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AQUACULTURE ASIA

Aquaculture without Frontiers in Nepal

Self-help group farms ornamental fish

From Kyoto 1976 to Phuket 2010

Waigieu seaperch

Freshwater mullet

Endangered bagrid catfish

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From the postbag: Thoughts on *vannamei*

This issue we have some feedback from a reader worth some consideration - Ed:

The article *A different form of dumping: the need for a precautionary approach for yet another new species for shrimp farming* (Aquaculture Asia, XII (4); 3-6. by De Silva, S.S., Mohan, C.V., Phillips, M.J.) is quite relevant to India at the moment although it was published in 2007. For a long time the majority of farmers in India were opposed to *Penaeus vannamei* as it was grown in other Asian countries mostly at high to very high densities and up to the size of 20 grams ABW. Indian farmers who traditionally grow *P. monodon* to large sizes and not more than 2 MT per hectare, found the option of growing small sized *vannamei*, at high densities and large volumes, unattractive. For them, the risks are way too high for the expected returns and besides, it will require a lot of capital investment to improve farm infrastructure to manage high densities, which is not easy to come by for the small farmers. Hence, small farmers kept away from *vannamei*, and also opposed the introduction, fearing entry of exotic pathogens through brood stock imports, undue pressure on the carrying capacity of the resources and the eminent price drop due to increased production. Their apprehensions were well justified, as highlighted by the authors of the article cited in the beginning of this article.

Nevertheless, *vannamei* is officially in India and, despite all the gloom surrounding exotic species introduction, there seems to be a silver lining too. The growth of current breed of SPF seeds to 40 gram animals is a blessing for the small farmers, as they too can grow this species to large sizes and low volumes, at densities they are comfortable with and with their existing infrastructure. The silver lining appears brighter, because of the inherent problems farmers are facing, due to the deteriorating quality of the *monodon* wild brood stock. As rightly pointed out by the authors of the cited article, the benefits of this exotic species will accrue with the sector only if:

- Only authentic SPF brooders are imported and thoroughly screened in a quarantine facility.
- Authorities maintain strict vigil and hatchery operators use self-restraint to ensure supply of only SPF seeds to farmers and not seeds from pond reared brood stock.
- The farmers adhere to norms and produce quality shrimps under sustainable practices.
- Processors quickly gear up to handle the additional production and explore local and overseas market for this new species.

If the stakeholders take adequate precautions, remain wary of the disaster that could strike and be wide alert, then the aquaculture sector in India which is vastly made up of small scale farmers doing sustenance and livelihood farming, would benefit from this species introduction. If we make mistakes like some of the other Asian countries, we will have a disaster in our hands.

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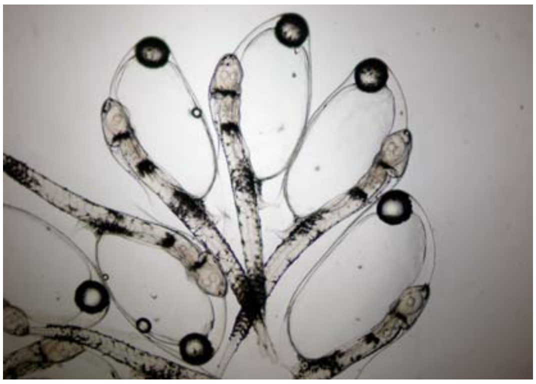

Peter Edwards writes on

Rural Aquaculture

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Visit to the AwF funded small-scale aquaculture project in Nepal

During a consultancy in Nepal late last year to review the Nepalese component of the EU-funded project 'Aqua Internship: Asia Link Program in Bangladesh, Nepal and Vietnam', I took the opportunity to make a brief visit to the Aquaculture Without Frontiers (AwF) funded project: 'Nepal - Empowering women through small-scale aquaculture'. The AwF project, now in its second two year phase, is operating in the temperate Mid-Hills region of the country.

The AwF project has been built on a previous successful small-scale aquaculture project implemented by the same team in the tropical lowland Terai region of Nepal, which I also revisited. The AwF rural aquaculture project is being implemented jointly by Dr Ram C. Bhujel of the Aquaculture and Aquatic Resources Management (AARM) program of the Asian Institute of Technology (AIT), Thailand who is the project Team Leader, and Dr Madhav K. Shrestha of the Institute of Agriculture

Below: A typical small-scale pond in the initial project site in the Terai.

and Animal Science (IAAS), Chitwan, Nepal who is the Project Coordinator, in cooperation with a local NGO and village women's groups.

Background

About 85% of the people in Nepal live in rural areas and rely on subsistence agriculture. Animal protein is scarce and aquaculture is not a traditional activity as it is in many Asian countries. Aquaculture has been promoted for the past 50 years but it remains underdeveloped; this is especially so for rural or small-scale aquaculture which has considerable potential to improve the nutrition of rural communities as well as generate a source of supplementary income.

The initial small-scale aquaculture project was launched more than a decade ago in Chitwan district in the tropical lowland Terai region of the country, funded by a German NGO called WDP-German Committee. A group of 26 women from the indigenous Tharu community, mostly illiterate subsistence farmers who also catch fish from rivers and swamps, were selected to participate in the project. Fish used to be a major component of their diet but they were encountering declining catches and as they did not know how to cope with the problem they were keen to learn how to farm fish. The Project Team designed and implemented with women household members a small-scale aquaculture initiative. The women were advised to build 200 m^2 ponds although some built larger ponds if they had available land. The project provided training and technical support and procured fish seed but funded only half of the pond construction cost at an agreed rate based on local conditions to help to identify genuine interest, with the family mostly providing their own labour.

About half of the farmers chose more familiar carps and the other half stocked Nile tilapia. Low-cost production was recommended based on a green water system using on-farm livestock manure and inorganic fertilisers, supplemented with bran, leaves and kitchen wastes. During my earlier visit in 2000 I had observed that the water in the ponds was stained dark brown by tannins released from heavy manuring with ruminant manure. On-station research at AIT and on-farm research in NE Thailand had previously discovered that it is not feasible to fertilise ponds with large amounts of ruminant manure as dark brown water inhibits light penetration necessary for the phytoplankton to grown and provide natural food for filter feeding fish. I therefore recommended that the manuring rate be reduced and supplemented with ruminant urine which has a higher nutrient content than faeces and/ or inorganic fertilisers. As a result of this and increasing farmers expertise, the pond water soon changed in colour from brown to green with increased growth of stocked fish. Extrapolated average fish production was an impressive 4-5 tonnes/ha /year with average household harvests of 66 kg of carps or 42 kg of tilapia per 8 month cycle. This difference between carp and tilapia production was due to the larger average size of carps ponds of 234 m^2 compared to that of the 131 m^2 of the tilapia farmers who tended to be from relatively poorer households. Research at AIT also showed no difference in fish production between a polyculture of carps and a monoculture of tilapia with the same fertilisation and supplementary feeding regime.

Some farmers in the Terai have expanded the size of their pond and the intensity of their operation to generate more income from fish culture.

As fish production peaked at 300-350 m^2 it was suggested that small-scale farmers should not build ponds larger than this as they would lack resources to feed the fish. It was further estimated that a pond of 175-300 m^2 would produce about 50-90 kg of fish for household consumption and sale which would make a significant contribution to both household nutrition and income. An ADB-funded project on inland aquaculture in Nepal in the early 1980's had limited the participation of farmers to those who would construct a minimum pond size of 2,000 m^2 , clearly in excess of the ability of the vast majority of farmers to raise fish using on-farm resources or even those locally available.

The small-scale pond project in Chitwan in the Terai has been considered to be one of the most successful aquaculture projects in Nepal. It demonstrated to Nepalese policy makers, donors and others that fish could be cultured economically in small ponds. Furthermore, the pilot project proved that women can manage small-scale ponds. The women's group in Chitwan has since been upgraded formally to a 'Women's Fish Farming Cooperative', the first fish farming cooperative in the country. The Government and national and international NGOs are now promoting the Chitwan model throughout the country. The project site has become a popular place to visit by farmers and government and NGO officials.

By leaning from the lessons of the past and the experience with small-scale aquaculture in the Terai, the AwF project has recommended constructing ponds initially of 200m^2, only 10% of the size of the ADB project to better fit in with local farm resources.

Revisiting the small-scale project in Chitwan

Following the review of the Asia Link Programme at IAAS in Chitwan, I revisited the small-scale ponds at the former project site in the same district. Most of the small-scale family-level ponds were still in operation and several neighbouring farmers had built ponds without external assistance once they had observed that fish could be raised in small ponds. A few farmers had also considerably expanded the size of their ponds and the intensity of their

Dr Ram Bhujel of AIT, the AwF project director kindly guided me to see the project

The project village in the mid-hills region with the snow capped Annapurna mountain range in the distance.

A well fertilised 'green water' pond built in a rice field.

operation to enable them to sell more fish and therefore for aquaculture to comprise an increasing part of their household income.

AwF small-scale aquaculture project

Background

The project site is located in mid-hills of Nepal, approximately 150 km west of Kathmandu at an elevation between 500-700 m. The land in the village is irrigated with water originating from a glacier lake diverted from the Chepe River through the Rainastar Irrigation Project that has been in operation since 1984. The canal is the main source of water for the newly built family fish ponds. Irrigation has changed the cropping pattern of the village and farmers are seeking more opportunities for water-based crops, including fish.

Most people in the village rely on subsistence agriculture. However, the majority of men migrate to cities in or outside the country in search of work due to limited local income generating activities. Most women stay at home but struggle to provide enough food for the family. They grow mainly rice, some vegetables and also raise some livestock but due to a decline in land for pasture, raising animals has become difficult as it consumes considerable time to collect fodder. Cereals and root crops are the main food items and meat is becoming scarce and expensive. Overfishing and destructive fishing practices have also reduced the amount of wild fish caught from nearby rivers. In addition two hydropower dams, one downstream and the other upstream side of the village have blocked the fish migration. Thus most children suffer from moderate to severe stunting and one or more other forms of malnutrition.

The village was also affected by the recent decade-long internal conflict in the country. In fact the root causes of the conflict were rural poverty, lack of food security, discrimination against women and dalits (untouchables and disadvantaged groups of people) and their exclusion from the development process and social and political activities. The AwF project is an attempt to address some of these issues.

My visit

The initial two year phase of the AwF project ran in 2008 and 2009 and during my visit in November the project was in its second 2-year phase. Dr Ram Bhujel guided me to visit the project site in his home village, Dhamilikuwa, Lamgung District – a new interpretation of ‘charity starts at home’ although his family was not among the project beneficiaries. Clearly there was no conflict of interest but a boost to the project from intimate local knowledge. It was one of the most enjoyable project visits I’ve ever made as we had to trek for about an hour over a suspension bridge across a river, Marsyandi, in full spate; and hike up through the hills to reach the site as flooding had washed away a bridge across the only road into the area, with the mighty snow-capped Annapurna mountain range clearly visible in the distance.

I visited six family level-ponds built in Phase One of the project and briefly interviewed three women pond owners. They all expressed satisfaction at being introduced to the culture of carps and tilapia, being able to consume as well as sell table fish and to sell tilapia fingerlings to neighbours. The opening ceremony of a one-day training program for 15 enthusiastic women from Chakratirtha Village was being held during my visit for Phase Two of the project in a local school. The ceremony was being conducted by Hare Ram Devkota who was assisting the project as the field component of his M.Sc. Internship through the Asia Link Programme while enrolled at IAAS. A training manual in local language had been prepared and distributed by Mr Devkota to the participants.

In reply to my question at the ceremony, “why are you interested in raising fish?” the women enthusiastically replied:

- To have fish without spending money
- There’s no need to leave the farm to buy fish
- It’s healthy food
- To resolve child malnutrition
- To earn income
- To offer guests
- It’s nice to be able to observe fish next to the house and especially when guests visit, fish ‘dance’ which is nice to observe
- Women and children can easily feed the fish
- Some support and information are being provided by the project.

Mr Kishor Pant (Chief) and Kul Prasad Adhikary (Subject Matter Specialist) from the District Agriculture Development Office (DADO) were also present at the opening ceremony. They reported that the local government was so impressed with Phase One that they were going to assess the feasibility of scaling-up the project to more villages in the district.

Women fish farmers and their pond built near the house.

Project details

To supplement information gleaned during my visit, additional information presented below has been summarised from the project reports which are available on the AwF websites at www.aquaculturewithoutfrontiers.org.

The main aim of the project is to test whether it is technically and economically feasible to improve the livelihoods of people in the Mid-Hills region of Nepal, that covers over two-thirds of the country, by introduction of small-scale aquaculture to supply animal protein and generate supplementary income. The specific objectives of the project are to develop an ‘AwF - Model Village’ and to empower women through the establishment of women’s fish farming groups so that they can raise fish while working at home.

The project was launched through an awareness program for a group of 50 women in March 2008. A CD ‘Women in Aquaculture Project’ based on the previous project in Chitwan was shown to them in a school in the village followed by a questions and answers session. The project team and representatives of the local organisations then visited potential pond sites of applicant families and advised them how to dig and manage fish ponds. This was followed by a one-day demonstration trip to the previous project site in Chitwan to familiarise all

A women farmer and her pond with a scare crow to frighten away fish eating birds.

50 women with real fish culture activities and the functioning of a cooperative of women fish farmers in an ethnic community managed by the women themselves. The two women's groups were trained by Dr Madhav Shrestha on the day following the demonstration trip. He explained how to dig and prepare a pond, and how to stock fry, feed and take care of them. Their confidence to be able to raise fish was also due in no small part to the interactions with the women's group at the successful fish culture site in Chitwan during the demonstration trip. Finally those 43 women fish farmers, the majority from poor households, were selected and organised into two Women's Fish Farmer groups based on their location within the village. Provision of financial assistance varied with social status as follows: 31, 2 and 6 women from poor, middle class and higher middle class households received 50, 40 and 30% financial support, respectively. Altogether 40 families dug new ponds in the first year of the project with the other three families who already had small ponds also included in the group for technical support but they received no financial assistance.

After completing pond construction 5kg of lime/100m^2 was applied and after 15 days another dose of 2,000kg/ha cow dung was added. Ponds were filled with water from the irrigation canal and were fertilised with di-ammonium phosphate (DAP) and urea at rates of 0.4 g N/m^2/day and 0.2g P/m^2/day as basal dose, respectively. Bighead, common, and silver carp fry were obtained from government fish farms in Pokhara and Chitwan. Fertilisation with alternate doses of cow urine and inorganic fertilisers continued on a weekly basis. Fish were fed locally available agricultural by-products (rice bran, oil cakes) on bamboo feeding trays. Many farmers also fertilised the ponds with cow or buffalo. Legumes and grasses were planted on the dikes to control dike erosion and to provide feed for grass carp. Regular monitoring was carried out by Mr. Hare Ram Devkota, an M. Sc. Aquaculture student at IAAS, Chitwan, who worked with the women's groups as an Aqua Intern supported by EU-funded Asia Link project. Although the EC-project has now been completed, the Aqua-Internship program (www.aarm-asialink.info/internship.html) is further expanding with the AwF-Nepal project serving as placement site for interns to work and learn. So far, students from India and Europe have done an internship at the project site to date.

The grow-out period was 7-8 months. Common carp grew biggest with some farmers able to harvest up to 1.0 kg sized fish in 8 months from about 50-60 g fingerlings while grass carp grew to 200-425 g. The daily weight gains of common carp and grass carp were about 2.0 and 1.0 g, respectively, much higher than 0.3 g/day for bighead and silver carp and carp. Some farmers partially or completely harvested fish a few months earlier because of shortage of water; some families started eating the fish when still small, <100g, while others waited longer to harvest larger

The newly formed women's in Phase 2 with trainers and local government officials.

An awareness meeting with a family to explain the nature of the project.

Dr Madhav Shrestha, the local project coordinator, training a women's group in a classroom of a primary school.

fish, some of which were sold. As the weather in Nepal turns cold, all the farmers had to harvest fish before December. All families consumed more than half of the fish by themselves either regularly or during festivals while less than half was sold for cash. Selling fish was not a problem as local people gathered to buy fish when a fish harvest was announced. Several farmers with tilapia recruits in their ponds gave them to neighbours for free or sold them as suggested by the project team.

A project diagramme explaining how to integrate a fish pond in the local farming system.

A third women's fish farming group with 27 members was also formed during the second year and three ponds were constructed at a lower secondary school, a total of 30 new ponds. Training and financial support were again provided and a fish farming training manual with data sheets for input records was distributed to the participants. Based on the experience of the first year farmers, common carp and grass carp were stocked as bighead carp and silver carp grew slowly. Additionally, tilapia was provided to all the farmers to test as a new species. Fingerlings of Nile tilapia were procured from Sundar Bazar in the same district where a few farmers were trying to raise fish independently. Stocking of fingerlings in the ponds was done after nursing in small hapas suspended in some ponds for over a month. Women fish farmers also group formed a committee to take responsibility for fish transportation and nursing of fry obtained from the seed from Fishery Research Center in Pokhara about 80 km away, and distribution of fingerlings.

Major outcomes and lessons learned

The AwF Nepal project in the first phase established three women's fish farming groups involving a total of 70 women in the village, trained them in fish farming and facilitated them to organise regular meetings to discuss problems and share experiences. Men also helped in pond construction, fish transport, organising meetings and facilitating discussions.

Forty three ponds with a mean size of 44 m^2 and a range of 12-169 m^2 water surface area were constructed with the support of AwF in the first year. Although three families completely lost all their fish, average survival was high at 73 % with some of the farmers having a very high survival rate up to 97%. The average size of the fish consumed was 124g and the average size of fish sold was 136 g. A high 76% of the total fish produced was consumed by the farmers' families or relatives, 3.4 kg/family. Two thirds of the families consumed all the fish they had grown, again indicating the severe fish shortage in the village. The average value of fish produced per farmer was US$12 with a maximum of US$90.

The project revealed that the women were happy to dig a pond on their land with a subsidy of US$10 or even less. The 27 women who joined the project in the second year built ponds ranging in size from 12 to 200 m^2 and produced an average of 6 kg/family, over 80% of which was consumed by the family. The total value of fish produced ranged from US$12 to US$66 with a mean of US$15, similar to the level obtained by the farmers in the first year.

Tilapia made a positive impression on farmers as it provides a solution of fish seed supply, with village seed production instead of sourcing from afar. Some farmers are now selling tilapia fry. Small fry had low survival during the first year. Therefore, fry were nursed in a hapa for about 2 months to produce large-size fingerlings to stock ponds in the second year. As there is demand for fingerling from other villages, if fingerlings could be produced locally, it would help to promote small-scale aquaculture in rural areas. Better production has been achieved from the ponds which are close to animal sheds as animal urine can be drained into the pond.

AwF money was well spent. With a grant of less than US$10,000 in only 2 years of the first phase of the project, the AwF-Nepal project dug 70 small ponds within Dhamilikuwa village, Lamjung, a representative Mid-Hills district of Nepal. Direct beneficiaries included 300 family members of the women fish farmers as well as children in primary school where three ponds were dug. More than 658 kg of fish were produced, 80% of which was consumed by the families. Although total value of fish produced was less than US$2,000, pond production should increase over time and more farmers should start to grow fish. These together should generate more than the US$10,000 invested by the project within another 2-3 years.

Relatively limited time was required to grow fish compared to other farming activities, only an estimated 10-15 minutes/day over 8 months, a total time spent of a only a couple of days. Most women group members reported that no additional time was necessary for fish farming. A women who expanded her fish pond from 36 to 200 m^2 said, ‘one rupee gives you 100 rupees; no other agriculture component gives you so much profit at such a low investment’.

Fish fry being transported up the hill to the project village.

Equalising the temperature of the water in a plastic bag with transported fry and the pond water.

In the second year of the project, fry were nursed in hapas before stocking into the grow-out ponds.

Taking a water sample in a pond recently fed with vegtation.

Left: Common carp being harvested from a villager's pond.

Prior to the initiation of the project, aquaculture activity was almost non existent in Lamjung district and the project created awareness about fish farming by women organised in groups. Several neighboring villages have already requested for assistance. Local FM radio broadcast the highlights of the project several times and various groups visited the project site. A District Fish Farming Association (DFFA) and network connecting the fish farmers of Lamjung has been set up with support from the District Agriculture Development Office (DADO), with a project team member serving as the chair of the association. The major responsibilities of the DFFA are to disseminate the idea of small-scale fish farming to other parts of the district, coordinate interested organisations and to generally facilitate its implementation. Women's groups have successfully convinced the district government to provide partial support for fish farming. There is every indication that this is likely to ser ve as a model for small-scale fish farming programs for the Mid-Hills region of Nepal.

Phase 2

In Phase 2, now underway, the Project Team is expanding small-scale aquaculture to northern parts of Lamjung district at a higher elevation and also to neighbouring districts, namely Gorkha, Tanahun and the upper parts of Nawalparasi, to test and further improve the productivity and efficiency of the AwF-Nepal model of small-scale aquaculture for the Mid Hills region of Nepal and to disseminate the project idea as widely as possible throughout the country.

However, the Project Team and the farmers are struggling to overcome some hurdles. The shortage of fingerlings is critical although some farmers are using mixed-sex tilapia as a solution as tilapia breeds in the ponds and produces fry. Attempts have been made to establish a hatchery in the region but if the shortage of fingerlings continues it may lead to abandonment of the ponds constructed over the last few years. Another challenge is how to move these farmers towards more commercial farming. The Project Team is suggesting that local banks need to hire an enterprise development technical officer and to provide micro-finance for aquaculture, with a provision for the first installment of the loan repayment due only after the first fish harvest.

Success story of the Barakhandapat Ornamental Fish Breeding Unit, at Patna cluster of Keonjhar, Odisha, India

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Ornamental fish keeping is one of the most popular hobbies in the world today with the growing interest in aquarium fishes resulting in steady increase in aquarium fish trade globally. The culture of freshwater ornamental fishes has provided a livelihood option to many who are working with utmost sincerity. It not only provides an aesthetic sense but also facilitates income generation.

While aquarium keeping is a hobby for many, to others it is a means of business. If we analyse the business opportunities and economic potential, ornamental fish may be more beneficial than cultivable food fish. Maintenance and feeding patterns are similar to those of food fish but ornamental fish farming opens up great opportunity for more revenue generation within a short period of time. Apart from being a hobby, ornamental fish keeping has also other positive dimensions including education, research, medicine, conservation and foreign exchange earnings.

Training of ornamental fish farming at CIFA.

The trade of ornamental fish in India has extended from urban to rural areas. Under the NAIP- Livelihood project, CIFA has tried to popularise ornamental fish farming in rural areas by involving rural women through self-help groups in three districts of Odisha. One such self-help group at Keonjhar has come out very successfully in the farming of livebearers at their unit. This success story is presented here with a hope that it would rekindle interest in ornamental fish keeping and production among the readers.

About Barakhandapat Self Help Group

Barakhandapat Self Help Group, a group of 10 female members in Jodichatara village of Patna cluster in Keonjhar district of Odisha was established in the year 2002. The members of this group are from the tribal communities and most of them are housewives of farmers. The elected president is Mrs Banita Naik and the secretary is Mrs Surekha Naik. Initially this self-help group was provided with some financial aid from the block headquarters to run microfinance activities. With the arduous efforts of the members, this group became one of the active groups in the district. They were given the task of monitoring the mid day meal programme in the primary school of the village.

On farm demonstration.

Stocking of livebearers.

Approach

In order to create awareness of ornamental fish breeding and culture techniques to improve the sustainable livelihood, a combined effort of NAIP and CIFA (ICAR) was made under the livelihood project (Component 3). Several village level training activities were conducted through screening of films on successful farming practices, meetings and other related activities were carried out for capacity building among the villagers especially the self-help groups. A two day exposure visit to CIFA was facilitated on 28th and 29th September, 2010 for the members with the main aim to familiarise them with the field work and practical aspects of ornamental fish farming. In addition, lectures were also delivered in simple way to create interest in ornamental fish breeding and culture. The self-help group members had opportunity to interact with the scientists and SRFs Field demonstrations of breeding techniques were also conducted in order to encourage them to take up ornamental fish farming.

Initiation of the work

The efforts of NAIP-CIFA have catalysed the members of Barakhandapat SHG to establish an ornamental unit in the Jodichatara village. Prior to establishing the unit a meeting was conducted among the scientists, SRFs and the members of the self-help group and detailed discussion was made on the know-how of setting up an ornamental unit. Each and every aspect from initial preparations to marketing of the produce was discussed threadbare and a layout diagram of the unit was provided. The owner of AQUA WORLD shop, Mr Sachikanta Behera who deals with all the necessities for ornamental fishes was introduced to the members. He had promised to purchase their produce at remunerative price.

In the meeting it was also decided that initially the self-help group on their own expense has to invest some amount for a cement platform and few tanks. To make them involved and ownership feeling, under PPP (Private Public Partnership) mode the self-help groups were advised to construct a cement platform of 7.5 x 5 metres and six tanks each of 1.5 x 1 x 0.6 metres. The members agreed to it readily without any reservation. Similarly, NAIP-CIFA provided eight rectangular FRP tanks of 450 litres capacity and a circular hatchery specially designed for breeding of live bearers and some of the egg layers. At first, the site for setting up the unit was selected and the SRFs were simultaneously asked to monitor the work. The construction work as per the required size was completed at a total expense of Rs. 10,000/- drawn from the savings of the self-help group.

Once the facility was ready the scientists visited the unit to provide technical guidance for stocking of fish and rearing. Prior to release of fish in the tanks the members of the self-help group were asked to fill the tanks and plant hydrilla twigs in pots inside the tanks. This work was supervised by the SRFs. CIFA provided shade nets and all the accessories like nets, sieves, pipes for siphoning purpose, plastic ware such as mugs, buckets, feed containers etc. When the full unit was ready, fish and feeds were provided to them by the institute.

Production of livebearers.

Initially livebearers like guppies, platys and mollies were introduced into the tanks and the members were then taught about the breeding behaviour. The SRFs supervised all the activities including breeding and feeding, method of siphoning, health and hygiene care, etc.

Breeding and production

With the effort of SHG members and constant supervision the ornamental fishes started to breed. After seeing the fry the members were excited and started taking all possible care as per instructions. They are also asked to provide feeds that are being provided from CIFA and were also taught on producing feeds at cheaper costs using rice bran, groundnut oil cake, soya bean, fish meal etc. In the meantime they were also trained to collect plankton from the pond for providing live food to the fish larvae. Besides, earthworms were also given as food to the fishes. The group members are performing efficiently. All of them take utmost care of the fishes and the production. The details of the production and other activities are monitored by SRF and noted in reports. Apart from this the group members also keep a record of their activities.

Activities of the self-help group.

Marketing

Once the fry attain marketable sizes, members themselves contact the trader for marketing the fish. The fishes are priced at per piece. The trader purchases the fishes at a remunerative price. For delivering the fish to the market, the members have appointed Mr Debanand Naik of the same village who takes their produce for sale to the trader at Keonjhar market. The fishes fetch a good price and this has created even more interest among the members. In one breeding cycle (3-4 months) group had already sold fishes worth Rs. 2,060/- and still are having fishes of marketable sizes of worth Rs. 8,000/- to be sold. The expected revenue from the unit is estimated at Rs. 12,000/unit/year during the first year. More income could be generated in subsequent years. The amount of money generated from the sale of fishes is deposited in the joint bank account of self-help group members.

Interests of the SHG members

An appreciable amount of income generation from ornamental fishes has been encouraging to the group members. They also have the feeling of self-contentment and express satisfaction and have plans for expansion. Past experience has boosted their confidence to produce more quality fishes which can fetch high value in the market.

Factors contributing to success

Factors that have contributed to the success include:

- Technical support and co-operation of NAIP-CIFA team.
- Timely supply of inputs and time to time suggestions and motivation.
- Co-ordination and keenness among the SHG members.
- Ready availability of suitable water.
- Growing demand of aquariums in urban areas.

Constraints

- The self-help group does face some contraints, namely:
- The market, located in Keonjhar town, is somewhat distant (20 km away).
- They lack a means of conveyance.

Needs of SHG

To establish ornamental fish culture operations, a self-help group requires:

- Training on breeding techniques of egg laying fishes.
- More on- field trainings and demonstrations.
- Exposure visits.
- Technical support from the authorities for efficient production and propagation.
- Better marketing facilities.

Lessons learnt

The ornamental unit has proved to be a boon as livelihood option for the economically challenged tribal community. This endeavour has lead to capacity building as well as income generation of the less privileged classes of the society. The skills learned would assure them self employment and secured financial status

Acknowledgement

The authors are thankful to National Director Dr Bangali Baboo and National Coordinator Dr A.P Srivastava, NAIP, Dr A.E. Eknath, Former Director of CIFA and Present Director General of NACA, Bangkok for their support and encouragement.

From Kyoto 1976 to Bangkok 2000 and Phuket 2010: Aquaculture development and personal transitions

Grey haired reflections on 34+ years of global aquaculture

Davy, F.B. and De Silva, S.S.

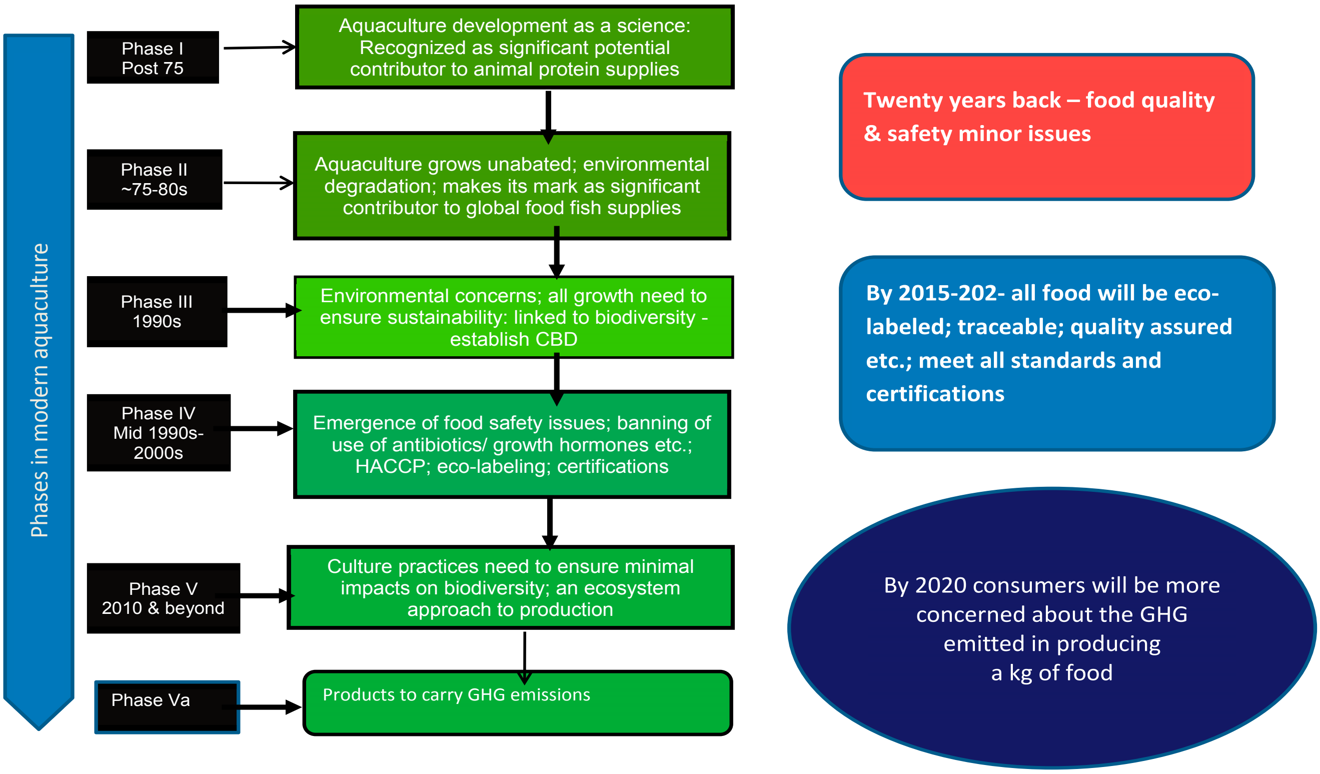
As we were crafting this article, we had just finished enjoying the Phuket Global Aquaculture conference. The conference was well attended and most participants seemed to have enjoyed the Phuket ambience as well as the meetings themselves. There was the usual mix of presentations by new and past colleagues, interspersed with many chats over coffee, tea and other assorted beverages often at all hours of the day and night, depending on time zones and jet lag...all forms of critically important interaction/sharing as is typical at these events. As is also often the case at such meetings, we started chatting about the past global aquaculture meetings and then polling how many of those in Phuket had attended the 1st Global conference in Kyoto, Japan, 26 May - 2 June 1976[1]. Kyoto was the initial global conference in this sequence and it took a first look back at aquaculture development over the past decade, and ways to best move forward, and the acceptance of the fact that it is only through aquaculture that the increasing demand for food fish could be met with. Although we may have missed some people, the best count that we were able to come up with was the three of us (see photo), and so we senior members were asked by the conference organisers to reflect on then and now...to briefly summarise our thoughts on the transitions from Kyoto to Phuket over 34 years of our history as a sector and as concerned individuals. Unfortunately we have not (as yet) been able to track down photos of us in Kyoto but as can been seen in the attached photo, we might best be summarised as increasing amounts of gray at least in the hair when compared to Kyoto days. In general 34 years used to be considered a full working life to be followed by retirement. Some of us are retired in one sense, but still trying to keep our minds ticking and stay involved in this exciting field of research and development activities of the sector at large. Aquaculture has, in many ways, become and continues to be, a very important part of us.

Aquaculture itself shows no signs of retiring but rather continuing to develop, expand and adapt. Looking back, we felt that a reflection on a few key changes in aquaculture, perhaps those that parallel some of the changes in us, might provide a useful starting point. Kyoto was the first truly global conference on aquaculture and it provided probably the first, and we would argue a very unique comparative view, on aquaculture development over the decade from 1966 to 1976. At that time aquaculture was the new "kid on the block", striving for recognition as a science, as an industry and a serious player in the future development of fisheries and agriculture. This was also a time when increasing production was the key development driver. Like aquaculture development, the three of us were also at an initial phase in developing our careers, having just completed our various post-graduate studies, very excited to have the opportunity to attend Kyoto and anxious to hear and see the various more senior, more famous members of the aquaculture world, many of whom for the first time gathered in Kyoto. We all agreed that Kyoto set an important stage for the development of the sector and it was likewise an important stage setter for each of us. Our reflections now move on to take a brief look at some of the change processes or development phases in aquaculture followed by a brief look at one of those early themes, investing in people and organisations; a theme that we feel still doesn't seem to receive the review and analysis that it deserves.

The usual suspects (left to right): Brian Davy, Sena De Silva and Patrick Sorgeloos.

Development and changes in aquaculture

In the figure below, we outline one view (from De Silva & Davy, 2010) on the phases in the development of aquaculture, in which this sector moved from an initial production focus into more environmentally concerned development and now market globalisation and food safety developments in more recent years.



International development and the work we do

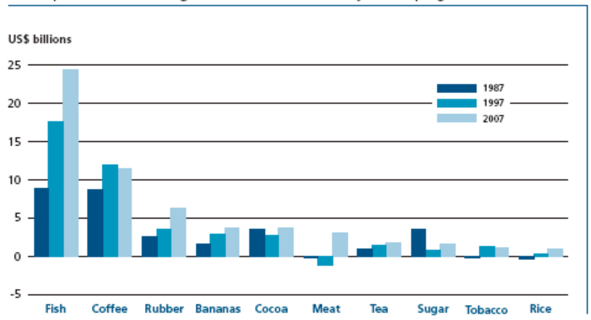
After World War II, the concept of international development started to take shape and aquaculture (and our links to it) were very much a part of this evolving international development paradigm. The evolution of this thinking took a variety of forms but in present day terminology a major shift has been the move to seeking sustainable solutions to the environmental, social and economic problems and particularly development in poorer/less developed countries. As aquaculture, the sector, was seeking to more firmly establish itself as an increasingly important part of this evolving international development process, and by extension many of us were seeking to establish niches as sector members. A key cornerstone of such development was capacity building; including the development of a wide variety of collaborative links and networks both for training but also collaborative research, via a wider set of networking and related shared learning mechanisms. All such development has played critical roles in these efforts, and in our professional lives. In tune with this thinking, the Kyoto Declaration called for development of regional networks and greater investment in networking and training more generally (among other items). What has been the impact of these investments and what have we learned from these efforts?

Investing in people and organisations; the unseen, unspoken change

Building on the Kyoto Declaration were the two follow-up conferences, first in Bangkok and most recently in Phuket, Thailand. This latter conference produced the most recent vision and associated documents, the Phuket Consensus[2], which outlines how aquaculture development has transformed fish as a commodity into one of the most important traded items globally. This is illustrated graphically in the figure below.

But just as important in our view at least, has been that this almost silent unspoken and little examined change in terms of people and capacity side of this development. This is probably one of the most transformative changes that has taken place but in many ways, it remains a largely invisible change. To date major aquaculture development has mainly taken place in Asia mostly in the so called "Third World" countries and so we found it useful to go back to some of the early

Net exports of selected agricultural commodities by developing countries



thinking of authors such as J. Gaillard (1991)[3]; particularly his examination of research as a profession in these early days in the Third World. In looking back through some of such early lenses, it is clear that capacity development, and education thinking more generally, have been one of the more important development changes in this era. Aquaculture development has benefited enormously from this marked increase in investment in people and educational facilities particularly in the developing world. We often see these changes on the ground in our various travels in the region; the numbers of high quality research and training centers, the increase in various aquaculture specialists working in national, regional and increasingly global organisations and the reach and impact of these people is increasingly having impacts particularly in the countries of the Third World. Likewise the changing face of the various educational institutions, that are apparent in our travels around Asia, is a major but relatively poorly documented and perhaps even more so, poorly analysed line of thinking. Overall it is clear that the improved science capacity, irrespective of the manner of quantification, was one of the main outcomes of the development efforts over this 30+ year period. When we started our aquaculture careers there were significant investments being made in capacity development by a wide variety of actors (donors, national institutions, researchers and most aquaculturists themselves), investments that we were part of. So exactly where are we in the capacity building side of this aquaculture development process? What have we learned from these experiences to date and where is, or will, capacity development and aquaculture education move in the future? Some initial reflections and general ideas follow.

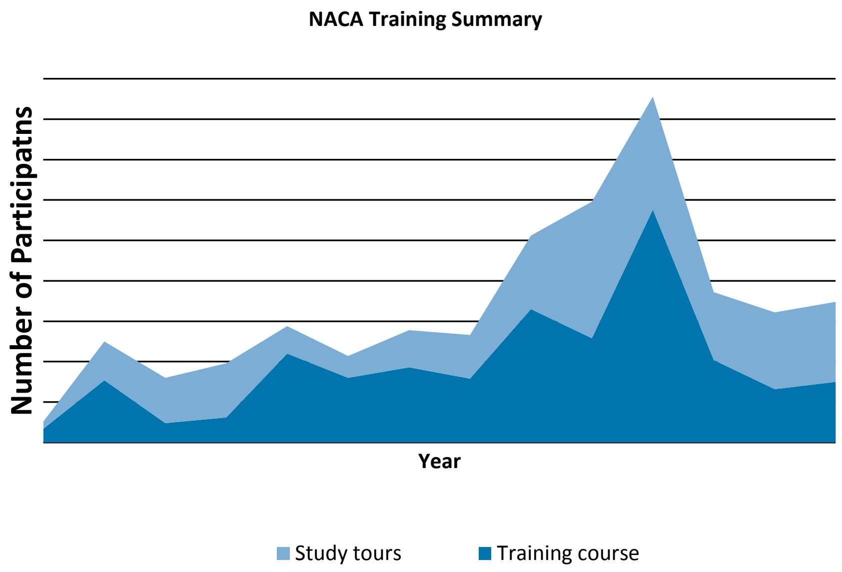
Human capacity development (HCD)

Human capacity development, as defined in the FAO Human Capacity Development Strategic Framework for Fisheries[4] is "the process by which individuals, groups organisations, institutions, and societies develop their abilities – both individually and collectively – to set and achieve objectives, perform functions, solve problems and to develop the means and conditions required to enable this process".

Other associated people factors

This capacity building and expansion in wider disciplinary involvement has taken a number of interesting turns with various consequences particularly in terms of shared learning and associated institutions. With the rapid growth in aquaculture the number of stakeholders involved in the sector has increased markedly over this time period and likewise there are an increasingly diverse set of backgrounds and organisational affiliations making up this changing mix of aquaculture players. Again little data seems to exist on some of these broader changes; numbers, trends and implications for development, both positive and negative implications.

For instance some broad trends paralleling the phases suggested above are the transition from production focussed fish breeding and nutrition research in the early years, then to disease and more recently to genetics. It seems that there are now wider moves into other disciplines in which social and information science thinking are playing increasing (but likely still inadequate) roles in these aquaculture development processes. We argue that the push pull of the choices made



in pursuing these various lines of research and development have not adequately been driven by relative needs but typically the result of more haphazard processes not guided by more planned mechanisms for allocation of resources over different scales and levels. Questions such as, has there been adequate emphases on genetics, for example of key species that will play major future roles in the appropriate development of the sector for instance? One question that comes to mind is whether our educational and training institutions are appropriately guided by suitable demand information. We now move to a brief but more general look at aquaculture education as one perspective on some of this thinking.

Aquaculture education: Some NACA experiences

Below we briefly review one Asian perspective on the development changes in education and training. Education programs for fisheries appeared in the Asian region at the turn of the last century. After almost a century of effort up to 1980's, a variety of deficiencies in the fisheries education systems were still a major issue (AFS 1988, AFS 1991 and De Silva et al. 2000 reviews). A faster growth phase of the aquaculture sector in Asia started in the 1980's, and so did aquaculture education. Consequently, the Asian region witnessed a rapid expansion of formal degree education in fisheries, aquaculture, aquatic resources management and related disciplines, even to the extent that such courses began to be provided by the distance mode, primarily catering to those already in employment but seeking to enhance their knowledge. At the turn of the new millennium, deficiencies seemed less of a major concern in aquaculture education with the shift to a wider diversity of aquaculture practices and an associated diversity of aquaculture education combined with changing demand, all leading to a greater need for aquaculture education to address an increasingly wide range of issues such as social development, sustainability, resource management (see Expert Consultation on Aquaculture Education in the Asia-Pacific Region, 2000). Practical training, often of the study tour type (for example as a mode of shared learning) with its quick response to industrial technology needs, and focus on specific skill development as well as its application with flexible and cost efficient learning approaches, has also developed into a most important education sector in aquaculture. Overall, most education and research institutes and government extension agencies conduct a wide variety of training activities at the national level, as well as some international/regional training programs established by various Asian regional organisations such as SEAFDEC, AIT, NACA among many others.

Aquaculture (and fisheries) training have made significant improvements in manpower and their capacities at various levels of aquaculture. There are some, but limited analysis of these trends and related thinking so we provide below one recent summary. Overall however these aspects of change have had limited examination and merit more focus and analysis. It is clear that this improved science capacity, however we seek to quantify it, was one of the main outcomes of the development efforts over this 44 year time window. In the following section, we briefly review one Asian perspective on education and training; the NACA experience, to provide one example of some of this thinking.

As can be seen in the figure below, study tours (e.g. white shrimp farming, feed manufacturing) and regular short term practical training courses (e.g. integrated fish farming, marine fish seed production, intensive shrimp farming, shrimp disease management) have been the main training options provided to date. The mix of study tours

and training courses continues to evolve with a priority for study tours likely driven by the large number of development projects in which study tour funding mechanisms are a priority. Although there was a peak demand in 2005, study tours continue to be in high demand throughout the region for a variety of aquaculture stakeholders from many member and non member countries.

New directions

As mentioned above, although the demand for aquaculture training continues to increase, assessment of these needs in order to develop more effective allocation of resources is suggested. So perhaps it is timely to re-examine this invisible development change and re-examine some of its implications as we plan for the next global conference.

Implementation thinking and implementation science in aquaculture

The knowing-doing gap

The back bone of Asian aquaculture is small farms- farmer owned/ leased, operated and managed- most of which are not well connected to science and its knowledge production systems; in fact some argue that there is an increasing disconnect or even increasing barriers between the supply of research knowledge and appropriate links to practitioners or implementation stakeholders. Typically, these are mainly farmers and other practical knowledge producers as well as other users and generally our existing systems (e.g. extension services) are pressed to spend adequate time and resources in understanding who are the key actors and how to appropriately reach them; for example, in terms of some sort of evolving extension thinking. In terms of the production side of these farming systems and this is particularly challenging given the large number of such family owned and operated small scale farms, particularly in Asia. In other sectors this is sometimes referred to as the "knowing to doing" gap. Our aquaculture training and extension systems for instance, continue to struggle with these knowledge dissemination processes. Fortunately some parts of this linked series of problems are improving. For example more of these Asian small scale farmers are becoming organised into associations, clusters and similar social groupings around common problems such as the new set of global production to marketing challenges. Better Management Practices[5] (BMPs) are being developed for important cultured commodities and these are being adopted related to such changes and these offer related knowledge linkage opportunities.

To date, to our knowledge, few organisations have attempted to address this aquaculture gap. Yet we see changes in the future perhaps guided by parallel opportunities developing in other sciences, for instance where there is a greater "demand pull" from users (farmers, health practitioners and other research knowledge users). The new journal Implementation Science[6] focussing on the health sector is a good example of the application of some of these ideas; this journal focuses on this developing demand for much better understanding of how to encourage greater uptake of health research, understanding the barriers to such processes and hurdles particularly "on the ground" or at the coal face.

We have taken to calling this interface as the 'aquaface' in our aquaculture work. Perhaps aquaculture needs to move more into implementation thinking including developing a new journal Aquaculture Implementation: Working at the Aquaface.

Knowledge translation

Knowledge translation[7] is an approach being developed particularly in the health sector with a strong appeal in terms of related practical aquaface thinking. Approaches and links or perhaps even "health models" could provide important comparative guidance to our work on aquaculture implementation.

Links

1. http://www.fao.org/docrep/005/ac863e/AC863E00.htm#TOC
2. http://www.aqua-conference2010.org/fileadmin/user_upload/gca/media/Phuket_Consensus_Final%20-%2013-12-10.pdf
3. http://books.google.com/books?id=I2ccZ7LOt1YC
4. http://www.fao.org/fishery/topic/14847/en
5. http://www.enaca.org/modules/wfdownloads/singlefile.php?cid=12&lid=1035
6. http://www.implementationscience.com/
7. http://www.idrc.ca/research-matters/ev-128908-201-1-DO_TOPIC.html

Embryonic and larval development of Waigieu seaperch (*Psammoperca waigiensis*)

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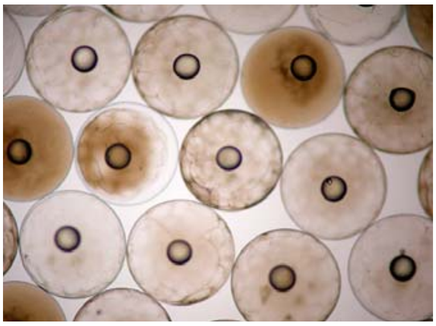
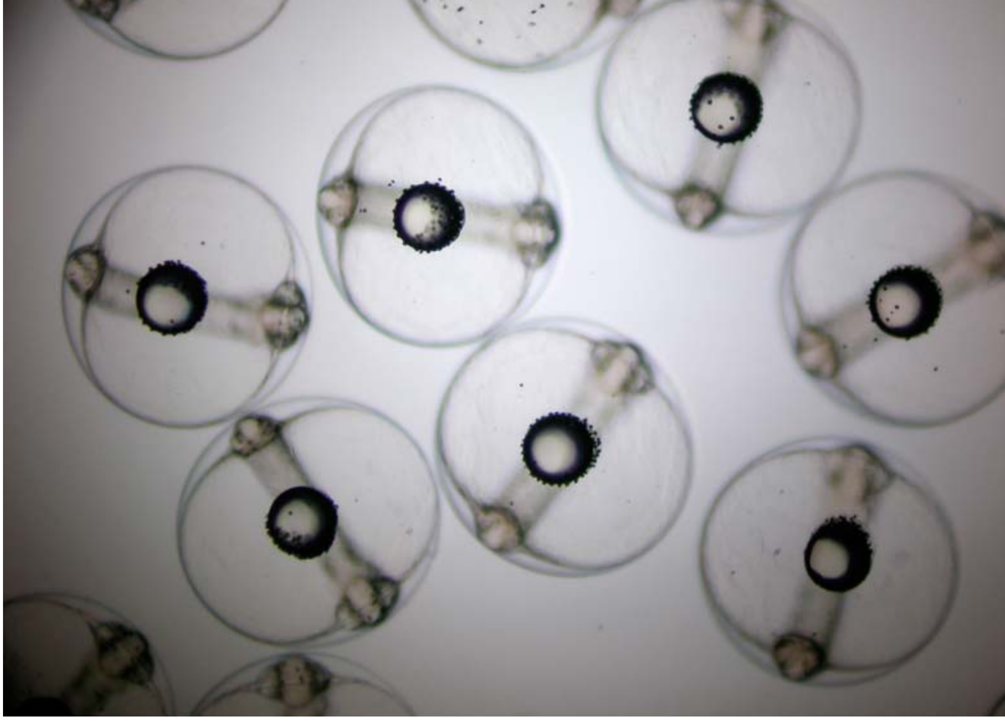
Waigieu seaperch (*Psammoperca waigiensis*) is a marine finfish species inhabiting the coastal waters of the Asia-Pacific region and Australia (Shimose and Tachihara, 2005). It is a high value fish species and is considered a candidate for marine aquaculture in Vietnam (Vu V. Toan 2002). However, it has received little attention from fish farmers when compared to other species that are being cultured popularly in Vietnam such as grouper (*Epinephelus* spp), cobia (*Rachycentron*



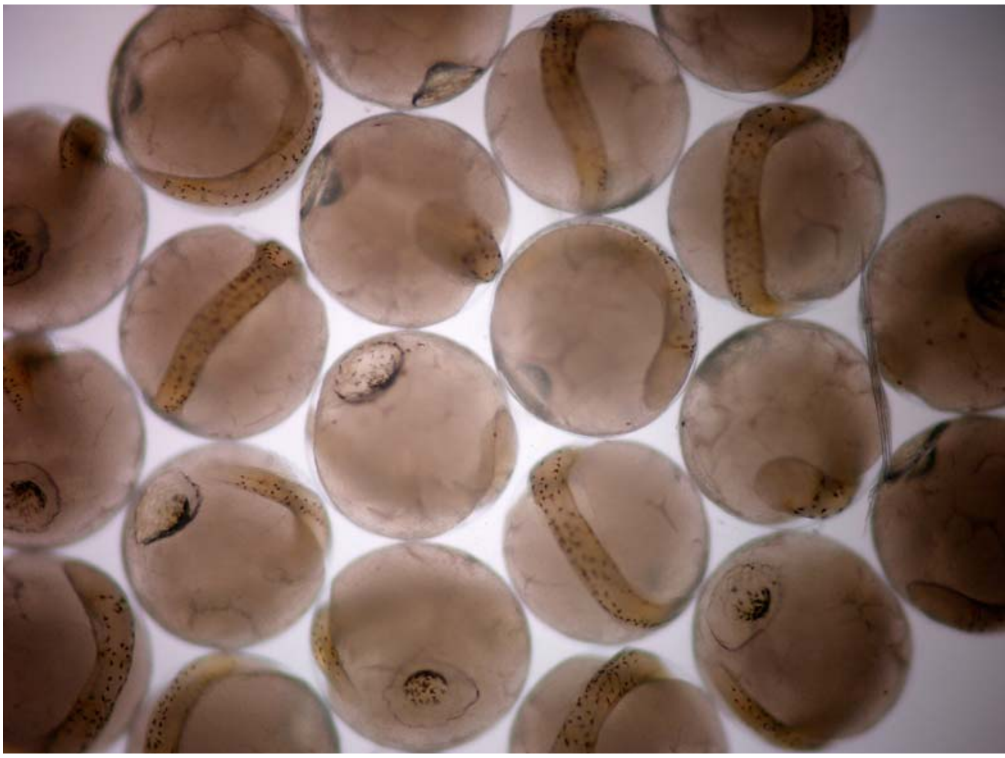
Fertilised egg.

canadum), mangrove red snapper (*Lutjanus erythropterus*), red drum (*Scyaenops ocellatus*) and Asian seabass (*Lates calcarifer*). This may be explained by the reported slow growth rate of this species (Nguyen et al, 2003) and higher value of other cultured commodities that have established export markets, such as tiger shrimp, grouper and cobia, which currently attract the most attention from farmers. There have been several studies conducted on this species but to date the details of the embryonic and larval development has not been fully reported.

In fish farming, understanding the embryonic and larval development pattern is desirable for successful rearing of fish fry. The Waigieu seaperch, like many other tropical marine fish being cultured in Vietnam, is a multiple spawner, whose spawning season lasts from March until October. Knowledge of factors such as temperature, salinity and the changes inside eggs and larvae during metamorphosis is important for building techniques and procedures in seed production of fish in general. The aim of our study was to provide a basic for understanding of the early development of the Waigieu seaperch from fertilised egg through to larval development.



Early embryo with eye vesicle.

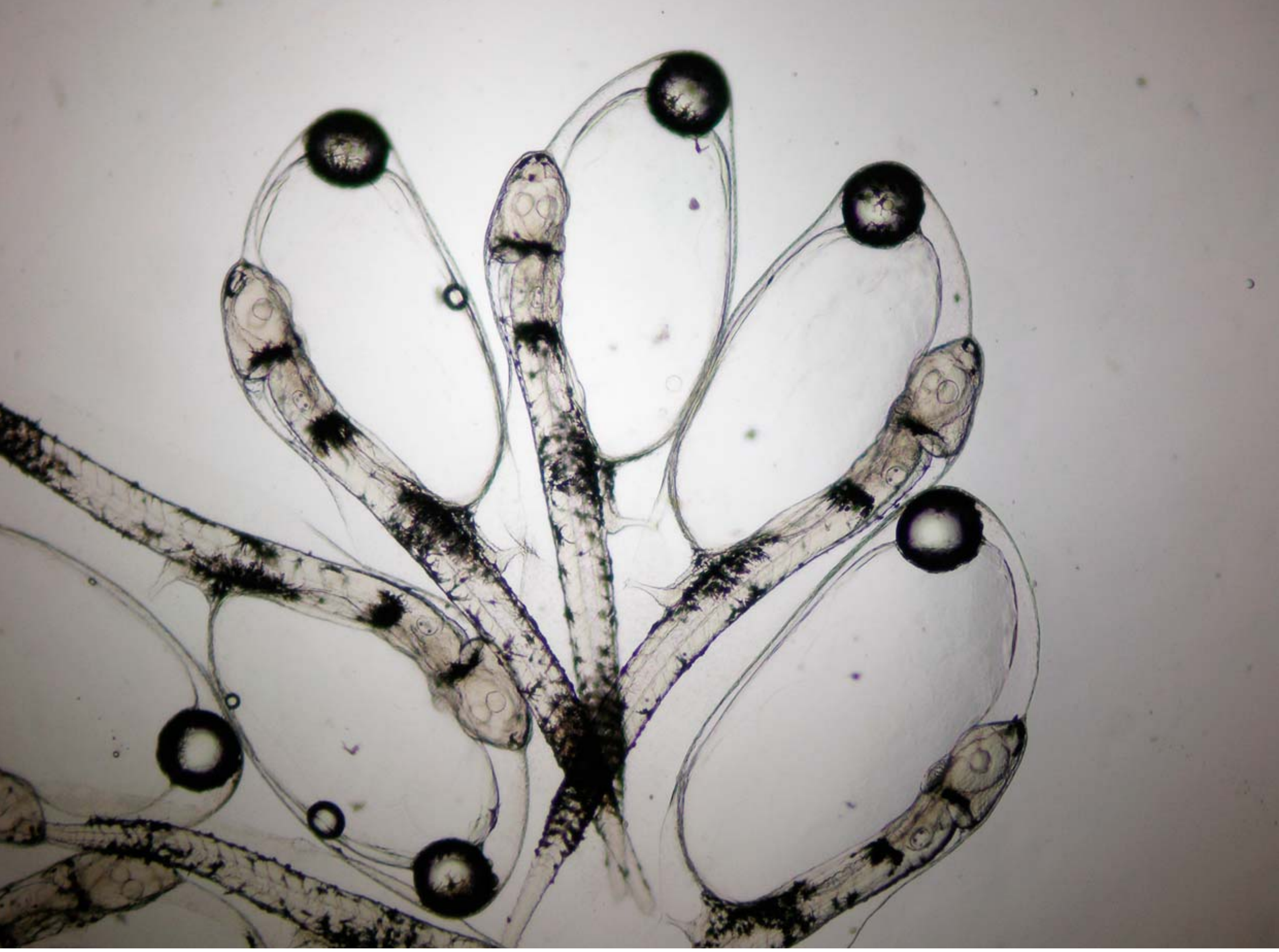


Heart function, free movement of tail.

Approach

Broodstock of greater than 3 years in age, with respective range of total length and body weight of 22-28 cm and 120-320 g, were kept in cage (1.5 x 4 x 4m) that was placed in earthen pond of 3,000 m^3. The average water temperature ranged between 28-32°C; salinity: 26-34 ‰; pH: 7.8-8.6 and dissolved oxygen (DO): 3.5-4.6 mg/l. The culture density was around 3 kg/m^3 (approximately 20 fish/m^3) with an estimated sex ratio of 1:1. The broodstock were fed daily with raw fish at 3-5 % of their body weight, estimated by biomass.

In the peak spawning season from April to August, the ripe males and females were selected and transferred into spawning tanks. The fish were stimulated to spawn by either exchanging water or adding water to increase water level in the tanks as tide. Fertilised eggs were collected immediately after spawning and maintained at 29 ± 0.5°C. Some of them were transferred into a beaker (500 mL) for embryonic development observations. Larvae were fed once a day with rotifer *Branchionus plicatilis* until the end of the experiment at 10 days after hatching (DAH). They were randomly sampled (n = 20) daily from hatch to 10 DAH. Embryo and larvae were photographed on a trough slide under a microscope with a camera attachment. Diameter and length measurements were made with a graduated eyepiece on a binocular microscope. At each examination, appropriately 50 eggs were scanned and the predominant development stages were considered as typical for that period of development.



Newly hatched larvae.

Findings

The fertilised eggs hatched within 16-17 hours at a water temperature of 28-30°C and salinity of 30 - 32 ppt. The embryonic stages of development of the Waigieu seaperch eggs are given in Table 1. First cleavage occurs about 15 minutes after fertilisation. Cell division continues every 10 to 15 minutes and the egg develop to the multi-celled stage within 2 hours and 30 minutes. Like other marine finfish species, its embryonic development goes through the usual stages such as cleavage, blastula, gastrula, neurola and embryonic stages. Embryonic heart starts to function in about 14 hours and hatching out takes place about 16 hours and 30 minutes after fertilisation at temperatures of 28-30°C and salinity of 30-32 ppt (Table 1).

Table 1: Embryonic development of waigieu seaperch (*Psammoperca waigiensis*) at temperature: 28 - 30°C, pH: 7.6 - 8.0, salinity: 30 - 32 ppt.

Stages of embryonic development	Time (h:min)
Fertilisation	0:10
2 - cell	0:15
4 - cell	0:25
8 - cell	0:35
16 - cell	1:00
32 - cell	1:30
Multi - cell	2:30
Blastula	3:10
Gastrula	4:20
Neural stage	6:05
Early embryo with eye vesicle	10:35
Heart function, free movement of tail	14:10
Hatching	16:30

Eggs are swollen after fertilisation in about 10 minutes. The cleavage occurs only in the blastodisc, a thin region of yolk-free cytoplasm at the animal cap of the egg. Most of the egg cell is full of yolk. The first cell movement of fish gastrulation is the epiboly of the blastoderm cells over the yolk. In the initial phase, the deep blastoderm cells move outwardly to intercalate with the more superficial cells (Warga and Kimmel 1990). Later, these cells move over the surface of the yolk to envelop it completely.

Newly hatched larvae have an average total length of 1.36 mm. The average yolk sac length is about 0.80 mm. One oil globule is located at the anterior part of the yolk sac which supports the hatchling to float almost vertically or about 45 degree from its usual horizontal position. The body is slender and pale in color with a distribution of pigments. The eyes, digestive tract, anus and caudal fins are distinctly seen but the mouth remains closed for a while or a period of about three days. Three days after hatching, most of the yolk sac is absorbed and the oil globule diminishes to a negligible size. At this stage, the mouth opens and the jaw begins to move as

Larvae 2 days after hatching.

the larva starts to feed. The mouth parts appear when the fish is three days old. The yolk sac is completely absorbed at day four after hatching. Under normal conditions, the rate of absorption of the yolk sac has been given in Table 2.

Discussion

Aquaculture is one of the fastest growing food production sectors in the world, although the transition from low-input to more intensive methods has been performed only during the last few decades. Aquaculture, especially for tropical species, is still far from the demonstrated sophistication of livestock and poultry production, particularly with regards to reproductive biology and understanding of early life cycle of fish has not been sufficient. One of the most serious bottlenecks in the development of sustainable aquaculture in developing countries is the control of reproductive processes of fish in captivity particularly in early life cycle of fish (Bromage et al., 1992).

Table 2: Larval development of waigieu seaperch (*Psammoperca waigiensis*) at temperature: 28 - 30°C, pH: 7.6 - 8.0, salinity: 30 - 32 ppt. Value is given as mean ± SD.

Age	Total length (mm)	Yolk sac diameter (mm)	Oil drop diameter (mm)
1 DAH	1.82 ± 0.25	0.50 ± 0.03	0.21 ± 0.01
2 DAH	2.36 ± 0.34	0.20 – 0.24	0.12 ± 0.01
3 DAH	2.44 ± 0.46	0.12 ± 0.01	0.05 ± 0.01
4 DAH	2.60 ± 0.48	0.02 ± 0.01	-
5 DAH	2.80 ± 0.56	-	-
6 DAH	2.94 ± 0.66	-	-
7 DAH	3.20 ± 0.57	-	-
8 DAH	3.28 ± 0.40	-	-
9 DAH	3.46 ± 0.55	-	-
10 DAH	3.62 ± 0.72	-	-

DAH: day after hatching.

In the present study, the embryonic and larval development of the Waigieu seaperch are described for the first time from fertilised egg to 10 day larvae after hatching. Embryonic development lasted about 16-17 hours at water temperature of 28-30°C and salinity of 30-32 ppt. In our experiment, the larvae just survived until day 10 after hatching, thus a complete metamorphosis of the larvae until juvenile stage was not described. The reason perhaps we did not provide sufficient food for the larvae and nutritional requirement has been a problem in larval rearing in this case. In other report, it stated that the Waigieu seaperch reached juvenile stage within 30 days after hatching, where the metamorphosis is complete (Nguyen et al 2003). Eggs were considered normal when cleavage was symmetrical, cells had similar size and cell formation was complete, whereas abnormal eggs were associated with irregular cleavage, poor cell formation with vesicular inclusions, and deformation of blastomeres (Kjørsvik et al., 1990). Egg size and the cleavage are important indicators for egg and larval quality and viability during incubation and rearing in aquaculture. The average diameter of the Waigieu seaperch eggs are around 0.75 – 0.85 mm. Under culture conditions, egg size may not be very

Larvae 3 days after hatching.

important for subsequent larval performance. In a study using rainbow trout, Bromage and coworkers (Bromage et al., 1992) showed that large egg produced large fry, as the size differences will soon be masked by other environmental determinants of growth. In the wild, on the other hand, egg size may be important for subsequent larval growth and survival (Brooks et al., 1997). Egg size may be influenced by temperature both on blood levels of vitellogenin and the uptake of vitellogenin into the growing oocyte (Kjørsvik et al., 1990). In this study, no relationship between egg size and larval performance was observed.

In conclusion, our findings indicated that Waigieu seaperch eggs are pelagic and the cleavage pattern is the same as those of other tropical marine finfish. The findings can also contribute to a better understanding of the embryonic and larval development of other commercial marine finfish. The results of this study might provide a basis for further studies to determine the complete early life history of the Waigieu seaperch. These detailed descriptions may be helpful for commercial production of tropical marine finfish. They can be used to explain some aspects of the early life cycle at culture conditions and can help to develop better larval culture techniques in marine finfish hatchery.

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Culture feasibility of freshwater mullet *Rhinomugil corsula* in ponds in India

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Rhinomugil corsula is a freshwater gray mullet indigenous to India. They are peaceful and live in schools but swim actively at the surface with their eyes above water. They grow to around 35-45 cm[1] in length. The fish are generally caught from rivers, reservoirs, ox-bow lakes and estuaries using dip-nets, gill nets, cast nets and traps as a commercial fishery in India[2].

The economic importance of the fish is high from the commercial stand point as consumers' preference for this fish is high and they are undeterred even at elevated market prices. Freshwater mullet are occasionally exported to Burma from the east adjacent coastal region of India[3]. However, due to destruction of the natural breeding habitats, indiscriminate fishing and several other environmental factors, availability of this fish is threatened. Capture fishery resources of this fish have become too sparse to meet consumers' demand.

Due to their compatibility and economic importance freshwater mullet can be used as a supplemental fish in carp and prawn poly-culture ponds. However, there is scant information available on the culture of this species in freshwater ponds. We therefore decided to investigate the feasibility developing standard technology for extensive culture of this species in freshwater ponds, tanks and reservoirs, focusing on issues of domestication, food and feeding habits, acceptance of artificial feeds, growth and production potential under controlled conditions.

One highly beneficial aspect of the freshwater mullet is its planktivorous and detritivorous feeding habit, which offers the possibility of using it as a supplemental fish in carp and prawn polyculture ponds. Its superiority in growth, owing to its grazing feeding habit with a short food chain, has been indicated in several reports[4-6]. All these factors are indicative of the considerable scope for augmenting seed production as the critical first step towards an attempt at bringing in this new species into culture. This article deals with the seed resource inventory, feed and feeding behavior, acceptability of artificial feeds and growth on it and culture possibility of freshwater mullet in ponds as a part of species diversification in polyculture.

The study was carried out at Central Institute of Freshwater Aquaculture (CIFA), Kausalyaganga, Bhubaneswar, India, as a part of research into species diversification in poly culture of carps and freshwater prawns.

Fish seed resource inventory and collection

Freshwater mullet seed normally abound in shallow freshwater bodies often subject to flooding and inundation facilitating their free access. We surveyed local Daya River in the coastal region of Orissa for seed. We found seed to be available from August to October after the floods had receded from the abounded shallow waters. However, as the fry move in schools and swim actively with their eyes raised above the water surface, it proved very difficult to collect live seed from the river system. Freshwater mullet have a common tendency to make short fast jumps to escape danger. At the slightest alarm they also tend to dive down rapidly and emerge again at a distance.

We caught the fry, along with a variety of weed fishes, using fine meshed nets. It proved difficult to separate the mullet from weed fishes so after collection we stocked the catch in small nearby village ponds for acclimatisation, so as to avoid mortality. Since the acceptance of artificial feeds by freshwater mullet was not known, the fry were fed with a mixture of wheat bran and rice polish daily by broadcast. It was very interesting to note that they were voraciously browsing on the floating wheat bran and rice polish while moving in shoals at the surface. However, their recovery was adversely affected by the bird picking.

After 40-60 days of rearing in village ponds, the mullet seed were seined out from the surface of the water column. At 40-50 mm size, they were picked up and segregated from the undesired weed fishes. These fingerlings were transported to the CIFA fish farm for experimental work.

Food and feeding habit of freshwater mullet

The feeding behavior of freshwater mullet was observed in glass aquaria, plastic pools and stone-lined ponds while providing artificial feeds. The mullet were found to graze and browse voraciously from the water surface. Careful examination on their feeding behavior under pond conditions indicated that they were nibbling on the bottom soil and other substrates available in water near at the pond edge in groups. They were also engulfing organic matter along with mud and sand.

The gut contents of pond reared mullet were analysed to understand the food and feeding habit. Gut analysis showed it to have a long coiled intestine with a pyloric bulb and muscular gizzard, which is possibly used to mix and grind the food the ingested food. Gut contents included 34% detritus, mud and sand; 29% decayed organic matters, 28% phytoplankton, 6% zooplankton and 3% benthic organisms. The presence of phytoplankton, zooplankton, benthos and decayed organic matters in freshwater mullet gut indicates an omnivorous feeding habit.

Growth of freshwater mullet fingerlings on artificial feeds

Growth studies of freshwater mullet fingerlings on different artificial feeds was carried out under laboratory conditions. Grow out culture was carried out in poly-culture with carps and prawns. During the culture period growth and production potential was evaluated.

The fingerlings were acclimatised to captive conditions for seven days by stocking in fiber reinforced plastic (FRP) tanks containing fresh pond water. Four experimental trials each with three replicates were carried out under indoor conditions using 500 liter capacity FRP tanks. Cloth filtered pond water was used as rearing medium. Each tank was stocked with 10 fingerlings (47.63 ± 0.42 mm size and 1.26 ± 0.01 g weight). Four experimental diets were prepared using rice polish, ground nut oilcake, fish meal and soybean meal with the addition of vitamins-mineral premix, vegetable oil & n-3 in different combinations (details presented elsewhere). Initially fish were reluctant to take feed but after 2-3 days they started eating voraciously. After 120 days of rearing the experiment was terminated. Fish grew to 4.83 ± 1.16 g, 5.41 ± 1.27 g, 6.98 ± 1.34g and 3.34 ± 0.95 g with Feed-I, II, III and IV respectively. Addition of vitamins-mineral premix, vegetable oil and n-3 was found best suitable for their growth.

Pond reared freshwater mullet.

Fingerlings of Rhinomugil corsula reared in earthen pond.

Grow out culture of freshwater mullet in ponds

Monoculture of *Rhinomugil corsula*

Freshwater mullet were introduced to stone line ponds for monoculture growout trials in two stocking densities. Pond acclimatised fingerlings of 1.48 ± 0.04 g were stocked @12,500/ha and 6,250/ha. Fish were fed daily with the mixture of ground nut oil cake and wheat bran (1:1 by weight) in dough form in feeding tray suspended at the depth of 5-8 cm. After nine months of culture the mean growth was 44.47 ± 8.61 g at higher density and 97.77±11.72 g at lower density.

Poly-culture with Indian major carps

Trials on poly-culture of freshwater mullet with carps were carried out in village ponds. Ponds were stocked with *R. corsula* (average weight. 1.35 g) @ 1,000 /ha. Fingerlings of rohu, catla and mrigal were also co-stocked in equal proportions @ 4,000/ha combined density. The growth of the mullet was 100-151 g without any adverse effects on the growth of the Indian major carps in a 10 month culture, indicating the compatibility with carp culture in freshwater ponds.

Two other experiments were conducted starting with larger sized fingerlings. In one set of experiment the ponds were stocked @ 1,000/ha with the stocking size at initial weight of 3.13±0.38 g and in other set ponds were stocked @ 2,000/ha with the same stocking size. In both the ponds carp fingerlings of rohu, catla and mrigal were stocked in equal proportions @ 4,000/ha combined density. After nine months of rearing the final weight of freshwater mullet was 132.88±18.57 g in the low stocking density treatment and 93.81±10.95 g in higher stocking density. This suggests the feasibility of freshwater mullet culture with carps.

Poly-culture with freshwater prawns

An attempt was made to farm freshwater mullet together with the freshwater prawn *Macrobachium malcolmsonii*. Ponds were prepared and stocked with freshwater mullet @ 7,500 fingerlings/ha and *M. malcolmsonii* @ 30,000 juveniles/ha. While *R. corsula* were fed in feeding tray, the feed of *M. malcolmsonii* was broadcast into the ponds. After a rearing period of eight months, freshwater mullet growth was 86 -124 g and *M. malcolmsonii* grown to 12-55 g.

A second trial was carried out in stone line tanks (10 x 8 m). The tanks were filled with pond water to maintain 1 meter water depth. The tanks were stocked with freshwater mullet fingerlings of 2.95 ± 0.16 g @ 7,500/ha. *M. malcolmsonii* juveniles of 0.2 ± 0.03 g were stocked @ 25,000/ha. Freshwater mullet were fed daily with the mixture of ground nut oil cake and wheat bran @ 5-10% of the body weight in suspended feeding tray, whereas for

Crop of Rhinomugil corsula in mono-culture.

Below: Segregated prawn from polyculture of R. corsula.

prawn, commercial prawn feed was broadcast in the marginal area of tanks. After 12 months of culture the pond was harvested when the freshwater mullet had grown to 175.12 ± 28.54 g and *M. malcolmsonii* 35.14 ± 6.62 g. Total estimated production of freshwater mullet was @1,187kg/ha/year and prawn @ 700kg/ha/year. This preliminary study indicated that freshwater mullet can be cultured with freshwater prawns in earthen ponds with compatibility.

Conclusion

The higher market price of freshwater mullet is in fact an added advantage in the favor of its domestication and culture. The fish is suitable to supplement the culture in freshwater ponds, wet lands and other shallow water confinement with carps and prawn. Due to their grazing feeding behavior and short food chain, the culture of freshwater mullet may be less capital intensive in carp and prawn polyculture.

At present, seed availability is the main constraint for taking up culture of freshwater mullet in ponds. Breeding of freshwater mullet in captivity is unknown and studies dealing with brood fish management and induced spawning would be required to ensure adequate supply of seed. This would ultimately strengthen the prospects of rapid expansion of culture based table-sized fish production on commercial lines.

Acknowledgements

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Management in seed production of an endangered catfish, *Horabagrus brachysoma* during its hatchery phase

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Horabagrus brachysoma is a medium bagrid catfish found in the Indian sub-continent. It is popularly known as Asian sun catfish or yellow catfish due to its yellowish body colour with two black blotches just beyond the gill cover. It is well accepted as ornamental fish during its early life and as a food fish in the adult stage. Its adaptability to different environments, maturity in captivity, acceptance of a wide range of food and good growth in confined water make it as a prospective species for aquaculture. Rampant overfishing of wild stocks and destruction of spawning grounds have caused its natural populations to decline, and it is now regarded as an endangered species.

Seed production technology is a prerequisite for successful culture of any species and captive production is the only viable option for this endangered fish. As this is a new species for culture, we like to share the management required during the captive production of its seed for the hatchery managers.

Ready for fertilisation of stripped egg and milt.

Brood stock management

The brood accepts well to artificial pelleted feed. We have had success feeding them pelleted food containing 30% protein @ 2% of body weight. Periodic sampling is necessary to monitor the feeding rate as well as health of broodstock. In between, water exchange in broodstock ponds is essential to provide clean environment for enhancing maturation.

The male and female fish mature at the age of first and second year of life, respectively. The females are usually of 50-60 g in weight at first maturity. These females show

40-50% response to induced breeding. It is better to avoid females at first maturity and select third year or above age group females. The females of >80g may be considered for breeding if age of females is not known. We used the inducing agent Ovaprim, a mixture of sGnRHa and domperidone was injected up to 1.5 ml/kg body weight in a single dose for final oocyte maturation and ovulation. The stripping period varies from 12-14 hours. At times the female does not respond to stripping, but shows bulged and soft abdomen with swelling vent. So it is advisable for the operator must inject a resolving dose of ≤ 0.1 ml ovaprim per female irrespective of size. The female typically responds to stripping within 4-5 hours thereafter. Care must be taken to strip the female when free flow of eggs appears, which comes out in a semi-fluid state. Sometimes eggs come out in a more liquid form, which indicates delay in stripping. Delay in stripping lead to low fertilisation and hatching of eggs, yielding low larval output. A well-fed female (100 g) can yield 18,000-19,000 eggs. The milt of one male is sufficient to fertilise the eggs of same weight female.

Yolk-sac larvae of H. brachysoma.

Larval rearing for fry production

Indoor rearing of hatchling provide optimum environment to grow fast. It also provides sufficient feed and best opportunity to grow without predators as well as competitors. Survival is always more and consistent during the rearing of hatchlings in indoor systems rather than releasing them directly to an open system. Better results will be obtained if good management practices are followed during stocking, feeding and rearing of hatchlings during the in-door hatchery activities.

Stocking management

Fertilised eggs take 22-23 hours for complete hatching. It is necessary to separate the larvae from unhatched eggs and egg shells thorough frequent washing. The larvae measure 4-5 mm in size. We reared larvae in fibreglass tanks inside the hatchery up to the fry stage to get higher survival compared to pond rearing. As the larvae swim forward in shoals after 10-12 days, it is better to use circular rearing tanks, which provides them with the opportunity for uninterrupted movement. 12-15 cm water was kept in the tanks and continuous aeration must be provided to avoid oxygen depletion in the water. The cleaned larvae brought from the hatching tubs were spread in rearing tanks. Healthy larvae migrate to the side of the container. Unhatched eggs, weak and deformed larvae remain at the center of the rearing tank, which must be siphoned out next day to avoid further problem in the tank due to their gradual death and decay. 20-30% larvae were observed to show vertical suspension in the water column, attaching on the wall of the container at the end of third day of hatching. The larvae do not require feeding until third day of life when their yolk sac is absorbed.

Feeding of H. brachysoma larvae during in-door rearing for fry production.

The larvae should be stocked at low density up to 7 individual per litre, where growth of larvae ranges within 40-45 mg and survival rate remains above 70% during 3-4 weeks of rearing. The density level can be increased up to 13 larvae per litre to get a growth rate above 25 mg with survival rate of 60% or more in stagnant water conditions. The growth rate is affected if density reaches 20-27 larvae per litre. The lower growth might be due to heavy competition for food among the larvae in the confined rearing area. An increase of frequency feeding may be the suitable step for uniform feeding among the larvae. However, the management pressure increases for the hatchery manager in this situation so it is better to rear at a medium density to avoid stress and to obtain good growth and survival. Our study also indicated that stocking of 25 mg fry and above resulted with good survival during fingerling production. The hatchery manager should stock around 13 larvae per litre to utilise maximum hatchery space for production of fry without compromising survival.

Water management

It is better to avoid the use of open or running water during rearing as it sometimes contains contaminants. Seasoned ground water remains always best to be used during rearing. It is essential to provide good quality water as the larvae are tiny and delicate and water quality will be reflected in the growth and survival rate of larvae during the rearing period. A depth of 13-15 cm water in the round tank is sufficient during larval rearing. It is advisable to use an aerator for providing uninterrupted air supply. Two-thirds of the water volume must be replaced twice daily to remove unused feed and fecal matter from the tanks, and provide the best environment for growth. If the tanks are not properly cleaned the water quality will suffer due to production of ammonia, ionized ammonia and hydrogen sulphide from the wates. Free ammonia is always highly toxic to larval fish. Similarly high concentration of H_2S affects the gills. We observed the values of NH_3, NH_{4+} and CO_2 to be in the range 0.02-0.03 ppm, 0.01-0.03 ppm, and 8-10 ppm respectively in the water of medium density rearing tanks. Care should be taken for minimal disturbance to larvae during cleaning and refilling of water in the tanks, to avoid stress.

Feed management

The newly hatched larvae need not to be fed till third day of life when the yolk sac is absorbed. The larvae show active movement from the fourth day of life, when they reach about 5 mm size with clear development of barbels, jaw and fins.

First feeding is always considered important during larval rearing. The quality and quantity of feed, and its acceptability play a main role on growth and survival during rearing operation. Mixed zooplankton is well accepted by the hatchlings and their feeding can be observed from the browsing at the floor of the tank. The duration of feeding is also accepted as an important criteria during rearing. The larvae must be fed at least twice daily after each cleaning. As plankton remain alive in the water column of rearing tank, the larvae can feed on them at liberty. Artemia nauplii may also be given as feed, but they do not remain alive in the tank for as long. Larvae do not have much preference for artificial during its early life, preferring live prey. However, the larvae will begin to accept artificial feed from 10-12 days in age. They take another 5-6 days to learn to accept the feed well.

It is better to give them tightly bound soft feed in dough form containing 35-40% protein even though they accept crumbled feed (30-40µ). The acceptance and utilisation is always better in dough compared to crumble form. But care must be taken to siphon out the unused particles scattered on the tank bottom after one hour of feeding. The larvae show better growth and survival when feed is offered along with the live plankton. The larvae do not show hiding behavior as seen in juvenile or adult stages in nature.

Fry rearing for fingerling production

It is always preferred to stock fingerlings in the culture pond to restrict the early mortality, as larger sized fingerlings usually result in better survival. Similarly the culture period is reduced by stocking more mature fingerlings. Hence the rearing of fry to fingerling has been given importance while working on any species, so also in this catfish. It needs pre- and post-stocking care during rearing of fry in the nursery tanks for higher growth and survival.

Pre-stocking management

Small earthen ponds may be used as the nursery for the production of fingerlings but large mortalities are usually encountered due to their delicate nature and shock of the changed environment. Hence small nursery tanks within

Below: A haul of fingerlings.

20 m^2 area are preferred for easy management during the rearing activity. A minimum of 30-45 cm water must be maintained in the tanks. One-third of tank area must be provided with shade, so that the fry may take shelter during sunny days. It is always better to inoculate live plankton in the tanks before releasing the fry. This provides instant feed to the newly released fish, as they are acclimatised with plankton during their larval stage. It reduces the possibility of higher mortality at the beginning of rearing period.

Stocking of fry

The fry should be stocked after inoculating live plankton population in the stocking tanks. The growth and survival of fry depends on the quality and size of fry besides the number stocked. It is better to avoid much handling before releasing them to nursery tanks. Fry of 25-30 mg in weight are believed to be good enough for stocking in the nursery tanks. This size usually obtained while rearing the larvae in medium density as described in larval rearing. The fish density is to be decided by the hatchery manager depending on the size to be harvested. 100/m^2 density yields good size (300-400 mg) of fingerlings in a six week rearing period. However, it is felt that this density leads to underutilisation of rearing space. Hence doubling the density does not have significant impact on growth (250-300 mg). On the other hand the hatchery operator can also stock up to 300-400/m^2 if growth (150-200 mg) is not considered important. The survival rate at these high density ranges from 45-50%. If individual size and number of individuals for stocking are not constraints, the maximum number of surviving fry from a minimum rearing space was achieved up to a density of 400/m^2.

Post-stocking management

Fish feeding

The fry released in the nursery tank utilise live plankton present in the water immediately. They should be provided feed in dough as they are accustomed to this form of feed during their larval stage. Gradually the dough form of feed should be replaced by crumbled form. Higher food value, complete utilisation and less impact on water quality deterioration are some of the benefit of using crumbled feed. As the fish move individually, it is always advisable to distribute the feed in many places through the feeding trays. This reduces the feed disparity among the growing fry. The fish should be fed at the rate of 10-15% of their body weight in two divided meals. But the ration size should be reduced gradually as the fish grow, which may be restricted to 3-5% at the end of the rearing period.

Other management activity

As the rearing is performed in shallow water, filamentous algae grow profusely due to sunlight penetration and nutrients obtained from the unconsumed feed. Heavy infestation not only restricts the movement of fingerlings but also invites oxygen depletion at night. Sudden mortality of fingerling due to low oxygen level is a common phenomenon in the rearing tanks. So it is wise to net out the algae frequently to get rid from this problem.

Water quality deterioration is often found due to unconsumed feed and fecal matter. Their presence increases ammonia level in the tank, which is always toxic to the growing fingerlings. Hence care must be taken to replace or exchange water by flow-through system at least once in a week to maintain good environment. The fingerlings grow well when the pH, dissolved oxygen, alkalinity and ammonia level range from 7.2-7.6, 6-7 mg/l, 90-120 mg/l and 0.006-0.01 mg/l respectively as observed in our previous experiment on fingerling production.

Harvest

The harvest of fingerlings always depends on the purchase of seed by the farmer. It is always better to harvest the fish after two months of rearing. By this time the fingerlings achieve up to 1 g in weight with a survival rate of 60-70% in low density rearing (Fig. 4). At this stage, there is good demand for this species in aquarium shops. Usually this fish shows homogenous growth during the rearing period. If the seed are not sold completely, the remainder can be further reared for juvenile (8-10 g) production during another 3-4 months period to get a higher price. The farmers usually do not hesitate to purchase these seed because of the reduction of culture period and higher survival rate in pond.

Conclusion

The availability of seed always plays an important role for success of aquaculture in any species. Every species has specific care to be taken during their rearing in different life stages. Selection of proper aged brood for breeding operation, rearing at suitable density and good water quality plays a major role during its hatchery production. Little attention with small management measures during rearing operation can lead to a huge seed production of this valuable species. These can be utilised as ornamentals during the early stage and the fish reared further has food value. As the fish is in endangered status, the fingerlings may be utilised for restoring their population in the natural water bodies.

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SCOUTING INNOVATIONS IN FISHERIES AND AQUACULTURE
"Innovation is celebration of creativity", said Dr.Abdul Kalam. Innovation has been the foundation of civilization and the civilization is constantly influenced by innovations. Our country with long tradition in fisheries and aquaculture, fisheries and fish farmers have innovated a number of techniques and technologies and continue to innovate to sustain their livelihoods. With a view to harness the innovative potential of people at the grass root level, this initiative has been undertaken by conducting a nationwide essay competition for fishers and fish farmers
Objectives of the competition
To document significant innovations made by fishers and fish farmers in fisheries and aquaculture.
To recognize innovators and strengthen partnerships between fishers, fish farmers and development professionals and scientists.
To raise awarness on the benefits of farmer participatory research in innovation as well as in extension with a view to increase fish production
Who can Participate and How?
The competition is open to fishers and fish farmers from all parts of the country. The innovations have to be described with all details supported with drawings, pictures, etc. Farmers can take assistance of others in providing description, if necessary. Essays can be written in any language with which farmer is comfortable. Inclusion of an English translation is preferable but not mandatory.
Last date for submission 01.12.2011.
The Best innovators, selected by a panel of judges with interest in farmers innovation, will be awarded three prizes
I Prize : Rs.25,000/-, II Prize : Rs.15,000/-, III Prize : Rs.10,000/-
In addition, best entries would be chosen for inclusion in a special publication to be brought out under the title "Farmers as Scientists Examples from Indian Fisheries and Aquaculture".
Further based on the levels of partnership additional plans to expose innovators to the best innovations around the world would be explored.
If you wish to know more about farmers innovation, visit :
http://www.nif.org.in/(National Innovation Foundation-India)
The Hindu-Farmers Note Book-M.J.PRABHU (http://www.thehindu.com/sci-tech/agriculture)
http://audio.enaca.org/global_aquaculture_2010/mc_nandeesha.pdf
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2011 Vet
Note : We are seeking partnership to make this initiative a national movement. Those intrested to join with the effort are requested to write to Dean, Fisheries College and Research Institute, Thoothukudi-628008 (mcnraju@gmail.com, deanfcri@gmail.com), (Ph : 0461-2340154, Fax : 0461-2340574), The second circular including the details of all partners will be issued on 01.11.2011.

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First ever Ministerial Meeting on Aquaculture

The first Asia Regional Ministerial Meeting on Aquaculture for Food Security, Nutrition and Economic Development was convened in Colombo on 28-29 July, hosted by the Government of Sri Lanka. This was the first time an international ministerial-level meeting has been held on aquaculture in the Asian region, or indeed the world. The purpose of the meeting was to discuss regional cooperation in improving the contribution of aquaculture regarding the above issues.

We are very pleased that delegations from seventeen countries were in attendance, namely Bangladesh Cambodia, China, Fiji, India, Indonesia, DPR Korea, Lao PDR, Malaysia, Maldives, Myanmar, Nepal, Philippines, Sri Lanka, Thailand, Timor Leste and Vietnam.

The keynote address was made His Excellency, the Hon. Mahinda Rajapaksa, President of Sri Lanka. The text of the speech is appended below. Opening remarks were delivered by Dr Arni M. Mathiesen, Assistant Director General, Fisheries and Aquaculture Department, FAO; Prof. Sena De Silva, Director General of NACA; and Dr Rajitha Senaratne, Hon. Minister of Fisheries and Aquatic Resources Development, Sri Lanka. The opening ceremony was followed by ministerial statements concerning aquaculture, food security, nutrition and economic development.

The highlight of the meeting was the issue of the joint “Colombo Declaration”, a political commitment to regional cooperation in aquaculture development for food security, nutrition and economic development. The declaration provides a policy framework for Asian governments to collaborate in pursuing these common goals, to share experience and build on each others strengths for the benefit of all.

Recordings of the ministerial statements and other presentations made at the meeting will be available for download from the podcasting section of the NACA website in due course.

The Colombo Declaration is available for download from:

http://www.enaca.org/modules/wfdownloads/singlefile.php?cid=209&lid=1041

Keynote address delivered by His Excellency, Mahinda Rajapaksa, President of Sri Lanka

I welcome you all to Sri Lanka, as we are privileged to host this ministerial meeting at a time when we examine the opportunities and challenges to food security in our region and the world, and realise the potential benefits from effective aquaculture development in our region.

As an island nation we have a very long tradition in fisheries, a tradition that keeps expanding with growing demand for fish which forms a very important source amounting to seventy per cent of animal protein in the national diet of Sri Lankans.

It is remarkable that the Asian region with its vast fisheries resources produces more than 90% of the world's farmed fish. This reflects the importance of aquaculture for food security, nutrition, and economic development. But, as in many other sectors of food production essential to humankind, fisheries is also greatly threatened today.

The fisheries resources are over-exploited and the physical resources to produce more fish are fast reaching their limits to yield more under available technology. You meet today facing the challenge of the world having to produce thirty million more tons of fish per year by 2030 to feed an ever growing population.

We often read today of how fish is our last wild food and that our oceans are being picked clean. We learn of factory trawlers that scrape the ocean floor threatening the livelihoods of fishing communities in countries and regions. These trawlers are commercial operations while the small time fisherman goes out fishing as a means of day to day living. This meeting is most timely because the natural habitat of fish is being gravely threatened and aquaculture development is of special importance.

For us to protect our fish farmers, it requires many policy initiatives such as strong trading standards removing non-tariff barriers and eliminating unfair trading practices. Methods that can improve sustainability are necessary because their absence can have adverse effects on small farmers and fishers. These need to be tackled with speed and great sensitivity before vulnerable communities that depend on fishing and fish farming are harmed.

In this context, I am pleased to learn of the approval of the Global Aquaculture Certification Guidelines by the FAO Committee on Fisheries. I commend FAO and urge that all of us make a commitment to implement these guidelines in Asia. I must thank the COFI leadership for setting the global agenda for fisheries and aquaculture.

As aquaculture expands further out to sea issues of responsible management of international waters would pose a challenge to policy makers and planners investors and many other stakeholders. New policies and laws will be necessary on issues such as leasing or renting of the sea with due protection for economic zones.

His Excellency, Mahinda Rajapaksa, President of Sri Lanka.

We have to now face the reality that the world's and our region's marine stocks are fast depleting with small and traditional fishers facing serious livelihood problems. They make up a very large section of the Asian work force. Finding ways to help them is a matter of urgency. Perhaps, one way would be to create opportunities for aquaculture and related service industries as alternative and additional livelihoods. We must also protect and improve our natural stocks of fish so that fishing will continue to provide food, jobs and income.

Aquaculture can also help to address important issues on the environment and social welfare. These include climate change and problems of greenhouse gas emissions. We must also look at aquaculture for improving the coastal environment which is of special relevance to Sri Lanka with the planned growth of tourism.

The growth of aquaculture needs the development of technology in all of its sectors. It is encouraging that we in Asia are rich in related technology and have shown our ability to develop them further and use them for good results. But in a region that is so large it is necessary to overcome the problem of uneven development and fully exploit the great potential for aquaculture and to fully realise the value of this asset.

Although fisheries is part of our lives and has been so through history, yet fisheries and aquaculture are small compared to other Asian countries and I think it will remain so. But it is a major sector for economic growth. Though currently contributing 2% of GDP, this can and should be improved.

In addition to the sea around us, Sri Lanka has many rivers and lagoons and man-made lakes built for irrigation that support fish production. These irrigation tanks have opened the possibility of a rice-fish culture. This can be a dramatic way of producing more food and helping to improve the rice farmer's income.

I am happy to learn that the National Aquaculture Development Authority (NAQDA) established by our government in 1998, in addition to supporting our goals in aquaculture, is also working on the development of rice-fish culture as a means of giving new strength to the rural economy.

I am also reminded of the severe drought that prevails in some countries in the African Continent and I strongly suggest that the FAO along with the WFP and other UN agencies devise a speedy mechanism to provide food for the people in those countries.

Sri Lanka is now catching up with what we lost during three decades when terrorism deprived us of so much of development. It prevented fishing and fish farming in the North and East from getting the same attention as in other provinces. For many years, fishing in the northern and eastern waters had to be prohibited or greatly restricted. Today, with peace prevailing, we are moving to massive national development in every sector including fisheries. We have given a special place for aquaculture and fisheries for a major role in food production, job creation and income generation. These programmes are spread throughout the country today with an added emphasis in the North and East to give the people there, a better life freed of the fear and threats of terror.

I wish to thank FAO for continued assistance to our efforts. On fisheries and aquaculture, I believe that our collective wisdom, knowledge and work will help maintain Asia's leadership in global aquaculture production in the coming decades. It is very important that these same assets should be used to ensure that the countries and provinces less developed in aquaculture are able to fully realise the potential of their fisheries and aquaculture. Cooperation and collaboration is of the utmost importance in this task.

It is important today to look at where we stand in regional cooperation on aquaculture. When the Network of Aquaculture Centres in Asia-Pacific (NACA) was established in 1990 dedicated to aquaculture development, Sri Lanka was one of the first countries to ratify the agreement.

It was a gesture of our commitment to practical regional cooperation in an important area of development. Since then, NACA has become a strong organisation that serves our region and beyond too in aquaculture development. I am happy that NACA is now headed by a fellow Sri Lankan Professor Sena de Silva.

I recall the first Conference on Aquaculture in the Third Millennium, organised by NACA, the FAO and the Royal Thai Government in the Year 2000 when I had the privilege of participating as an honoured guest. The Bangkok Declaration and Strategy, adopted at this conference remains the core instrument for aquaculture development. It has shown strength as an instrument and a guide. Later, it was fortified by the consensus at the Global Conference of Aquaculture held in Phuket in September last year. These are milestones of success but what more can be done?

I wish to remind you that for many years, we have tried to improve the welfare of people in fisheries and improve the productivity from the waters to obtain a richer harvest from the sea and other sources. We have tried many methods from policies to regulations, incentives, subsidies, in fact, everything that public administration allows. We borrowed expertise and technology. We sent our people abroad for training to improve our human resources. We improved facilities for research and technology development.

The results of all this have been mixed. We made some good inroads but, our efforts were also challenged by social, cultural and environmental issues. Yet, some of our projects sustained. These were streamlined into institutional processes.

If there is a lesson I can draw from our few successes, it is that political commitment is the key to sustaining the goal of any initiative. Place this in the larger context of our region and political commitment becomes an even more crucial element. This raises the important question as to how, we in the Asian Region can direct and sustain political leadership and commitment to fisheries and aquaculture development.

We see from experience today that individual states can work together more effectively to achieve common goals, especially, if they provide the means and resources for regional associations to become stronger. Therefore, political leadership and commitment must also be backed with enough resources.

An expanded regional initiative can only be sustained by having both political leadership and adequate resources. That we are not lacking in political commitment will be seen when we adopt the "Colombo Declaration" tomorrow. It is a political commitment to "Regional Cooperation in Aquaculture Development for Food Security, Nutrition and Economic Development in Asia".

But there is another challenge. We have to provide the resources as well. For this purpose, I think the way forward would be to establish a Common Regional Fund that will in the future become a Common Global Fund for responsible aquaculture. If you think this is an idea worth looking at, I believe that in this gathering there is plenty of experience to develop the mechanism for such a fund. Let us not miss such a golden opportunity.

FAO has shown that together we can contribute to the welfare of the people of Asia from where aquaculture stands today and where it should go to. These are great goals. But my concern is that we do not have the luxury of time to reach these stated goals. I am not unduly worried about resources. Together we have the people and material needed to achieve these goals. But the challenge is how we put these resources together that are within different borders and institutions of individual states and territories to work towards our common objectives.

These hopes and challenges make it urgent to commit the Asian political leadership in fisheries and aquaculture to collectively face the problems that will diminish the welfare of our people. This is the challenge we all face today.

There are many issues of international politics and governance that affect aquaculture and fisheries. Product marketing in compliance with various international trading standards is a serious problem to developing countries and to the small scale fish farmers who produce the most of Asia's aquaculture output. Just as in any other agricultural commodity, we must address this situation politically.

Let us remind ourselves that the best results come when farmers, especially, the small holders are empowered technologically and politically. It is when they have both the means and the voice. With greater awareness and empowerment , higher standards and good farming practice, they will not be driven out of business.

Finally, let me express my fullest confidence in the success of the Ministerial Meeting and my great optimism that its results will strengthen and further promote fisheries and aquaculture in Asia and also provide effective ways to resolve the problems of overfishing and threats faced by the world's maritime species that are unprecedented in human history.

I wish you well in your deliberations and trust you will have a pleasant stay in our country and carry away the most pleasant memories of Sri Lanka.

Farewell Sena and welcome Eknath!

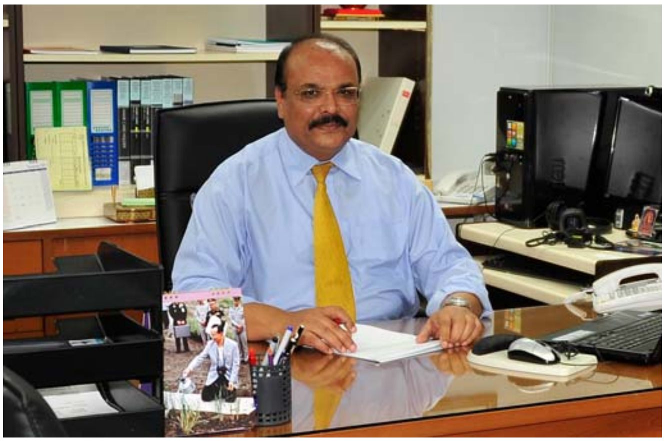
Message from the new Director General

I am honored and privileged to inform you all that I joined NACA as its new Director General on September 1. I took the baton from Prof. Sena De Silva after a brief and pleasant transition period of 10 days in August interacting with all NACA professional and administration staff on various administration and programme related matters. Let me at the outset; take this opportunity to express my sincere gratitude to the Honourable Members of the Governing Council of NACA for their confidence in me to lead NACA for the next five years. I also wish to express my sincere appreciation to Prof. Sena De Silva for his leadership of NACA during the past five years, his transparent and forthrightness in management decisions, for effecting a smooth transition of leadership to the incoming DG, and most significantly, for implementing important reforms in governance and accountability of the NACA Secretariat. I do pledge to build on the experience and exemplary track record of my predecessors and strive to live-up to the expectations of the GC members, national aquaculture centres of the member governments, donor community, and our partners and well wishers. At the same time, I commit myself to the ideals of NACA as the most cost-effective organisation in the region, true networking of centres, participatory governance, inspiring work environment, and a vibrant multicultural setting.

As I begin my tenure, I wish to draw my inspiration and guiding principles from the two most significant instruments concluded recently and handed over to me by the NACA GC: The Colombo Declaration agreed on July 29th in Sri Lanka by the Honourable Ministers of NACA member governments expressing their commitment to regional cooperation in aquaculture development for food security, nutrition, and economic development in Asia; and A Strategy and Framework for Regional Cooperation in Aquaculture developed by consensus on July 29th in Sri Lanka by the NACA member governments. My immediate task ahead is to translate the strategy framework for regional cooperation and the thematic programmes identified therein into a deliverable action plan for implementation in partnership with the NACA national lead centres, FAO, and various other regional and international organisations. It is my cherished desire that all our partners will join hands with NACA in developing the vision and a road map for regional cooperation for aquaculture.

Now, more than ever, aquaculture is considered as the only viable solution to close the looming gap in demand and supply of food fish. Enhancement of productivity and

Outgoing Director General, Prof. Sena De Silva.



Incoming Director General, Dr Ambekar Eknath.

On behalf of the staff of the NACA Secretariat, I would like to express my sincere thanks to our outgoing Director General, Prof. Sena De Silva, for his contribution to the organisation, aquaculture development and most of all for his dedication to improving the lot of small-scale farmers in the region.

I think it is fair to say that there are few institutional leaders today who have upheld the interests of the region's farmers in such a frank and fearless way. He will be greatly missed by the staff of the Secretariat and we wish him all the best in his renewed endeavours at Deakin University, and we look forward to our ongoing collaboration with him.

I would also like to take this opportunity to welcome our new Director General, Dr Ambekar Eknath, and hope that his years with the organisation will be productive and enjoyable.

Simon Wilkinson, Editor.

sustainability and to establish strong research base for the evolving tropical aquaculture systems will require building of strategic partnerships and alliances. The contemporary research and development agenda is clearly in favour of sustainable farming systems, transparency in production systems, and strict adherence to responsible codes of practice. NACA has contributed significantly to these demanding agenda. Successive leaders and the core professional staff have endeavoured to implement the programmes identified by the NACA Technical Advisory Committee (TAC) and the NACA GC with intense personal interest and dedication. Nevertheless, not all mechanisms are in place in NACA – as can be expected from a young and evolving organisation. Therefore in the near future, as a matter of highest priority, I wish to focus on three essential pre-requisites as NACA embarks on long-term programmes – recruitment of core people in the Secretariat, strengthening of core programmes, and securing of core funds.

NACA undoubtedly is the most cost-effective and one of the most productive organisations in the region. Programme implementation, however, at times, has been hampered due to lack of core-strength in some programmes. There is a need to attract and recruit young professionals from across the region and develop them into core staff committed to the NACA vision and mandate. Attracting senior professionals either on sabbatical and or deputation to NACA for developing new ideas and programmes, and for mentoring of young scientists is also needed at this point in time. I also look forward to committed participation of scientists from the member-government institutions and network centres, throughout the duration of the project/programme in the interest of continuity and sustainability of outcomes.

The uniqueness of NACA is its formal partnering of member-governments in programme development and extremely cost-effective implementation. It is because of this participatory nature that the NACA programmes have always remained focused, relevant and almost always resulted in substantial benefits to the region. There is, however, a need to develop a proactive anticipatory research agenda for the period of at least fifteen years articulating a portfolio of programmes and strategies for implementation. In this regard, the Strategy and Framework for Regional Cooperation in Aquaculture developed by the member-governments is a step in the right direction. Translating this strategy framework into an action plan will require a much wider consultation involving relevant institutions and individuals.

Securing of funds for implementation of various NACA programmes is usually done by NACA professional staff in response to invitations from certain donor agencies and in consultation with institutions of “target” member countries. Efforts are made to include other “non-target” countries through complementary funds wherever feasible. This project and donor driven approach has often led to skewed benefits and has been a cause of major concern during annual NACA GC deliberations. In his inaugural speech during the high level Ministerial meeting in July in Sri Lanka, his Excellency the President of Sri Lanka, emphasised the need for setting up of a “Regional Fund” for a sustained research and development effort in the regions and for equitable distribution of benefits. Establishment of such a core regional fund can be achieved by political goodwill and commitment.

I look forward to productive and exciting times ahead as we all work together towards our common vision of regional networking and cooperation for the benefit of our peoples in the region.

Ambekar E. Eknath

2nd Regional Training Course on Application of Business Management Principles in Small Scale Aquaculture

NACA in conjunction with the Fisheries Training Programme of the United Nations University and Nha Trang University launched a training programme on the Application of Business Management Principles in Small Scale Aquaculture in 2009. The objective was to develop a training course that would assist small-scale farmers to gain and improve skills that will help them to run an aquaculture business efficiently. The training materials for the programme were initially developed and improved through an inception planning and two preparatory workshops, and have been refined based on feedback from the first run of the training course.

Participants

Thirteen participants attended this second regional training course, which was held at Nha Trang University from 12-20 July 2011. Participants were drawn from Bangladesh, Cambodia, Indonesia, Malaysia, Myanmar, Philippines, Sri Lanka, Timor Leste and Vietnam. Participants included farmers, government officers, researchers and university teachers. All had either had direct experience in small scale aquaculture or worked closely worked with small scale farmers and are involved in capacity building for small scale farmers. Participants expertise reflected a broad range of current aquaculture practices and systems prevailing in the region, enabling participants to examine aquaculture development issues from different perspectives and providing an environment where they could interact with diverse views and opinions.

Trainers were experienced professionals from Hólar University, NACA and Nha Trang University, familiar with development context and issues of small scale aquaculture in the region. The training team collectively possessed strong academic backgrounds and expertise in economics, business management, rural development and aquaculture technology.

Course contents and delivery

The course contents have been evolving and continuously improved through various workshops and experience gained from the first run. The second training course consisted of eight modules, most of which were stand alone in terms of content but with continuity and closely related to aquaculture practice, in particular small-scale practices that constitute the backbone of the sector in Asia and current global development trends.

A pre-training need assessment was carried out to determine knowledge gaps and some modifications were made based on the results of the assessment prior to delivery. The course examined important physical, biological and socio-economic factors that impact on farm economic performance. In view of current aquaculture development trends, the concept and importance of better management practices, food safety, global trade, scale of production and farmers' organisation were emphasised. Economic principles were presented and discussed in the context of Asian small scale aquaculture practices. Various essential farm planning and analytical tools were introduced. Classroom exercises and case studies were incorporated into these sessions for participants to practice their skills. Participants were requested before the course to collect farm operation data of either their own farms or systems they were most familiar with. These farm data represented a range of farming systems and formed the base information and cases for participants to apply analytical skills in a real world situation. They were encouraged to draw meaningful conclusions through the analyses, suggest improvement and plan for future operation.

The training was implemented in a learner-centred, four-phase experiential learning approach, which requires participants' active participation in various training activities including:

- Experiencing through lectures, reading, recalling and sharing participants' specific experiences, case studies and field trips.
- Processing though group discussion, sharing experiences, analysing cases / data, and reporting.

- Generalising through summarisation, group discussions on some conclusive statements, and reflecting what participants have learned to their working experiences.
- Applying through individual planning on how the knowledge and skill gained here will be used in participants' work situation and serve the need of small scale farmers in their areas.

Results and evaluation

An evaluation was conducted at the end of the training course. Participants considered the training course to be very relevant to current aquaculture development in Asia. They ranked all the sessions to be very relevant, useful, and important. Their opinions showed that such a training course was important in capacity building of small scale farmers in applying business management skills in their aquaculture practice. This would help them to adapt to dynamic global economic environment and remain competitive.

All participants successfully completed the training programme with upgraded knowledge and skills in economics, farm planning and management. All of them demonstrated their confidence in improving farming efficiency through applying economic principles and analytical and management tools in their case studies. They expressed their determinations to extend what they have learned in the training course to other farmers.

In delivering the sessions, trainers tried to simplify the complex economic concepts and presented them in a direct and applicable way. Participant experiences were incorporated in almost every session so that they could understand the concepts and apply skills through examining their own farming practices. This methods proved to be very effective in stimulate their learning interests and self motivation, and hence ensured a high level of efficiency of knowledge and skills transfer.

Look to the future

Improving business management skills for small scale aquaculture farmers in Asia requires a long term effort and is a great need. Along with technological advances, application of business management principles in small scale aquaculture is becoming critically important to retain its competitiveness and sustainability. Considerable attention and inputs are expected from academic institutions, governmental organisations, NGOs and other development agencies to ensure that capacity building of small scale farmers in this aspect is not neglected and the endeavour sustained and successful.

The training team is currently still working on the training materials and course contents, looking for further improvement based on participants' evaluation and trainers' feedbacks. The possibility of localising the training materials and carrying out in-country training of farmers using local resource persons and languages will be explored.

NACA will make all endeavours to conduct this course as a regular annual event, with continuous modifications to the course material to 'pitch' the course to the rural small scale farmer, in a manner that is comprehensible, applicable and adaptable to their circumstances.

Consultation on Lake and Reservoir Fisheries and Aquaculture Development in Asia

The ICEIDA funded project on *Strategies for development of Asian reservoir & lake fisheries management* concluded with a final Consultation on Lake and Reservoir Fisheries and Aquaculture Development in Asia. The consultation was held at the Institute of Hydrobiology, Chinese Academy of Science, Wuhan from 20-24 September.

The consultation organised by NACA in conjunction with the Institute of Hydrobiology was co-hosted by the Institute of Hydroecology, Ministry of Water Resources, Chinese Academy of Sciences, State Key Laboratory for Hydroecology and Biotechnology, Institute of Hydrobiology, and WWF-HSBC Climate Change Partnership, and brought together over 40 key researchers from nine Asian countries and the FAO.

The consultation brought together over 40 key researchers from nine Asian countries and the FAO. There was a significant representation from the Mekong River Commission (MRC) Fisheries Programme, from all riparian countries, including the program coordinator, Xaypladeth Choulamany. The consultation was declared opened by the Director of the Institute of Hydrobiology and short introductory remarks were given by Miao Weimin, Aquaculture Officer, RAP/FAO, Bangkok, Sena S De Silva, Former Director General of NACA and Wang Zhaomin, Director General, Hubei Fisheries Bureau, China.

The scientific proceedings were divided into five sessions, with Session 1 consisting of key note addresses by Li Zhongjie on "Development and reform of lake and reservoir fisheries in China", Sena S De Silva, on the "Importance of

reservoirs and lakes in food fish production in Asia", and Chang Jianbo "On successful stimulation of gonad maturation of freshwater reared *Acipenser sinensis* by controlling annual temperature patterns". The other sessions were conducted on the following themes: Country perspectives, management aspects, ecosystems / stock enhancement / water quality, and translocations / introductions / climate change. Each session was followed by a discussion on the common issues relevant to improving fish production in lakes and reservoirs in the region and related environmental aspects. The consultation also discussed in detail a concept proposal for a "Regional Program on Stock Enhancement" developed by the MRC in consultation with NACA and the FAO, at a consultation held in Vientiane, Lao PDR in August 2010. The group made further suggestions to expand the scope of the activity and endorsed that this concept proposal be developed as a regional project to be funded under the Technical Cooperation Programme (TCP) of the FAO. The concluding remarks of the consultation were delivered by Mr Arni Helgason, Icelandic International Development Agency and Professor Liu Jiashou of the Institute of Hydrobiology, Chinese Academy of Sciences.

The participants had the opportunity to visit Liangzhi Lake where major management changes have been made, resulting in significant improvements in economic gains and improvements in water quality. The lake fishery now essentially concentrates on the production of Chinese mitten crab and mandarin fish, both high valued species. Over the years the improved management has been successful in eliminating eutrophication problems in the lake.

Asia Regional Seminar on Certification for Small Scale Aquaculture in Thailand

Over the last few years there has been a surge of interest in the development of certification standards for aquaculture products. Many certification schemes have been established addressing a diverse range of issues surrounding aquaculture production including environmental integrity, food safety and quality, social responsibility, animal health and welfare and other issues such as organic aquaculture.

The implementation of certification standards in Asian aquaculture is confounded by the fact that the majority of farms are small scale holdings. There are a very large number of them, they are organised very loosely or not at all and farmers are for the most part poor. This is the context in which aquaculture certification must be implemented. Individual certification is very difficult to implement in the region due to the practicalities of dealing with large number of small scale farmers and their limited capacity to bear associated costs. Increasingly, Governments are encouraging group-based management approaches to empower small scale producers to overcome these issues.

FAO and the Thai Department of Fisheries have conducted a joint project on Certification for Small Scale Aquaculture in Thailand. The project aimed to help small scale farmers implement certification through a group approach, to enhance their market access and improve their environmental, social and economic sustainability. Working in a group reduces the cost of certification for individual farmers, improves market access and assists farmers to move up in the value chain. The project initially conducted public consultations amongst all players in the supply chain to gather views on existing certification systems, their practicality, credibility, implementation status and constraints. Consultations were also held with selected groups of small scale farmers to ensure that their opportunities and constraints were given priority consideration. The feedback was used to develop recommendations on improving certification systems for aquaculture in Thailand. The project also convened training in group certification for small scale farmers, for farmers, government officers and NGOs involved in this activity.

The development of a group-based aquaculture certification scheme was piloted with shrimp farmers in Chantaburi and Trang provinces and tilapia in Chonburi and Petchaburi provinces. The project assisted farmers to register their group with the government, to establish governance and record keeping systems, and to establish an internal control system in order to facilitate compliance with required production standards and traceability. A Standard Farming Manual was prepared by each group describing the farming practices required of group members. Groups held crop planning meetings before commencement of the crop cycle, and held monthly meetings during grow out to discuss production issues and provide mutual technical support. Groups typically entered into group contracts for purchase of inputs such as seed and feed in order to benefit from bulk order discounts. Overall the groups have been very positive in their responses and comments on the project, and there has been a marked improvement in farming practices as a result of the group approach, standardisation and training.

As the project is nearing completion, a regional seminar was held in Bangkok from 15-16 September to share the experiences of Thailand more widely with countries within ASEAN and with other organisations that are that working on certification and related trade issues for small-scale aquaculture. Around 50 people attended the seminar, including representatives from the governments in the region, representatives of Thai shrimp producers, and private-sector organisations with an interest in certification such as Fairtrade, TÜV NORD and others.

Project personnel gave presentations on the experiences gained in the establishment and certification of farmer groups; development of traceability and GIS systems to support certification and analysis of the Thai national certification system. This was followed by a general discussion on a report commissioned by the project examining the issue of harmonising the Thai system with the FAO Guidelines on Aquaculture Certification; and progress in developing an ASEAN standard for shrimp certification and scaling up strategies. As the current proliferation of certification standards has caused fragmentation and confusion in the industry, participants also discussed the concept of developing a system for benchmarking aquaculture certification standards against the FAO Guidelines on Aquaculture Certification as a means to establishing equivalence between different certification standards.

The project was funded by FAO through a Technical Cooperation Programme facility. A website is in development based on the outcomes of the project, including online traceability database will be available in due course.

Special issue of the AFS Journal: Integrated technologies for advanced shrimp production

The special issue is a collection of papers presented at the "Symposium on Integrated Technologies for Advanced Shrimp Production"which was held in October 13-15, 2009 in the East-West Centre, University of Hawaii and sponsored by a grant from the National Oceanic and Atmospheric Administration to the Oceanic Institute.

The special issue consists of 12 papers which include contributions from renowned scientists who are no strangers to the shrimp farming world. Together, they present the latest in shrimp farming, dealing with cutting edge technologies on topics ranging from genetics, to environmental and health management. The 222 page hard copy of the special issue costs US$10 for AFS members and US$20 for non members. Contact info@asianfisheriessociety.org for orders. The special issue includes the following papers:

1. The Global Status of Significant Infectious Diseases of Farmed Shrimp (Lightner, D.V. and R.M. Redman).
2. Emerging Diseases in Shrimp Culture: Overview of Viral and Bacterial Diseases in the Americas (Marcela Salazar, Lacides Aragon, Linda Gűiza, Xenia Caraballo and Clarissa Granja).
3. Immunomodulation by DNA Vaccination against White Spot Syndrome Virus (WSSV) (Tomoya Kono, Jean Fall, Hiroki Korenaga, Hiroaki Takayama, Toshiyuki Iizasa, Tohru Mekata, Toshiaki Itami and Masahiro Sakai).
4. Promoting Health Management of Shrimp Aquaculture on Guam and Commonwealth of Northern Mariana Islands (Hui Gong).
5. Environmental Management of Shrimp Farms in Asia to Promote Healthy Shrimp and Reduce Negative Impacts (Claude E. Boyd).
6. Performance of a Closed Recirculating System with Foam Separation, Nitrification and Denitrification Units for Intensive Culture of Kuruma Shrimp, *Marsupenaeus japonicus*: a Bench Scale Study (Oshihiro Suzuki, Tsuyoshi Takeshima, Thoru Mekata, Tomoya Kono, Masahiro Sakai, Toshiaki Itami and Toshiroh Maruyama).
7. Integration of Quantitative and Molecular Genetics in Shrimp Breeding (John A.H. Benzie).
8. Identification and Expression Analysis of Nitric Oxide Synthase Gene, Mj NOS, in Kuruma Shrimp *Marsupenaeus japonicas* (Mari Inada, Tohru Mekata, Raja Sudhakaran, Shogo Okugawa, Amel Mohammed el Asely, Nguyen T. H. Linh, Terutoyo Yoshida, Tomoya Kono, Masahiro Sakai, Toshifumi Yui and Toshiaki Itami).
9. Genetic Improvement and Farming Technological Innovation on Fleshy Shrimp *Fenneropenaeus chinensis* in China (Qingyin Wang, Jian Li, Jie Kong, Jie Huang, Weiji Wang, Xianhong Meng and Yuying He).
10. Development of Rapid, Simple and Sensitive Real-Time Reverse Transcriptase Loop-Mediated Isothermal Amplification Method (RT-LAMP) to Detect Viral Diseases (PRDV, YHV, IHHNV and TSV) of Penaeid Shrimp (Raja Sudhakaran, Tohru Mekata, Mari Inada, Shogo Okugawa, Tomoya Kono, Kidchakan Supamattaya, Terutoyo Yoshida, Masahiro Sakai and Toshiaki Itami).
11. Omics' Studies for Genetic Improvement of Shrimp in China (Fuhua Li and Jiahai Xiang).
12. An Integrated Approach to Sustainable Shrimp Farming (Shaun M. Moss, Dustin R. Moss, Clete A. Otoshi and Steve M. Arce).

Farmers as Stakeholders in Commercial Aquaculture: Free download

As part of its Golden Juilee celebrations, the Central Institute of Fisheries Education held a symposium on farmers as stakeholders in commercial aquaculture. The proceedings are available for download (PDF, 17MB) from the CIFE website. The contents includes:

- Farmers as Stakeholders in Commercial Aquaculture – a Synthesis (M. Krishnan, P.S. Ananthan, R.S. Biradar, W.S. Lakra).
- Inclusive Shrimp Farming: Development Model For Marginal Stakeholders In India (Manoj M. Sharma).
- Fishers First: Participatory Model in Seaweed Farming in India (Abhiram Seth and Tanmaye Seth).
- High value aquaculture and marginal stake holders in India with special reference to *L. vannamei* (Saji Chacko).
- The impact of commercial shrimp farming in Andhra Pradesh on Marginal farmers (P. Elan Cheran).
- Integrating farmers as stakeholders in coastal commercial aquaculture (M. Krishnan, R. S. Biradar, Swadesh Prakash, P. S. Ananthan, Vinod Kumar Yadav and B. Nightingale Devi).
- Ensuring community participation for sustainable public-private-partnership in aquaculture (Ojha S.N., Sheela Immanuel, Ananthan P.S., Mishra, S.K and Nisha Elezabeth Joshwa).
- Farmers focus strategies to enhance local availability of quality fish seed for commercial Aquaculture (Nalini Ranjan Kumar and M. Krishnan).
- Indigenous Technical Knowledge (ITK) as local resource for sustainable development: Study of cases in fisheries and aquaculture (Arpita Sharma, Banti Debnath and S.K. Mishra).
- A study on the performance appraisal of Non-Governmental Organizations in fisheries development in India (S.K.Mishra, S.N.Ojha, Sheela Immanuel, Arpita Sharma, Swadesh Prakash, Archana Sinha and Lipi Das).

Download the proceedings from:

http://www.cife.edu.in/cife/index.php?option=com_content&view=article&id=344

Marker for banned antibiotic naturally occurs in freshwater prawns and other crustaceans

A recent paper in the Journal of Agricultural and Food Chemistry reports that a marker for the banned antibiotic nitrofurazone naturally occurs in freshwater shrimp and other crustaceans. The finding is of trade significance, since laboratory tests for chemical residues can lead to the rejection of imported consignments and restrictions on market access. As the sensitivity of laboratory tests increases, there is increasing risk that false positives may be generated by natural background levels of chemicals in the environment. The abstract of the paper follows below:

Van Poucke, C., Detavernier, C., Wille, M., Kwakman, J., Sorgeloos, P., Van Peteghem, C. 2011.Investigation into the possible natural occurrence of semicarbazide in *Macrobrachium rosenbergii* prawns. Journal of Agricultural and Food Chemistry 59(5): 2107-2112.

Abstract

In the past year there has been an increased incidence in Belgium of cases of positive semicarbazide (SEM) tests in imported freshwater *Macrobrachium rosenbergii* prawns, seemingly indicating the possible abuse of nitrofurazone, a banned antimicrobial agent.

This was in contrast to all other European countries where no significant increase in SEM-positive samples was detected. A possible explanation for this discrepancy between Belgium and the other European Union member states could be the fact that only in Belgium were whole prawns (meat and shell) analysed for the presence of tissue-bound metabolites of nitrofurans, whereas in the other countries only the edible part (meat) of these prawns was analysed.

To investigate the possible natural occurrence of SEM in freshwater prawns, an animal trial was set up.

In this experiment two groups of 10 juvenile *M. rosenbergii*, previously raised under standardised laboratory conditions, were stocked into two separate aquaria, a control group under reference conditions (no addition of nitrofurazone) and a group exposed to a daily dose of 50 mg of nitrofurazone L($^{-1}$) of culture water.

Results of this animal trial proved that SEM naturally occurs in *M. rosenbergii* prawns but that at the current minimum required performance limit (MRPL) no tissue-bound SEM can be found in the meat of nontreated animals. In addition to this animal trial, commercial samples of other crustacean species, the shell and meat of which were analysed separately, were also analysed for the presence of SEM.

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