basis providing guarantee by the association. All the ponds are stocked simultaneously or within a week. If any farmer fails to stock within 10 days, he was not allowed to stock for next 60 days. The stocking density is @ 5 post larvae per square meter and the survival rate averages 80-90%. The total feed consumption is about 1.2 to 1.4 tonnes/ha with a feed conversion ratio (FCR) of 1.2 to 1.4.

Pond management

Ponds are monitored round the clock by observing the check tray and the behavior of shrimps. In order to reap successful crop for all, the association enforces some regulations on its members and it is considered the moral duty of all the farmers to follow them strictly. All the farms should have a reservoir of minimum 10% of its total water spread area and chlorination of reservoir is compulsory. All farms should employ technicians and consultants authorized by the association. If a farmer wants to try a new input, permission needs to be obtained from the association. If any disease problem arises during the culture, it must be brought to the immediate notice of the association. The association recommends for premature harvesting or bleaching of the pond, based on the size of the shrimp/day of culture. The association also supervises the process of bleaching and reimburses the cost of seed and bleaching powder.

Harvesting, production and marketing

The association collects quotations from the available traders and decides the price for the produce on competitive basis. It bargains for better prices and advises the same to the members. The farmer can sell his produce according to his wish and bargain again with the available bidders to get more. Shrimp harvesting is normally done after 120 days of culture when they have attained 30 g size. In some cases the culture period is extended to 130 – 150 days to get a good size. Harvested shrimps are mainly handpicked from the outlet, cleaned, segregated, weighed and iced. Average production is about 1.5 tonnes/ha (30 tails/kg).

Creation and maintenance of common infrastructure

The association has created common infrastructure like a supply canal for sea water, approach roads, common inlet canals and drainage. The responsibility to maintain them properly has been bestowed on the members. However, the association bares the cost of repairs.

Membership and organization

Membership is compulsory for all farmers. A membership fee of Rs.500/- and monthly subscription of Rs.50/- per pond is paid to the association. A president heads the association with a secretary and a treasurer and all are elected democratically. While choosing the office bearers experience in shrimp farming and exposure to different agencies working with shrimp culture were given preference. An honorarium is paid to the secretary for carrying out the association work. The members share common expenses. Whenever some money was urgently needed either the association or office bearers spend it initially and recoup later. The association normally meets once per month, attendance at the meetings is compulsory and repeated absence warrants proscription. Resolutions are prepared and passed unanimously after detailed discussion.

Other activities

The association help its members to obtain licenses from the Aquaculture Authority by providing necessary documents obtained from revenue authorities, prepare their applications, and submit them to the District Committee and follow-up for their clearance. It adjudicates the disputes among members amicably through discussion and persuasion. It has close

Common infrastructure - inlet canal

contacts with district and regional level associations and deputes members for meetings and cooperates with them for promotion of shrimp culture. It maintains good rapport with the local people and it takes utmost care to prevent any negative impact on them. It also offers generous donations for festivals, schools and other charitable works. It interacts closely with the district administration and gets development schemes for the welfare of the local community.

Scientist investigator with office bearers of shrimp farmers association

Success of the association

The members as well as farmers from adjoining areas have been witness to the successful functioning of this association. Since 1998 they have raised successful shrimp crops and obtained good harvests. The farmers attribute their success to the association, which has ensured supply of quality seed, convinced the companies/suppliers for credit facilities for inputs and attracted new farmers into its fold as evidenced by the expansion of area under shrimp farming. The association has brought unity among the farmers, secured fair price for the produce, provided a platform for exchanging views, sharing their knowledge among the farmers and it has ensured harmony with the local people.

Strengthening the association

Registration of the association as a legal body under relevant government provisions will strengthen its activities. Even credit, insurance and licenses may be issued only to the association, which has holistic approach for development of sustainable aquaculture in the farm cluster. Financial assistance may be given to such groups for developing infrastructure like wastewater treatment plants, cold storage facilities etc. Farmers' representatives from the association may be included in the District and State level committees of the Aquaculture Authority to share their views in the planning process. Besides village level associations, there may be an active district level farmers committee and a dynamic farmers' federation at state level which can take care of the interests of shrimp farmers and function as an influential body. Accordingly the shrimp farmers associations should be linked organically. The president and secretary of every association can become the members of the district committee and the president and secretary of all district committees can become the ex-officio members of the farmers' federation at state level. This will promote interaction and co-operation between the farmers and bring them under one umbrella for better benefits.

The association wants regular information through mass media on current price situation so that the farmers can get better returns for their produce. It was also of the opinion that hatcheries were responsible for majority of the mishaps and suggested safeguards through seed certification. It expected the Government to support the farmers through speedy issue of licenses, easy availability of credit, insurance and electricity. Establishment of aqua clinics and inputs testing/ screening centers in coastal areas, closer interaction with research organizations, extension agencies and farmers, regulation of aquaculture and sensitizing anti-aquaculture activists about eco-friendly aquaculture were some other suggestions expressed by the association.

Employment

The association ensures that local or nearby villagers alone are employed in local shrimp farms. On an average, two permanent labourers are employed per hectare of farm for carrying out regular operations and they stay at the farm throughout the culture period. Casual laborers are engaged during pond preparation, repairing of pond structures, deweeding, harvest and other routine works. Women are involved as casual labourers in pond preparation and harvesting. The villagers availed employment approximately for 60-75 days in a year in the shrimp farms.

Conclusion

The study has clearly indicated the following points.

- Farmers/farmer groups and their voluntary code of conduct are very important for sustainable shrimp aquaculture.
- Quality inputs and proper farming practices are essential for successful shrimp farming.
- Shrimp farming practiced with due consideration to environment and other stakeholders will help in eliminating social and environmental conflicts.
- The success of the Thambikottai-Vadakadu shrimp farmers association in sustaining shrimp farming is an eye-opener and more such Farmers groups/associations are the need of the hour. This could be assisted through provision of incentives by the government.

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Dr. Nihar Ranjan Chattopadhyay is now attached to West Bengal University of Animal & Fishery Sciences as Professor in Aquaculture and is actively engaged in fisheries education, research and extension in West Bengal, India. He has developed some innovative technology and various reports in the field of fish culture and standardization of techniques for the breeding and larval rearing of Pangasius sutchi.

Fish breeding in captivity - some innovative adaptations of technology by Bengal farmers

Prof. N.R Chattopadhyay

Head, Department of Aquaculture, Faculty of fishery sciences, West Bengal University of Animal & Fishery sciences Mohanpur, Nadia, West Bengal, India.

Fish breeding in captivity was introduced in India with the intension to make sufficient quantities of quality seedstock available to support farming. This technology offers many advantages in fish culture practice including reduced mortality during transport and production of hybrid vigor through hybridization. After the discovery of induced breeding techniques during the late 1950's the expertise was initially transferred to field conditions through extension workers on a relatively small number of farms. Later, the technology was transferred more widely through contact from one farmer to another. Innovative adaptation of this technology by Bengal farmers has enabled them to establish a positive role in producing a quality and dependable seed supply. This is evident by the fact that Bengal farmers contribute to 70% - 80% of the total seed produced in India.

A field survey conducted in the year 2000 revealed that through successive years farmers have modified the base technology from time to time and that these modifications have made it more meaningful in contributing to the seed supply for the country. Some of the major farmer-led modifications are listed below.

Extension of Breeding Period

Initially the breeding season for inducing fish in captivity was restricted to June to August. However, farmers have managed to extend this period by three months with the season now running from April until September. In the case of magur sometimes farmers can undertake breeding in winter by making use of the bottom water in the pond. This obviously indicates the farmer's skill in broodstock management.

Figure 1: Male pangasid catfish receives a dose of pituitary extract to help initiate spawning

Figure 2: Low-cost overhead tanks are built on piles of earth excavated during pond construction

Repeated use of broodstock

Initially the broodstock were used only once per season for breeding purposes. Now, with the more understanding about broodstock management, maturation and spawning techniques, the farmers of Bengal can now use the same broodstock two or three times per season at an interval of 45 days for both Indian major carps and exotic carps. This knowledge has established Bengali farmers as the leading seed producers in the country.

Alteration in the time and dose of injection

Initially farmers used to give the first dose of pituitary extract after sunset at around 6-7 in the evening with a second injection given 6 hours later at around 11- 12pm. Bengal farmers have since shifted the time for first injection to 9-10am in the morning followed by a second injection at 3-4pm. This ensures better fertilization and hatching rates as it occurs in the early morning when the environmental temperatures range between 20-25C. This time frame for injection also gives better fertilization and hatching percentage when stripping is adopted. Farmers find better fertilization and hatching rates can be achieved on cloudy days by advancing the time of the second injection by one hour.

Dosage of injection (pituitary extract)

Field trials indicate that administration of a low preliminary 'priming' dose followed by a higher effective dose after 4-6 hours is more successful than use of a single 'knock-out dose'. From my studies in this area, I recommend the following standardized doses for these species commonly cultured in Bengal:

For Thai magur

- Summer dose — 8mg/kg body weight
- Winter dose — 10mg/kg body weight

For Indian major carp

- Female- 1st dose - 1-2 mg/kg body weight
- 2nd dose- 5-8 mg/kg body weight
- Male - Single dose 1-2 mg/kg body weight

For exotic carp

- Female - 1st dose 2mg/kg body weight
- 2nd dose 9mg/kg body weight
- 10mg/kg body weight (Grass Carp)

For minor carp

- Single dose 1.25 - 2.5mg/kg body weight

For pangasid cat fish

- Female - 1st dose - 1.5mg/kg body weight
- 2nd dose - 6mg/kg body weight
- Male single dose — 1mg/kg body weight (Fig. 1).

Low cost technology for construction of overhead tanks

During surveys I have found that the farmers have developed a very effective low cost technology for construction of overhead tanks that would otherwise involve a huge expenditure that they could not afford.

...continued on page 16

Figure 3: Farmers are opting for Chinese-style hatcheries, often within the grow out pond

Use of Probiotics in larval rearing of new candidate species

Rehana Abidi

National Bureau of Fish Genetic Resources
Telibagh, Lucknow-226 002, U. P.
India

India is a rich country blessed with enormous wealth of natural resources but unfortunately both terrestrial and aquatic resources are declining due to various anthropogenic stresses. On one hand our aquatic resources are dwindling and we are losing precious genetic resources and on the other hand neither do we have a contingency plan nor we have an appropriate technology for culture of most of the endemic cultivable food and ornamental species. One solution to this problem may be the domestication and culture of new candidate species, which include *Labeo gonius*, *L. dero*, *L. calbasu*, *Notopterus* sp., *Tor* sp., *Mystus* sp., *Pangasius pangasius*, *Lates calcarifer*, *Mugil cephalus* and other endemic ornamental fishes and shrimps.

There are several bottlenecks in achieving the target of profitable culture of new candidate species. The larval rearing of these fishes in captivity is not so easy. In most experiments survival rate is very poor. The reasons may be food, water nutrients and/or diseases. In India the average survival rate of shrimp larvae is reported to be around 25-30 % while in Thailand the average survival is around 50-60 %[1]. Hence for success in culture of candidate species we must ensure quality feed, good environment and disease free seeds and juveniles. Antibiotics have sometimes been used to reduce disease, however indiscriminate use has in some cases led to increased antibiotic resistance and problem of tissue residues and trade issues[2,3]. Vaccines are successfully used in other livestock industries but there are no vaccines currently available for most of the fish diseases in this region. So how can we prevent disease and improve the growth of fish at aquafarms ? Obviously effective farm management practices are crucial and there are many management issues that need to be addressed. However, one measure that might be of assistance is the use of "probiotics".

Probiotics are a cultured product or live microbial feed supplement, which beneficially affects the host by improving its intestinal balance and health of the host[4]. The first probiotic discovered long time ago was *Lactobacillus* sp., the lactic acid producing bacteria. They were thought to prevent colonization of the gut by other disease causing bacteria - a process known as competitive exclusion. Presently the range of probiotics extends well beyond the *Lactobacillus* sp. to include *Bacillus* sp., *Vibrio* sp., *Pseudomonas*, yeasts and algae. Some of the commercial probiotics currently available include Aqualact, Probe-la, Lacto-sacc Epicin, Biogreen, Environ, Wunopuo- 15 and Epizyme. Feed probiotics are applied with the feed and a binder (egg or cod liver oil) and most commercial preparation contain either *Lactobacillus* sp. or *Saccharornyces cerevisiae*.

The characteristic feature of a probiotic microbe is it should be able to colonize the gastro-intestinal tract, but the intestinal microflora in aquatic animals changes rapidly with the constant influx of microbes coming from water and food. The microbial community of the gut can therefore be considered to be transient in nature. This transience allows the extension of the probiotic concept to the use of live microbial preparations in ponds. Therefore in aquaculture it is difficult to delink probiotics from bioremediators[5].

Probiotics also show antagonism to other organisms through: i) competition with other species for binding (colonization) sites; ii) specific antagonism against other species; and iii) nonspecific antagonism against other species. Probiotic bacteria may stabilize the intestinal microflora and the principle of bacterial antagonism applies to the preparation of new probiotics as well. Some of the antagonistic bacteria against fish and shellfish pathogens include *Bacillus* spores, *Roseobacter* sp., *Cornobacterium divergens*, *Pseudomonas* sp., *Alteromonas*, and *Pseudoalteromonas* against pathogens like *Vibrio harveyi*, *V. anguillarum*, *Edwardasiella*, *Aeromonas*, and *Pastrella*[6].

The composition of the intestinal flora of the larvae from first feeding onwards plays an important part in the defense against colonization and growth of opportunistic pathogens. Maeda and Nagami (1989) reported decline in pathogenic Vibrio in larval tanks of prawns and crabs by using probiotics. Other studies on the role of probiotics in shell fish culture include the work done by Douillet and Langdon[7], Maeda and Liao[8], Uma et al.[9], Vasudevan[2], Sridhar and Paul Raj[10], and Anikumari et al.[11]. The role of probiotics in health management of fish has been studied by Baird[18], Robertsen et al.[12], Metaillier and Hollocou[13], Gopalannan et al.[14], Mohammad[15], and Karunasagar[5].

Most of the probiotics have been isolated from seawater such as the unicellular marine alga *Tetraselmis suecica* and another marine alga *Ulva fasciata*. Several bacteria have been examined as potential probiotics for fish. While using the probiotics for effective disease control one must take care in their choice because some of them may be potentially pathogenic for aquatic animals eg. *V. alginolyticus* and as we still don't know the precise mode of action of these organisms, it is essential to ensure that the organism (probiotic) is harmless to the host.

A survey of Nellore district (Andhra Pradesh) which has 31 giant freshwater prawn culture ponds and several shrimp culture facilities[16] has revealed that farmers are using both water and feed probiotics. The water probiotics contain multiple strains of bacteria like *Bacillus acidophilus*, *B. subtilis*, *B. licheniformis*, *Nitrobacter* sp., *Aerobacter* sp. and *Saccharomyces cerevisiae* etc. and feed probiotics contain *Lactobacillus* sp., *Bacillus* sp. or *Saccharomyces cerevisiae*. The farmers claim that these probiotics improve the growth of shrimp larvae in initial period up to 50 days of culture. Survival of larvae is also reported to be better[11].

Regular use of probiotics in feed of fish, in U. K. and other European countries has been reported to have several health benefits. In shrimp hatcheries it is reported to have controlled the high incidence of diseases in larvae and led to dramatic improvement in shrimp health. Atlantic Salmon fed with probiotics enjoyed increased survival and reduced mortality caused by Vibriosis, Furunculosis and Enteric Redmouth diseases. Moreover, fish showed enhanced appetite, grew better and had lessr problems with fin and tail rot. *Vibrio alginolyncus* introduced in larval rearing tanks caused a reduction in the incidence and severity of luminous vibriosis caused by *Vibrio harveyi* and improvement in growth of shrimp larvae[17].

Indian fish pathologists are also looking at probiotics as a potentially useful disease prevention measure in aquafarms and active research is continuing. The Cochin University of Science and Technology, Kochi, Kerala has taken lead in the research on probiotics. Other National Institutes like Central Marine Fisheries Research Institute, Kochi, College of Fisheries, Mangalore, Kamataka, National Institute of Oceanography, Goa, Central Salt and Marine Chemicals Research Institute, Bhavnagar, Gujrat and some universities are also involved in research on potential probiotics.

In nutshell, we can say that there are many positive reports about the use of probiotics, particularly in feeding of larvae from first feeding onwards. Probiotics are a welcome addition to the armament of disease prophylaxis in aqua-farms although the technology and science behind it is still very much in a developmental phase. It seems likely that the use of probiotics will gradually increase and that success of aquaculture in future may be synonymous with the success of probiotics, which, if validated through rigorous scientific investigation and used wisely, may prove to be a boon for the aquaculture industry.

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Fish breeding in captivity - some innovative adaptations of technology by Bengal farmers

...continued from page 14

Farmers stack the soil while excavating pond in the farm site and then, when it is high enough, they construct the overhead tank on the stack. This is an effective way to reduce the cost considerably as it does not involve construction of any tower or pillar. (Fig. 2).

Rejection of the breeding pool concept

A survey on 2000 to assess the current status of hatcheries in Bengal, revealed that the farmers have totally rejected the breeding pool approach and instead both breeding and hatching is done in Chinese-style hatcheries. The farmers are of the opinion that the sloping towards central outlet prevents the total mixing of milt and egg and there by reduces fertilization rate. Better fertilization rates are achieved when spawning is done in Chinese hatcheries as the floor surface is plain, which permits easy mixing of milt and eggs.

In some farms that I have observed the hatcheries are located within the grow out pond. This not only requires less supply of water to hatcheries but also reduces the cost of supplying a constant flow to hatcheries. (Fig. 3).

Scientific Guidelines for farmers engaged in freshwater Prawn farming in India

Vishal Saxena

Senior Research Fellow
Central Institute of Fisheries Education, Andheri (West), Versova, Mumbai 61, India

The commercial importance and popularity of the giant freshwater prawn *M. rosenbergii* is gaining recognition due to its high growth rate, hardiness and very low protein requirement. A profitable and foreign currency earning venture, freshwater prawn farming has taken a unique place in the present aquaculture scenario of India. As the population grows more and more people are adopting prawn farming to fulfil the increasing demand for food.

In India, freshwater prawn farming could not catch the attention of the farmers until a few years ago due to unsophisticated and low production technologies. Now, after the occurrence of white spot virus in marine shrimp farming, and due to emergence of improved management practices capable of supporting higher production the farmers are adopting it with great enthusiasm. However, despite the development of sophisticated and high yield technologies most freshwater prawn farms in India use extensive farming systems. I have suggested some guidelines that will help farmers to increase both their production and the sustainability of their farm.

Guidelines for collection of wild / hatchery produced seeds

There are currently two sources of freshwater prawn seed in India. One is wild seed collected from the lower reaches of rivers and brackish waters and the other is hatchery-produced seed. It has been widely reported that the seed collected from wild habitats usually do not grow to appropriate marketable sizes. The main reason for this is that the wild seeds are usually a mixture of different species of prawns at different stages of development. As a result there is a wide variation in the size of stock at harvest. To overcome this problem, prawn farmers should segregate the desired cultivable species from the other species of prawn. Farmers should also stock the larvae and post larvae of that particular species that are around the same weight or nearby. These problems can be reduced by using hatchery-produced seeds where available. Hatchery-produced seeds are also generally found to be better than wild seeds in terms of growth rate, resistance towards disease and tolerance to confined conditions.

If possible, both wild and hatchery produced seeds should be tested for serious pre-existing diseases before stocking. Some hatcheries can supply seed that has been screened for disease using advanced molecular diagnostic techniques like PCR, ELISA, and Latex agglutinisation. The seeds should be conditioned for two to three days before their release in the stocking pond to help them adjust to the culture conditions.

Guidelines for the grow out culture of fresh water prawns

Grow out culture of freshwater prawns is mostly carried out in earthen ponds ranging from 500 m^2 to 1 ha with average depth of 1-1.5 m. Post larvae at Pl-20 stage and nursery-reared juveniles of 1-2 g are most suitable for stocking. The stocking density of the prawn larvae and juveniles should be based on desired marketable size and the different facilities available at the farm. It is generally found by most of the farmers that the marketable size at harvest is reduced with increasing stocking density. It is advisable to stock prawn seed at the rate of around 5-10/m^2 to get an appropriate harvesting size on the completion of entire culture period. When prawn larvae get to a somewhat larger size, some hideouts or shelters like broken tiles, pieces of PVC pipes or earthen pipes should be placed at the bottom of the pond to reduce the problem of cannibalism.

Guidelines for feed & feeding in grow-out culture ponds

Feed management is the backbone of effective prawn farming on which the fate of the entire farm resides. Being an omnivorous or preferably carnivorous animal, a diet comprising of trash fish, mussel or clam meat, small worms, insect larvae and small molluscs is suitable to get proper growth and high production (note that the use of other crustaceans as feed carries a high risk of introducing disease). In addition, supplementary feed prepared from groundnut oil cake, soybean oil cake, crushed rice, wheat flour, fishmeal, egg, with added vitamin and mineral mixture can be used to raise the yield. Pelleted feeds are usually preferred to wet feeds to provide all the nutrients required by prawns in appropriate quantities. Feeding rates are decided on the basis of size and number of prawn, water quality parameters as well as on the nature of feed. It is better to use check trays to monitor the demand of prawns. Tray feeding is the best method of feeding, as there is no wastage and water pollution using this method. Broadcasting can also be employed as feeding method but should only be done either in the edges of the pond or at the fixed locations. The feeding should be done in morning and evening hours since the metabolic rate and other activities of prawn are reduced during the day.

Guidelines for water quality management

Monitoring water quality parameters is a vital aspect of prawn farming. Changes in water quality parameters occur on the basis of stocking density, feeding rate and water exchange. Oxygen depletion is the most common hazard in prawn farms, which can be caused by heavy organic load, over-feeding and presence of algal blooms. The level of oxygen can be raised by using aerators or water exchange. A list of water parameters with optimum ranges is given underneath.

Table 1: Optimum parameters for for freshwater prawn culture

Parameters	Optimum range
pH	7.5-8.5
Temperature	29-31°C
Hardness	100-150 ppm
Alkalinity	>50 ppm
Ammonia	0.1 ppm
$CaCO_3$	>40 ppm
DO	4 ppm

The growth rate reduces with high values of hardness in water. Heavy fertilization with manure and organic fertilizers is not preferred in prawn farming since it leads to oxygen depletion due to decomposition of excess organic material by microbes. Water exchange should be done at appropriate rate and at fixed intervals to maintain water quality.

Guidelines for control and prevention of the prawn diseases

There are a number of agents including bacteria, viruses, fungi, parasites, microbial toxins and adverse factors, which can cause harmful diseases in prawns and cause the entire culture system to suddenly collapse. Therefore, proper care and attention should be paid towards the diagnosis, control and prevention of disease. Care should be taken in testing the seeds before stocking for any dangerous disease. The seed should also be examined carefully for any symptoms or signs of weakness indicating the onset of disease. This helps to ensure that quality seed is stocked, reducing the risk of disease problems on the farm. It is generally observed that in adverse environmental conditions such as low dissolved oxygen and high fluctuation in temperature, pH or hardness of water that some microbes start secreting toxins, which can initiate many hazardous diseases and can cause depletion of yield. To control and minimize microbial disease outbreaks, farmers should maintain the water quality parameters in a good range, observe a sound feeding strategy and keep other environmental factors and stocking density at appropriate levels.

There are a lot of diseases caused by viral infections in prawn culture systems. No effective drug or vaccine is available to control these since viruses are not sensitive to antibiotics. However, the incidence and spread of viral diseases can be minimized to some extent through use of good management techniques to maintain water quality, appropriate feed management and health care management.

Guidelines for harvest and post-harvest handling of prawns

Harvesting of prawns is a critical point in successful prawn farming. The shell condition of the prawns should be checked before harvesting to minimize the catch of soft-shelled prawns. The best harvesting period has been suggested to be during morning and evening hours because the high intensity of sun light can be an inducing agent for molting, leading to a greater proportion of soft-shelled prawns. It is better to harvest only marketable sized prawns and allow the smaller ones to gain more weight. Through this batch harvesting, the reduced density of prawns can increase the growth rate of prawns remaining in the pond.

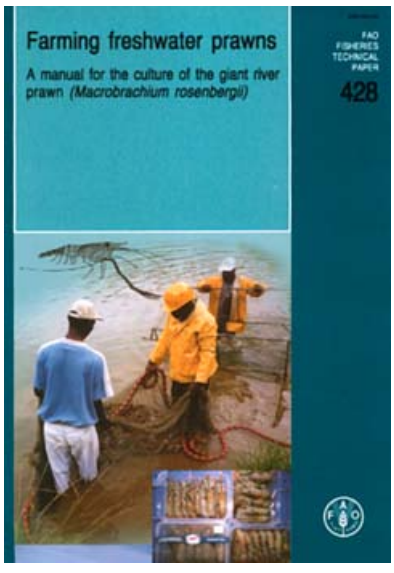
"...the incidence and spread of viral diseases can be minimized to some extent through use of good management techniques..."

After harvesting, the prawns should be washed in potable & pressurized ice water to remove dirt and other unwanted matter. Before selling or transferring the prawns to processing plants, the prawns should be chilled with ice to minimize bacterial, autolytic and chemical spoilage. The ice to be used for chilling should be made from potable water. The best way to chill prawns is to use ice in the proportion of 1:1 ice to prawn by weight as this controls the temperature and slows down the action of enzymes which reduce prawn quality. Flake ice should be used for chilling of prawns because it is softer and does not damage the prawns, as may happen if crushed or block ice is used.

Conclusion

Bearing enormous resources of inland & brackish waters, India has immense scope for fresh water farming but still has not realized its full potential. This is mainly due to limitations on the supply of quality seed, the extensive farming methods used and the lack of awareness of better management practices among farmers. With proper farm and water quality management and intensive attention to the health of stock fresh water prawns can become a major food commodity and source of income for rural people. I hope that the guidelines provided in this article will be helpful for the farmers of India in enhancing their production and in making it sustainable.

Watch out for our forthcoming review



WHAT'S NEW ON THE WEB

Fifth Technical Symposium on Mekong River Fisheries

Paul Bulcock, NACA

Being hosted for the first time in Thailand the recent Mekong River Commission's (MRC) "Fifth Technical Symposium on Mekong Fisheries" presented a wide range of focussed and relevant research. Held at the Sofitel Raja Orchid Hotel in Khon Kaen, from 11-13 December 2002 valuable new knowledge was outlined and discussed through a variety of mediums including poster and oral presentations and a mini workshop.

The scope of the event was also broadened in recognition of the need for proactive and integrated approaches between other development sectors and those of aquatic resource management and fisheries.

Poster presentations reflected this scope, displaying research on fishery composition and activities throughout study sites in Laos PDR, Vietnam, Thailand and Cambodia, nutritional, reproductive and biological aspects of key species and status of aqua cultural activities. Further to this aspects of gender roles, co-management, the use of Environmental Impact assessments (EIA) and technical innovations such as design of improved fish passages were presented.

In the second component a mini workshop was conducted "Fisheries in Development. " By presenting an overview of natural resources, development and human activities the holistic nature of the development process and the subsequent interactions and communication tools used between both the fisheries and other development sectors were revealed. Participants were thus provided with a greater understanding concerning issues of relevance to those involved in the field of aquatic resource management and development.

Based upon the three themes of Fisheries Ecology and Impact Assessment; Enhancing Livelihood; and Aquaculture and Fisheries Management, oral presentations continued to impress the immense benefit to all those involved in the field of aquatic resources management – and resources management in general of MRC research. Throughout these presentations the potential practical applications of this research became apparent through the monitoring of resources, enhanced broodstock and reproductive techniques and improved methods of fisheries management including crucially, the full involvement of stakeholders in this process.

Abstracts of all research were supplied and will be available from the STREAM website. Please send enquiries to paul.bulcock@enaca.org.

Gender Issues in Aquaculture

Women play a crucial role in aquaculture production. For example in Cambodia, higher yields are obtained from fish ponds managed mainly by women. In Thailand and China, they often bear the sole responsibility of farm and aquaculture production because of male migration to cities. However, women's contribution to aquaculture is often unrecognized and the real benefits from their involvement in the activity are not objectively assessed. This is surprising given that small-scale aquaculture development is increasingly considered as a means by which the livelihoods of the poor, including women, could be improved.

That's the introduction to a new website offered by the University of Stirling, which addresses gender issues in aquaculture.

The site covers the outputs of several gender-related projects including the Women in Aquaculture Project funded by the Asia-Pacific Economic Cooperation forum (APEC) and the Gender-Responsive Aquaculture Policy Workshop held in Bangkok funded by DFID.

The site also provides links to the project reports and also to several recent publications addressing gender issues in aquaculture and in more general policy making terms. Included among these is a very useful reference, the Gender Manual: A Practical Guide for Development Policy Makers and Practitioners.

Information on this topic has never really been that easy to find but the site contains worthwhile linkages to information resources. If you have an interest in gender issues in aquaculture, you will undoubtedly find this a worthwhile and useful site.

The site is available from http://www.dfid.stir.ac.uk/dfid/gender/gender.htm or for more information you can contact Cecile Brugere at C.D.Brugere@ncl.ac.uk.

Diffusion and Adoption of Shrimp Farming Technologies

Kumaran. M, Ponnusamy. K and N. Kalaimani

Central Institute of Brackishwater Aquaculture(CIBA),
75, Santhome High Road, Chennai-600 028, India.

Shrimp culture has had a long tradition in India and began with the tidal stocking of shrimp in paddy fields and lagoons along the backwaters and subsequent holding of them until harvest. Known locally as shrimp/prawn filtration, this traditional farming method is still practiced as a major cultural activity in the states of Kerala and West Bengal and also in limited areas in Karnataka and Goa with a production of 150-200kg/ha for sustenance[1]. Congenial conditions such as availability of unutilized coastal land, successful transfer of hatchery technology, increased export demand and opening up of the economy in 1990s led to the rapid expansion of commercial intensive shrimp aquaculture. Shrimp farming area increased from 65,100 ha in 1990-91 to 145,906 ha in 2000-2001 and correspondingly production of shrimp increased from 35,500 tonnes to 97,096 tonnes (Table 1) during the same period[2].

Shrimp aquaculture suffered a serious setback in the mid 1990s due to viral disease that caused heavy losses and the industry is in the process of reviving. Farmers need timely advice for the maintenance of proper water and soil conditions to ensure the survival and growth of shrimp and also in disease management. To understand the nature of diffusion and adoption of shrimp farming practices, an investigation was taken up in Nagapattinam district of Tamil Nadu, India that is one of the shrimp farming "hot spots" along the east coast. Tamil Nadu is blessed with 56,000 ha of potential land for brackishwater aquaculture.

A sample of 30 farmers was proportionally selected from three creeks in the study area viz., Vettar, Kaduviar and Vellaiyar creeks for the study. Open-ended questions were used to find out the diffusion process. Seventeen farming practices were included covering the entire gamut of shrimp farming as suggested by the Subject Matter Specialists to study adoption. Adoption Quotient and Extent of Adoption as a whole for each individual practice were calculated by using the following formulae.

$$\text{Adoption Quotient} = \frac{\text{No. Practices adopted by the respondent}}{\text{Total No. Practices}} \times 100$$

$$\text{Adoption} = \frac{\text{No. respondents who had adopted the practice}}{\text{Total number of respondents}} \times 100$$

Ten socio-personal variables were studied to understand the profile of farmers and the extent of adoption. The data were collected by employing a well-structured and pre-tested interview schedule. Mean, percentage and correlation statistics were used for analysis and interpretation.

Profile of shrimp farmers

The findings of the study reported in Table 3 revealed that majority of the respondents (57%) were less than 40 years of age and two thirds had collegiate and above level of educational status (67%). The innovative and high profit nature of the enterprise could have attracted young and highly educated people. Most of the respondents (67%) had other occupations in addition to shrimp farming possibly due to the risk and cost intensive nature of shrimp enterprise. About eighty per cent had a farm size of less than four hectares. More than half of the respondents (57%) had at least five years of farming experience. Almost all the farmers were practicing improved extensive farming of *Penaeus monodon* (Tiger shrimp) with a stocking density of 3-5 post larvae/m^2.

The annual income of most of the respondents was less than Rs. 25,000 due to failure of culture in earlier crops because of disease outbreak. The majority of the respondents (60%) availed credit from banks or private moneylenders. Farmers were aware of extension agencies of organizations associated with shrimp aquaculture, but most of the respondents had limited contacts with them. Most had a medium to high degree of mass media exposure. They were of the opinion that aquacultural programmes are very rare in mass media channels. Most of the respondents were members of the Nagapattinam Aqua Farmers Association (NAFA). Fellow farmers and feed company representatives were the prime sources of information. Similar findings are reported by others[4].

Diffusion of shrimp farming practices

About 80% of the respondents said that fellow farmers were their primary source of information due to their familiarity, easy accessibility and trustworthiness. Feed retailers/ representatives were the most important source of information (67%) for all technical matters like seed and stocking, feed and supplementary feeding, water quality management, health, harvest and marketing. The input dealers/traders employed biology graduates as field technicians/assistants who had undergone training in shrimp farming. These field technicians regularly visited their customer shrimp farms to provide all necessary technical assistance.

Studies on mariculture practices and extension needs of shrimp farmers conducted in Kerala and Andhra Pradesh respectively revealed similar findings[5].

Among the institutional sources available, the Brackishwater Fish Farmers Development Agency (BFDA) (53.33%) and Marine Products Export Development Authority

Table 1: Shrimp farming by State in India: Area under culture and production

State	Estimated Potential Area (ha)		90-91	91-92	92-93	93-94	94-95	95-96	96-97	97-98	98-99	99-00	00-01
West Bengal	4,05,000	A	33,815	33,918	34,050	34,150	34,400	34,660	42,605	42,525	42,067	41,980	42,210
		P	12,500	13,800	16,300	16,500	25,000	23,445	19,949	15,121	18,326	21,780	21,079
Orissa	31,600	A	7,075	7,417	7,760	8,150	8,500	11,000	11,332	11,332	8,000	9,000	7,423
		P	4,100	3,800	4,300	3,300	4,800	6,000	6,805	5,000	6,000	3,400	7,360
Andhra Pradesh	1,50,000	A	6,000	8,100	9,500	19,500	34,500	50,000	80,249	88,290	71,000	83,930	74,226
		P	7,350	9,700	12,800	26,000	34,000	27,140	30,577	34,075	44,856	46,270	53,100
Tamil Nadu	56,000	A	250	480	530	1,050	2,000	2,879	640	670	1,087	1,882	2,537
		P	450	700	1,100	2,000	3,000	1,092	1,129	1,197	1,820	2,940	3,792
Pondicherry	800	A	Neg.	Neg.	Neg.	Neg.	Neg.	37	22	22	22	-	-
		P	Neg.	Neg.	Neg.	Neg.	Neg.	10	27	20	27	-	-
Kerala	65,000	A	13,000	13,145	13,400	13,860	14,100	14,657	14,658	14,595	14,705	14,470	14,743
		P	8,925	9,500	9,750	11,500	12,000	9,000	8,225	7,290	7,660	7,150	7,327
Karnataka	8,000	A	2,500	2,542	2,570	2,600	3,500	3,500	3,500	3,540	3,564	3,635	2,975
		P	1,000	1,100	1,500	1,500	2,500	2,050	2,300	2,640	2,690	2,890	2,733
Goa	18,500	A	525	525	550	575	600	650	650	650	650	770	929
		P	245	300	350	400	450	550	580	590	590	840	966
Maharashtra	80,000	A	1,800	1,869	1,980	2,180	2,400	716	929	970	426	533	422
		P	800	930	1,050	300	400	740	523	700	409	390	315
Gujarat	3,76,000	A	125	231	360	475	700	884	997	997	316	447	442
		P	125	170	200	500	700	546	572	235	256	340	424
Total	11,90,900	**A**	**65,100**	**68,227**	**70,700**	**82,540**	**100,700**	**118,983**	**135,582**	**141,591**	**141,837**	**156,647**	**145,906**
		P	**35,500**	**40,000**	**47,000**	**62,000**	**82,850**	**70,573**	**70,686**	**66,868**	**82,634**	**86,000**	**97,096**
Average kg/ha			**545**	**586**	**665**	**751**	**823**	**593**	**521**	**472**	**583**	**549**	**666**

Source: MPEDA A=Area under culture in ha P = Estimated production in MT Neg. = Negligible

Table 2: Shrimp farming in Tamil Nadu

Name of district	Area (ha)	Production (t)
Thiruvallur	353	100
Kancheepuram	133	150
Villupuram	97	135
Cuddalore	815	535
Nagapattinam	1483	1585
Tiruvarur	75	150
Thanjavur	514	235
Pudukkottai	230	140
Ramanathapuram	978	485
Thoothukudi	488	50
Tirunelveli	16.35	3
Kanyakumari	6.11	3
Total	**5,193**	**3,571**

Source : Report, Department of Fisheries, Government of Tamil Nadu[3].

Table 3: Personal profile of farmers

Variable	% of Farmers (n=30)
Age	
Up to 40 years	57
Above 40 years	43
Education	
SSLC/H.Sc	33
Graduate and above	67
Occupation	
Aquaculture alone	33
Aqua+Others	67
Farm Size	
Up to 4ha	80
Above 4 ha	20
Experience	
Upto 5 years	57
Above 5 years	43
Annual income	
< Rs. 25,000	93
> Rs. 25,000	7
Credit	
Obtained	60
Not Obtained	40
Extension contact	
Low	40
Medium	40
High	20
Mass media exposure	
Low	13
Medium	60
High	27
Social participation	
Low	7
Medium	33
High	60

(MPEDA) (40%) were the better-utilized sources. This may be because of the fact that MPEDA is the promoter of shrimp farming and provider of subsidies and training in the initial stages of commercial shrimp farming and BFDA is the extension agency of the state department of fisheries located in the study area and it is the nodal agency to prepare projects, study its feasibility, help in site selection, farm construction and recommend for subsidies/insurance provided by the government & banks and arrange for license issued by the Aquaculture Authority. Some progressive farmers were subscribers of aquaculture journals like Aqua Star, Fishing Chimes, reports /guides from feed companies etc., and they in turn become the source of information to others (40%). Around one fifth of the respondents reported that research institutions (20%) and consultants (16.67%) were their information sources. The farmers were of the view that the research institutions and government departments were difficult to access hence they were unable to utilize them effectively for technical information.

Adoption of Shrimp farming practices

Among the 17 practices covered, it was observed that the farmers of Nagapattinam were following the scientific practices at a higher adoption level (Table 4). About 87% of the farmers had high adoption while only about 13% had low or medium level of adoption. This is mainly due to their awareness and technical guidance from the input dealers. Excluding the non-adoption of effluent treatment plants owing to their small size of holdings other practices have been variedly adopted. All farmers had adopted pond preparation, stocking of hatchery produced and disease checked seed, sampling and biomass estimation and application of quality pelleted feed practices. This may be due to the fact that the above-mentioned practices are prerequisite for successful culture. Barring a few most of them (87%) had adopted improved

Table 4: Extent of adoption of shrimp farming practices

Extent of Adoption	Percentage of farmers
Low	6.67
Medium	6.67
High	86.66

extensive farming. Most did not measure pond parameters such as temperature, PH, transparency, biological oxygen demand and dissolved oxygen regularly. They were of the view that is not necessary to measure these parameters strictly with lower stocking densities (3-5 larvae/square meter).

Most of the farmers adopted the recommended water quality management measures (80%), molting precautions (73.33%), application of probiotics (76.67%), precautions to prevent diseases (76.67%) and post harvest operations (90%) like icing and grading and had contacts with institutional organizations promoting shrimp farming (63.33%). The farmers (93.33%) had not adopted discharge water treatment plants (Table 5). Practices with lesser adoption included site selection and pond construction, optimum pond parameters, duties of a responsible farmer and contact with institutional sources of information because of lack of technical help and service laboratories. It is evident that the farmers were very receptive to the technological advancements and refinements. But there is a general lack of technological support from the government agencies mainly due to inadequate field level staff. The farmers were fully dependent on feed technicians of feed companies who may sometimes mislead the farmers due to their business interests.

Correlation analysis

In order to understand the nature of relationships between farmers' profile characteristics and their extent of adoption correlation analysis and Student T Test was conducted (Table 6). Out of 10 variables taken for analysis social participation alone had a significant (at 5% level) positive relationship with farmers' extent of adoption. It is obvious that the farmers who were members of local institutions like NAFA will have the opportunity to interact with farmers of adjacent shrimp farming area and members of various organizations working with shrimp farming and know more about shrimp farming practices. Therefore, it is understood that the profile characteristics of shrimp farmers (age, education, occupation, farm size, farming experience and contact with extension agency) had no obvious influence over their extent of adoption of farming practices.

Suggestions for improvement and conclusion

This study reveals that the shrimp farmers surveyed in Nagipattinam relied on their peers and feed retailers/ technicians for technical information. They had adopted most of the improved shrimp farming practices that are indispensable. They depend on feed technicians whose motivation is mainly to sale of their products. In general the farmers are very receptive for adoption but there is a general lack of dissemination of information from government agencies. Based on these findings the following suggestions are made for strengthening institutional Transfer of Technology (TOT) systems and sustainable shrimp production:

- Evolution of a transfer of technology mechanism involving R & D systems and extension system of the state governments and farming community is the need of the hour since research institutions may not able to reach all the clients (Research - Extension (State Departments of Fisheries) - Clients) effectively like the state fisheries personnel due to their location and minimum staff strength.
- Organizing farmers into vibrant groups, that take care of forward inputs and backward assistance for their members. Even credit, insurance and licenses may be issued only to the group, which is responsible for everything and facilitates sustainable aquaculture in multiple aspects. Financial assistance may be given to such groups for developing infrastructure like constructing wastewater treatment plants, storage facilities etc.
- Areas suitable for shrimp farming in coastal belts may be converted as aquaculture parks or estates with active private sector involvement in line with the industrial parks

or estates with all forward (seed, inputs, credit, health clinic, labs, training) and backward (market, processing, storage) linkages.
- Education of farmers on responsible aquaculture employing personal, group and mass contact extension methods. Adequate attention may be given for Mass Media in TOT.
- Formulation of an aquaculture policy that regulates as well as promotes sustainable aquaculture.

Acknowledgement

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Table 5: Adoption of Shrimp farming technologies

Practices	% of farmers adopted
Site selection and Pond construction	57
Pond preparation (Liming, manuring etc.)	100
Type of farming	87
Stocking of hatchery seed	100
Stocking of disease checked seed	100
Optimum pond parameters	40
Water quality management	80
Sampling and biomass estimation	100
Molting precautions (Feed & water)	73
Quality feed	100
Feed quantity estimation based on biomass	60
Application of pro biotic (Feed, Water & soil)	76
Discharge water treatment plant	7
Precautions of white spot virus disease	77
Duties of a registered shrimp farmers	27
Post harvest operations	90
Contact with institutional information sources	63

Table 6: Relationship between farmers' personal profile and their extent of adoption

Variable	Correlation coefficient
Age	0.0328
Education	0.0184
Occupation	-0.0355
Farm size	-0.0516
Farm type	-0.0274
Credit behaviour	0.2474
Annual income	0.0649
Mass media exposure	0.2023
Extension agency contact	0.0531
Social participation	**0.3548 ***

Aquaculture calendar

5th International Abalone Symposium 20-25 April 2003

The symposium will be held at the Ocian University of Qingao, China. Presentations dealing with the biology, fisheries and aquacutlure of abalone are invited. Presentations addressing the practical implementation of scientific resouts are particularly encouraged. A carefully selected panel of world-renowned experts in abalone biology, fisheries, aquaculture and marketing will address the symposium ina series of plenary and concurrent sessions. The main topics include: International abalone marketing; Fisheries management; Aquaculture technology; Larval biology and settlement; Pathology and diseases; Nutrition and feeding; Genetics; Physiology, biochemistry and biotechnology; and harvest and processing. An exhibition will also be held and abalone related tours and field trips are available.

For more information contact: Ms Hongming Ma & Wenbing Zhang, Secretariat, AB 2003, Tel +86 532 8978075, Fax +86 532 897 8076 or email ab2003@ouqd.edu.cn

Facilitating the Agricultural Innovation Process: Workshop 21 April to 3 May 2003, Andra Pradesh, India

A 12 day workshop will be held at the International crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Andra Pradesh. The objective of the training workshop is to promote opportunities for the national, regional, sub-regional and international agricultural research/extension program leaders in Asia to improve tgheir capacity and abilities in three areas of the agricultural innovation process:

- Strengthening creativity skills to promote innovation
- Facilitating linkages between stakeholders in the innovation system
- Engendering participatory research to engage researchers, extensionists and farmers in the process of innovation.

Candidates should have some field experience in participatory agricultural research and extension. The cost of the training workshop is US$2,000, including accommodation, meals, incidentals, training materials and local transportation. The workshop will be held in English.

For more information, contact Mr Rex Navarro, Head of the Learning Systems Unit, ICRISAT, Tel +91 40 3296161, Fax +91 40 3241239, email rex.Navarro@cgiar.org.

NOTICE: Change of date for Aquamarkets 2003 meeting

Due to current developments in the Mid-East which could make it difficult for people to decide whether or not travel, NACA and its two co-organizers, the Philippine Department of Agriculture and the Philippine department of Industry, have deemed it prudent to re-schedule AquaMarkets 2003 – Regional Seminar, Consultation and Exhibition to 2-6 June 2003. The daily Programme remains the same.

Please send registrations by fax to 662 561 1727, or send the electronic forms to: aquamarkets2003@enaca.org.

For those who have confirmed their participation, please contact aquamarkets2003@enaca.org for further information or questions.

AQUAMARKETS 2003 : Accessing and Meeting Requirements of Markets for Aquaculture Products, Regional Seminar 2-6 June 2003, Manila, Philippines

We invite you to a seminar of fish farmers, fishery product traders, entrepreneurs, prospective investors, suppliers, technical service support providers, industry analysts, experts, advisers, technologists, researchers and government policy makers from more than 25 countries from Asia- Pacific, Europe and North America.

Interact with co- participants and with resource persons from various UN specialized agencies and other international organizations including ADB, ESCAP, ICLARM, INFOFISH, FAO, IBRD, ITC, OIE, UNCTAD, WHO, WTO and others. The topics: various issues and policy approaches relating to access and competitiveness in markets for aquaculture products and impacts of certain trade issues on poverty and environment.

Contact the NACA Secretariat on aquamarkets2003@enaca.org or Fax +66-2 561 1727 or visit http:// www.enaca.org/RegionalSeminar.htm

World Aquaculture 2003, 19-23 May 2003, Salvador, Brazil

Contact WAS Conference Manager, 2423 Fallbrook Place, Escondido, CA 92027 USA. Tel +1 (760) 4324270, fax +1 (760) 4324275, or email worldaqua@aol.com

Mangrove 2003, Bahia Brazil, 20-24 May

The theme of the conference is Connecting research and participative management of estuaries and mangroves. The Mangrove 2003 Conference will seek to promote the necessary link between generation of knowledge and environmental management, in order to enhance local participation in solutions for socio-environmental problems.

For more information please contact: The Conference Secretary at mangrove2003@ufba.br or visit http:// www.mangrove2003.ufba.br/

AQUARAMA 2003, 29 May – 1 June

The meeting is billed as the 3rd World Conference on Ornamental Fish Aquaculture. Sessions cover application of biotechnology in the ornamental fish industry; production of new ornamental species; culture of freshwater ornamentals; culture of marine ornamentals; new developments in the ornamental fish industry; and challenges and issues facing the ornamental fish industry. For more information contact julian_lim@cmpasia.com.sg or visit www.aquarama.com.sg.

Rights and Duties in the Coastal Zone: Multidisciplinary Scientific Conference on Sustainable Coastal Zone Management, 12-14 June 2003, Stockholm, Sweden

This conference will compare various property-rights regimes in the coastal zone, and their associated management systems, with a focus on the developed part of the world. It will also consider various policy instrument options and other formal or informal institutional solutions, in cases when property rights are difficult to defined or enforce.

One way to prevent or resolve conflicts is through insightful design and enforcement of property-rights regimes in the coastal zone. Whose are the property rights, i.e. who are entitled to rights and duties in the use of the coastal zone? And what rules for exercising the rights do the property-rights regimes involve? Are present property-rights regimes in the coastal zone inconsistent with the dynamics of the ecological resource they are supposed to control? For example, do they take into account migration among species and the existence of thresholds in the behavior of ecosystems? These and other issues, which are crucial for the management of the coastal environment, have been addressed by the Swedish research programme Sustainable Coastal Zone Management, a partner in the conference.

For more information visit http://www.beijer.kva.se/conference.htm

Organic Aquaculture & Sea Farming 2003, 15-17 June 2003, Ho Chi Minh City, Vietnam

The programme will include: Industry situation & outlook; production and processing case studies; markets and marketing; technological developments and issues. The annual VIETFISH international fisheries exhibition will be held in conjunction with the meeting.

Contact INFOFISH, PO Box 10899, 50728 Kuala Lumpur, Malaysia, tel (603) 26914466, fax (603) 26916804, email infish@po.jaring.my.

Sixth International Symposium on Fish Parasites 22-26 September 2003: Bloemfontein, South Africa

Contact Professor Jo Van As, Department of Zoology and Entomology,University of the Free State, PO Box 339, Bloemfontein 9300, South Africa, fax: +2751 448 8711, vanasjg@sci.uovs.ac.za

Environmental Management of Enclosed Coastal Seas, 18-21 November 2003, Thailand

The conference program will include three special session themes: i) Gulf of Thailand; ii) Asian forum for discussion of sustainable development in Asia and the preservation of coastal environments; and iii) NGO forum, to discuss the roles of NGOs in better understanding and promoting friendly coexistence between nature and people in coastal areas. The technical session themes will be related to the scientific, technical, management, educational and information aspects of coastal seas. Technical tours will be held after the conference to Kung Krabaen Bay, the King's project on Coastal Zone Management in Chantaburi Province and on Koh Chang Island in Trad Province. The deadline for submission of abstracts is 30 April 2003.

For more information visit www.emecs2003.com.

Aquaculture Australia, 3-5 December 2003

Heighway, the publisher of Fish Farming International, has launched an international trade exhibition – Aquaculture Australia – to be held at the prestigious Sydney Convention & Exhibition Centre, in the city's Darling Harbour, from December 3 to 5, 2003.

The Australian aquaculture industry is predicted to increase its current first-sale product value of around A$750m to some A$2.5 billion by the end of the decade. Spearheading this are the growth leaders tuna, pearls and edible molluscs, salmon, barramundi and tropical shrimp. Yet given the many other diverse species at advanced stages of development, this estimate is viewed as conservative.

Aquaculture Australia aims to reflect the growing commercialisation of the host nation's industry, focussing on how to make aquaculture work as a business. Such a theme will no doubt be evident among the booths at Darling Harbour in 2003, but it is intended also to address this theme by way of a major international conference running alongside the exhibition. This would feature a range of international speakers passing on their advice and experience in running successful aquaculture businesses.

At its recent launch at the AquaFest 2002 conference in Hobart, Tasmania, the Heighway team received positive backing from all of the leading figures in the industry it canvassed – including the host Tasmanian Aquaculture Council, the National Aquaculture Council, the Fisheries Research & Development Corporation (FRDC) and the federal department of Agriculture Fisheries & Forestry Australia (AFFA) – as well as many producers and industry suppliers attending the Hobart event.

In addition, the New South Wales government's business development department has signalled its interest in helping such an event through the possibility of hosting an official function during the Sydney show. Farther afield, and in keeping with Australia's strategic position for business in the region, Heighway has received a positive response for the event from the Network of Aquaculture Centres in Asia-Pacific (NACA)– an inter-governmental body of which Australia recently became a member.

Add all this to the setting in one of the world's most dynamic and enjoyable cities, and Aquaculture Australia has all the potential to become a regular leading event in the industry's calendar.

For further details please contact: Sue Hill, Exhibition Sales Manager, Heighway Events, Telephone House, 69-77 Paul Street, London, EC2A 4LQ, UK, Tel/Fax: +44 (0)20 7017 4516 / 4537 Email: sue.hill@informa.com.

Farmers as Scientists

This is a series anchored by M.C. Nandeesha. It describes farmer-driven innovations and experiences.

Aquaculture Education in India – opportunities for global partnership

Dr. M.C.Nandeesha has taken up a new position as Professor and Head of the Department of Aquaculture, College of Fisheries, Central Agricultural University, PO Box No. 120, Agartala-799001, Tripura, India. This is a four-year old institution established to cater to the manpower and research requirements of the Northeastern part of the country in the fisheries sector. He has nearly two decades of experience in teaching, research and development and has worked with Universities, NGOs and multilateral organizations within and outside the country. Email address: mcnraju@yahoo.com.

The current issue of Aquaculture Asia is focused on Indian aquaculture so I thought it may be appropriate to look at the aquaculture education situation in India and stimulate discussion on this fundamental issue. Education being the foundation for all development, good aquaculture education will be a foundation for sustainable aquaculture development in the country. China is reaping the benefit of investment in education of all sectors that are important to the country, including aquaculture. China tops the list and India stands second in aquaculture production with more than 2.0 million metric ton production from aquaculture. Aquaculture research and education has contributed significantly for rapid increase in aquaculture production in the country and it will continue to play major role in harnessing the huge untapped potential in both fresh and coastal environments. In this context, this article attempts at examining some of the issues relevant to aquaculture education in India in the space available through this column.

Growth of Aquaculture Education

Aquaculture education in India began receiving higher importance with the emergence of freshwater fish culture technology being developed and promoted by the Central Inland Fisheries Research Institute since early 1960s. Fisheries Education as a formal degree program was conceived by Dr. K.C.Naik, the then Vice Chancellor of the University of Agricultural Sciences in Karnataka in southern India. The foresight of this great visionary led to the early emergence of fisheries education as a professional degree program. The first Fisheries College of the country was headed for almost two decades by Professor H.P.C. Shetty. With a group of dedicated faculty, he laid a strong foundation for fisheries education in the country. The Mangalore College received technical support for the development course program through USAID from Auburn University and some of the staff were also trained in the USA at a higher level as part of the bilateral program. The Marine Products Processing Center established through the Indo-Japanese collaboration program at Mangalore during 1963 became an excellent facility for training of students. Following the success of Mangalore Fisheries College, many other states in the country have established Fisheries Colleges and there are now twelve spread all over the country (Table 1). Among these, six colleges offer postgraduate education in aquaculture. In addition, there is a National University of Fisheries (Central Institute of Fisheries Education) located at Bombay that offers postgraduate programs in different disciplines of Fisheries including aquaculture. Several hundred fisheries graduates from these institutions are now working throughout India and are contributing to aquaculture development.

Aquaculture Department

The Aquaculture Department is one of the major groups in all Fisheries Colleges and a large number of staff are involved in carrying out the three major functions of the Agricultural Universities, namely teaching, research and extension. Although most Colleges have been established following the pattern of Mangalore Fisheries College, there is large variation in the number of staff between the Colleges. Mangalore College had specialized teachers in many disciplines and that helped to build the institution activities strongly. However, increasing resource constraints and inadequate planning have resulted in a drastic reduction of staff strength in the newly established Colleges. This calls for the situation to be reviewed in various agricultural universities and alternate strategies need to be evolved to impart quality education with minimal staff strength. Teaching programs without active research and extension components are not effective and so the issue of minimal staff required to run a degree program needs to be determined based on the experiences of several institutions within and outside the country. The Indian Council for Agricultural Research (ICAR), a nodal agency for monitoring quality of agricultural education in the country is reviewing the situation through an accreditation program to bring parity in agricultural education programs offered throughout India.

Instructional facilities

While staff strength in the institutions is a key factor for training, facilities available to help students in acquiring skills also determine the quality of graduates passing out of these institutions. Although several of these Colleges have created essential basic facilities for teaching purposes, many of them require pilot scale instructional facilities, wherein students would be able to acquire skills and confidence to the required degree by the time they complete the course. Most Agricultural Universities in the Country have large areas of land available for cultivation of agricultural crops on a commercial scale to help students gain the necessary expertise in agriculture. However, the same is not true in the fisheries sector. Since Agricultural Universities are generally headed by persons with agricultural backgrounds often the fisheries sector has not been getting its due share in terms of resource allocation and other support services. Operational difficulties encountered in managing large facilities under the Government structures are the major reason facilities have not been created for training.

Dr. K.Gopal Rao on the left standing before a pond of 20 ha. He is currently heading the Fisheries College in Andhra Pradesh, a state which has excelled in aquaculture. Farmers have shown that the larger the pond the better the production in carps

Unfortunately, although this true to some degree, it is most essential to have at least pilot scale structures to help students gain experience on the systems that are relevant to the region. In this operating environment several Fisheries Colleges would need substantial support from the respective State Governments and the ICAR to strengthen their teaching facilities.

Table 1: Location of Fisheries Colleges in various states of India and existing faculty strength

Location	Faculty Sanctioned	Faculty in Position	With Ph.D. degree	With Master degree
College of Fisheries, Mangalore, Karnatka	87	52	18	39
College of Fisheries, Tuticorin, Tamil Nadu	60	54	14	40
College of Fisheries, Panangad, Kerala	51	34	19	15
College of Fisheries, Nellore,AndhraPradesh	21	8	5	3
College of Fisheries, Ratnagiri, Maharashtra	30	19	8	11
College of Fisheries, Rangailunda, Orissa	22	15	5	10
College of Fisheries, Pantanagar,UttarPradesh	12	6	6	
College of Fisheries, Dholi, Bihar	18	4	1	3
College of Fisheries, Raha, Assam	12	11	2	9
College of Fisheries, Veraval, Gujarat	10	5	3	2
College of Fisheries, Mohanpur, West Bengal	33	24	14	10
College of Fisheries, Lembucherra, Tripura	33	15	8	7

Aquaculture Education in landlocked States

Several states in India are landlocked in nature, but the course structures followed are more or less similar based on the standard curriculum developed by ICAR. However, colleges located in different agro-climatic conditions have been given the freedom to modify their curriculum to an extent of 25% to meet specific needs of the State. To ensure equal opportunity for the students graduating from the Colleges of these landlocked states to seek jobs or self-employment, efforts are made to teach marine courses by evolving different strategies. Although, the mandate of Fisheries Colleges established under the State Government is to cater for the requirements of the respective State, keeping in view of the emerging opportunities through globalization, landlocked state colleges need to examine the possibility of establishing partnership arrangements with other Fisheries Colleges in order that Students from these areas can spend a semester or two to undergo courses in marine sector that can't be easily covered within the state. National Fisheries Universities with centers in coastal areas and other Central Institutes also have opportunities to help the landlocked states. ICAR intervention might help these landlocked states through the existing structures.

Linkages between the Colleges

As there are twelve Colleges and several teachers in these institutions are involved in aquaculture teaching, there is an opportunity to create a platform for sharing of information between these institutions with a primary mandate for teaching. With information technology making all such linkages possible with minimal cost and effort, a network of these Aquaculture Departments would be most useful. Learning from each other's experience to improve teaching and training would serve as a big boost to improve aquaculture education in the country. We would like to explore this opportunity as a first step in this direction from the Northeast, wherein electronic communication is improving with the emphasis laid by the Government. The region being not easily accessible, electronic media is proving to be one of the easy options to derive the benefit of expert advise from others interested to assist the region.

Networking with farming community

Farmers have made tremendous progress in the country in the area of aquaculture. Early innovation of farmers in composite culture of carps and subsequent improvement of technology by the pioneering contribution of the Central Inland Fisheries Research Institute and various Fisheries Colleges have contributed significantly for the increase in production up to 10 tons/ha/year. Since the income derived from the technology was not commensurate in all regions due to varied demand for fish species, farmers in Andhra Pradesh invented a new technique of culturing largely rohu *Labeo rohita* in a composite culture system consisting of up to 80-90% rohu and demonstrating a production potential up to 10-15 tons/ha/year with the new system. Similar breathtaking achievements have been made by farmers in the area of shrimp culture and prawn culture, although in many instances environmental issues remain as major concern. Farmers have taken the opportunity to demonstrate commercial viability of technologies generated and in the adaptation process have invented several new techniques. Educational institutions have begun to recognize the innovative potential of farmers and are establishing close working relationships for mutual benefits. To increase the level of partnership and make the relationship more interactive, additional support mechanisms need to be built at the institutions.

A graduate student from Fisheries College in Tripura feeling proud to hold market fish. Knowledge accompanied with skills acquisition helps build confidence.

Many Fisheries Colleges have been following Fisheries work experience (FWE) established on the lines of Rural Agricultural Work Experience (RAWE) for training of students. Almost six months are utilized for this field based fisheries work experience wherein aquaculture forms part of the training. Since Colleges are located in different states and all colleges do not have good opportunity to experience developments in aquaculture, there is a need to evolve mechanisms to create opportunity for the students from one state to move to another state and work in a farm wherein they could gain the required experience. Identification of students interested to specialize in a particular discipline during the work experience period (either in processing or aquaculture) and placing them on a continual basis for six months in the identified discipline might help in better acquisition of experience in the chosen field instead of the current pattern of providing field experience in all the major areas of fisheries.

An integrated fish farming model prepared by the students of College of Fisheries, West Bengal demonstrates the potential. Dr. N.R. Chatterjee from that College underwent training on integrated fish farming course in Wuxi in China.

Turtle and Tortoise are endangered in most parts of the world, but they are also most preferred food item in several parts of the world. Students watching at a species conserved in a temple pond in Tripura State and exploring ways to propagate them

Networking within the region

Asia has a number of specialized institutions in aquaculture and there is an opportunity to establish close linkage between these institutions. Japan started fisheries education programs as early as in 1897 and today it has a dedicated university for Fisheries – Tokyo University of Fisheries. Japan has played a significant role in assisting several other countries in the region with expertise and Chinese Taipei appears to have benefited immensely and has translated several of the ideas into commercial realities in that country. Through SEAFDEC, Japan has also provided significant support for the Aquaculture Center established in Philippines for the South-East Asian Region. The Asian Institute of Technology in Thailand has played a key role in contributing for the development of small-scale aquaculture technology in the region and in training of human resources from several countries including India. Dr. Peter Edwards (who regularly writes on rural aquaculture for this magazine) played a key role in shaping aquaculture education at AIT for more than two decades. Some graduates from various Fisheries Colleges of the Country have completed the Master degree course in Aquaculture at AIT and have distinguished themselves in the field. Although AIT has established strong linkages with several Southeast Asian Countries due to donor interest and support, linkages with Indian Fisheries Colleges are yet to be strengthened. There is an opportunity to train staff from Fisheries Colleges at a higher level at AIT. The wealth of experience available at this institution on rural aquaculture would be beneficial in many ways to our country. In Thailand, there are also number of other Universities involved in aquaculture education including the Kasetsart University, which offers a four year degree program exclusively in aquaculture. China is another country, where Fisheries Education has a nearly century long history and a University dedicated to Fisheries study is located in Shanghai. China being the leader in world aquaculture production has been helping other countries to gain from its experience by regularly organizing a training course on "Integrated Fish Farming " at their International Freshwater Fisheries Research Centre in Wuxi City. This course has been popular and few aquaculture staff from various Colleges in the Country have availed the opportunity to attend this training. The Network of Aquaculture Centres in Asia-Pacific has been coordinating the program and is willing to assist those interested to attend this course following the existing procedures. To gain practical experience in Chinese aquaculture systems, this is one of the best available opportunities that can be explored easily. In both China and Japan, under the existing bilateral programs some students are pursuing higher education in the area of aquaculture.

In the Philippines, there are a number of Fisheries Institutions apart from SEAFDEC that are well known for research and training in aquaculture. The National University of Singapore through its Zoology Department has assisted many students from the Indian Fisheries Colleges to obtain higher education in aquaculture. Deakin University in Australia offers a two year Master degree program in Aquaculture. The distance education program in aquaculture started by that University has good relevance to our country and the University is interested to explore various options with other interested

Ramakrishna Mission is movement started by Swami Vivekananda in India to bring social development and it has excelled in building values in Society. The mission is one of the most successful organizations in the NGO sector of India in demonstrating fish culture potential. Students are exposed to the opportunity and necessity of combining science with values to bring peace and prosperity

groups. Professor Sena S. De Silva, a well known scientist on Asian Aquaculture systems is leading the program in that University. He has taken lead in organizing two workshops on Aquaculture Education in the past three years in partnership with NACA and as a result of these workshops the formation of an "Aquaculture Education Consortium" has been proposed by NACA. This is an exciting program, which aims to use modern information technology tools to derive the best expertise available in aquaculture from each country of the region and make them available to all at a reasonable cost.

Besides the institutions in Asia, a number of institutions in North America and Europe have been providing places for training of students at a higher level. The bilateral linkage between the College of Fisheries, Mangalore and ODA-UK in late 1990s contributed significantly for the faculty improvement and creation good instrumentation facilities. Tamil Nadu Fisheries College also has received major support through the World Bank for staff and facilities improvement in the recent past.

Changing Scenario: Job seekers to job providers

Until now, graduates from various Colleges have been absorbed largely in various Government sectors of the country. Shrimp culture expansion in the early stages provided good lot of opportunities, but with the outbreak of diseases and restrictions in coastal aquaculture activity through recent regulations have changed the situation. With the declining job opportunities in the Government and private sectors, graduates have to find new ways to secure their livelihood and self-employment is one of the options available. India, with a population of one billion and with fast changing food habits will experience increased demand in most parts of the country. Market opportunity studies are essential to support graduates to venture into self-employment through aquaculture. Some graduates have already ventured into self-employment in aquaculture and they have been reasonably successful. Discussions with such self-employed graduates reveal those opportunities that exist in the field and the necessity to improve instructional and teaching facilities at the Colleges. Entering into self-employment requires not only adequate skills and knowledge in aquaculture, but also some knowledge of business and community management. This calls for examination of existing facilities in various institutions and creation of opportunities for sharing of resources and knowledge available in each of the institutions.

A good catch from sewage fed ponds in Kolkata. Students learn the potential of recycling wastes through aquaculture (Photo courtesy: Dr. V. Sugunan, CIFRI, Kolkata)

"A good education is fundamental to all other development"

Students watching a reservoir catch of fish. India has enormous opportunity to develop fish culture in reservoirs. Experience of China might be helpful in this direction to harness this huge potential (Photo courtesy: Mr. Puroshotham, CIFE, Mumbai)

Dr. S. Ayyappan receiving Professor H.P.C. Shetty award from Dr. Panjab Singh, the then Director General of ICAR during the VI Indian Fisheries Forum held in Bombay during 2002 (photo courtesy: Asian Fisheries Society, Indian Branch)

Conclusion

During the past three decades aquaculture education has developed significantly in India. State Governments play key role in shaping aquaculture education in their respective jurisdictions. Colleges have to depend largely on State finance to meet basic necessities like staff and instructional facilities. Hence, ensuring parity among all Colleges is not an easy task with each State having its own priorities and development needs. The National University of Fisheries can play a greater role in coordinating aquaculture education in the country. As stated earlier, ICAR is a nodal agency for Agricultural Education in the country and the organization is making efforts to bring excellence in education through various approaches. Currently, ICAR Fisheries division is headed by Dr. S. Ayyappan, Deputy Director General (Fisheries). He is the first fisheries graduate to secure this highest position of the country in the fisheries sector. With all his interest to improve fisheries in the country, aquaculture education being fundamental to all other developments in the aquaculture sector, he is already implementing plans to assist the Colleges in several ways. Learning from each others experiences being one of the best options, it is necessary that discussions are held at various levels to identify the strengths of various institutions and areas that require support. Already NACA, in partnership with Deakin University, is carrying out assessment and assistance strategies at the Asian level. The proposed Aquaculture Education Consortium would be a good platform to streamline aquaculture education in Asia. As is well known, "Only the candle that is lit can light other candles". A good education is fundamental to all other development.

Marine finfish section

The Grouper Section has taken on a new and broader name: It has become the Marine Finfish Section to take account of other species. This section is almost wholly based on the Marine Finfish Aquaculture Network which is prepared by Sih Yang Sim (Editor), Michael Phillips (NACA Environment Specialist) and Mike Rimmer (Principal Fisheries Biologist of the Queensland Department of Primary Industries). Visit www.enaca.org/grouper for more information on the network.

News

New Version of Marine Finfish Aquaculture Network Website with New Features

A brand-spanking new version of the Asia-Pacific Marine Finfish Aquaculture Network website is now available with many new and useful features. These include:

- Weekly average wholesale prices for live fish in Hong Kong
- Discussion Forum
- Photo Gallery
- Resource Materials and Articles

If you have a question on marine finfish aquaculture please use the 'Discussion Forum' available from the site. Here you can chat with your colleagues, ask a question and confer with other people involved in marine finfish aquaculture. Have you developed a new technique on your farm that would like to share with others ? Please consider sharing your experience on marine finfish aquaculture with others in the network.

We welcome you to visit the new website at http://www.enaca.org/grouper/ for more information. The website will regularly updated with news, publications and other materials and announcements will continue to be made via the email newsletter. We encourage you to send marine finfish aquaculture information to grouper@enaca.org.

The Asia-Pacific Marine Finfish Aquaculture Network hopes that the new website will serve users better, and your comments, suggestions and input for its further development are most welcome.

DPI Leads Study on Cod Farm Exports

The Australian Department of Primary Industries is spearheading the development of gold-spot cod aquaculture. Gold-spot cod (*Epinephelus coioides*) a popular fish in Asian markets, is in demand as a live export commodity and for frozen fillets. DPI aquaculture biologist Mike Rimmer is head of an international team as part of a $1 million, four-year project to explore the commercialization of the gold-spot cod in Queensland and Southeast Asia. The project has been funded by the Australian Centre for International Agricultural Research. "There has been a lot of interest from existing prawn farmers in the possibilities of diversifying into gold-spot cod aquaculture," Dr Rimmer said. "There are extremely positive signs – the fish are very hardy and can tolerate low salinity, making them ideal for coastal aquaculture. They are also fast growing and reach market size within one year. Our ACIAR-funded project is exploring the technology needed to develop this species commercially, and how to convert existing enterprises to make them suitable for the commercial production of the fish". *Source: Sunday Mail (QLD), March 2, 2003.*

Grouper Aquaculture Workshop, Northern Fisheries Centre, Cairns, 6 March 2003

A grouper aquaculture workshop was held at Northern Fisheries Centre, Cairns, on 6 March 2003, to extend the results of Australian Centre for International Agricultural Research (ACIAR) Project Improved hatchery and grow-out technology for grouper aquaculture in the Asia-Pacific region to the aquaculture industry in northern Australia. Featured speaker at the workshop was Dr Joebert Toledo, who heads the grouper aquaculture research team at the Southeast Asian Fisheries Development Centre's Aquaculture Department at Iloilo in the Philippines. The workshop was attended by 15 finfish and prawn farmers and hatchery operators. Dr Toledo reported the results obtained by SEAFDEC researchers working with gold-spot (estuary) cod *Epinephelus coioides*. As a result of this research, hatchery survival of gold-spot cod has improved from around 3% at the start of the project (1999) to around 30% today. This has resulted in the hatchery production for this species becoming commercially viable.

Workshop participants also heard from Queensland Department of Primary Industries (DPI) researchers with updates on grouper broodstock management and the status of live feeds development for marine finfish hatcheries. In addition, the outcomes of the International Marinelife Alliance / Marine Aquarium Council / The Nature Conservancy project on Developing Industry Standards for the Live Reef Food Fish Trade were presented at the workshop.

Following the workshop, Dr Toledo and Dr Mike Rimmer (project leader for the ACIAR grouper project) visited farms, hatcheries and research institutes in northern Queensland. The field trip provided an opportunity to further discuss with farmers opportunities for the development of grouper aquaculture in Australia, and further on-farm research is planned. Visits to the Australian Institute of Marine Science and James Cook University's Aquaculture Department provided opportunities for the development of future collaborative research projects.

Dr Toledo's visit to Australia was sponsored by ACIAR, DPI and SEAFDEC AQD.

For further information contact:
Dr Mike Rimmer, Principal Fisheries Biologist (Mariculture & Stock Enhancement), DPI, Agency for Food and Fibre Sciences - Fisheries and Aquaculture, Northern Fisheries Centre PO Box 5396, Cairns, Queensland 4870, Australia, Phone: +61 7 4035 0109, Fax: +61 7 4035 6703, E-mail: Mike.Rimmer@dpi.qld.gov.au.

Prawn Farm Venture Into Marine Fish Hatchery, Singapore

A 20 ha prawn farm on Pulau Ubin, Singapore is setting up Singapore's first commercial fish hatchery. AddPower Ventures, the company that manages the 12-year-old farm, is planning to pump in $3 million to set up a hatchery producing grouper and golden pomfret fry to sell here and abroad. Mr Lawrence Goh, the managing director of AddPower, said: "At the moment, there is a vacuum in the hatchery industry here.

'Farmers buy from Taiwan and Thailand, but from November to April, it is too cold for Taiwanese fish to lay eggs. The climate in Singapore is best for producing fish eggs as it's warm all year round. But to be successful, you need the technology and know-how.'

This is where the Agri-Food and Veterinary Authority of Singapore (AVA), which has a Marine Aquaculture Centre on St John's Island, comes into the picture. It has been carrying out research in the field of hatching fry and is willing to pass on its expertise to farmers. For each type of fish, Mr Goh and his three partners hope to produce about five to six million fry. Mr Goh says the demand for grouper fry last year among local farmers was only one million. The rest of the produce will be exported to neighboring countries such as Malaysia and Indonesia.

Fish farmer Toh Kai Tiok was excited to learn about the new hatchery. He said: 'Now, we can buy our fry from Indonesia but there are sometimes problems because there is more salt in the sea water there. With a local hatchery, it should be easier to rear healthy fish because they are hatched in the same sea water'.

Source: The Straits Times (Singapore), January 12, 2003.

New publications

An Economic Assessment of Current Practice and Methods to Improve feed Management of caged Finfish in Several SE Asia Regions *(Peter J. Blyth and Ross A. Dodd)*

Intensive sea cage aquaculture is in its infancy in SE Asia although there is still significant production of approximately 130,000 tonnes of mixed tropical species (*Epinephelus* sp., *Lutjanus* sp., *Plectropomus* sp., *Cromileptes* sp., *Rachycentron* sp., *Lates* sp., and others) carried out in small wooden systems that are fed manually. This compares to the industrial farming techniques (large cages and automation) found in Europe, America, Australia and Japan (*Salmo* sp., *Seriola* sp., *Pagrus* sp., *Dicentrarchus* sp., and *Sparus* sp.)

In order to grow this sector sustainably in SE Asia, the existing sea cage industry needs to under go certain reforms. These include:

- reliable hatchery supply of disease free fingerlings from disease from broodstock
- trait selection programs targeted at key species for domestication
- modernization of the sea grow-out systems (eg. Larger more durable cage systems – steel/HDPE plastic)
- feed management technology
- cessation of trash fish use for development of suitable dry pelletised diets
- relocation of cage systems from sub-optimal sites to locations with deeper, better quality water
- greater degree of government and private sector co-operation (eg. Government & private sector sea cage research facilities where long term research can occur into nutrition, feed management, disease control, broodstock control and domestication programs)

These reforms will help this sector to become a significant contributor to the regional economy in an environmentally sustainable manner.

A full copy of the report is available in PDF format (885KB) from http://www.enaca.org/Grouper/ResourceMaterials/Grow-out/Feed2003.pdf, or you can contact Mr Peter J. Blyth, SunAqua Pty. Ltd. PO Box 1035, New farm, Qld 4005, Australia, E-mail: pjblyth@bigpond.com.

Prospects and Problems For Mariculture in Hong Kong Associated with Wild-Caught Seed and Feed *(Y.J. Sadovy and P.P.F. Lau Aquaculture Economic and Management, 6 (3&4): 177-190)*

Mariculture has the potential to supplement world seafood supplies and generate livelihoods and income. It can only do this, however, if it is sustainably practiced in relation to the input of natural resources on which much of it continues to depend. There is, therefore, a need to understand the links between inputs from wild sources, such as fish seed and fish feed, and mariculture practices. Such links are often not considered, with mariculture typically viewed in complete isolation from the status of its natural resource inputs. The mariculture industry in Hong Kong is evaluated, as a case study, in terms of fish and feed inputs, some of which continue to be derived from wild sources. It is argued that better use of wild resources, and a clearer understanding of the links between culture and capture, would provide many benefits to the mariculture industry, and, more broadly, to seafood supply through mariculture industry in general. Possible directions of development for the local industry include the widespread adoption of pellet feed and hatchery production of juveniles. While regional economic factors will inevitably determine the operation of the industry in the short-term, the biological constraints identified in this paper must be considered for long-term persistence of mariculture operations at the regional levels as well as to ensure better use of natural resources.

For full article contact Dr Y.J. Sadovy, Department of Ecology & Biodiversity, The University of Hong Kong, Pokfulam Road, Hong Kong. S.A.R. China, Tel: 852-2299 0603, Fax: 852-2517 6082, E-mail: yjsadovy@hkusua.hku.hk

The Evolution of the Fry Market in the Marine Fish Culture Industry of Hong Kong: An Economic Perspective *(L.W.C. Lai and B. T. Yu)*

This paper documents from an economic perspective the evolution of the fry market as part of the marine fish culture industry in Hong Kong, and related research efforts. The fry market, which involves a division of labor among fry import traders, local fry catchers and local culturists, has helped the adjustment of the industry in the face of foreign competition. Due to the success in artificial breeding of key cultured fish and keen product competition, the prices of fry have been falling. The contribution of the fry breeders to sustaining the culture industry is discussed.

For full article contact the author, Professor Lawrence W. C. Lai, Department of Real Estate and Construction, The University of Hong Kong, Pokfulam Road, Hong Kong, S.A.R. China, Tel: 852-2559 7988, Fax: 852-2559 9457, E-mail: wclai@hkucc.hku.hk.

New Tools for the Detection of Seabass Nodavirus Viral Sources and Virulence for Eggs and The Larvae

Nodaviruses are responsible for a viral disease characterized by the degeneration of the brain and retina in several species of fish, including the seabass. The aim of this work was to study the transmission and virulence of two genetically distinct viral strains of different origins on the eggs and larvae of seabass, using an immunological test (ELISA: Enzyme-Linked Immunosorbent Assay) performed on homogenized larval tissue. The viral strains were isolated from sick seabass taken from farms on the Atlantic coast (Atlantic strain SB1) or on the Mediterranean coast (Mediterranean strain SB2).

The Atlantic strain performed particularly well in the immunological test. The Atlantic viral strain SB1 is more pathogenic for eggs than SB2 when an experimental contamination was carried out at the time of fertilization. Strains SB1 and SB2 are also pathogenic for larvae, and the cerebral lesions that are characteristic of the disease appeared between 4 and 6 days after challenge. This immunological test can be used to detect the virus in larvae before the clinical and behavioural signs of the disease appear.

In conclusion, the development of a test to screen for nodavirus in the tissues of seabass at an early developmental stage of the egg and the larvae complements the panoply of tests recommended by the International Office of Epizootic Disease (IOED) for the detection of viral pathologies in fish. This immunological test on tissues complements the one previously developed for the detection of anti-nodavirus antibodies in the blood of adult seabass and opens up the prospect of early detection and control of contaminated fish in fish farms. Moreover, it provides new data concerning the virulence of two genetically different strains of nodavirus during the larval development of the fish.

For more information contact Breuil Gilles, IFREMER Laboratoire Recherche Piscicole de Mediterranee, Chemin de Maguelone, France, Phone: 33-4 6780 4004, Fax: 33-4 6768 2885, E-mail: gbreuil@ifremer.fr.

Husbandry and Health Management of Grouper – Vietnamese Version

The manual "Husbandry and Health Management of Grouper" developed by SEAFDEC AQD and APEC is now available in Vietnamese language. The manual is designed to be easily used by farmers, and has been translated into Bahasa, Thai, Mandarin, and Philipino in addition to English version. The Vietnamese translation was conducted by SUMA (Support to Brackish Water and Marine Aquaculture) of DANIDA.

If you would like to get a copy, please contact Mr Le Dinh Buu: Khanh Hoa SUMA Office, 78 Thong Nhat St., Nha Trang, Vietnam, Tel: 84-058 822941, Fax: 84-058 822921. E-mail: lbuu.suma@fsps.com.vn

Poverty and Reefs – A Global Overview *(Emma Whittingham, Jock Campbell and Phil Townsley)*

The aim of the project is to use a livelihoods approach to assess the wider, more qualitative, value of coral reefs to vulnerable coastal communities. This knowledge is intended to contribute to informing DFID's future policy on support for reefs and coastal communities as a strategy for poverty eradication. It is also hoped that the work will contribute to wider global policy development in the area of coral reefs.

This report is based on a global overview of literature and experience on the value of reef-related benefit flows to poor coastal communities and is illustrated with examples from the case studies. The report is presented in five sections. The first section provides an outline of types of people who depend upon reefs, their global distribution and numbers. It also discusses the global and regional distribution of coral reefs. Section two is the main section of the report and provides an overview of reef-related benefit flows to the poor. This section is based on an analysis of benefit flows using the sustainable livelihoods framework and includes much of the case study results. Section three reviews the changes that are occurring in these benefit flows and why these changes are occurring. Section 4 looks at the array of different interventions that now affect the lives of reef-dependent poor and assesses their impact. Section 5 discusses the finding from the previous 4 sections and evolves some principles for addressing poverty-related reef issues. It also looks at the policy implications of the findings for DFID and suggests some ways forward.

The full report is available for download as a MS Word document (3.11 MB) from the Onefish website: http://www.onefish.org/id/132235.

Discussion Topic - Cobia Larval Nursery in Earthen Pond

Mr Huy from Vietnam has posted a question on the Marine Finfish Discussion Forum on the website and would like to discuss the above topic with people who have experience in this area. Mr Huy working in a marine finfish hatchery in Nghe An province, Vietnam. The hatchery has been successful in seed production of cobia (*Rachycentron canadum*) in intensive system. However, the production cost is high and one alternative approach is to reduce cost and develop low-cost nursery technique with extensive or semi-extensive nursery in earthen pond. He has heard that mass production of cobia in China has been

carried out in earthen pond. Therefore, he is going to conduct some experiments this year with this nursery technique. However, he has little experience regarding this nursery technique, so if you have experience in this field please share your experiences with him and send your respond to grouper@enaca.org or post your comment in the discussion forum on the Marine Finfish Aquaculture Network Website, www.enaca.org/grouper.

Status and development of mariculture in Indonesia

Ketut Sugama

Central Research Institute for Aquaculture, Agency for Marine and Fisheries Research of Indonesia

Indonesia is an archipelagic country with the total area calculated around 7.7 million km^2, consisting of 1.9 million km^2 of land 5.8 million km^2 of seawater. Its vast natural resources supported by a favorable climate, has a great potential for aquaculture development. Although aquaculture is considered as a promising activity the rate of utilization of the aquaculture potential in Indonesia is still very low, especially for marine aquaculture (Table 1).

The uneven distribution of population has caused overall development to be concentrated in Java Island and the surroundings. Application of Act No. 22/1999 tends to spread the development to the other parts of the country, including aquaculture development. Local governments are now being actively identified for their potentials and effort to optimize the utilization. The implementation of the Act No.22/1999 usually faces common problems such as lack of accessibility, manpower, and distribution of inputs (seed, feed, etc). In order to guide the development of aquaculture, the Central Government has established 12 centers of aquaculture development (4 centers each for freshwater, brackishwater, and marine culture) located in each of west, middle and eastern part the country. Each province may also have their own centers according to the local potential species. Apart from aquaculture development centers, there are also three National Research Institutes for Aquaculture (marine, brackish and fresh water aquaculture) and several research stations. The location of the development centers and national research institute are shown on the map.

Status of Development

Several research and development centers have been established to develop aquaculture technologies and dissemination. Aquaculture technologies are being developed for at least 25 species including finfish as well as non-finfish to be applicable for farmers. Dissemination of technologies is conducted by training, information, demonstration and supervision. Table 2 lists the species being researched and their status of development.

Production

Aquaculture production by major species of culture is shown in Table 3.

Major Aquaculture Species of Economic Importance

The policy of aquaculture development in Indonesia is directed mainly for (a) empowering fish farmers, especially in rural areas, (b) increasing export earnings from fish commodities, (c) increasing fish consumption for food security, and (d) rehabilitation and conservation of aquaculture resources. In line with the national policy, freshwater aquaculture development is mainly aimed to supply animal protein for local consumption, and to produce fish meal for feed. While marine and brackishwater aquaculture development is more engaged with the effort to increase export earnings. Considering recent technological development and marketing, the main species have been developed and the candidate species with brightest potential for commercial aquaculture development in coastal and offshore areas of Indonesia are the penaeid shrimp (*Penaeus monodon*, *P. merguensis*, *P.indicus*), swimming crab (*Portunus pelagicus*), mud crab (*Scylla paramamosain*), sea bass (*Lates calcarifer*), milkfish (*Chanos chanos*) groupers (*Epinephelus spp.*, *Cromileptes altivelis*, *Plectropomus spp*. etc.), Big-eye trevally (*Caranx sexfasciatus*), Golden trevally (*Gnathonodon speciosus*), Napoleon wrase (*Cheilinus undulatus*), Red snappers (*Lutjanus argentimaculatus*, *L. sebae*), Tunas (*Thunnus spp.*), pearl oyster (*Pinctada maxima*), seaweed (*Euchema* sp., *Gracillaria* sp.).

Ongoing Research

Several projects involving the hatchery and grow-out stages of these species are currently under way. It is foreseen that grouper and snapper species will be raised within the next few years in Indonesia.

Broodstock management

The technology of seed production of some marine finfish have been developed such as milkfish (*Chanos chanos*), sea bass (*Lates calcarifer*), highfin/humpback/mouse grouper (*Cromileptes altivelis*) and tiger grouper

Table 1. Utilization of aquaculture potential area in Indonesia

Type of Aquaculture	Potential Area (1,000 Ha)	Utilization	
		Ha	%
Marine	2,002	0.388	0.17
Brackishwater	913	411.23	45.416
Freshwater Pond	375	68.69	18.317
Freshwater Cage	550	0.051	0.0093
Paddy Field	240	141.27	58.86

Table 2. List of aquaculture species and their status of development

Common Name	Scientific Names	Grow-out	Hatchery
Milkfish	*Chanos chanos*	D	D
Seabass	*Lates calcarifer*	D	D
Red Snapper	*Lutjanus argentimaculatus, L. sebae*	ED	R/D
Siganid	*Siganus* spp.	D	R/D
Highfin Grouper	*Cromileptes altivelis*	LD	D
Tiger Grouper	*Epinephelus fuscoqutatus*	LD	D
Malabar Gouper	*E. malabaricus*	ED	R/D
Flowery Grouper	*E. polyphekadion*	ED	D
Giant Grouper	*E. lanceolatus*	ED	R/D
Estuarine Gouper	*E.coioides*	ED	D
Coral Trout	*Plectrophomus.leopardus*	ED	R/D
Napoleon wrase	*Cheilinus undulatus*	ED	R/D
Tiger Shrimp	*Penaeus monodon*	D	D
Banana Shrimp	*P.merguiensis*	D	D
White Shrimp	*P.indicus*	D	D
Lobster	*Panulirus* sp.	ED	R/D
Mud Crab	*Scylla paramamosain.*	LD	R/D
Swimming Crab	*Portunus pelagicus*	D	D
Sea Horse	*Barracuda* sp.	LD	R/D
Pearl Oyster	*Pinctada maxima*	D	D
Abalone	*Haliotis assinina*	ED	R/D
Sea cucumber	*Holothuria scabra*	LD	D
Squid	*Loligo* sp.	LD	D
Sea weeds	*Euchema sp, Gracillaria sp*	D	D

D: Developed; ED: Early development; LD: Limited development; R/D: Research and development

(*Epinephelus fuscoguttatus*). The basis of every hatchery operation is the maintenance of a healthy group of adult reproductive fish conditioned to spawn year around as cued by environmental variables such as photoperiod, water exchange and water temperature. The consistent supply of large numbers of high-quality fertilized eggs can only be achieved by implementing a rigorous protocol aimed at reducing stress level of fish, from the time of capture through acclimation to captivity and final maturation.

The techniques for capture, transportation, handling, sexing, sampling, and acclimation of marine finfish breeders have been adequately developed. Prophylaxis using antibiotics, antiseptics, medicine and quarantine is necessary before introducing fish into the maturation tanks. A detailed description of quarantine technique for grouper fish is presented in manual (Sugama, et. al., 2001). Recent advances have led to improved transportation, handling, sampling and control of diseases.

Maturation and Spawning

A particular feature of marine finfish breeding in Indonesia is that the broodstock of most, if not all, species are maintained in an outdoor tank. These tanks are up to 200 tons in volume and 2-3 deep. Socking density is usually around 20-30 pairs in a single tank. The broodstock tank is equipped with a drain water pipe, water inlet and outlet (over-flow) pipes and egg collection tank with a fine net (400mm) that is connected with the outlet pipe, and an aeration system. The system is flow-through, achieving 200-300% water exchange daily. The broodstock are fed with fresh or frozen trash fish (mainly *Sardinella* sp) and squid that was mixed with vitamin mix containing Vitamin A, C and E.

Generally, the fish spawn naturally in the tanks. Most marine finfish spawn throughout a year, and for the groupers spawning usually occurs 3-4 days before and after the new moon phase, while milkfish and sea bass are not associated with the moon phase but strongly connected with the rainy season. The peak spawning season generally occurs between October to March.

Larval rearing

Larval rearing and mass seed production techniques of milkfish, sea bass, and highfin and tiger groupers are fully developed and have been adopted by

Table 3. Mariculture production by species of culture

Brackishwater Aquaculture (tonnes)					
Finfish	**1997**	**1998**	**1999**	**2000**	**2001***
Milkfish	142,709	158,666	209,758	222,228	237,720
Sea bass	2,483	2,039	5,251	3,937	4,210
Mullet	12,264	8,386	13,120	10,841	11,600
Tilapia	22,800	21,593	22,581	25,835	27,630
Others	190,003	163,066	162,225	167,176	15,660
Crustacean					
Tiger Shrimp	96,317	74,824	92,726	93,759	100,300
Banana Shrimp	30,609	22,589	28,872	28,965	30,980
Metapenaues	40,191	20,434	19,255	20,453	21,880
Mud Crab	5,176	2,065	5,143	5,322	5,700
Swimming Crab	2,095	866	3,584	3,496	3,740
Others	328	264	93	544	580
Marine Aquaculture (tonnes)					
Groupers	-	-	1,759	6,879	7,670
Sea bass	-	-	490	759	850
Seaweed	-	-	133,720	187,471	209,240
Pearl	-	-	0.5	0.6	0.7
Sea Cucumber	-	-	-	582	650
Lobster	-	-	-	29	32
Others	-	-	-	1,393.4	1,553.3

Source of data: DG of Aquaculture 2001

farmers (backyard hatchery operators). The hatchery managers produce eggs. Some they use to produce their own fry and some they sell to the backyard hatchery operators. Larval rearing is undertaken using indoor methods. This is basically intensive larval rearing undertaken in fiberglass or concrete tank up to 20 ton, usually 10 ton. The rearing tank is circular or rectangular in shape, flat-bottomed and with light blue color. Larval rearing is undertaken using green water (*Nannochloropsis*). The algal density used for green water ranges from 300,000 to 500,000 cells/ml. The eggs are generally added directly to the larval rearing tanks. The major feed for larval rearing are rotifers (SS and S types), artemia, copepods (if available and not so important) and artificial micro diet (Sugama et.al., 2002).

Nursery

The pond culture system is used for the nursery phase of milkfish. The ponds are about 100m^2 in size and 20 cm in depth. Two to three weeks before the ponds are stocked with milkfish larvae (TL: 1.8-2.0cm), the ponds are fertilized with organic and inorganic fertilizers. Maximum stocking density is 25 fish/m^2. After 1.5 months of culture the larvae attain body sizes of 5-6 cm total length (TL). So farmers my purchase fingerlings and stock them in grow-out ponds.

Two culture systems are used for the nursery phase of groupers and sea bass culture, the pond and cages. Before the ponds are stocked with fish (TL 2.0-2.5 cm), copepods, newly hatched artemia and small shrimp (*Palaemon* spp) are stocked to provide prey for the juvenile fish. Chopped small shrimp and trash fish are also supplied as supplementary feed. After two months of rearing the juveniles attained a size of 5-6 cm TL, and ready for grow-out in marine cages or ponds. The small cages (1x1x1.5m) are placed in the sea. Maximum stocking density per cage is 2,000 fingerlings. The fish are fed four to six times a day at the beginning of stocking, but feeding is gradually reduced to twice a day when they reach about 6 cm TL. Growth to 6 cm TL take about 1.5-2 months. Continuous grading at seven-day intervals is necessary during the nursery phase to reduce cannibalism. Estimated annual production of fry and fingerlings of high-value marine finfish is presented in Table 4.

Table 4: Estimated production of seeds from hatcheries

Species	1999	2001
Milkfish, *Chanos chanos*	227, 989, 617	240,000,000*
Sea bass, *Lates calcarifer*	15,000,000	NA
Groupers, *Cromileptes altivelis and Epinephelus spp.*	7,883,800*	15,000,700*

** Personal data from private hatcheries. NA: Not available*

Growout

Of the species being considered in this paper, there are four species such as milkfish, sea bass, highfin and tiger groupers have reached the commercial scale. Preliminary results of highfin grouper (*Cromileptes altivelis*) cultured in cage are only recently available in this part of the world. In growout trials recently conducted by farmers in the Lampung Bay (South Sumatra) very good financial and economic returns have been found. Over 2,500 fingerlings (5-7 cm TL) produced at Gondol Research Institute for Mariculture were stocked in cages (4 units cages 3x3x2 m). Fingerlings were fed trash fish at 3-5 % of total body weight daily. Fish grew from an average weight of 3-5 g to over 500 g in fourteen months, indicating that already reaching a commercial size. Although the survival rate was 50% a high profit was still achieved as the price of live fish at the farm gate was expensive, around US$ 25-30/kg (Trubus, 2001).

Problems and Constraints

Disease outbreaks now frequently occur in grouper hatcheries and grow-out areas especially affected by virus (VNN and Iridovirus) and parasites (*Benedenian* and *Cryptocaryon* sp) (Koesharyani, et. al., 2001). This has resulted in significant economic loss and it would appear to be the major constraint to sustainability of this industry.

Feeding exclusively with trash fish is likely to be undesirable for both economic and environmental reason in the longer term, and cost effective alternatives in the form of moist or dry pellets need to be developed. It has been widely demonstrated that grouper will adapt to both moist and dry pellets, although some training may be required with the latter.

Research Priorities

The development of reliable techniques for mass production of seeds of marine finfish trough artificial propagation in hatcheries is necessary for establishment of a sustainable offshore cage industry in Indonesia. Research should be focused on improving technology in areas of broodstock nutrition, egg quality, live feeds, first feeding, larval, fingerling and grow out nutrition and disease control. At present, the source of broodstock comes from the wild. Domesticated broodstock would be the first priority in increasing capabilities in genetic improvement in growth rate and disease resistance.

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Advice on Aquatic Animal Health Care

Problems in shrimp culture during the wet season

Pornlerd Chanratchakool
Aquatic Animal Health Research Institute, Department of Fisheries, Thailand
Email: pornlerc@fisheries.go.th

Dr Pornlerd Chanratchakool is a shrimp health and production management expert. He lectures in the joint NACA/AAHRI annual training course on shrimp health management

Recently, many farmers have faced the problem of fluctuations in salinity and temperature causing shrimp diseases; particularly yellowhead, white spot and luminescent bacteria that generally cause farmers to lose their crops. They have also had problems with stunted growth or black gill. Many of these problems can be overcome. Most farmers generally prefer to stock shrimp in the wet season, as they believe there are fewer problems than in the dry or cold seasons. However, culture in the wet season also brings various problems that I would like to discuss to help farmers plan their future crops and take adequate precautions.

1. Problems in pond preparation: In acid sulfate soil areas, heavy rain will cause acid sulfate to leach from the pond bottom and dike if the pond has been dried too long in dry season. Therefore the pond should be limed or heavily flushed at least once until the water pH is higher than 7. Fertilizer or lime should then be further applied.
2. Problem in salinity: Due to the different salinities among shrimp farming areas, farmers should report the actual pond salinity to the hatchery or nursery so that they can adjust, in advance, the salinity of postlarvae close to the farmers' requirement. For safety and high survival, postlarvae should be also nursed in small enclosure with 4-5 ppt salinity if pond salinity is extremely low.
3. Problem with predators: If the pond and water has been prepared too early for stocking, predators such as metapenaeus shrimp, dwarf prawn or finfish may be observed as they grow faster in the rainy season. If these are present they should be eliminated or the pond should be re-prepared as such animals may cause poor shrimp survival or introduce diseases including viruses.
4. Problems with rain during stocking: It is commonly raining in the afternoon or evening during the wet season and this can flush acid sulfate from the dikes into the pond. This acid water will cause high mortality to newly stocked postlarvae, which are generally weak after transportation and acclimatization. Therefore stocking of postlarvae in the morning can avoid the problem with rain. Regular liming with CaCO3 on pond dikes will minimize this problem.
5. Problems with shrimp floating after raining: After heavy rain, shrimp are observed on the surface of ponds, particularly in acid sulfate soil areas or in old or deep ponds that have poor water circulation. Flushing of acid sulfate from dike into pond can cause low water pH, which subsequently increases toxicity of hydrogen sulfide gas accumulated at the pond bottom. This causes shrimp weak and float to the surface. To solve this problem, bottom water should be drained and lime solution should be spread all over the pond in order to increase water pH over 7.5. Feeding amounts should then be reduced until the shrimp are observed in feeding trays as normal.
6. Problems with clear water after raining: This problem generally exists in acid sulfate soil or sandy soil areas. It is mainly caused by the rapid change of alkalinity and carbon dioxide level in pond water after heavy rain, which suddenly reduces the phytoplankton population. To solve this problem, pond water should be renewed or green water containing dense phytoplankton from nearby pond or drainage canals should be added. $CaCO_3$ lime should be subsequently applied daily or every two days at the rate of 125-187 kg/ha together with fertilization. In general, application of $CaCO_3$ lime or dolomite at the rate of 125-187 kg/ha every two days during the first 50 days after stocking can improve water color. If water is still clear and lab-lab (algal mats) are developing, artificial color may be applied in order to reduce light intensity.
7. Problems on floating after water exchange: This may happen in the farms close to canals or river mouth where early rain may flush acid sulfate developed in dry season from upstream. Therefore it is very risky to conduct heavy water exchange during early raining period. The best solution is to stop water exchange during the first 1-2 days of spring tide. Water from outside can then be added to acclimatize shrimp in the pond before draining water the next day. In order to check water

quality before pumping into growout ponds, 5-10 shrimp from growout ponds stocked in net cages at the inlet canal should be a good living indicator.

8. More suspended solid after raining: In sandy or sandy soil area, there will always be more hanging colloidal particles in the pond after heavy rain. In order to remove these suspended solid particles, water should be heavily drained and followed by application of lime at the rate of 62-125 kg/ha/day without aeration (airjet type) at daytime. If these particles still remain within 2-3 days, flocculant should be applied before water exchange. During this treatment, feeding should be reduced approximately by 20-50% because flocculant may affect feeding of shrimp.
9. Problem with softshell and abnormal walking legs : In acid sulfate soil and low alkalinity (less than 50 ppm) areas, particularly using water from canals, shrimp may have softshell, be unable to moult and have abnormal pereopods. Shrimp are not able to feed due to the unbalance of minerals. Application of $CaCO_3$ lime or dolomite at the rate of 125-187 kg/ha every 1-2 days during the first 50 days of stocking is recommended.

The above is only a part of general problems and solutions for each problem will be different in each location. Therefore, farmers should regularly monitor shrimp health and water quality and immediately solve the problems. Proper position and management of aerators for cleaning feeding areas of pond bottom could also reduce shrimp mortality.

The key principle for solving the above problems is efficient water management by having a reservoir (25% of farm area, with 3 m. depth) attached to growout pond. If necessary, chemicals or disinfectants could be applied in this reservoir before introducing to growout pond. Proper stocking density (less than 50 PL/m^2) can reduce organic loads in the pond and improve water and sludge treatments.

The above prevention and treatment are simple management, which are the basic and key instructions for shrimp culture. If farmers could keep pond bottom clean, water colour constant and water exchange with care, these problems will be minimized. Finally, the author hopes that this article will assist farmers in understanding the background of the problems, in precaution and treatment at a certain steps and also wishes them successful crops in the next raining season.

ปัญหาการเลี้ยงกุ้งในฤดูฝน

by Pornlerd Chanratchakool, PhD

Aquatic Animal Health Research Institute, Bangkok

สองสามเดือนที่ผ่านมาเกษตรกรหลายท่านคงจะประสบปัญหาเรื่องความเค็มและอุณหภูมิที่ค่อนข้างจะแปรปรวนผิดปกติในแทบทุกพื้นที่ซึ่งทำให้เกิดโรคต่าง ๆ เช่นหัวเหลือง ดวงขาว และเรืองแสงได้ง่ายขึ้น ซึ่งโรคดังกล่าวทำความเสียหายให้กับเกษตรกรอย่างมาก นอกจากนี้ในรายที่ไม่เกิดโรครุนแรงก็อาจพบปัญหากุ้งโตค่อนข้างช้า หรือในบางท้องที่มีปัญหากุ้งน็อคกุ้งเหงือกดำเกิดขึ้นมาก แต่เกษตรกรอีกหลายท่านก็สามารถเลี้ยงกุ้งผ่านมาได้อย่างสบาย มาถึงช่วงฤดูฝน ซึ่งเป็นช่วงที่เกษตรกรชาวนากุ้งส่วนใหญ่วางแผนการปล่อยกุ้งค่อนข้างจะพร้อมเพรียงกัน เพราะคาดว่าจะสามารถเลี้ยงกุ้งได้ง่ายกว่าหน้าแล้ง หรือหนาว แต่ท่านทั้งหลายอย่าได้ประมาท เพราะการเลี้ยงกุ้งในช่วงฤดูฝนก็มีปัญหามากเหมือนกัน ดังนั้นผู้เขียนจึงขอหยิบยกเอาปัญหาที่มักจะเกิดขึ้นบ่อย ๆ กับการเลี้ยงกุ้งในช่วงฤดูฝนมาเล่าสู่กันฟังเพื่อเป็นข้อมูลประกอบการวางแผนการเลี้ยง และการป้องกันแก้ไขปัญหาต่าง ๆ ที่อาจจะเกิดขึ้นได้ในแต่ละพื้นที่

1. ปัญหาเรื่องการเตรียมบ่อ ในพื้นที่ดินกรดถ้าเกษตรกรตากบ่อไว้นานระหว่างช่วงหน้าแล้งเมื่อฝนตกลงมาชะดินจะทำให้เกิดความเป็นกรดอย่างมากที่บริเวณพื้นบ่อและคันบ่อ เพราะฉะนั้นก่อนการลงปูนหรือเตรียมน้ำควรจะปล่อยน้ำเข้าบ่อแล้วล้างพื้นบ่ออย่างน้อย 1 ครั้งก่อนจากนั้นตรวจเช็ค pH ของน้ำซึ่งควรจะสูงกว่า 7 แล้วจึงลงปูนหรือปุ๋ยต่อไป

2. ปัญหาเรื่องความเค็มของน้ำ เนื่องจากความเค็ม ของน้ำในแต่ละท้องที่จะแตกต่างกันค่อนข้างมาก เพราะฉะนั้นจำเป็นอย่างยิ่งที่ผู้เลี้ยงกุ้งจะต้องตรวจ เช็คความเค็มของน้ำในบ่อเลี้ยงให้แน่นอนและ แจ้งให้ทางบ่ออนุบาลลูกกุ้งปรับความเค็มให้ถูกต้องก่อนเพื่อความปลอดภัย หากความเค็มของน้ำที่ใช้เริ่มเลี้ยงต่ำมาก ควรหาทางอนุบาลลูกกุ้งในคอกที่มีความเค็ม 4–5 ส่วนในพันส่วน เพื่อให้ลูกกุ้งมีอัตรารอดสูงขึ้น

3. ปัญหาเรื่องศัตรูธรรมชาติ ในรายที่มีการเตรียมน้ำ ค่อนข้างนานก่อนปล่อยลูกกุ้งควรจะตรวจเช็คว่ามีกุ้งกะต่อม กุ้งตะกาด หรือปลาเกิดขึ้นหรือเปล่า ถ้ามีศัตรูพวกนี้อยู่ควรจะกำจัดออกก่อน หรือเตรียมน้ำใหม่ มิฉะนั้นจะทำให้อัตรารอดของกุ้งที่ต้องการเลี้ยงต่ำมาก หรือพาหะเหล่านั้นนำโรคต่าง ๆ เข้ามาในบ่อได้

4. ปัญหาฝนตกขณะปล่อยกุ้ง โดยทั่วไปแล้วฝนมักจะตกตอนบ่ายหรือค่ำมากกว่าในช่วงเช้า เพราะฉะนั้น การปล่อยกุ้งตอนเช้าจะหลีกเลี่ยงปัญหานี้ได้พอสมควร โดยเฉพาะในแหล่งที่ดินเป็นกรดจัด ซึ่งถ้าหลังจากปล่อยลูกกุ้งลงไปแล้วเกิดฝนตกลงมา ลูกกุ้งยังไม่สามารถปรับตัวเข้ากับสภาพบ่อได้ดีนัก น้ำฝนที่ชะล้างเอากรดบริเวณคันบ่อลงมาอาจทำให้ลูกกุ้งที่อ่อนแอตายได้ง่าย การใช้ปูนมาร์ลหว่านบริเวณขานบ่อไว้ตลอดเวลาจะช่วยลดปัญหาได้ค่อนข้างมาก

5. ปัญหากุ้งลอยหลังจากฝนตก จะพบมากในบริเวณที่เป็นดินกรดอีกเช่นกัน และส่วนมากจะเกิดกับบ่อเก่าเลี้ยงกุ้งมานาน หรือบ่อที่ลึกไม่ค่อยได้ ถ่ายน้ำ เมื่อฝนตกชะล้างเอากรดลงมาในบ่อทำให้ pH ของน้ำในบ่อต่ำ ซึ่งจะมีผลทำให้แก๊สไข่เน่าที่ก้นบ่อมีความเป็นพิษมากขึ้น กุ้งก็จะลอยขึ้นมา วิธีการแก้ไขควรจะระบายน้ำก้นบ่อออก พร้อมกับใช้ปูนขาวละลายน้ำสาดให้ทั่วบ่อ เพื่อปรับให้ pH ของน้ำสูงกว่า 7.5 หลังจากนั้นควรจะงดหรือลดปริมาณอาหารลงตามสมควร จนกว่ากุ้งจะเริ่มเข้ายอมากินอาหารตามปกติ

6. น้ำใสหลังจากฝนตก พบมากในบริเวณดินเป็นกรด หรือดินทราย เนื่องจากเกิดการเปลี่ยนแปลงของค่าความเป็นด่าง และปริมาณของคาร์บอนไดออกไซด์ ในน้ำอย่างรวดเร็วหลังฝนตก ทำให้แพลงค์ตอนตาย การแก้ไขอาจทำได้โดยระบายน้ำเก่าออกเติมน้ำใหม่ หรือสูบน้ำจากบริเวณคลองน้ำทิ้ง หรือบ่อข้างเคียงที่มีแพลงค์ตอนเข้ามาใส่ปูนมาร์ล ในอัตรา 20–30 กิโลกรัม/ไร่ ทุกวันหรือ 2 วัน รวมทั้งการใส่ปุ๋ยก็จะช่วยให้แพลงค์ตอนเกิดได้เร็วขึ้น การใส่ปูนมาร์ลหรือโดโลไมท์ในอัตรา 20–30 กิโลกรัม/ไร่ ทุก 2 วันในช่วง 50 วันแรกหลังจากปล่อยกุ้งจะช่วยให้สีน้ำคงที่ได้ดีขึ้น แต่อย่างไรก็ตาม หากสีน้ำยังไม่เกิดในขณะที่สาหร่ายหรือตะไคร่เริ่มเกิด อาจจำเป็นต้องใช้สีน้ำเทียมบังแสงไว้ก่อน

7. กุ้งลอยหลังจากถ่ายน้ำ มักเกิดในบริเวณที่เป็นคลอง หรือปากคลองต่าง ๆ โดยเมื่อฝนตกในครั้งแรก ๆ จะชะล้างเอากรด หรือของเสียต่าง ๆ ที่หมักหมมอยู่ในคลองตลอดช่วงหน้าแล้งที่ผ่านมาละลายอยู่ในน้ำดังกล่าว การถ่ายน้ำปริมาณมากในแต่ละครั้งจะมีความเสี่ยงมาก วิธีที่ดี คือ งดการถ่ายน้ำในช่วง 1–2 วันแรกของช่วงน้ำเกิด จากนั้นจึงใช้วิธีเติมน้ำเข้าบ่อก่อนวันต่อมาจึงเริ่มถ่ายน้ำมากขึ้น เพื่อให้กุ้งได้ปรับตัว การใช้กุ้งในบ่อเป็นตัวเช็คคุณภาพของน้ำในคลองก่อนการสูบเข้ามาใช้จะช่วยลดปัญหาได้มาก และทำได้ง่าย ๆ โดยการสร้างกระชังนำกุ้งในบ่อ 5–10 ตัว มาใส่กระชังที่แขวนไว้ในคลองทุกครั้งก่อนการสูบน้ำไปใช้

8. การเกิดตะกอนแขวนลอยในบ่อ ในพื้นที่ดินทราย หรือดินร่วนปนทรายหลังจากฝนตกหนักจะเกิดตะกอนดินแขวนลอยอยู่ในน้ำมาก ควรจะถ่ายน้ำในบ่อออกให้มาก รวมทั้งการใช้ปูนขาวใส่ในอัตรา 10–20 กิโลกรัม/ไร่/วัน เพิ่มระดับน้ำให้สูงขึ้น การงด ใช้เครื่องเป่าอากาศ (แอร์เจ็ท) ในช่วงกลางวันจะช่วยลดการฟุ้งกระจายของสาร แขวนลอยได้เช่นกัน หากตะกอนยังไม่ลดลงภายใน 2–3 วัน อาจจำเป็นต้องใช้สารจับตะกอนช่วย ก่อนการถ่ายน้ำในช่วงดังกล่าวกุ้งอาจจะกินอาหาร ลดลงจึงควรลดอาหารลง 20–50 % ตามความ เหมาะสม

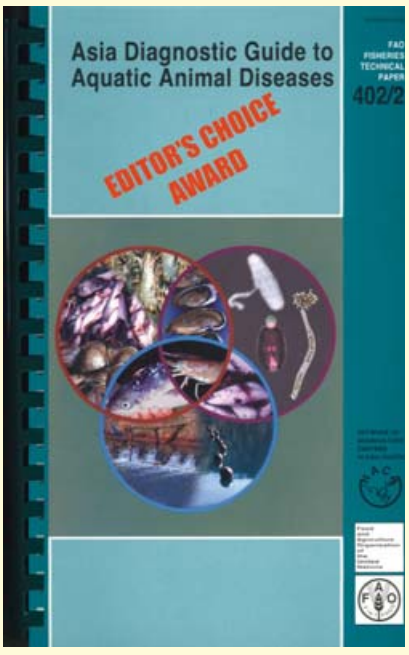
9. ลูกกุ้งลอกคราบไม่ออก ขาคดงอ พบมากในแหล่งดินกรด และน้ำมีค่าความเป็นด่างต่ำกว่า 50 ส่วนในล้านส่วน โดยเฉพาะในแหล่งที่ใช้น้ำจากคลอง ลูกกุ้งจะอ่อนแอ เปลือกไม่แข็ง ลอกคราบไม่ออก และยังพบขาเดินคดงอ กุ้งไม่สามารถกินอาหารได้ อาจเกิดเนื่องจากปริมาณแร่ธาตุไม่สมดุลย์ การใช้ปูนมาร์ลหรือโดโลไมท์ 20–30 กิโลกรัม/ไร่ ทุก 1–2 วัน ในช่วง 50 วันแรกของการเลี้ยงกุ้งจะช่วยลดปัญหาได้

จากที่กล่าวมาทั้งหมดเป็นเพียงส่วนหนึ่งของปัญหาที่มักพบอยู่เสมอ และที่สำคัญคือการแก้ปัญหาในแต่ละแห่งก็จะแตกต่างกันไป ดังนั้นเกษตรกรจะต้องหมั่นตรวจสอบสุขภาพกุ้ง รวมทั้งตรวจเช็คคุณภาพน้ำอย่างสม่ำเสมอ รีบแก้ไขปัญหาทันที การจัดวางเครื่องตีน้ำ และการใช้เครื่องตีน้ำตั้งแต่เริ่มปล่อยกุ้ง ในช่วงเวลาที่เหมาะสม เพื่อทำความสะอาดพื้นบ่อบริเวณแนวหว่านอาหารจะช่วยลดปัญหาเรื่องกุ้งตายได้มากเช่นกัน

สิ่งที่สำคัญและจะช่วยให้การแก้ไขปัญหาต่าง ๆ ทำได้ง่ายขึ้นก็คือ การจัดเตรียมน้ำในบ่อพักน้ำให้เพียงพอ เกษตรกรสามารถแบ่งพื้นที่ของบ่อเลี้ยงที่มีเพียงบ่อเดียวออกเป็นสองส่วน โดยใช้พื้นที่หนึ่งในสี่ส่วนมาทำเป็นบ่อพักน้ำซึ่งจะขุดให้ลึกมากที่สุด (3 เมตร) ก็จะสามารถเก็บน้ำได้มากขึ้น เพียงพอที่จะใช้ เติมหรือถ่ายในระหว่างการเลี้ยง หากมีความจำเป็นที่จะต้องมีการใช้ ยาฆ่าเชื้อหรือสารเคมีใด ๆ ก็สามารถทำได้ในบ่อดังกล่าวนี้ก่อนที่จะนำน้ำไปใช้

นอกจากนี้ การปล่อยกุ้งลงเลี้ยงในอัตรา ไม่เกิน 80,000 ตัวต่อไร่ก็จะช่วยลดปริมาณสารอินทรีย์ ต่าง ๆ ที่จะใส่ลงในบ่อระหว่างการเลี้ยงได้มาก ซึ่งก็จะทำให้การบำบัดน้ำและของเสียในบ่อทำได้ง่ายขึ้น

จะเห็นได้ว่าการป้องกันและแก้ไขปัญหาต่าง ๆ จะเป็นการใช้การจัดการง่าย ๆ ที่เป็นพื้นฐานสำคัญของการเลี้ยงกุ้งทั้งนั้น ถ้าเกษตรกรสามารถรักษาพื้นบ่อให้สะอาด ควบคุมสีน้ำได้คงที่ รวมทั้งถ่ายน้ำด้วยความระมัดระวังก็จะช่วยป้องกันปัญหาต่าง ๆ ได้พอสมควร ท้ายสุดนี้ผู้เขียนหวังว่าข้อมูลที่หยิบยกขึ้นมานี้คงจะช่วยให้เกษตรกร เพิ่มความระมัดระวังและมีความเข้าใจถึงปัญหาพื้นฐานต่าง ๆ ตลอดจนการแก้ไขปัญหาที่เกิดขึ้นได้ในระดับหนึ่ง และขออวยพรให้เกษตรกรทุกท่านประสพความสำเร็จในการเลี้ยงกุ้งในฤดูฝนนี้โดยทั่วกัน



Asia Diagnostic Guide to Aquatic Animal Diseases

The Asia Diagnostic Guide is a comprehensive, up-datable diagnostic guide for the pathogens and diseases listed in the NACA/FAO and OIE Quarterly Aquatic Animal Disease (QAAD) Reporting System including a number of other diseases which are significant in the Asia region. It jointly published by FAO and NACA under the Asia-Pacific Regional Programme on Aquatic Health Management.

This 240 page volume contains a general introduction on health and aquatic animals and the roles and levels of diagnostics. Section 2 to 4 cover Finfish Diseases, Molluscan Diseases and Crustacean Diseases. Each host section commences with a chapter on "General techniques" which covers essential starting points that will enable prompt and effective response(s) to disease situations in aquatic animal production. These chapters are not disease specific and emphasize the importance of gross observations and how and when they should be made, including information on environmental parameters worth recording, general procedures for sampling and fixation and the importance of record-keeping. The guide is illustrated with more than 160 colour photos. Limited hard copies and a CD version are available for cost of postage. A free electronic (PDF) version is available from the NACA website (http://www.enaca.org/aapqis/ - visit the publications link).

Information System of Fish Germplasm Resources in China

Yang Ningsheng, Ge Chanshui, Ouyang Haiying, Yuan Yongming

Information Center, Chinese Academy of Fishery Sciences

China is the largest fish-producing nation in the world. With abundant aquatic living resources, China has more than 3,500 fish species. Of these, about 2,400 are marine species distributed in the South China Sea (1,400 species), the East China Sea (800 species), Yellow Sea and Bohai Sea (200 species). There are also more than 900 fresh water species, distributed in Yangtze River Basin (291 species), Pearl River Basin (271 species), Yellow River Basin (124 species), Heilong Jiang River Basin (97 species), Qinhai an Tibetan waters (71 species) and Chinese Taipei (81 species). In addition, China has also introduced about 60 foreign species from the world in the last few decades. All those species are very important resources for Chinese fisheries industries and provide numerous seed varieties for Chinese aquaculture.

However, due to changes in global climate, damage to some ecosystems, soil erosion, water pollution, and over fishing, China's aquatic biodiversity is facing a serious threat. Take the Yangtze River as an example. Over the past decades, driven by commercial interests, the government has built many dams and facilities on the river for generation of electricity and other purposes. These water constructions directly or indirectly disturb fish ecosystems and block the migration of some fish. Many fish species have to go up and down the river to find food or to spawn. However, quite a few stocks are now unable to access their original feeding or spawning grounds. As a result, some fish stocks have severely declined, as recruitment is not available. It is reported that in the 1980's, fishing production in the river was less than half of that in the 1950's, and fry-catching production was only one fourth of that in the 1960's. Some high valued species have become seriously endangered such as the Hilsa herring *Lipotes vexillifer*. At the same time, marine fish stocks are also suffering from serious declines mainly owing to over-fishing and water pollution. Red sea bream, Olive flounder, prawn and crab used to be very important commercial species in China. However, their wild biomass is estimated at only 29% of levels ten years ago.

How to conserve and adequately utilize fish resources is becoming a critical issue for China to ensure the sustainable development of fishing and aquaculture industries. The Chinese government has been aware of the problems recently and started to support some projects in these regards. For example, over the past years, the government has invested to build and protect some natural fish ecosystems in the Yangtze River has supported some research on fish germplasm including the collection of basic information of each species or stock such as their classification, morphology, habitation, propagation and geographical distribution, and laboratory analysis of their chromosomes, isoenzymes and DNA. The Information System of Fish Germplasm Resources in China is one of the projects supported by the Ministry of Science and Technology. The aim of the project is to collect and process fish germplasm information, with emphasis on the commercially important cultured species and to build a number of databases in the effort of keeping all the data available on each aquatic species or stock in China; and to make these accessible to people working in the fields of germplasm research, resource conservation and fish production.

The Database

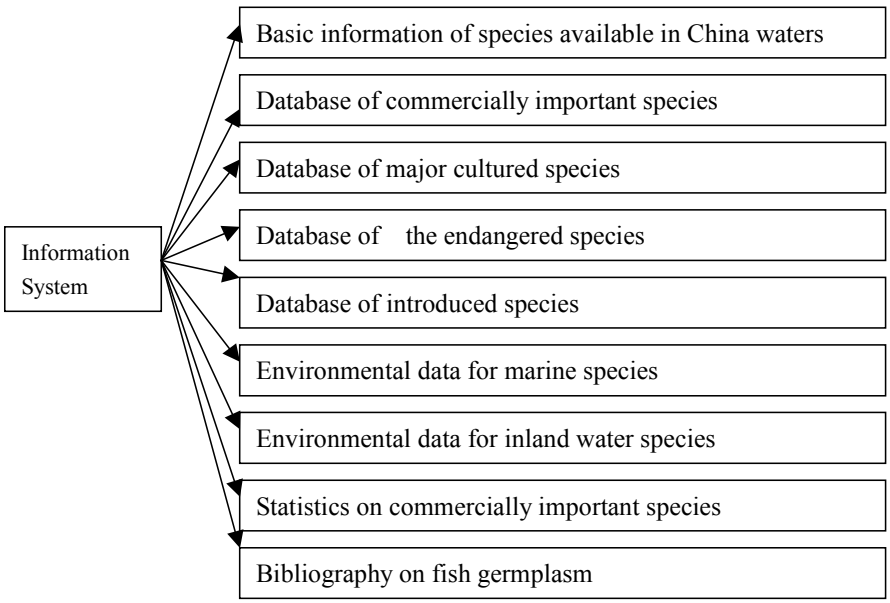
Based on Microsoft Access, the system consists primarily of 9 databases:

Information collected

Each database contains information as follows:

- Basic information on species available in Chinese waters collects information on 4,518 species, of which 2,584 are

Figure 1: Information system structure



marine species and 2174 fresh water species. The information includes species picture, classification, morphology, habitation, propagation and geographical distribution.

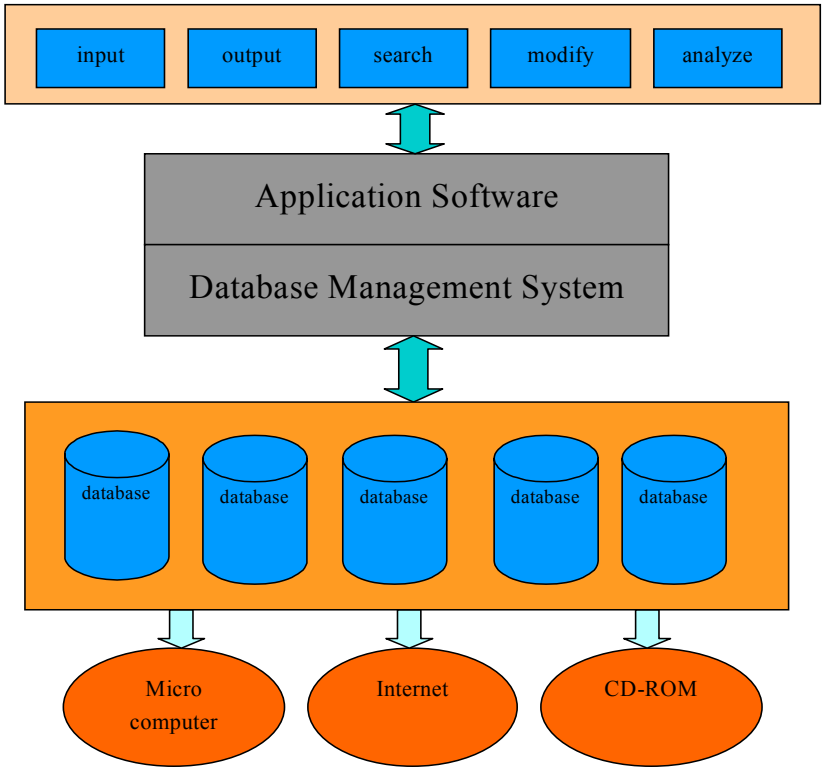
- Database of commercially important species collects information on 68 species including their biology, genetics, molecular biology and stock economics.
- Database of major cultured species collects information on 177 species including their culture technologies (seed production, farming, disease control, feeding and harvesting).
- Database of endangered species collects information on 545 species, of which 22 species are also provided with information on culture technologies.
- Database of introduced species collects information on 69 species that China has introduced from foreign countries since the 1970's and contains the information on culture technologies (seed production, farming, disease control, feeding and harvesting).
- Environmental data for marine species contains fish stocks and related data on marine waters where the fish are located.
- Environmental data for inland water species contains fish stocks and related data of inland waters where the fish are located.
- Statistics on commercially important species provides data and charts on catch or aquaculture of those species.
- Bibliography of fish germplasm provides research papers or literature on the particular fish stocks.

System Functions

The system has been built up with following functions:

- Data input. Various types of data can be entered into the databases including text, numerical data and graphs.
- Dada modification. All the data in the system can be modified, renewed and deleted.
- Search. Through website http:// zzzy.cafs.ac.cn, users can search all the information available from the system by identifying the following fields:

Figure 2:System architechture



- Species name, including its scientific name, English name and Chinese name.
- The living environment, i.e. specific sea areas, rivers, lakes, or provinces.
- Classification code.
- Production patterns, i.e. aquaculture patterns or catch patterns.
- Data output. Search results can be either printed out or downloaded as files of different types such as.dbf,.txt,.html etc.
- Data analysis. With a search result, some graphic description can be illustrated such as geographic distribution, statistics variation and production developing trends.

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Notes from the Publisher

...continued from page 3

As you all know, NACA is owned and operated by its member governments who contribute a modest budget for its core operations. The modest budget is carefully managed by the Secretariat or NACA's coordinating unit so that it is applied with the view of giving the best returns to the members. I am sure we shall be apprised of the results of NACA's programs by the Secretariat during the Seminar and the Council Meeting. In this regard I would like to express my appreciation to the Secretariat for facilitating my job as Chairman and creating the opportunities for member governments to take part and benefit from the numerous regional, subregional and bilateral activities of the Organization. Malaysia is highly satisfied with the results and the developments and on behalf of my government I wish to reiterate our continuing support to NACA.

I would like to express my gratitude again to the Government of Myanmar for hosting this Meeting. I look forward to a very instructive Seminar Workshop and another fruitful Council Meeting."

What's New in Aquaculture

Call for research grant applications from developing country scientists

The International Foundation for Science (IFS) provides support to young scientists of merit in developing countries by awarding research grants and providing grantees with additional services such as travel grants and purchasing assistance.

The IFS supports research related to the renewable utilization of biological resources in areas such as crop and animal production, forestry, food science, natural products, aquaculture and fisheries, as well as research on the sustainable utilization and conservation of natural ecosystems, including themes such as water and biodiversity. Proposals for projects may address biological, chemical, or physical processes as well as social and economic relationships important in the conservation, production, and renewable utilization of the biological resource base.

Research grants are awarded up to a maximum value of USD 12,000 for a period of one to three years and may be renewed twice. They are intended for the purchase of equipment, expendable supplies, and literature. Applicants must be citizens of, and carry out the research in, a developing country. They should be attached to a university or national research institution in a developing country. As well as being under the age of 40 (under 30 for applicants from China) and at the start of their research career, candidates must possess a higher academic degree, which should be at least an MSc or equivalent.

Applications are made on the application form, in English or French, which is available from the IFS Secretariat or can be downloaded from the website http://www.ifs.se, or contact IFS at Grev Turegatan 19, SE-114 38 Stockholm, Sweden, Fax: +46-8-54581801.

Shrimp Disease Control and Coastal Management in India

A report of the national workshop held in Chennai from 4-6 March is now available. The workshop was the culmination of the two and a half year MPEDA-NACA Technical Assistance Programme. The findings and recommendations from the study were presented to strengthen health management in India. For more information on the Technical Assistance Programme contact Mr Vishnu Bhat (MPEDA) vbhat@mpeda.nic.in or Dr Michael Phillips michael.phillips@enaca.org. The report can be downloaded (PDF 371 KB, 12 pages) from

http://www.enaca.org/Shrimp/Publications/NACA-MPEDA_Workshop_Summary.pdf

Kimberley Aquaculture Aboriginal Corporation Newsletter No. 11

This KAAC newsletter is available for download. This issue features stories on:

- Cherabin Aquaculture Mission to Thailand;
- Trochus Project;
- Multispecies Hatchery Activities, and the opening of the new Manbana Aquaculture Hatchery and Visitor Centre in the Kimberley area.

If you are interested in aquaculture development, or would like more information on aquaculture, please contact KAAC's Community Aquaculture Project Officer, Jacynta Fong, KAAC, PO Box 180, Broome WA 6725, Australia, Phone +61 (08) 9192 1482, email kaac.capo@bigpond.com. The newsletter is available from http://www.enaca.org/KAAC_Newsletter_11.pdf

New bigger, juicier, meatier oysters

Australians may soon be eating bigger, juicier, meatier oysters thanks to a new smart oyster tray for oyster farmers. The new taste experience for seafood lovers has been made possible by a specially designed smart polymer that stops the growth of organisms that interfere with the food supply needed by growing oysters.

The smart oyster tray was designed by a team of research scientists from both CSIRO and Australia's Co-Operative Research Centre for Aquaculture (CRC). Dr Veronica Cross of CSIRO Novels Materials & Processes says, 'The Smart Oyster Tray means higher-grade, meatier oysters, because the young growing oyster is not obstructed from the free flow of nutrient-rich seawater it feeds on. The Smart Oyster Tray also means less work for oyster farmers, who for years have fought off the seaweed and algae growth that has crowded the long-lines and trays suspended from rafts in "off-the-bottom" oyster farming'.

Fouling is often removed at harvest by hand, by low or high-pressure hoses, or by dipping "young" stock in a solution that kills unwanted organisms. All very laborious tasks that are now no longer necessary', says Dr Cross.

The new Smart Oyster Tray comes in the form of a traditionally shaped oyster tray, manufactured with specially designed polymers (plastics) that contain slow-release, harmless biodegradable antifouling chemicals. Dr Cross says, 'The Smart Oyster Tray is a high-density polyethylene, which contains an environmentally benign antifouling chemical agent within the plastic's molecular structure, which is slowly released over time. The antifouling chemical agent is an environmentally safe organic compound as it degrades in seawater in a matter of hours.'

The development of this material required the identification and selection of a new antifouling polymer suitable for injection molding and compatible with the antifouling agent. The product can be used for the culture of edible oysters, pearl oysters, abalone and prawns. Applications for the CSIRO Smart Oyster Tray are likely to extend to other shellfish farming, nets used in aquaculture and underwater farming infrastructure.

Dr Cross says that CSIRO is currently interested in discussing the development of its technology for commercial use with parties with an interest in the manufacture and marketing of aquaculture products. For more information, contact Dr Veronica Cross, Industry Manager, CSIRO Novel Materials & Processes +61 (03) 9545 2978 or email veronica.cross@csiro.au.

Shrimp Media Monitoring now available as separate newsletter

If you would like to receive the full text bulletin in your email, you can now subscribe to Shrimp Media Monitoring in a separate email newsletter. Just submit your email address in the subscription box at http://www.enaca.org/Shrimp/index.htm

The State of World Fisheries & Aquaculture 2002

The Food and Agriculture Organization has just released its latest review of the status of global fisheries and aquaculture. This comprehensive publication contains the latest global production statistics and trends. It is available for download (PDF 2.4MB) from http://www.enaca.org/World_Fisheries_Aquaculture_2002.pdf

[Thoroughly recommended – a must have for anyone who needs to know about global aquaculture trends – Ed.]

Gender and agriculture in the information society - invitation for proposals

CTA, IDRC, and IICD have launched GenARDIS: A small grants fund to support work on gender issues in ICTs in agricultural and rural development in Africa, the Caribbean and the Pacific.

The programme was developed in recognition of the constraints and challenges encountered by rural women in ACP countries with respect to ICTs. The challenges include limited time availability to participate in training and use of ICTs, minimal access to technology such as radios, mobile telephones or computers, inadequate availability of information in local languages that is relevant to local contexts.

The fund provides an opportunity for organizations in ACP countries to strengthen gender-related work on ICTs in agriculture and rural development. Submissions can consist of research programmes, small projects to be executed, publications, broadcasts, etc. and must be owned and executed by organizations or individuals in ACP countries. We invite proposals from inhabitants of ACP countries focusing on innovative use of ICTs by and for rural women to improve the well being of families and communities. Nine of the best submissions will be granted a one-time sum of EUR 5.000 each to develop their activity.

This is a competitive call for applications for non-renewable grants of up to 5,000 Euros. The deadline for receipt of applications is April 15, 2003. An expert panel will judge the submissions. Announcement of the successful applicants will be made on June 1, 2003. Successful applicants will be expected to write a comprehensive report on their use of the funds and contribute to a workshop to be held in 2004. All submissions must be received before the deadline (April 15, 2003). Submissions via e-mail are preferred.

CAFRAD has been contracted as mediator and administrator for the grant providers. For more information and to obtain an application form, please send an email to GenARDIS@cta.int

List your grants here & get better proposals

Want to raise awareness about your grants or donor programme ? Would you like to get better quality proposals ? Send us the details of your programme related to aquatic resource management and/or related livelihoods and we'll include it in our various media channels. Contact simon.wilkinson@enaca.org.

NACA's 16th member - Iran

NACA is pleased to announce that the Islamic Republic of Iran has sent a letter of accession to the NACA Agreement, signed by the Honorable minister of Jihad-e-Agriculture. Iran has been a long-time participant in and supporter of network activities. On behalf of the network the Secretariat welcomes this formalization of an already prosperous relationship, and we look forward to working even closer with our Iranian colleagues.

Shrimp Health Management Training Workshop 18-23 August, Thailand

This course is co-organized annually by NACA and the Aquatic Animal Health Research Institute of Thailand. The course runs for six days and includes lectures, practical, case studies, visits to farms and adequate time for discussion. The lectures are based on the information contained in the book "Health Management in Shrimp Ponds" and are illustrated with an extensive range of photographic slides. Emphasis is placed on the benefits of maintaining healthy stock and preventing disease through appropriate management of the pond. The use of chemical treatments will be covered but only as part of an integrated management system. Topics addressed include an update on shrimp culture systems; pond environment; pond preparation; water management; farm records; disease; larval assessments; chemical treatments; and the current situation in Thailand.

The registration fee is US$ 750. It covers the cost of tuition, a copy of "Health Management in Shrimp Ponds" and the workshop dinner. Participants will be responsible for the cost of hotel accommodation and subsistence during the workshop.

Key resource speakers include Dr Pornlerd Chanratchakool (AAHRI), Dr James F. Turnbull (Stirling University), Dr Chalor Limsuwan (Kasetsart University) and Mr Dan Fegan (National Centre for Genetic Engineering a & Biotechnology). For further information download the brochure (PDF 223 KB) from http://www.enaca.org/Training/ShrimpHealthWorkshop.pdf or contact The Training Officer, P.O. Box 1040, Kasetsart Post Office, Bangkok 10903, Thailand, Telephone: + 66–2–5611728 to 9, Facsimile: + 66–2-5611727, E-mail: training@enaca.org.

Board Bionotes: Asia-Pacific Chapter of WAS

The new President is Dan Fegan (Thailand), President-Elect is Mike Rimmer (Australia), Secretary-Treasurer is Pedro Bueno (Director General of NACA). Vice President is Yves Harache (New Caledonia) and the two new directors are Charles Bai (Korea) and Robert Bishop (New Zealand). Renee Chou (Singapore) and Wilfred Yapp (Philippines) remain as Directors. The full bionotes on the new board are available for download (PDF 193 KB, 7 pages) http://www.enaca.org/PDF/NewBoardIntroBionotes.pdf.

The Chapter continues to grow with approximately 300 members. The first chapter conference will be held in Bangkok in October 2003 with the support of the Thailand Department of

Fisheries and the Network of Aquaculture Centres of Asia-Pacific (NACA).

US FDA proposes registration for food and feed facilities

The U.S. Food and drug Admin C.D.Brugere@ncl.ac.ukistration (FDA) has announced a proposed regulation that would require domestic U.S. and foreign food facilities that manufacture, process, pack, or hold food for human or animal consumption in the United States to register with the agency by December 12, 2003. The proposal is one of the keystones in implementing the Public Health Security and Bioterrorism Preparedness and Response Act of 2002. This act provided FDA new authority in protecting the nation's food supply against terrorist acts and other threats.

The proposed regulation would require the owner, operator, or agent in charge of a domestic or foreign facility to submit a registration to FDA, including the name and address of each facility at which, and trade names under which, the registrant conducts business, and the categories of food the facility handles. For a foreign facility, the registration must include the name of the U.S. agent for the facility. The U.S. agent may register a foreign facility if it is authorized to do so by the facility. The proposal also would require facilities to update any changes to the information previously submitted within 30 days of the change.

The law requires FDA to notify the registrant of receipt of registration and to assign each facility a unique registration number. Registration will be made available via the internet. There is no fee.

Under the Bioterrorism Act, facilities must register by December 12, 2003. The FDA is offering the public 60 days to comment on the proposed rule. FDA plans to issue a final rule by October 12, 2003 and to have its registration system operational by that time.

Failing to register by the deadline will be a prohibited act which can be subject to civil or criminal action in federal court. The Bioterrorism Act also requires food from unregistered foreign facilities to be held at the port of entry unless the FDA directs that the food be moved to a secure location.

Copies of the proposed regulation may be obtained from http:// www.fda.gov/oc/bioterrorism/bioact.html

Source: Suzi Fraser, Aquafeed.com 4 February 2003. For more information on this important issue please visit www.Aquafeed.com.

China Imposes Fishing Ban on Yangtze River

China has imposed a six-month ban on fishing the Yangtze, its longest river that will affect 50,000 fish related workers. Under the new ban fishing or selling fish from the river is prohibited. The ban encompasses the whole river basin, which includes over 4,000 km of the main river and another 4,000 km of its tributaries in 10 provinces. Two major lakes are also included, Po Yang and Dong Ting, the two largest freshwater lakes in China. Due to the different times that fish breed within this massive system the bans are as follows Feb 1- April 30th in the upper reaches of the Yangtze (between Deqin, Yunnan, province and Gezhouba, Hubei province) and April 1 to June 30th, in the lower reaches (from Gezhouba to the river mouth).

The ban comes following years of bad fishing practises, pollution and land reclamation that has put many species at risk. The ban is a further legal move following bans on fishing on the middle and lower Yangtze in 2000 and seasonal fishing bans in both the East and South China Seas. *(Source: Onefish, Feb 2003; Xinhua News Agency, Feb 1, 2003).*

US Intends to Implement protective measures against prawn imports

Thailand's The Foreign Trade Promotion Department's US office has reported that the US will make stricter inspections of imported prawn, with an emphasis on testing for chloramphenicol. The US may also follow the EU's example and set quotas for prawn imports from each country. The US is one of the largest prawn markets in the world with an average consumption rate of 1.55kg per person annually and produces only 20 per cent of the prawn it consumes. Despite this in the first eleven months of 2002, exports of Thailand to the US fell by 43% over the same period in 2001.

(Source: Financial Times Information, January 27, 2003)

Shrimp inspection relaxed

The 100% inspection of Thai shrimp and chicken exports to the EU could be relaxed due to current negotiations. The EU will send officials to inspect the production processes of these products, but the firms to be inspected will receive no prior notice. The moves follow talks between the Deputy Agriculture Minister and the EU, and it is believed that if successful, the inspections could lead to the future lifting of the current strict inspections. It is estimated that Thailand lost US$ 250,000,000 as a result of the EU tests on chicken. Thailand considered alerting the World Trade Organisation (WTO) and not raising its imports of powdered milk from the EU. It now intends to send agricultural officials to ports in Europe and the US to help coordinate the inspections.

(Source: Fish Information and Services, January 2003; Malaysia General News, January 23, 2003; Thai Press Reports, January 28, 2003).

Bangladesh determined to protect farmers and fishers rights over biological resources.

Bangladesh has outlined its plans to protect farmer's rights over their biological resources, the government intends to support and conduct research in agriculture, plant breeding, fisheries and cattle rearing and turn globilisation to its advantage. The Bangladesh Environmental Lawyers Association (BELA) organised the two-day workshop on "Protecting Farmers Rights: Issues and Options" to discuss such matters. Issues such as The Trade Related Intellectual Property Rights (TRIPs) Agreement which Bangladesh is a party to and funding for almost all kinds of agriculture research, animal and plant breeding in the country were discussed. The Bangladesh government has constituted a National Committee on Plant Genetic Resources which has prepared two drafts; Bio-diversity and Community Knowledge Protection Act and Plant Protection Act within the guiding framework of TRIPs.

(Source: United News of Bangladesh, February 1, 2003).

中国淡水虾蟹养殖业的现状和要求

中国水产科学研究院淡水渔业研究中心

徐　跑

一、淡水虾蟹养殖业的基本情况

（一）养殖规模和产量进一步增加

近几年来中国淡水虾蟹养殖业发展很快，总体生产形势良好，河蟹、青虾、罗氏沼虾和南美白对虾已成为普通百姓餐桌上常见的佳肴，克氏原螯虾的加工出口形势也十分喜人，2001 年淡水虾蟹产量创历史最高水平，成为农村的经济增长点。

1、 河蟹 (*Eriocheir sinensis*)　河蟹肉味鲜美且市场价格较高，在水产业结构调整中，成为许多地方的首选品种，2001 年，中国河蟹养殖面积已达 40 万公顷，比上一年增加 13.3 万公顷，量达 27 万吨，产值达 140 亿元(人民币)，河蟹育苗产量达 20 万公斤，比 1990 年增长 160 多倍，这为推动河蟹养殖的快速健康发展打下了坚实的基础。

2、 罗氏沼虾 (*Macrobrachium rosenbergii*)　罗氏沼虾自 1976 年引进已达 24 年，至 2001 年全国育量达 130 多亿尾，养殖面积 4 万公顷，成虾年产量 10 万余吨，遍及广西、江苏、上海、浙江、福建等 16 个省市。罗氏沼虾因 1993 年对虾遭受灾害性病害而获得空前发展育机，形成了 1993~1997 年的发展高峰期。1998 年苗种生产最好，而成虾销售出现滑坡，一般只能以 20~36 元/ 公斤出售。然而 1999 年多数虾农都能获利。虾农认为，养殖赚钱，比种棉花、水稻、小麦。养殖成本低，即使虾价下降到 20 元/公斤，也有赚头，因此，再次掀起养虾热潮。而且产量普遍提高，平均产量为 3750kg/公顷，最高达 4725 kg/公顷，但 2001 年罗氏沼虾养殖由于受肌肉白浊病的影响，养殖面积产量有所下降。另外，南美白对虾的兴起，许多养殖户由养殖罗氏沼虾转向南美白对虾。

3、 青虾 (*M. niponensis*)　中国青虾养殖业也很得到了 快速的发展，2000 年全国青虾的产量为 25 万吨(其中 10 万吨为养殖产量)，主要是青虾养殖具有市场大，经济效益好，技术操作简单，启动投资和本较低的原因在九十年代发展迅速，目前青虾养殖面积也不断扩大，占稻田养殖绝大部分。青虾养殖是稻田种养结构优化中的最大产业。

4、 新品种养殖--南美白对虾 (*Penaeus vannamei*)　南美白对虾原产于太平洋西海岸至墨西哥湾中部，是当今世界上公认的养殖产量最高的三大优良虾种之一。由于该虾对盐度适应性广，经淡化后可在淡水中养殖，因此试养成功后，已成为淡水虾蟹养殖中新的养殖热点。与罗氏沼虾相比，有实出优点，一是适温范围广，一般水温在 8~37℃之间都能生存和生长 ；二是生长快，产量高，从下塘的虾苗长到每公斤 70~80 尾可出售商品虾，一般只天左右，比罗氏沼虾缩短一半，一年可养二、三茬，为全年均衡上市创造了极为有利条件。如遇到养殖中后期发生病害也可提早上市，减少损失；三是壳薄，肉质细嫩鲜美，出肉率高达 60%以上，可加工成鲜冻虾仁、条冻虾、盐渍虾等多种产品，加工价值比罗氏沼虾高；四是食性杂，生命力强，饲料较易解决。

更可喜的是 2001 年我国对虾养殖在连续多年徘徊后走出低谷，产量达 22 万吨，基本恢复到历史最好水平，这与南美白对虾养殖推广有重要关系。

（二）养殖技术完善，并得到进一步推广

近年来淡水虾蟹的市场价格一降再降，而且降速之快，可谓是触目惊心，但养殖者仍有一定的利润空间，这与养殖技术的普遍提高是分不开的。

1、 通过养殖技术的提高，养殖产量得到增加

罗氏沼虾的大面积养殖年产量已由几年前的 1500~2250 公斤/公顷上升到 3000~3750 公斤/公顷，效达 3 万元人民币/公顷，我国浙江最高单产达 5250 公斤/公顷，罗氏沼虾养殖由前期高价支撑发展到目前提高单产来支撑是发展的必然趋势，因而养殖模式也发生了变化，特点有二：一是提早放苗，二是增加放养密度，提高单产。

2、 通过降本节支，使养殖获得效益

在苗种方面，如通过河蟹的土池育苗，罗氏沼虾的低浓度育苗，以及提高虾蟹苗种在养殖成本中的比例下降很快，为养殖获得效益打下了基础。在饲料和药物方面，由于市场竞争激烈，各厂家通过挖掘内部潜力来降本，使饲料和药物市场价格下降，为养殖业者留下利润空间。正对大规格河蟹价格高，河蟹放苗量下降，保证成活率的基础上，追求成蟹的大规格。同时采用鱼、蟹混 养、虾蟹混养有效利用水体空间，通过各养殖品种间生物习

性的互补来促进水质的调节和饵料的利用，不用或少用防病种植水草和投放大量活螺蛳，在养殖初期可不投饵或少投饵，从而达到提高河蟹品质，降本增效的目的。

3、 推广生态育苗和生态养殖，使病害得以控制

提高河蟹的生态育苗，即“土池育苗”、“绿水育苗”、“肥水育苗”等，是防病的第一点。生态育苗是以微生物和藻类植物为净化基础，通过蟹苗及水体中生物间的动态平衡来完成育苗的全过程。而工厂化育苗是通过大量换水及用药来完成育苗全过程。前者成本小、成活率高，且育出的苗体质健壮。目前常使用的微生物制剂有：光合细菌、天垒菌、不消化细菌等，它们除了可分解池底有机物外，本身还具有大量氨基酸、维生素、类胡萝卜素等营养物质，在生长过程中还会释放出大量天然抗生素，具有很强的杀灭致病菌的效果。从而减少疾病发生。在养殖过程中也采用生态养殖方法，通过种植可形成茬口，衔接的水草品种改变过去通过混养肥水鱼来调控水质的做法，一年四季河蟹池中水草不断，而达到最佳的生态环境。同时，底池投放大量活螺蛳，不仅可为河蟹提供大量的鲜活动物饵料，而且可吃掉河蟹的残余饵料达到调节水质的目的。

（三）市场销售受到高度重视

随着虾蟹养殖面积和产量的不断增加，各地高度重视对新市场的开拓和建立新的市场流通体系。

1、 品牌意识增强

近年来，为使产品具有竞争力，各地纷纷注册商标，为自己的产品树立好品牌，如江苏州“阳澄”牌、昆山的“大闸蟹”牌、安徽宿松县的“黄湖”牌河蟹等，浙江还专门为本地青虾注册“水精灵”商标，利用品牌到我国大城市进行宣传销售效果显著。

2、 虾蟹深加工受到重视

开展虾蟹深加工是产业化发展的必然。对马氏沼虾加工，先后开发了冻虾、调味虾、蝴蝶虾、虾仁汉堡、凤尾虾、鲜醉沼虾、香糟大虾及各种小包装的沼虾休闲食品，深受消费者欢迎。目前我国虾蟹加工的主要产品以醉虾、醉蟹、冻虾仁、烤虾、蟹肉加工、活虾速冻为主，我国加入 WTO 后，我国水产资源丰实、产量高、成本低，深加工的很大的潜力可挖。将要进一步水产品加工的“革命”。

二、我国淡水虾蟹发展的要求

为保证我国淡水虾蟹养殖业的健康、稳定、持续和协调发展，确保养殖生产的安全性，保护养殖生产者的利益，为渔、农民增收、农村发展，应做到以下要求：

1、 加快虾、蟹良种场建设

通过建立淡水虾蟹原良种场，对品种进行优化选育或引进更新，向虾蟹育苗场提供优质亲本，向广大养殖户提供优质苗种。

2、 适度控制养殖规模

市场表明，淡水虾、蟹已进入买方市场，暴利的时代已经结束，各地不应盲目扩大养殖规模。重点应放在提高养殖技术，降低成本，总结推广高产量、高品质和高效益的养殖模式，从加大技术培训和技术指导力度着手，让广大养殖生产者了解，掌握和应用最新技术。

3、 加强病害防治

为做好淡水虾、蟹的病害防治工作，要尽快建立起淡水虾、蟹病害快速诊断测报体系，及时跟踪各地的发病情况，让未发病地区及时做好预防工作。要注意养殖环境的监测，确保优良的养殖环境和养殖安全。要大力推广健康或无毒苗种的培育技术，从源头上防止病害的发生。

4、 重视产品质量

近几年淡水虾蟹产量得到大幅增长，但其品质却不尽人意，这对我国渔业产业的发展是很不利的，特别是加入 WTO，我国水产贸易既享受权利，同时也要承担义务，各国对进行虾、蟹产品的检验越来越严格，抗生素等化学药物的滥用和残留不仅危及虾、蟹养殖本身，甚至会危及整个虾、蟹养殖业。对此我国应予以高度重视。对虾、蟹病害的控制“以防为主”，不能仅停留在口头上，要必须严格限制有关抗生素和其它化学药物的使用，加强养殖水体的管理，有效恢复养殖生态环境，才能保证虾、蟹养殖业的持续健康发展。必须以无公害水产为目标，做好养殖环境的修复工作，制定切实可行的行业监管体系。

5、 做好市场营销工作

在目前市场不景气的情况下，要着重开拓国内、外两个市场，除鲜活产品外，开发更多、更好的加工品种。

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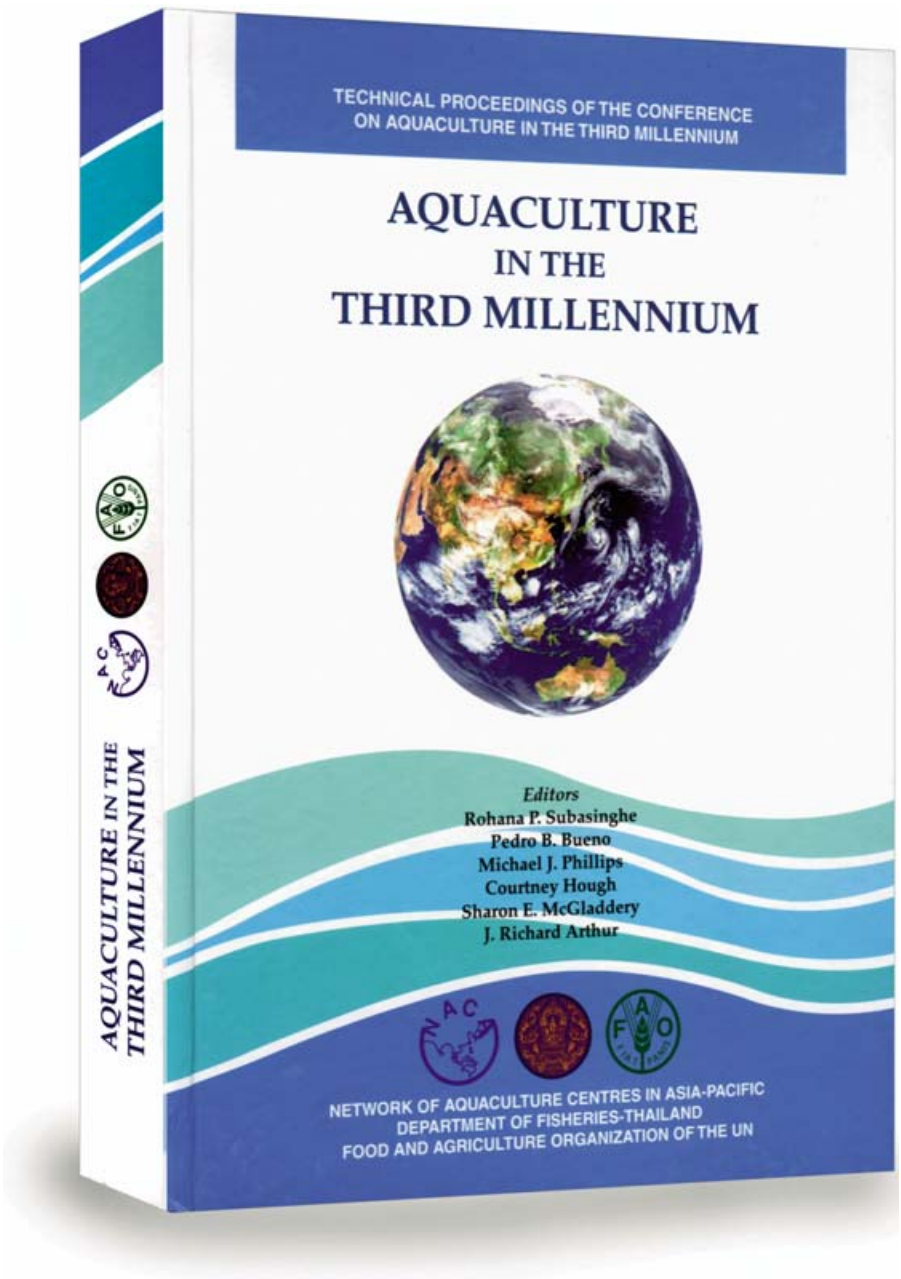

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