ISSN 0859-600X

Volume XIV No. 1 January-March 2009

AQUACULTURE ASIA

Myanmar revisited after Cyclone Nargis

Boosting Sri Lankan reservoir fisheries

Fisheries of Chalan Beel, Bangladesh

Rice-fish culture

National aquatic health strategies

Seed production of butter catfish

Aquaculture Asia
is an autonomous publication that gives people in developing countries a voice. The views and opinions expressed herein are those of the contributors and do not represent the policies or position of NACA.

Editor
Simon Wilkinson
simon@enaca.org

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

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

Submit articles to:
magazine@enaca.org

Printed by

Scand-Media Co., Ltd.

AQUACULTURE ASIA

Volume XIV No. 1
January-March 2009

ISSN 0859-600X

The food and energy crisis: A taste of things to come

Last year saw the climax of the world's most recent energy shock. The oil price climbed with alarming speed to a peak just shy of US$150, nearly triple its January 2007 low of US$55. This rapid increase in energy cost revealed two things: The limitations in global oil production capacity; and perhaps more alarmingly, the amount of fossil fuel energy in the human food chain. The higher energy costs resulted in significant increases in the cost of food across the board.

When supply cannot meet demand, prices rise, and those that can least afford to pay are priced out of the market. When the commodity in question is food, it is the poor that go hungry. The increasing food prices caused considerable alarm amongst governments and development agencies. In July 2008 the International Monetary Fund issued a warning that the increasing oil and food costs posed a threat to food security in many poor and developing countries.

The crisis was brought on by the increasing competition for limited oil resources, which has intensified as the standard of living has risen in many parts of the developing world, and as developing economies continue to industrialise. In particular, the rapid growth of the titanic Chinese and Indian economies has contributed to a spike in global energy demand.

The energy crisis put food security firmly back on the agenda. The point is that we need to keep it there. The present global economic downturn has granted the world a temporary reprieve, but once economies begin to recover, prices will once again soar. We should learn from this brief vision of the future and take steps to avoid a repeat episode.

For many years the aquaculture industry has been moving towards increasing culture of 'high value' and typically carnivorous aquaculture species, i.e. high priced luxuries for wealthy consumers. Low cost species by contrast haven't got nearly as much attention in the press, although they are considerably more important from a food security point of view in that they are more affordable, are less energy and resource intensive (being predominantly herbivorous or otherwise low in the food chain) and comprise the clear majority of global aquaculture production.

It's fair to say that low-cost species haven't received the attention they deserved, and perhaps they should. With this in mind, NACA and FAO will convene a workshop on 'Market chains and issues associated with biosecurity of low-valued cultured commodities in Asia', in Siam Reap, Cambodia, 23-26 February 2009. Further details about the workshop, as well as the report and issues raised, will be made available on the Inland Fisheries and Aquaculture section of the NACA website in due course.

Simon Wilkinson

AQUACULTURE ASIA

In this issue


Page 3.


Page 12.


Page 18.


Page 25.


Page 33.

Peter Edwards writes on

Rural Aquaculture

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

Myanmar revisited

Background

Rarely do I receive feedback on my columns but 'Comments on possible improvements to carp culture in Andhra Pradesh' (Aquaculture Asia Volume XIII, Number 3, pp. 3-7, 2008) has generated considerable interest: several colleagues contacted me, the column has been reprinted in the Indian magazine 'Fishing Chimes' (Volume 28, No.7, pp.10-14), and I was invited by U Tin Maung Thann, Vice President of the Myanmar Fisheries Federation (MFF) and U Than Lwin, Chairman of the Myanmar Fish Farmers Association to visit Myanmar last September to present in person my impressions of rohu farming in Andhra Pradesh, India, to compare it with rohu farming in Myanmar, and to make suggestions as to how current practice could be improved in their country. It was especially nice to have a chance to interact again with Tin who was my Masters degree student in the early 90s. Following graduation he was employed for several years in AIT's Outreach program, experience which he's putting to good use in Myanmar.

Fingerlings being transferred from boat to grow-out pond.

I readily agreed to this kind invitation on condition that I be taken on a field trip to revisit rohu farms, although I had visited the country three years ago ('Rural aquaculture in Myanmar', Aquaculture Asia, Volume 10, No.2., pp. 5-8). I was taken on a most impressive three day field trip by my two hosts, as can be judged from the photos of the wide range of activities. This was followed by an all-day workshop held at the MFF on 'Improving rohu aquaculture systems in Myanmar'.

I also joined a field trip arranged by Myanmar Egress into the Ayeyarwady delta with a group of German and Swiss donors who had financed the reconstruction of houses and a school for victims of Cyclone Nargis. The cyclone caused a tidal wave of about 5 metres to sweep through the delta in May 2008, causing widespread death and destruction. I was able to meet small-scale farmers who had been severely affected by the cyclone, including some who had been involved in rohu culture. On the last day of my week's visit I gave a seminar, 'Promising development strategies for small-scale aquaculture in Nargis affected areas'. The seminar was attended by about 30 people, including representatives from major NGOs involved in rehabilitation programs. As with the rohu workshop, I felt uneasy pontificating about aquaculture in the country based on only a few days of experience.

Large-scale farms

The following discussion on carp farming in Myanmar is based on the three day field trip and on information provided by farmers at the workshop. There are major similarities as well as differences between the systems in Andhra Pradesh and Myanmar. Both are rohu dominated with similar high total production and high yields. Several hundred thousand tonnes of carp are currently being produced mainly by about 3,000 large-scale farmers in Myanmar on a total area of over 80,000 ha with an average yield of 4.5 tonnes/ha although better farmers (32,000 ha) claimed to produce 12.5-16.0 tonnes/ha. Farm gate prices are similar in both areas, about US $1/kg.

Returns from fish farming were high initially in Myanmar but are falling now with rising feed costs (60-65% of total operating costs) and increasing competition in export markets. Hence the reason for my invitation to compare farming practices in the two areas and to suggest possible ways to improve technical and financial efficiency in Myanmar.

The major seed producing area in Myanmar is in Kayan, east of Yangon, where 200 nursery farms cover 800 ha as well as a similar area of grow-out ponds. This was the first area developed for carp culture in the country, with fish ponds constructed in a rice growing region. As there was insufficient area for expansion, 17,200 ha of grow-out ponds were later built on undeveloped land in an area previously insecure due to insurgency in Twante to the west of Yangon. Some of the current farmers were formerly rice farmers, although many of today's fish farmers entered aquaculture from other professions.

At the Ayeyarwady Advanced Freshwater Fish Hatchery, U Win Kyaing has developed an improved breed of rohu. Wild stock were collected from the Ayeyarwady river in 1996 and through selective breeding the growth rate is now 50% faster than that of commonly farmed stock, the fry and fingerlings are stronger and swim faster, and growth in grow-out is 10-15% higher. Furthermore, the attractive reddish coloration and shape of fish fetch a higher price in both local and export markets.

As in Andhra Pradesh, it takes two seasons to produce table size fish as fingerlings are first stunted and then are grown out in a separate pond system. Fingerlings of 2.5 cm size

My hosts and guides U Than Lwin (foreground) and U Tin Maung Thann (background).

Fingerlings being transported in the aerated hold of a boat.

Powdered feed being loaded into a nylon net feeding basket.

are purchased from hatcheries and nursed in monoculture. at a relatively high density to 12.5-15.0 cm or about 10 g in nursery farms during the first year. Stocking density of fry in nursery ponds is 375,000 ha or 37.5/m^2 with rohu comprising about 95% of fingerling production.

Feeding efficiency is likely to be low.

Feed may also be offered to fish in perforated sacs suspended in the pond.

Pelleted feed is increasingly used.

Various reasons were given for stunting, even though some farmers believe it is possible to grow rohu to marketable size in one year: as former livestock rearers, they observed that older animals are stronger and grow faster than small animals; stunting produces uniform sized fingerlings; if they stock small fingerlings in grow-out ponds, the stocked fish will disappear from predation; and the logistics of transporting fingerlings from Kayan to Twante by boat which can only be carried out from the end of May until December when there is sufficient water in the river system. Furthermore, the water level in low-lying Twante is too high to drain the ponds for advanced nursing to take place there; ponds can only be drained in the dry season, by gravity with the remaining 15 cm of water pumped out.

Most grow-out farms are large, ranging in total area from 20-600 ha with an average farm size of about 80 ha. Pond size ranges from about 20-88 ha. Pond depth is 1.5-2.0 m. As in Andhra Pradesh, farmers believe that 'bigger is better'. Although large ponds are easier and cheaper to build than small ponds, farmers agreed with me that the ponds are too big and would like to divide them up. However, farmers believe that the optimal pond size is still a relatively large 6-8 ha, an order of magnitude larger than the size I said was probably optimal for efficient feeding and stock management. As in Andhra Pradesh, the ponds have been constructed by trenching around the perimeter to make the dike so it would be difficult to divide the ponds.

Farm-made mixtures of rice bran and oil cakes are used, and inefficiently, as in Andhra Pradesh. In Myanmar the powdered feed consists of rice bran and ground oil cake (groundnut, mustard, sesame or sunflower) at a 9:1 ratio. The farm-made feed is of low quality and feed ingredient availability and supply are insufficient due to high competition for other uses. As described in articles in Aquaculture Asia Volume 12 (3):7-12 and Volume (4):22-26, use of pelleted feed in Myanmar is increasing rapidly and much faster than in Andhra Pradesh, with 17 feed mills currently manufacturing pelleted aquafeeds although farmers are concerned about their cost.

In grow-out ponds rohu are stocked at 5,000/ha or 0.5 m^2, mrigal at 500/ha or 0.05 m^2 and catla at 250/ha or 0.025/m^2. In the second year rohu can reach 1.6-2.0 kg and catla 3.0-3.3 kg. The cycle is usually single stock and single harvest by seining, with the grow-out ponds drained every 2-3 years.

In Andhra Pradesh the farmers use fertilisers to produce 'green water' which they believe is the major factor in cost-effective fish production. In contrast, fertilisers (mainly inorganic fertilisers, as chicken and cattle manure would have to be transported long distances) are used only for pond preparation. Burmese farmers are unwilling to use fertilisers as: there are insufficient organic manures available; they believe that inorganic fertilisers are expensive and are especially discouraged to use them by the cost required to fertilise their large ponds; the response to fertilization is said to be too slow; and inorganic fertilisers are believed to be dangerous for fish. Furthermore, farmers believe that using only feed is sufficient for fish to grow; this is of course true but at increased cost of production!

I also observed damage to the carp farms caused by Nargis. Upwelling of pond water from the storm surge stirred up the bottom sediments in the ponds and washed out fertile

Seined fish are transported by boat.

water throughout Twante. Pond dikes on many farms were breached with loss of fish although they had been repaired at the time of my visit. Farm equipment, fish feed and farm workers' housing were also washed away and temporary dwellings made from plastic sheets were widespread.

Carp workshop

The workshop was attended by 120 people including 60 rohu farmers. I made a presentation on 'Carp culture in Andhra Pradesh with lessons for Myanmar'. My column on Andhra Pradesh had been previously translated into Burmese and was distributed to participants at the workshop.

I was also formally asked to respond to 15 written questions from Myanmar fish farmers which are summarized: What changes should we make to our fish farming system; should we bring in genetically improved rohu from India or upgrade local fish; what is the protein requirement for rohu fingerlings and as they grow larger does the percentage protein in the feed need to be reduced; what is the ideal fish pond size for semi-intensive culture of rohu; what are the ideal stocking densities for rohu in monoculture and in polyculture with catla, mrigal and grass carp; for best growth of rohu is feeding only sufficient or is fertilization also required; if fertiliser is required, is chemical fertiliser sufficient or is livestock manure also required; which type of feed is best for rohu, pelleted feed or the conventional rice bran: oilcake mixture; is it best to feed pellets to rohu in a basket in the pond or to broadcast them; and what are the main aspects that need to be addressed and implemented during farming, harvesting and processing rohu for competition on the global market? These questions I addressed during my presentation and in a final question and answer session.

The major concerns were on feed and stocking and harvesting strategies. It would appear that high yields of carps are being produced on some farms but that cost of production needs to be lowered. This could possibly be achieved, in addition to cheaper feed and more cost effective feeding strategies through improved stock management strategies to better utilize pond carrying capacity and space or water volume and to reduce the time to produce harvestable fish. In particular, the best strategies to produce fish of export size of 0.7-0.9 kg are being sought.

The participants were also divided into seven working groups, each of which was asked to deliberate one of the following topics: seed quality; stocking strategies; grow-out production

The locally improved strain of rohu.

operations; feed and feeding practices; farm-level harvesting and marketing; domestic and export markets; and government policy and financial matters. The relative importance of these issues was scored by participants and the outcomes of the group discussions were later converted into problem trees.

Fish export

The two groups discussing harvesting and markets raised several important issues. Farmed fish is exported as well as sold on the local market although the domestic fish price is lower than that for export. The domestic price for fish has risen recently as supply as fallen, possibly due to fish exports, indicating that more fish could be produced for the local market.

Myanmar exports about 100,000 tonnes of fish annually, about 30% of the rohu produced and about 10% of striped catfish (*Pangasianodon hypophthalmus*) with a small amount of tilapia. The export size for rohu is mainly 1-2 kg with about 90% being 1 kg fish. The main markets are the Middle East (Kuwait, Iraq, Saudi Arabia and United Arab Emirates) for gutted and chopped fish, mainly for Asian guest workers, and Bangladesh for frozen whole fish. The domestic market demands smaller sized fish, 0.25-0.50 kg, compared to 0.9-1.0 kg for the export market. Myanmar could export considerably more freshwater fish if the main constraint of market glut or shortage is overcome to provide a regular supply of fish for export.

It is important for fish farms to be able to supply the desired sizes of fish in the amounts requested by buyers so that the exporter can bargain for a good price, with increased prices paid to farmers also. Poor infrastructure for transportation of fish from farm to exporter and inadequate market information systems together with a lack of cooperation between producers and exporters hinder their competitive ability. Farmers need to receive requests from exporters for volumes and sizes of fish required at least 2-3 months in advance to give them time to produce the fish. Risks of undersupply or oversupply of fish of improper sizes makes it difficult for exporters to make trading agreements. This often leads to a glut of fish that cannot be exported on the local market, depressing local prices.

Myanmar initially was the only country exporting fish to Bangladesh, mainly rohu, but is now facing increasing competition from India. Myanmar cannot compete well with India, despite only being one and a half days by boat from Chittagong compared to a much longer journey for fish from Andhra Pradesh in India, because of poor marketing infrastructure and the inability to regularly supply large volumes of fish at specified sizes. Another reason is lower quality fish from Myanmar that fetch a low market price, due in part to use of insufficient ice. If exporters were able to get a better price for fish, part of the increased profit would be passed on to the farmers.

Initially striped catfish was mainly raised in monoculture for the export market but now is mainly raised in polyculture with rohu and is mostly consumed domestically; about 30 tonnes are marketed daily. It is difficult for Myanmar to compete at

Striped catfish are often included in the polyculture of Indian major carps.

Nile tilapia are usually grown in monoculture.

Rohu pond destroyed by Nargis in Dedanaw Village.

Aye Aye Mon, one of the four AIT alumni working for Myanmar Egress explaining the purpose of my visit to farmers in Nargis impacted Thee Gone Lay Village.

A fish pond dyke breached by Nargis repaired with earth filled sacs.

A farmer's wife and their children in front of their temporary dwelling in Nargis impacted Dedanaw Village.

One of the 130,000 boats destroyed by Cyclone Nargis.

present with Vietnam to export catfish as the flesh colour is not as good as that of Vietnamese fish so the demand and market price are low. Some is exported to China and Thailand in Asia as well as to Europe and the Middle East. Some catfish has even been exported to Vietnam but only to fulfil orders for re-export.

A Vietnamese government delegation visited Myanmar last year and offered the opinion that Myanmar could not compete with them because of feed. While there is insufficient trash fish to feed catfish in Myanmar, pelleted feed is increasingly being used in both countries. Myanmar has the advantage over Vietnam that it has large amounts of potential arable land that could be used to grow soybean and other possible feedstuffs for inclusion in aquafeeds. Vietnam has well

Above: Temporary plastic sheet dwellings for farm workers. Below: Newly constructed house in Cyclone Nargis impacted Thee Gone Lay Village.

established marketing networks for catfish but Myanmar could become a serious competitor in future if its agricultural sector could be integrated with aquaculture to provide feed.

Production of tilapia has declined relative to last year as it was mainly for export and Myanmar cannot compete with China in exporting the fish. Some tilapia frozen whole is exported to the Middle East and the UK.

The workshop discussion group on policy and financial access raised several issues that need to be addressed for Myanmar to be competitive in exporting fish. There are poor banking facilities with high interest rates. There are insufficient loans from the government as well as insufficient money for investment. The government also levies a high tax of 10% on exported fish. It limits the amount of ice that can be used to be keep fish frozen to an insufficient maximum of 15% which leads to poor flesh quality for the Middle East compared to better quality fish from competitors able to use more ice for ‘glazing’.

Small-scale farms

For the purpose of this column, a small-scale farmer is one who operates a family-level, crop-dominated farm, here rice, with small numbers of scavenging pigs and poultry, and is diversifying his/her livelihood through incorporation of a third sub-system, aquaculture.

I visited two areas severely affected by Cyclone Nargis: Dedanaw Village, Kungyan Gone Township, Yangon Division, about three hours drive south of Yangon, where houses had been reconstructed; and Thee Gone Lay Village, Dedaye Township, Ayeyarwady Division, another hour by road and a further 2 hours by boat, where the village school had been reconstructed. By chance, as the visit to the two villages had been arranged to visit the reconstruction of houses and a school, I found that rohu had been farmed in both villages but fish had been washed away by the tidal wave and culture facilities damaged or destroyed.

The farmer and his family that I interviewed in Dedanaw Village were living in a temporary dwelling as their house had been destroyed. The farmer had constructed a 500 m^2 pond in which he had been stocking rohu and feeding them with rice bran. He obtained seed from the major rohu growing area of Twante by travelling on public transport. He used to produce about 300 kg of fish which he sold in the nearby township, generating significant income.

I also interviewed a group of farmers in Thee Gone Lay Village where two farmers had been growing rohu in a rice/fish system. A trench three metres wide and one metre deep had been constructed around their rice fields although I was not able to see the system because the area was flooded. The fish were also fed rice bran and the harvested fish were sold in a nearby township, again indicating that aquaculture is a viable livelihood option for small-scale farmers in the Ayeyarwady delta. The farmers expressed interest in forming a village fish farming group to help other farmers in the village to farm fish but they would need capital to construct fish culture facilities and permission from local authorities to convert some of their rice fields to either trenches or fish ponds. It would be technically feasible to build fish ponds in the village as indicated by the presence of a large existing

Discussion groups at the Rohu Workshop.

Ceremony to celebrate the opening of the new school in Nargis impacted Thee Gone Lay Village.

Writer with farmers in Nargis impacted Thee gone Lay Village foreground village water supply pond background.

pond serving as a communal water supply for the village. Tilapia has been stocked in such ponds throughout Myanmar through a program of the Department of Public Health to control mosquitoes, although the fish are not caught and consumed.

The seminar I gave on small-scale aquaculture options was based on my experience in small-scale aquaculture in general as well as on observations made during the one day trip. The main issue is that there has been no development assistance in aquaculture for the small-scale farming sector in Myanmar because of government concerns about national food security.

As discussed in my previous article on aquaculture in the country, a narrow focus on rice at the expense of fish constrains the attainment of food security. The government supports only relatively large-scale fish farms. Supporting government policy is required to allow the conversion of a portion of farmers' rice fields into fish ponds. Perhaps the integrated rice/fish system developed by two farmers in Thee Gone Lay Village could be promoted on a widespread scale as it may not require a change in government policy. What is clear is however, is that there are several promising technical aquaculture options available for brackish water as well as freshwater and terrestrial agricultural environments that are socially and economically appropriate for the utilisation for the benefit of poor farmers and fishers in Myanmar.

Assistance to areas affected by Cyclone Nargis

My visit to the delta was arranged by Myanmar Egress, a civil society organization with three wings: a capacity development centre; a think tank for policy research and advocacy; and a media unit publishing a newspaper and a business magazine. Myanmar Egress has also formed an NGO; the Nargis Action Group with four Burmese AIT alumni (Tin Maung Thann, Htin Aung Kyaw, Aye Aye Mon and Aye Mya Mya) to provide relief work for Nargis affected areas. The group is currently working with a number of international organizations and NGOs and links up with MFF for aquaculture and fisheries activities. Should you wish to provide assistance to the cyclone victims, I suggest you contact U Tin Maung Thann who, besides being the Vice President of MFF, is also President and Director (Policy) of Myanmar Egress. He may be contacted at tmthann@gmail.com. The need for assistance, especially to Nargis affected areas is acute. Officially the death toll is about 160,000 with about 70,000 missing to give a total of about 230,000. Unofficially the death toll is at least 300,000 persons. If the latter figure even approaches the truth, this would make the death toll greater than the Asian tsunami, further illustrating the need for assistance.

Harvesting, traditional preservation and marketing of fishes of Chalan Beel, Bangladesh

Galib, S.M. and Samad, M.A.

Department of Fisheries, University of Rajshahi, Rajshahi 6205, Bangladesh, e-mail: thegalib@gmail.com

Overview

The legendary Chalan Beel is the largest beel (wetland) situated in the north western region of Bangladesh, with an area of more than 350 km^2 during the rainy season and about 90 km^2 during the dry season. It is one of the most important inland wetlands, creating employment opportunities and providing a huge amount of fish to rural people every year. Chalan Beel is located in area overlapping Atrai of Nawgaon district; Singra, Gurudaspur, Baraigram of Natore district; Chatmohor and Bhangura of Pabna district; and Tarash, Ullapara, and Rayganj of Sinajganj district. Most areas of Chalan Beel are flooded land and consist of numerous small beels and canals. Several rivers and their tributaries form a dense water network over the entire beel area.

Gone fishing...a child baits his hook for fishing in Chalan Beel.

During the rainy season, the entire Chalan Beel fills with water and creates a breeding ground for many native fish species. The people living around this beel include both professional fishermen and general members of the public who also harvest a huge amount of fishes at this time. The traditional method of preserving fishes through sun drying is an old practice in areas adjacent to the beel. We conducted a study of the harvesting, preservation and marketing of fishes in the Chalan Beel area.

View over part of Chalan Beel.

Methodology

Various parts of Chalan Beel including Atrai, Singra, Baraigram, Gurudaspur, Chatmohor, and Bhangura were surveyed for a period of 12 months from September 2006 to August 2007. During the field survey, different areas of the beel, fish landing centres, fish markets and fish drying sites were visited. Information was collected by direct interviews from fishermen, fish traders, and dried fish producers. Fish samples of each species were collected and preserved in labelled plastic jars using 10% formalin solution.

Fishing by drag net.

Fishes of Chalan Beel

A total of 81 fish species were recorded from Chalan Beel including 72 indigenous fish species and nine exotic species. Native fishes were recorded under following 12 fish orders - Cypriniformes (33.33%), Siluriformes (29.17%), Perciformes (13.89%), Channiformes (5.56%), Mastacembeliformes and Clupeiformes (4.17% each), Osteoglossiformes (2.78%), Cyprinodontiformes, Anguilliformes, Synbranchiformes, Beloniformes and Tetraodontiformes (1.39% each). Among the available indigenous fishes, 38.89% fishes were in the list of threatened fishes of Bangladesh declared by IUCN[1]. In addition to fishes, small freshwater prawns, crabs and some other fisheries items were very common in Chalan Beel.

Harvesting of fishes

Harvesting of fishes in Chalan Beel was done by using a variety of fishing gears. A total of 27 different types of fishing gears were recorded during investigation period from different areas of the beel. Recorded fishing gears were categorized into five major types which were nets (44.44%), traps (18.51%), hooks and lines (22.22%), and wounding gears (14.81%). Moreover, fishermen used bana (bamboo split made into rectangular shaped structures) prior to fishing to enclose specific water area for making their fishing more effective. Also, a technique locally called katha fishing is often used during the dry season. This involves providing tree branches or other aquatic vegetation in a specific area of the beel during rainy season (in the deeper portion of the beel) aimed at creating shelters to encourage aggregation of fish, for easy capture.

In the studied areas, nets were recorded as the most effective fishing gear to catch fish both for small scale and large scale harvesting. A wide range of fishes both small and large were caught by these nets. Around 20% of fish traps were used for catching large fishes with the remainder used for small to moderate size fishes. Hooks and lines were found to catch predominantly moderate to large size fishes only with different baits including earthworms, small frogs and small live fishes. Among the recorded wounding gears, 75% were used during heavy flooding period and 25% were used at the end of rainy season and when water level of the beel was low. All the wounding gears were used for harvesting large size fishes.

Impacts of illegal and over fishing

The use of illegal fishing gear and overfishing were found to be very common problems in Chalan Beel. Fishermen were harvesting indiscriminately without considering the impact on natural broodstock or fry. More than 80% of the nets used in fishing were found to be small meshed, capable of catching almost all types of fishes. As both broodstock and fry were caught indiscriminately, fish abundance and the availability of particular species in the beel are decreasing every year.

Moreover, during dry season, fishermen harvest fish from low depressions of the beel by complete dewatering. This badly damages fish stocks, contributing to conservation and fisheries management concerns.


Lift nets are also used for fishing in the beel.

Traditional preservation of fishes

Several preservation methods were observed during investigation period. Many fishermen used square or rectangular shaped guizza (bamboo splits made with floats) and deck of their boats for preservation of their catches. They also preserved their harvested fish (38.89% of native fishes) with ice. Crushed block ice was used in 100% ice preservation.

The most common and an old preservation method practiced in areas adjacent to Chalan Beel was sun drying. Both commercial scale and household sun drying were conducted in the beel areas. The fish used for drying varies according to the time of year and availability of particular species. Commercial operations generally dry 10-140 kg of fish per day while households dry less than 10 kg per day.


Harvested olive barbs (Puntius sarana).

There are at least several hundred of producers involved in drying fishes in the studied areas. All the dried fish producers followed traditional drying methods (i.e. directly under the sun). A total of about 30 fish species were recorded to be prepared in this manner while two other species of prawn and crab were also observed being dried. The dried fishes and prawns are used for human consumption but dried crab was used for poultry or fish feed after crushing. Among the 30 species of fishes recorded, 20% were used in small scale household drying.

Most of the dried fish producers (70%) did not mix any salt with raw fishes prior to drying. The remaining 30% of producers used commercial salts but they did not maintain any proper ratio of fish and salt. In general, they used 50-250 g of salt for one kilogram of raw fishes.

Fishes were generally dried on racks made from bamboo (locally called chatal) but are also dried directly on nets laid on the ground. In some cases heavy infestation by flies was conspicuous. Drying duration usually varied between two to six days depending on the size of fish and weather conditions. After drying, the fish were sorted according to species and size. The product was then packed into plastic or hessian bags and temporarily stored in tents.


Sorting of dried fishes.

Marketing of fishes

The marketing channels for fresh fish harvested from Chalan Beel was composed of fishermen, several middlemen (up to six in number) and finally consumers. Fishes were brought to local fish landing centres initially then transported to other places of the country. People involved in the marketing channels often used several vehicles for transportation depending on the distance they needed to travel. In case of short distances (less than 5 km) they normally used bicycles, vans, rickshaws or nocimon but for longer distances they used buses, trucks and trains. Over longer distances, aluminium pots or bamboo baskets were used, together with crushed block ice.

Marketing channels for dried fish were somewhat different. Dried fish producers usually carried their product to a dried fish landing centre 2-4 times a month. Very small amounts of dried fish were sold to the local travelling vendors and people at the drying site.

Tent for temporary storage of dried fishes.

Small-scale household fish drying.

Conclusion

By and large, Chalan Beel is still playing an important role in the development of the Bangladesh economy through creation of employment opportunities for many fishermen and fish traders; and through supplying animal protein to the people. The beel represents an important resource base for the country. However, at present fish populations in the beel are at stake due to the use of illegal fishing gear, overfishing, reduction of water area, and through construction of roads and bridges through the middle of the beel. Proper scientific management of the beel and its fishery is an urgent requirement if maximum sustainable yield is to be achieved. More attention should be given for the conservation of fishes and other species in Chalan Beel. There is clearly a need for implementing fisheries regulations, particularly to protect mature fish during the breeding season. A sufficient number of temporary or permanent fish sanctuaries must be established for this purpose.

As Chalan Beel provides a huge amount of dried fish every year, the sun drying methods employed must be modernized. Considering the socio-economic capabilities of dried fish producers, low cost technologies such as solar tent drying should be adopted for obtaining quality dried products. Technical and financial support need to be provided to producers from government and other related authorities.

Reference

1. International Union for Conservation of Nature and Natural Resources - Bangladesh. (2000). Red Book of Threatened Fishes of Bangladesh. IUCN - The World Conservation Union. 116 pp.

Role of community in production and supply of larger, quality fingerlings

Radheyshyam, De, H.K. and Saha, G.S.

Central Institute of Freshwater Aquaculture, Kausalyagang, Bhubaneswar - 751 002, Orissa, India, email radheyshyam.cifa@gmail.com

Introduction

Quality carp seed is a prerequisite for sustainable development of aquaculture, and uncertainty in the availability of stocking materials is one of the major constraints to rapid expansion and growth of the industry. Fish seed are generally classified into spawn (6-8 mm size), fry (20-25 mm size) and fingerlings (100-150 mm size), and may be sold as 'yearlings' once reaching 100-200 g weight.

An increasing quantity of carp seed is being produced in India every year. For instance, the total fry production in India was estimated to be 632 million in 1986-87, which increased to 18.5 billion in 2002-2003 and is presently about 20 billion. However, reliable data on the production of larger size fingerlings and/or yearlings are not available. To stock the estimated 2.5 million hectares of ponds and tanks and 2.0 million hectares of reservoirs in India at 7,000 fingerlings/hectare, some 31 billion larger sized fingerlings are needed. However, only 10-15% of carp seed is grown to fingerling stage and rest perish in the nursing systems due to various biological, physical and chemical constraints. The production and distribution of seed is complex and dynamic. Although some entrepreneurs produce and distribute fish seed to end users, often as a part of complex networks, supply often remains erratic, particularly in rural areas. By and large, the gap between demand and supply of quality, larger sized seed remains a daunting task in rural aquaculture development, in spite of concerted R & D efforts. One approach to mitigating this problem is to encourage village communities to produce larger size fingerlings locally, which will also support more neighbouring farmers to adopt fish culture.

Why use larger fingerlings?

Larger fingerlings offer many advantages:

- Larger fingerlings have higher survival as they are less vulnerable to predation and disease and more tolerant of environmental fluctuations.
- Larger fingerlings require less time to reach marketable size and result in higher production.
- More suitable for multi cropping and cyclic carp culture to ensure food fish production the whole year round.
- Larger fingerlings have higher demand in the early season, as they make best use of seasonal grow out ponds.
- Stunted fingerlings grow extra fast and can be sold at a higher price.

How to produce larger sized fingerlings?

Larger fingerlings can be produced by:

- Nurturing spawn in high density, followed by thinning of fry which are then raised to fingerlings and yearlings.
- Nursing spawn at low density, which makes fry grow faster; advanced fry also grow into fingerlings 1-2 months earlier than conventionally reared fry and fingerlings.
- Producing spawn through early breeding before onset of monsoon to maximise time available for growth.
- Rearing fry at higher densities for 10-12 months to get stunted fingerlings/yearlings.
- Supply of quality food (optimum density of ideal zooplankton and added vitamin B and B12) and low density helps to ensure healthy seed with fast growth and survival of fingerlings.

Nursing fish seed in community ponds

Fish seed nursing in backyard/community ponds becomes easy when a group of farmers/fishers with a common interest work together, shouldering the responsibilities jointly. However, such self-help groups need to have one or two disciplined, co-operative, and influential, risk bearing and devoted team leaders. The leaders must be farmers by profession, social by temperament and have missionary zeal for serving their fellow rural farmers. The leader is also expected to be simple, easily approachable by poor farmers and adaptive enough so that rural farmers will accept him/her unreservedly. Dynamism and good communication skills as well as capacity to deal with the authorities are essential.

For example, in fish seed nursing in community or homestead ponds, the major technological package of practices include renovation of water bodies, de-silting, eradication of aquatic and terrestrial weeds, removal of weed fishes and predators, liming, manuring and fertiliser application, procurement and stocking of fish seed, feeding, monitoring of health and growth, guarding the crop, netting and harvesting, marketing and transporting seed, and supplementary use of pond embankments for growing fruits, vegetable crops and live stock maintenance. These activities require joint community work, making use of people of both sexes and all ages. The community, being an informal association, most of the formalities and paper work are also eliminated.

Potential for community based fingerling rearing

Natural resources are the backbone for economic development of rural communities. Community based fish seed nursing can take place in large or small water bodies, including many under-utilised areas such as canals, roadside ditches from where clay and soil is removed for repairing bunds and roads, and borrow pits where earth has been excavated for construction of mud walls etc. However, most such alternative water bodies are invariably shaded by large marginal trees and covered with aquatic weeds or eutrophic, requiring significant start up work to make them suitable for seed production.

Good local leader – essential for success

As far as possible, water bodies with competing community interests or those that are being utilised by other groups should be avoided to prevent conflicts. Instead, emphasis is laid on utilising derelict water bodies as stated above, which are usually free from competing interests. The identification of common interest groups and their organisation at the initial stage is often a difficult task for executing agencies. The availability of good local leadership is essential in uniting community interests and fostering a collaborative approach.

Steps for community-based large fingerling production

Fish seed production includes egg to spawn production for around three days, spawn to fry nursing for 15-20 days, fry to fingerling rearing for 60-90 days and fingerling to yearling rearing for 7-8 months. In coastal India, in same perennial ponds fry, fingerlings and yearlings are reared in succession during June-July, August-November and December-June respectively. Alternatively, community ponds may be stocked with carp fry and rearing of fingerlings and yearlings are continued in succession. For rearing of larger sized carp fingerlings, ponds of 0.05-0.1 ha with an average depth of 1.0-2.0 m are preferred.

Trees and bushes that provide shading and deposit excessive organic matter by leaf fall in the ponds are cleared before launching the fish seed nursing operation. Pond embankments are renovated with the provision of secured inlets and outlets. Since backyard ponds are shallow and small, aquatic weed clearance is usually performed manually. Predatory animals/fishes and weed fishes are eradicated by de-watering and drying the ponds or application of suitable piscicides.

Raw cattle dung is generally applied at around 3 tonnes/ha as basal manure in ponds. To enhance the fertilization effect liming is done at 200-250 kg/ha. For sustained production of natural fish food organisms a mixture of de-oiled cake, cattle dung/bio-gas slurry and single super phosphate in the ratio of 25:250:1 or 3-5 kg of multiplex pre-mineral mixture and vitamins in combination with RCD and de-oiled cake at 1,000 and 200kg/ha respectively are used in liquid forms four to five times before stocking spawn. Application of a mixture of 100 kg RCD, 50 kg poultry manure and 25 kg mustard oilcake/ha weekly once after seed stocking can ensure the abundant production of zooplankton. Addition of vitamin B and B12 gives better growth and survival of healthy seeds.

Where the ponds are used for fry rearing, the fry may be harvested by repeated netting on day 15-20 of rearing. At times, two crops of fry may be taken. After fry harvesting, the ponds are fertilised with the mixture of above manure to produce adequate natural food organisms. Two or three days after the pond has been fertilised, fresh fry are stocked along with the residual fry in such a way to maintain fry density at around 300,000-500,000/ha. Later a mixture of the above fertilisers is applied in liquid form at weekly or fortnightly intervals. Fingerlings are also fed traditionally and harvested by repeated netting after three months of rearing.

Fertiliser is again added to the ponds after harvesting the crop of fingerlings. Culture of yearlings is carried out by stocking appropriate carp fingerlings along with residual stock of fingerlings at 30,000-50,000/ha. During culture period ponds are fertilised once per month. Fingerlings are fed intermittently with kitchen wastes and with a mixture of ground nut oil cake and rice bran in the ratio of 1:1 by weight at 3-5% of the body weight. Complete harvesting of fingerlings is performed by de-watering the ponds in May to June.

To supply larger fingerlings earlier in the season, stunted fingerlings are grown. These are raised by stocking fingerlings at 250,000/ha in July-August. Stunted fingerlings grow up to 12-15 g in 10-12 months with 50-70% survival. They are grown with reduced nutrient uptake. When stunted fingerlings are placed on a high quality diet, they grow rapidly leading to efficient body weight gain. Hence stunted fingerlings/yearling are the most preferred stocking material by grow out farmers and fetch a higher price than the normal fingerlings. Hence fisher community sells off as much as they can to satisfy current year demand and then go for producing stunted fingerlings. Fish fingerlings are sold at the pond site to neighbouring village fish farmers or supplied through fish seed vendors of the region. However, large scale production of fingerlings is often distributed to distant locations in oxygenated packing.

In conclusion, the production of larger, quality seed through community-based approaches offers the following advantages:

- Provides a more secure supply of quality fish seed available to highly dispersed, small scale producers, therefore contributing to the growth of rural aquaculture.
- Generates income, livelihood opportunities and funds for further investment for the village community, drawing on locally available resources.
- May often be undertaken as a supplementary livelihood opportunity, enabling people to increase their income without disturbing their normal routine.
- Makes more efficient use of under utilised water resources of the village, while also improving their environmental conditions.
- Improves the organisation of farmer groups with common interests, empowering them and improving their socio-economic status.
- Improves access to extension and support services for fish seed nursing, through mutual sharing of experience and participatory approaches.

Can rice-fish farming provide food security in Bangladesh?

Ahmed, N.[1,2] and Luong-Van, J.[2]

1. Department of Fisheries Management, Bangladesh Agricultural University, Mymensingh 2202, Bangladesh; e-mail: nesar_2000@yahoo.com; 2. School of Environmental and Life Sciences, Charles Darwin University, Darwin, NT 0909, Australia; e-mail: jim.luong-van@cdu.edu.au.

Introduction

Bangladesh is one of the poorest and most densely populated countries in the world. More than 140 million people occupy the country's 144,000 km^2 of area, consuming rice and fish as staple foods. Bangladeshi people are popularly referred to as "Macche-Bhate Bangali" or "fish and rice makes a Bengali." Rice and fish have been an essential part of the life of Bangladeshi people from time immemorial. Rice farming is the single most important livelihood for a vast majority of the rural poor. The annual rice production is estimated to be 26.53 million tonnes[1], while fish production is 2.32 million tonnes[2]. The demand for rice and fish is constantly rising, with the population increasing by more than three million people each year. However, the land available for rice and fish farming is not expanding. Nevertheless, fish farming in rice fields offers a solution to this problem, contributing to food production and income generation.

The total area of rice fields in Bangladesh is about 10.14 million ha and there are a further 2.83 million ha of seasonal rice fields where water remains for four to six months of the year[3,4]. These inundated rice fields can play an important role in increasing fish production through integration of aquaculture. There are several positive effects of fish farming in rice yields. Integrated rice-fish production can optimise resource use through the complementary utilisation of land and water[5]. Integration of fish with rice farming improves diversification, intensification, productivity and sustainability[6,7,8]. Rice-fish farming is also being regarded as an important approach to integrated pest management (IPM).

The adoption of rice-fish farming in Bangladesh remains rather marginal to date due to socio-economic, environmental, technological and institutional constraints[9]. Traditionally wild fish have been harvested from rice fields. The green revolution of agriculture has become a constraint for the development of rice-fish farming. With the introduction of high yielding varieties (HYV) of rice, the pest control strategy has preferred chemical pesticides[10,11]. Nevertheless, reducing pesticide has taken place through IPM. The introduction of IPM with fish farming in rice fields becoming popular in many Asian countries, such as China, Philippines, Thailand and Vietnam[12].

In order to increase food production, a small number of farmers were encouraged to take up rice-fish farming in Bangladesh. Nevertheless, a number of issues are important for rice-fish farming including production technology, socio-economic and environmental aspects. This paper highlights key issues for sustainable rice-fish farming, to meet challenges for food security for the people of Bangladesh.

Silver carp is a common species in rice-fish farming systems.

Methodology

Field research was conducted for a period of six months from December 2007 to May 2008. The research design included selection of the study area, identification of target groups and selection of research tools for data collection (Figure 1). The method of data collection depends upon the nature, aim and objectives of the study. Selection of particular method depends on nature of the research problems, duration of fieldwork and distance of the research site. In order to assess the rice-fish farming systems relevant to farmers' concepts and understanding, a participatory research method was employed. The major advantage of this method is that its coverage is much wider. However, one of the major risks is that the investigation has to depend solely upon the memory of the respondents. This was, however, overcome by applying a combination of data collection methods.

The study was conducted in the Mymensingh area of north-central Bangladesh which is one of the rice bowls of the country. Geographically Mymensingh has been identified as the most important and promising area for rice-fish culture, because of favourable resources and climatic conditions, such as the availability of low-lying agricultural land, warm climate, fertile soil, and cheap and abundant labour. Hydrological conditions are also favourable for rice-fish farming as this area is located within the monsoon tropics with an average annual rainfall of 2,500 mm[13]. Moreover, conditions are highly encouraging for the expansion of rice-fish farming as the quantity of fish seed produced has risen rapidly in recent years from around 70 private hatcheries. Nevertheless, a small number of farmers (around 100) are involved in rice-fish farming in Gauripur and Phulpur sub-districts. These farmers received training from the Mymensingh Aquaculture Extension Project, funded by Danish International Development Assistance. Gauripur and Phulpur sub-districts were therefore selected for the study.

A combination of participatory, qualitative and quantitative methods was employed for primary data collection. A total of 80 rice-fish farmers, 40 in each sub-district, were interviewed at their houses and/or farm sites. The interviews, lasting about an hour, focused on rice-fish farming systems, culture practices, productivity and constraints of rice-fish farming. A Participatory Rural Appraisal tool - focus group discussion (FGD) was conducted with rice-fish and rice-only farmers to obtain qualitative information. FGD sessions were held in front of village shops, under large trees, in farmers' houses and on school premises, where participants could sit, feel comfortable and were easily observed. Finally, cross-check interviews were conducted with district and sub-district fisheries officers, agricultural extension officers, school teachers, researchers, policy makers and relevant non-government organisation (NGO) workers. Data from questionnaire interviews were analysed using Microsoft Excel software to produce descriptive statistics.

Farming systems

There are two types of rice-fish farming systems in the Mymensingh area depending on the source of fish: culture and capture. In the capture system, wild fish enter the rice fields from adjacent floodplains during the monsoon and reproduce in inundated rice fields. On the other hand, rice fields are deliberately stocked with fish in the culture system. Fish farming in rice fields can be broadly classified as concurrent (integrated) and rotational (alternate). In the concurrent system, rice and fish are grown together, while in the rotational system they are grown alternately. According to the survey, 54% of farmers practiced concurrent rice-fish farming and the rest (46%) cultured rotationally. In general, the concurrent rice-fish culture system is practiced in plainlands and medium lowlands, while the rotational system is performed in deeply flooded lowlands. The average farm size was found to be 0.33 ha and 0.29 ha in the concurrent and rotational system, respectively.

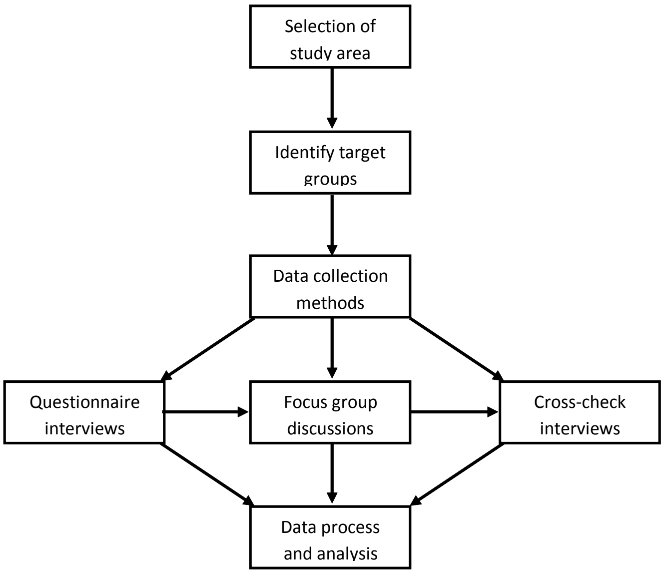
Two types of rice crops are cultivated in the concurrent system: boro and aman. Farmers cultivate boro rice during the dry season from January to April, and the monsoon season aman rice during June to October. The aman rice culture takes place in either deep or flooded water conditions with fish, and with a fish culture period of around 4 months. In the rotational system, farmers produce fish during the monsoon. Fish fingerlings are stocked in May to June and are harvested primarily from November to December, a culture

Rice fields are an important environmental landscape in Bangladesh.

A typical concurrent rice-fish farm.

A typical rotational rice-fish farm.

Figure 1. Research design for field survey of rice-fish farming.



period of around 5 to 8 months. Rotational farmers avoid cultivation of aman rice with fish due to high water levels. On the other hand, farmers avoid fish culture with boro rice because of water scarcity and lower availability of fingerlings.

A wide range of fish species are cultured in rice fields. The selection of species depends on farming systems. According to the survey, concurrent farmers mainly stocked common carp (*Cyprinus carpio*), silver barb (*Barbonymus gonionotus*), Nile tilapia (*Oreochromis niloticus*) and silver carp (*Hypophthalmichthys molitrix*). In rotational culture, on the other hand, the most common fish species stocked were catla (*Catla catla*), rohu (*Labeo rohita*), mrigal (*Cirrhina cirrhosus*), silver carp (*H. molitrix*), grass carp (*Ctenopharyngodon idella*) and bighead carp (*Aristichthys nobilis*). The average annual stocking density of fingerlings were 2,857 per ha in the concurrent system, while it was 4,917 per ha in the rotational system. The average size of fingerlings stocked varied between 4 and 8 cm in the concurrent system, and 6 to 10 cm in the rotational system.

Although small-scale fish farming in rice fields is an extensive aquaculture system that relies on the natural food (phytoplankton, zooplankton, periphyton, benthos), supplemental feeds are used by most respondents. In the concurrent system, farmers mainly use on-farm inputs, such as rice bran, wheat bran and mustard oilcake. On the other hand, a few rotational farmers apply fishmeal and industrially manufactured pelleted feeds, in addition to on-farm inputs. Farmers reported higher fish yields when feeding pelleted feed rather than on-farm inputs. The most common feeding frequency in the rotational system was once a day, while it was once or twice a week in the concurrent system. There was a substantial difference in feeding rate among culture systems.

In order to increase rice and fish production, a variety of fertilisers such as urea, triple super phosphate (TSP) and muriate of potash (MP) are used by the farmers. The fertiliser quantity used is related to farming system (Table 1). Concurrent farmers with two rice crops used less fertilisers on an annual basis than did rotational farmers of one rice crop because the presence of fish increased soil fertility.

The average annual yield of rice was higher in concurrent farming compared to rotational farming, because of two rice crops. Table 1 shows that concurrent farmers had a higher aman rice yield than boro rice as the stocking of fish affected the aman rice yield positively. Nevertheless, boro rice yield was slightly higher in rotational farming than that of concurrent farming.

The average annual yield of fish reported by respondents was 259 kg/ha in concurrent farming, while 1,108 kg/ha in rotational farming. The yield of fish was higher in rotational farming due to higher inputs of fish seed, feed and fertiliser. In addition, rotational farmers stocked larger fingerlings which could have a positive effect on survival and growth, and thus also the yield. Comparatively larger size fish was harvested in rotational farming due to longer culture period.

Constraints and opportunities

A number of constraints were reported by respondents for fish farming in rice fields, including lack of technical knowledge, natural disasters (flood, drought), high production costs and poor water quality. Regardless of farming systems, 42% of respondents identified lack of technical knowledge as their single most important constraint. The proportion of respondents identifying high production costs was 34%. Cost of fish farming in rice fields was reported to have increased significantly in recent years as a result of increased fish seed, feed, fertiliser and labour cost. The prices of both fish fry and feed have increased dramatically since fish farming has

Table 1. Inputs and outputs of fish farming in rice fields by culture systems in 2007.

Input and output	Concurrent farming		Rotational farming	
	Mean	SD	Mean	SD
Farm size (ha)	0.33	0.11	0.29	0.09
Fish stocking (fingerlings/ha/year)	2,857	453	4,917	721
Fish feeding (kg/ha/year)	491	128	1,373	217
Fertilisation (kg/ha/year)				
Urea	177	38	211	39
TSP	152	42	179	36
MP	38	12	67	18
Rice yield (kg/ha/ year)				
Boro	4,917	278	4,986	332
Aman	5,261	312	-	-
Fish yield (kg/ha/year)	259	98	1,108	217

SD: standard deviation

become widespread in pond systems. Inadequate finance can therefore be a significant constraint for fish farming in rice fields. Only 19% and 5% of farmers identified flood and poor water quality to be the most important constraint, respectively. Preventing fish escape is very difficult during the flood, especially for small farmers who are reluctant to raise their low and narrow dikes. Farmers also reported higher fish mortality occurred due to poor water quality as a result of water pollution, turbidity, low water levels and high water temperature. A few concurrent farmers noted that they had high fish mortalities when their neighbours used pesticides indiscriminately.

It seems that rice-only farmers quite unwilling to switch to rice-fish farming due to lack of technical knowledge. Farmers suggested that rice yields decrease due to space occupied by refuge. In addition, farmers perceived that fish damage rice plants and pesticide use for rice crops have negative impacts on fish production. Rice farmers are also reluctant to adopt rice-fish farming because of risks. It was found that better-off farmers are active in rice-fish farming due to the taking risk as they described "there is no gain without risk."

In spite of several constraints, there are opportunities for rice-fish culture development in Bangladesh. A SWOT (strengths, weaknesses, opportunities and threats) analysis was carried out with farmers to identify for its sustainable development (Table 2).

Environmental impacts

Rice-fish farming provides a sustainable alternative to rice monoculture, if farmers can take advantage of the natural productivity of the rice field ecosystem. Concurrent rice-fish farming is ecologically sound and a good method of diversification where fish regenerate nitrogen and phosphorus to improve soil fertility. Fish release nutrients by stirring the sediments in rice fields. Foraging and movement of fish in rice fields causes the aeration of the water, which increases photosynthesis[5,14]. Fish also predate on flies, snails and insects, and can help to control malaria mosquitoes and water-borne diseases. On the other hand, rice fields offer fish planktonic, periphytic and benthic food. Shading by rice plants also maintains the water temperature favourable for fish during the summer[4,15].

There is less use of fertilisers in concurrent rice-fish farming than rice monoculture. Fish wastes and the extra feed given to fish increase the amount of organic fertiliser in rice fields. Moreover, fish plays a significant role in controlling pests. They eat aquatic weeds and algae, act as hosts for pests and compete with rice for nutrients[12,16]. As a result, farmers need less fertiliser and pesticide leading to an improved environment. Thus, concurrent rice-fish farming is an organic method that maintains environmental sustainability.

Many fish species prefer to reproduce in rice fields. Such natural aggregations of fish in rice fields inspire rice-fish farming for increased productivity. Rice-fish interaction can indeed increase the rice yield. It has been reported that the cultivation of fish in rice fields increases rice yields by 8 to 15%[17].

Water management is an important issue for raising fish in rice fields.

Irrigation facilities can help to expand rice-fish farming.

A farmer with a silver carp - fish are an important source of animal protein for people in Bangladesh.

Table 2. SWOT analysis for the development of rice-fish culture in Bangladesh.

Strengths • Available low-lying rice fields • Large number of farmers involved in rice farming • Rice-fish farming is environment friendly • Integrated pest management • Rice and fish are staple foods • Available family labour	**Weakness** • Lack of technical knowledge • Water management problems • Inadequate technical support • Lack of irrigation facilities • Poor socio-economic conditions • Lack of credit facilities
Opportunities • Increased rice and fish production • Optimum resource utilisation of land and water • Diversified and intensified cropping systems • Employment opportunities • Increased income and food supply • Improvement of socio-economic conditions	**Threats** • Climate change (flood and drought) • Poor water quality • High fish mortality • Increasing production costs • Reducing culture areas • Increasing population

Food security

The switch from rice monoculture to rice-fish farming is not merely a change in cropping system, more importantly it is a shift to production of a more balanced diet (i.e. rice and fish). Not only the adequate supply of carbohydrate, but also the supply of animal protein is therefore a critical factor for the health and well-being of farming households. As a result of rice-fish farming, they are able to eat rice three times a day with fish. Rice fields are potentially a source of protein for fish farming households. Among the farming systems, concurrent farmers had a significantly higher share of fresh fish in their diet than rotational farmers. In the rotational system, fish farming was a cash crop and thus 80% of the production was sold to local markets while the rest was consumed by the households. In contrast, farmers of the concurrent system considered fish as a secondary farm product in terms of economic return. Thus, 40% of the fish production was consumed by the households while the remaining was sold to local markets. It was found that households of farmers tend to eat small fish than sell them. In addition to animal protein, small fish are a valuable source of micronutrients, vitamins and minerals. Small fish has also particular importance for the diets of children and lactating mothers to avoid child blindness and reduce infant mortality.

In order to meet the soaring demand for food, there is a need for increased food production in Bangladesh. However, intensive rice monoculture cannot provide a sustainable food supply at the cost of long-term environmental sustainability[12]. Among the farming systems, concurrent rice-fish farming is the best in terms of food supply. Increased rice-fish farming could be a significant approach to increase food production. Concurrent rice-fish farming could provide social, economic and environmental benefits. This farming positively affects the rice yield and makes the rice field a more efficient ecosystem for environmentally sound production of rice and fish. Thus, concurrent rice-fish farming offers a sustainable alternative to rice monoculture.

If rice-fish farming is expanded to 2.83 million ha of seasonal floodplains in Bangladesh, food production would be significantly higher than its present level. Moreover, farmers' income and local food supply will increase substantially. It is therefore assumed that integrated rice-fish farming can ensure food security for the people of Bangladesh.

Sustainability

While there is a great potential for rice-fish farming, a number of issues were identified affecting its sustainability including the lack of technical knowledge of farmers, high production costs and natural disasters (flood and drought). Moreover, rice-fish farming technology has not yet contributed substantially to food security in Bangladesh due to its low level of adoption. The lower levels of rice-fish farming adoption were found among poorer households. It seems that the benefits of rice-fish farming technology accumulate to better-off farmers unless institutional and organisational support is provided to resource-poor farmers. It is therefore worthwhile to find means of providing institutional and organisational support to poorer farmers, in terms of training facilities and extension services for sustainable rice-fish farming. Training and technical support would help to improve profitability and reduce risks. The provision of low-interest credit would also help to reduce risks for resource-poor farmers. Finally, a positive government policy can help to promote sustainable development of rice-fish farming throughout the country.

Acknowledgements

The study was supported through the Australian Government Endeavour Research Fellowship. The opinions expressed herein are those of the authors and do not necessarily reflect the views of the Endeavour Fellowship Programme. The authors express their gratitude to all farmers those have given a lot of valuable information without which the study could not have been realised.

References

1. BRKB. (2006). Rice statistics in Bangladesh. Bangladesh Rice Knowledge Bank, Bangladesh Rice Research Institute, Gazipur, Bangladesh.

2. DOF. (2007). Fishery statistical yearbook of Bangladesh 2005-2006. Fisheries Resources Survey System, Department of Fisheries, Dhaka, Bangladesh.
3. Dewan, S. (1992). Rice-fish farming systems in Bangladesh: past, present and future. In: Rice-Fish Research and Development in Asia (eds. C.R. dela Cruz, C. Lightfoot, B.A. Costa-Pierce, V.R. Carangal and M.P. Bimbao), ICLARM Conference Proceedings 24:11-17.
4. Wahab, M.A., Kunda, M., Azim, M.E., Dewan, S. and Thilsted, S.H. (2008). Evaluation of freshwater prawn-small fish culture concurrently with rice in Bangladesh. Aquaculture Research 39:1524-1532.
5. Frei, M. and Becker, K. (2005). Integrated rice-fish culture: coupled production saves resources. Natural Resources Forum 29:135-143.
6. Lightfoot C., dela Cruz, C.R. and Carangal, V.R. (1990). International research collaboration in rice-fish research. NAGA, the ICLARM Quarterly13:12-13.
7. Harun, A.K.Y and Pittman, K.A. (1997). Rice-fish culture: feeding, growth and yield of two size classes of *Puntius gonionotus* Bleeker and Oreochromis spp in Bangladesh. Aquaculture 154:261-281.
8. Nhan, D.K., Phong, L.T., Verdegem, M.J.C., Duong, L.T., Bosma, R.H. and Little, D.C. (2007). Integrated freshwater aquaculture, crop and livestock production in the Mekong delta, Vietnam: determinants and the role of the pond. Agricultural Systems 94:445-458.
9. Nabi, R. (2008). Constraints to the adoption of rice-fish farming by smallholders in Bangladesh: a farming systems analysis. Aquaculture Economics and Management 12:145-153.
10. Berg, H. (2002). Rice monoculture and integrated rice-fish farming in the Mekong delta, Vietnam - economic and ecological considerations. Ecological Economics 41:95-107.
11. Gupta, M.V., Sollows, J.D., Mazid, M.A., Rahman, A., Hussain, M.G. and Dey, M.M. (2002). Economics and adoption patterns of integrated rice-fish farming in Bangladesh. In: Rural Aquaculture (eds. P. Edwards, D.C. Little and H. Demaine), CABI Publishing, Oxford, UK, pp. 41-53.
12. Halwart, M. and Gupta, M.V. (2004). Culture of fish in rice fields. FAO and the WorldFish Center, 83 p.
13. FAO. (2000). Forest resources of Bangladesh - country report. Forest Resources Assessment Programme, Forestry Department, FAO Working Paper 15, Rome, Italy.
14. Mustow, S.E. (2002). The effects of shading on phytoplankton photosynthesis in rice-fish fields in Bangladesh. Agriculture, Ecosystems and Environment 90:89-96.
15. Kunda, M., Azim, M.E., Wahab, M.A., Dewan, S., Roos, N. and Thilsted, S.H. (2008). Potential of mixed culture of freshwater prawn (*Macrobrachium rosenbergii*) and self recruiting small species mola (*Amblypharyngodon mola*) in rotational rice-fish/prawn culture systems in Bangladesh. Aquaculture Research 39:506-517.
16. Lu, J. and Li, X. (2006). Review of rice-fish-farming systems in China - one of the globally important ingenious agricultural heritage systems (GIAHS). Aquaculture 260:106-113.
17. Mohanty, R.K., Verma, H.N. and Brahmanand, P.S. (2004). Performance evaluation of rice-fish integration system in rainfed medium and ecosystem. Aquaculture 23:125-135.

Nutritional and food security for rural poor through multi-commodity production from a lake of eastern Uttar Pradesh

Singh, S.K.

Central Institute of Freshwater Aquaculture, Kausalyagang, Bhubaneswar – 751 002, Orissa, India, email sharadsrinet@gmail.com

Introduction

India's population of more than 1 billion people may reach more than 1.4 billion by the end of 2020 AD, necessitating an intensive search for alternative and more efficient ways to produce food. In this search for new food supplies and their more equitable distribution, attention is naturally centred on the basic agricultural commodities. However, it is clearly recognised that these commodities should be supplemented by high quality protein food. In this context, aquatic food reserves can make an important contribution to supplies of protein. The natural water resources of Uttar Pradesh, India, consist of approximately 180,000 ha in the form of lakes, oxbow lakes, seasonal water logged areas, marshes and swamps[1]. Since time immemorial the flood plain lakes have provided man with many sources of livelihood. In eastern Uttar Pradesh, the lakes Bakhira, Ramgarh, Chilwa, Suraha, Reoti, Dah, Konar, Parvati and Leond Tal are some of the larger flood plains providing lucrative sources of multi commodity production.

Leond Tal is a perennial natural lake in the Siddharthnagar District, which forms a kind of no mans land. During the Mugal Empire period this lake and 80 others were awarded to the King of Bansi as 'Amir-UL-Bahar' by the Mugal Emperor Jahangir, and were know as 'Nankar' (the People's nourishment) during that period, in the area of Sarju River Basin and foot hills of Himalayas.

Topography and morphometry

The Leond Tal is surrounded by roads on eastern, western and south western sides, with its principal catchment area lying in the north and west. The tal lies in a clay-loamy soil region of the district and has a thick clayey mud deposition of 0.6-1.0 m depth at the bottom. The actual water surface area of the lake as per the Tahsil map is 327 ha. However, during flood conditions its surface area can increase 1.5 to 2.0 times. The lake is surrounded by the Sohna, Nathar-Deoria villages in the north; the Rajawapur, Burhoon and Duferia villages in the east; Kathautiaram, Mahua-Buzang villages in the south and Kataria, Babu and Leondi villages in the west. The main outlet of the lake is Ashadi Nullah, which receives water from

Rapti River and nearby catchments during monsoon floods via Kumahwa and Enwar Tals. However, after the monsoon this nullah remains dry with intermittent water patches of low lying area such as Kunahwa Tal, Enawar Tal, Ashadhi Tal. The total length of the nullah is over 12 km. The main outlet from the Tal is the Parasi Nullah which drains water from the Tal to river Rapti through Phajihatwa Nullah after travelling over 36 km from the Tal.

Mode of lake exploitation

The water of the lake is primarily used for irrigation, live stock bathing, drinking and for fishing in particular. While the peripheral land area of the tal provides grazing grounds for cattle, the shallow and weedy zones of the lake provide shelter and habitation for a wide variety of aquatic birds.

Lotus leaves harvested from the lake are also used by local population as plates for serving food. The lotus flowers are used in temples for worship and decoration, and the roots of this plant are also consumed by farmers locally. Lotus is auctioned yearly, depending on the lotus crop harvested from the lake by the Leond Tal Fishermen Co-operative Society. The fruit cover (thalamus), unripe seeds and shoots are consumed as vegetables. Seeds are also used for making garlands.

The wild paddy or tinni rice (*Oriza rutipogon*) is 1 or 2 m tall annual grass with creeping and erect stem. This rice plant grows naturally in the tal. Its edible grains form the staple food in the locality and are exported to other parts of the country. On auspicious occasions, Tinni rice is used for consumption. At times, it becomes very expensive and is sold at higher rate of Rs. 60 /- kg. The straw is used as fodder for the cattle. The cost of this rice varies from Rs.15-30 /- kg at the lake site.

Multi-commodity production

Leond Tal has great local significance as a multi-crop production system. The major commercially important aqua crops are fish, tinni rice and lotus (*Nelumbo nucifera*). The commercial cropping systems involved in the Tal are under-taken with special reference to socio-economic conditions of the co-operative societies of Sohna and Siddharthnagar.

The mean annual return from fishing activities, based on data collected from fisher surveys in 1996, is Rs. 136,000. The overall fish yield was between 5.7 tonnes and 93.8 tonnes between 1987 and 1996. The highest production was recorded in 1991 (28.7kg/ha) while the lowest production was recorded during 1993. Overall the mean fish production contributed to a mean of 36.7% of the lake's production volume during the period 1987-1996, although it comprised 62.3% of the total value.

The tinni rice production in the tal was in the range 902 kg to 8.27 tonnes from 1987 to 1996. During 1991 and 1996 due to damage of crop through flood water entry, the tinni production was severely affected. The highest productivity was recorded during the year 1992 and lowest in 1990. Mean production of tinni was 38.7% of the total crop volume of the tal, and represented 31.1% of the total value. Lotus seed production in terms of Kamalgatta output in the tal was 400kg to 7.5 tonnes with the minimum occurring in 1989 and maximum in 1996. The overall mean production of lotus seed was a mean of 29.6% of total lake crop production, whereas it comprised only 6.6% of the total value. There was not much production of lotus during the year 1987 and 1992 due to severe drought in the tal area.

Nutritional security

These crops provide not only income and employment, but also supplement the food of the rural poor in the area. The economic importance of lotus (seed, stem and root) is due mainly to its nutritional value. According to National Institute of Nutrition (1996), the nutritional composition of lotus (green matured) seed is 84.01% moisture, 3.9% protein, 0.7% fat, 1.1% mineral, 0.9% fibre, 8.8% carbohydrate along with 57 Kcal energy, 49.0 mg calcium and 151 mg phosphorus. Lotus root contains approximately 85.9% moisture, 1.7% protein, 0.1% fat, 0.2% minerals, 0.8% fibre, 11.3% carbohydrate along with 53 Kcal energy, 21 mg calcium, 74 mg phosphorus and 0.4 mg iron; while dry lotus seed contains 10.0% moisture, 17.2% protein, 2.4% fat, 3.8% nitrate, 2.6% fibre, 64.0% carbohydrate along with 346 Kcal energy. 36 mg calcium, 294 mg phosphorus and 2.3 mg iron.

Conclusion

The major cause of nutritional deficiency in our country is that a large number of people simply do not have the resources to buy enough food. They are poor and can neither afford sufficient quantity or quality of food. To an extent, this problem of deprivation can be solved by selecting and eating simple, inexpensive wholesome foods naturally available in lakes such as Leond Tal and other water bodies. For the local people, the lake is synonymous with nutritional security, by providing several crops that are accessible to the poorest of poor.

The gap between present and potential yield is high, in terms of fish production. High priority should hence go to bridging the productivity gap through a mutually reinforcing blend of technologies, services and public policies. Mainstreaming the nutritional dimension in the design of aquaculture based lake fish production (farming) systems is also essential. There is no time to relax on the food production front as pointed by the Commission on the "Nutrition challenges of the 21st century" in its respective publication entitled Ending Malnutrition by 2020 A.D. Considering the importance of above aquatic crops it seems to be worthy to undertake management and conser-vation of similar water bodies with an integrated approach to help secure the future nutritional security of the poor.

Reference and further reading

1. ISRO, 1998. Wetlands of India. (Project Report) Nation-wide wetland Mapping Ministry of Environment and Forest Govt. of India, Space Applica-tion centre (ISRO), Ahmedabad: 239 pp.
2. Jhingaran, V. G., Ahmad, S. M. and Singh, A. K., 1998. Reterospeces and prospects of integration aquaculture-agriculture-animal husbandry farming in India. In: Advances in Fisheries and Fish Production (Ed.) Ahmad, S. H.: 127 – 170.
3. NIN, 1996. Nutritive value of Indian Foods. National Institute of Nutrition, ICMR Hyderabad: 156 pp.
4. Rao, A. P. and Ram Singh, 1998. Rice-fish farming systems. In Advances in Fisheries and Fish Production (Ed.) S. H. Ahmed: 229 – 235 pp.

5. Singh, S. K., 2000. Hydrobiology and Fisheries of Leond Tal of District Siddharthnagar (U.P.) with special reference to the Aquaculture in the Lake (Tal) Ph.D. Thesis, Dr. R.M.L. Avadh University Faizabad, U.P. India 262 pp.
6. Singh, S. K. and Pande, P. N., 2000. Observation on the multi-community production and economic return from Leond Tal of eastern U.P. (Abs). The Fifth Indian Fisheries Forum; 17 – 20 January, 2000, CIFA, Kausalyaganga, Bhubaneswar, SS – 34: 145.
7. Swaminathan, M. S., 2002. Food security and Community Grain Banks. Yojana, 46 (Jan. 2002): 15 – 19.
8. Swarup K., Zafar, K., Mohmad and Das, U,K., 1976. Preliminary study of the fishery of Bakhira Lake. Zoo. Beit. 21(1): 81 – 85.
9. Thakur, N. K., 1996. In Darbhanga makhana cum fish culture may prove a boon. ICAR News, 2(1): 14.
10. Viddyanath, J., Bharat, G.K. and Jha V., 1991. Nutritional evaluation of *E. ferix salish* (Makhana). J. Food Sci. Technol., 28(5): 320-328.
11. Yadava, Y. S., 1995. Flood plain fisheries in India In: Advances in Ecology and Environmental Sciencies (Ed.) Mishra P. C., Ashis Publication, New Delhi: 307 – 315.

Emerging boost in Sri Lankan reservoir fish production: a case of adoption of past research findings

Amarasinghe, U.S.[1], Weerakoon, D.E.M.[2], Athukorala, D.A.[3]

1. Department of Zoology, University of Kelaniya, Kelaniya, Sri Lanka; 2. National Aquaculture Development Authority of Sri Lanka, 758 Baseline Road, Colombo 09, Sri Lanka, email zoousa@kln.ac.lk; 3. National Aquatic Resources Research and Development Agency, Crow Island, Colombo 15, Sri Lanka

Background

Sri Lanka is well renowned for its irrigational reservoir construction dating back to at least 2,000 years. There are also stone inscriptions indicating the levy of taxes on reservoir fishery landings dating back to first century A.D.[1]. However, in the modern era, the Sri Lankan inland fishery is almost totally confined to the large number of reservoirs in the country and is known to be characterized by three features, viz. (a) it is primarily based on the exotic cichlids (mainly *Oreochromis mossambicus* and *O. niloticus*), (b) it is an artisanal fishery using non-motorized canoes with an outrigger, and (c) the gear is uniform, consisting of gill nets of 8.5 – 12.7 cm mesh[2]. The Sri Lanka reservoir fishery is also perhaps one of the best documented in the region[2,3,4].

The observations that the reservoirs contain sizeable populations of many small sized indigenous, cyprinid (minor) species, that grow to a maximum size of about 8-10 cm led to research on the possibilities of harnessing these resources for human benefit. The research was conducted by three independent groups[5,6,7,8,9,10] to estimate fishery potential of minor cyprinids in Sri Lankan reservoirs. All these studies demonstrated that the minor cyprinid stocks in perennial reservoirs could be harnessed using small meshed gillnets resulting in significant catch per unit effort, and that such a fishery will not directly and or indirectly impact on the existing fishery, the mainstay, for exotic cichlids. The researchers showed that the recruitment of cichlids is not impacted upon as the young inhabit the littoral and sub-littoral areas, as opposed to the fully grown minor cyprinids that inhabit the open waters, as much as the adult exotic cichlids. Based on the biomass and total biological production, it was found that there is scope for an approximately a 100% increase of the total yield in Sri Lankan reservoirs through introduction of a subsidiary gillnet fishery for minor cyprinids[11].

Mass-balance trophic models have shown that exploitation of minor cyprinids in Sri Lankan reservoirs is advantageous to the existing cichlid fisheries through relaxing competition for plankton food resources in juvenile cichlids[12]. Also on global scale, the exploitation of untapped fishery resources in reservoirs such as minor cyprinids is recognized as a potential avenue for intensification of reservoir fisheries, especially in tropical and sub-tropical countries[13].

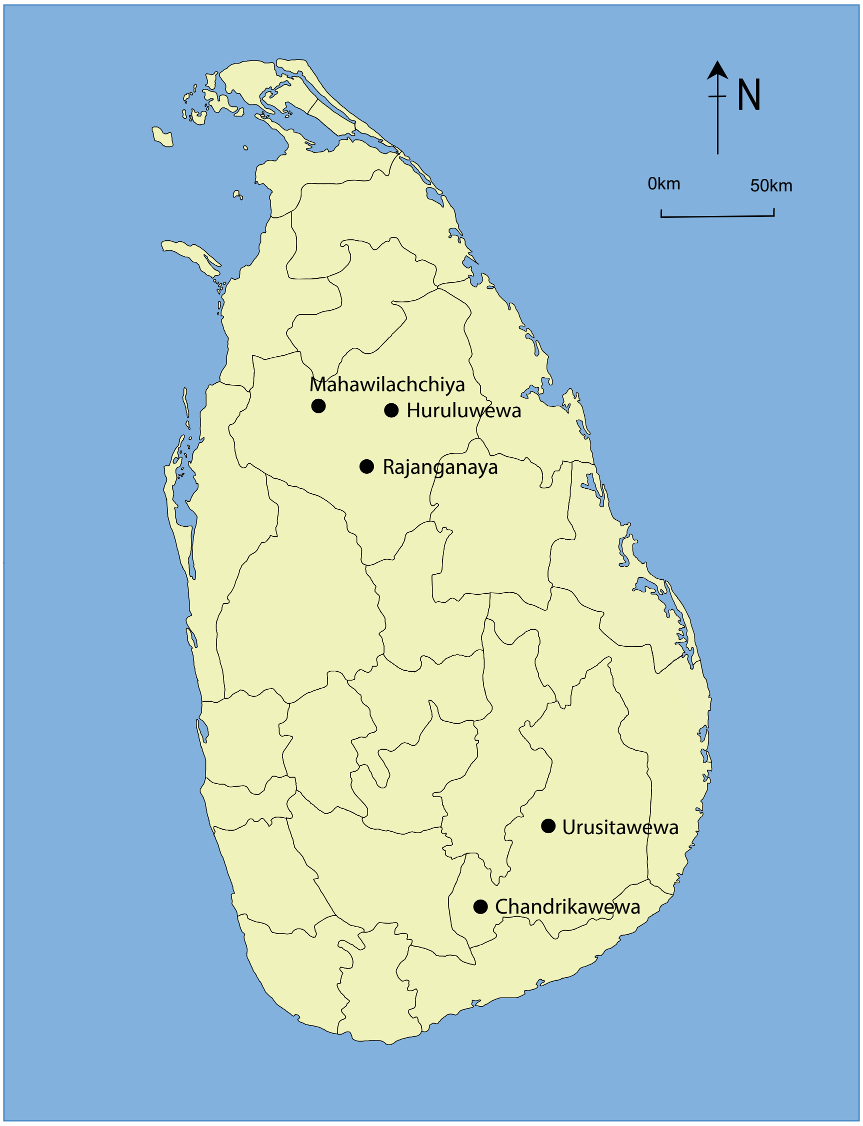
Dislodging the catch from the nets, a tedious task.

Progress in implementation of research findings

The research described above was not translated into practice for nearly 20 years, primarily because the implementing authorities were reluctant to change the existing mesh regulations permitting the introduction of a small meshed gear, and the general reluctance to "take a risk". In the recent past the researchers have started working in conjunction with newly created implementing agencies, such as the National Aquaculture Development Authority of Sri Lanka (NAQDA) with responsibility for inland fisheries development and the National Aquatic Resources Research and Development Agency (NARA), the research arm of the Ministry of Fisheries and Aquatic Resources in Sri Lanka. At the regional meeting conducted by NACA, in January 2008, under the auspices of the project "Development of Asian Reservoir Fisheries" funded by the Icelandic International Developmental Agency (ICEIDA) consensus was reached that the issue of harnessing of small fish resources is of regional importance and that Sri Lanka is best fitted to "test" the past research findings. Evidence is found in other south Asian countries such as Bangladesh that small indigenous fish species have a significant potential for contributing to human nutrition, especially since some species such as *Amblypharyngodon mola* are found to be rich in vitamin A[14].

Accordingly, the University of Kelaniya in conjunction with NAQDA and NARA, undertook research in three reservoirs in the North Central Province, i.e. Rajanganaya, Mahawilachchiya and Huruluwewa; one reservoir in Uva Province, Urusitawewa; and one reservoir in Sabaragamuwa Province, Chandrikawewa (Figure 1). In order to enable this activity to proceed the implementing authority, NAQDA, permitted the use of gillnets of 15-37 mm mesh sizes. Not surprisingly, as the trial got under way, it became apparent at least in three reservoirs that fishers have been harnessing (illegally) this resource for nearly 6 to 8 years using 25 mm mesh size gillnets, with 8 to 20 net panels of approximately 25 m x 3.5 m. These fishers, numbering 10 to 20 in each of the reservoirs caught on average 15 to 200 kg of minor cyprinids

Figure 1. Map of Sri Lanka showing locations of reservoirs where minor cyprinids are exploited (base image obtained from Wikimedia Commons http://commons.wikimedia.org, derivative is issued under a Creative Commons Attribution ShareAlike 2.5 license).



per day (mean 46 kg/fisher/day), and on the most productive days the catch could exceed 200 kg/fisher.

The minor cyprinid fishery

The main minor cyprinid species caught in this fishery, in order of abundance are *Amblypharyngodon melettinus*, *Puntius chola*, *P. filamentosus*, *P. dorsalis*, *Rasbora daniconius* amongst others. The ongoing limited fishery activities suggest that this is not a fishery that is favoured by many; it is rather labour intensive because of the time taken to dislodge the fish from the nets and consequently almost always women folk are involved in the activity. About 10 percent of the daily catch is sold fresh at Rs. 50/kg (approximately US$ 0.50) to local vendors, who in turn keep a profit of ten percent at the point of selling to the consumers. The rest is sun-dried and sold in bulk at Rs. 150-200/kg. To prepare fish for drying, the landings are washed, de-scaled and gutted using an efficient method developed by fishers, where landings are mixed with coarse sand, loaded into a fibre-glass canoe and crushed partially by foot covered with a canvass shoe. Subsequently, they are soaked in brine for a few hours before sun-drying.

Assuming that twenty and ten fishers are permitted to enter this fishery in each of the major (> 1,000 ha) and medium (300-1,000 ha) perennial reservoirs in Sri Lanka, respectively and each fisher would land 25 kg/day, the total yearly (300 days of fishing) landing per fisher would be 7.5 tonnes/year. It is recorded that there are 73 (70,850 ha) and 160 (17,001 ha) of large and medium scale perennial reservoirs in Sri Lanka. Accordingly, the total potential landings from this fishery per year approximate to 10,950 tonnes and 12,000 tonnes from large and medium sized reservoirs, respectively. This will be a significant addition to the current fishery which is estimated at 33,000 tonnes/year. In the original research findings it was estimated that the fishery potential of minor cyprinids in major and medium perennial reservoirs of Sri Lanka is about 250 kg/ha/year[11], which is about 22,000 tonnes of fish.

What is next?

Although it has been technically proven from the above data that there is a potential minor cyprinid fishery in large and medium perennial reservoirs, due to the small sized mesh nets used for harvesting, a considerable amount of awareness will have to be made among the stakeholders and policy makers to convince them that there is a need to change the current legislation to accommodate the use of small gill mesh nets for harvesting. At present small mesh (< 8.5 cm stretched mesh) gill nets are banned, on the premise that these could destroy the resource when small fish of the cichlid fishery are caught. This was especially so, when small meshed drag nets and 6.4 to 7.6 cm stretched mesh gillnets were used to catch juvenile cichlids, during the early 90s when there was no government patronage for inland fisheries. However, as mentioned earlier, since the minor cyprinid fishery is concentrated in the deeper areas, the damage to small cichlids will be negligible. Under the NACA-ICEIDA funded project "Development of Asian Reservoir Fisheries", small mesh (15 to 37 mm stretched mesh) gillnets were provided to selected fishers in some reservoirs on a pilot scale study. Eventually, NAQDA will take necessary steps to introduce a fishery for minor cyprinids in large and medium sized reservoirs in Sri Lanka as this is a promising means of increasing inland capture fisheries production in large and medium scale reservoirs which is an important mandate of NAQDA. However, this is not a straightforward task. Initially, the implementing authority will have to consult with the individual reservoir fishers associations/societies and impress upon them the advantages of introduction of such a fishery, and more importantly, that such an introduction will not harm the existing fishery. On reaching consensus and agreement, the existing mesh regulations need to be amended and together with the fisher societies determine the number of people permitted to enter such a fishery. As this new fishery will be introduced to a selected number of people in each reservoir, this strategy will involve a new group of fishers, in addition to those exploiting cichlids. Hence, it is necessary to put in place the appropriate management measures to avoid any form of conflict between the two groups.

Remaining research questions

As there is evidence that minor cyprinids have exploited in some reservoirs for at least the last eight years, the minor cyprinid resources are considered to be able to support a sustainable fishery. However, once a full-scale exploitation of this untapped fishery resource begins, the stocks are expected to reach a new equilibrium. Therefore, estimation of the optimal exploitation levels of this fishery resource has to be done through close monitoring after commercial scale fisheries begin.

Catch being washed and de-scaled before sun drying.

Minor cyprinid catch being taken for preparation for drying.

Research on postharvest technology for this untapped fishery resource is also needed to improve consumer acceptance. Minor cyprinids can also be used to prepare feeds in aquaculture systems and livestock industry[15]. Determination of the nutritive values of minor cyprinid-based fish meal is therefore an important research area.

Acknowledgements

We are grateful to Professor Sena S De Silva for revitalizing this area of study and encouraging us to publish this article, in view of its relevance to comparable developments/applications in the region. Our thanks are also due to ICEIDA for supporting the current phase of “commercial” scale trails under the auspices of a regional program on reservoir fisheries management and development coordinated through NACA.

References

1. Siriweera, W.I. (1994). A study of the economic history of pre-modern Sri Lanka. Vikas Publishing House Pvt Ltd., New Delhi.
2. De Silva, S.S. (1988). Reservoirs of Sri Lanka and their fisheries. FAO Fisheries Technical Paper 298. 128 pp.
3. Fernando, C.H. and H.H.A. Indrasena. (1969). The freshwater fisheries of Ceylon. Bulletin of Fisheries Research Station Ceylon 20: 101-134.
4. Amarasinghe, U.S. (1998). Reservoir fisheries management in Sri Lanka: Achievements, mistakes and lessons for future. International Review of Hydrobiology 83 (Special Issue): 523-530.
5. De Silva, S.S., Sirisena, H.K.G. (1987). New fish resources of reservoirs in Sri Lanka: Feasibility of introduction of a subsidiary gillnet fishery for minor cyprinids. Fisheries Research 6: 17-34.
6. De Silva, S.S., Sirisena, H.K.G. (1989). New fish resources of reservoirs in Sri Lanka. 3. Results of commercial-scale trials and yield estimates of a gillnet fishery for minor cyprinids. Fisheries Research 7: 279-287.
7. Sirisena, H.K.G., De Silva, S.S. (1988). New fish resources of reservoirs in Sri Lanka. II. Further studies on a gillnet fishery for minor cyprinids. Fisheries Research 7: 17-29.
8. Amarasinghe, U.S. (1990). Minor cyprinid resources in a man-made lake in Sri Lanka: a potential supplementary source of income for fishermen. Fisheries Research 9: 81-89.
9. Pet, J.S., Piet, G.J. (1993). The consequences of habitat occupation and habitat overlap of the introduced tilapia *Oreochromis mossambicus* and indigenous fish species for fishery management in a Sri Lankan reservoir. Journal of Fish Biology 43 (Supplement A): 193-208.
10. Piet, J.S., Vijverberg, J. (1998). An ecosystem perspective for the management of a tropical reservoir fishery. International Review of Hydrobiology 83 (Special Issue): 103-112.
11. Pet, J.S., Gevers, G.J.M., van Densen, W.L.T., Vijverberg, J. (1996). Management options for a more complete utilization of the biological fish production in Sri Lankan reservoirs. Ecology of Freshwater Fish 5: 1-14.
12. Villanueva M.C., Moreau, J., Amarasinghe, U.S., Schiemer, F. (2008). A comparison of the foodweb and the trophic structure between two Asian reservoirs by using ECOPATH with ECOSIM and ECOSPACE. In: Aquatic Ecosystem and Development: Comparative Asian Perspectives (F. Schiemer, D. Simon, U.S. Amarasinghe and J. Moreau, eds). Biology of Inland Waters, Backhuys Publishers, Leiden, The Netherlands. pp. 413-434.
13. Petr, T. (1994). Intensification of reservoir fisheries in tropical and sub-tropical countries. Internationale Revue der gestamten Hydrobiologie und Hydrographie 79: 131-138.
14. Roos, N., Md. Wahab, A., Hossain, M.A.R., Thilsted, S.H. (2007). Linking human nutrition and fisheries: Incorporating micronutrient-dense, small indigenous fish species in carp polyculture production in Bangladesh. Food and Nutrition Bulletin 28(2) (supplement): S280-S293.
15. Amarasinghe, U.S., Ajith Kumara, P.A.D., Ariyaratne, M.H.S. (2002). Role of non-exploited fishery resources in Sri Lankan reservoirs as a source of food for cage aquaculture. In: Management and Ecology of Lake and Reservoir Fisheries (Ed. I.G. Cowx). Fishing News Books, Blackwell Science Ltd., Oxford, U.K., 332-343 pp.

Often the whole family is involved in post-catch preparations.

Farming the freshwater prawn *Macrobrachium malcolmsonii*

Radheyshyam

Aquaculture Production and Environment Division, Central Institute of Freshwater Aquaculture, Kausalyagang, Bhubaneswar - 751 002, Orissa, India, email radheyshyam.cifa@gmail.com

Introduction

In India, the coastal shrimp farming industry has suffered serious losses due to outbreaks of viral diseases and its growth has also been limited through legal constraints, such as the introduction of legislation regulating development in the coastal zone. Recently, freshwater prawn culture has been recognized as an alternative, eco-friendly and sustainable system for prawn production. Freshwater prawn farming is popular in South East Asian countries but it has not gained much progress in India until recently, although freshwater prawns are a high priced product and have a high market demand in both domestic and export markets. In India the largest species that are of interest for aquaculture are *Macrobrachium rosenbergii*, *M. malcolmsonii* and *M. gangeticum* respectively. The latter two species are indigenous and can be farmed in monoculture[1,2,3,4] or in polyculture with compatible carps[2,4,5,6,7,8]. *M. rosenbergii* is the prawn preferred by farmers and is cultivated commercially in certain parts of the country. However, *M. malcolmsonii* is cultured traditionally and *M. gangeticum* experimentally; considering the culture potential of these species the Central Institute of Freshwater Aquaculture has made considerable efforts to develop culture technologies for commercial production, although concerted efforts on dissemination of appropriate technologies tailored to meet local conditions of farmers in different areas are required. This article describes farming technology for *M. malcolmsonii* under mono- and polyculture systems with fast growing compatible carps.

Site selection and pond construction for freshwater prawn farming

M. malcolmsonii may be cultured in earthen ponds, concrete tanks, small reservoirs, cages, pens and paddy fields. Culture locations should be free from pollution. Sandy loam, clayey loam, loam with adequate water retention quality of the soil is preferred for construction of freshwater prawn farms. Ponds should be situated in areas not vulnerable to flooding or drought, with a supply of good quality freshwater, access to road and transport facilities, and electricity supplies.

Ponds should be constructed such that water can be drained via gravity to facilitate harvesting of the prawn crops. For ease of the management, medium sized rectangular ponds of 0.2 – 0.5 ha are most suitable; however for commercial production pond area may be increased to 1.0-1.5 ha. In tropical areas the average depth of water should be 1.0-1.5 m in grow out ponds. Pond bottoms should be smooth and gradually sloping from the water inlet towards the outlet end for easy draining. The slope towards the outlet should be around 1:500 (2%) in larger ponds and 1:200 (0.5%) in smaller ponds. The provision of marginal shallow trench can facilitate drain harvesting of prawns. The pond embankments should be at least 40-70 cm above the highest water level. Depending on the soil quality, the internal slope of the pond embankments should be from 1:2 to 1:4. Water inlets and outlets should be equipped with screens during embankment construction. Water supply, distribution, screening and treatment (oxygenation) systems need to be provided in the freshwater prawn farms. Embankments should be covered with vegetation such as fast growing grasses to reduce soil erosion and crops such as bananas, papaya and coconuts may also be planted for integrated farming. If required, the pond should be fenced with nylon nets to prevent overland entry of predators into the ponds.

Pond management

Eradication of aquatic vegetation, weed and predatory animals

In newly constructed ponds there will be no aquatic weeds to remove. However, from the old ponds aquatic vegetation should be removed. Weed fishes as well as predatory fishes can be eradicated by applying mahua oil cake at 2.5 tonnes/ha. 18-21 days after the mahua oil cake application the pond may be stocked with prawn seed. Alternatively, bleach powder can be applied at 300-350 kg/ha depending upon the pond conditions. A combination of urea and bleaching powder may also be used, for this, 100 kg/ha urea is applied on the first day and the next day a half dosage of bleach powder (150 kg/ha) is applied. The pond can be stocked with prawn seed 8-10 days after application of bleaching powder. Finally, ponds can be simply be fully dried to remove weed and predatory fishes.

Liming and base manuring

To correct the pond pH lime is applied into the ponds. Depending upon soil pH, agricultural limestone is applied at 250-1000 kg/ha/year. The pond bottom can be treated to kill pathogens by applying burnt lime (calcium oxide) or hydrated lime (calcium hydroxide). In acidic soils a higher dosage of lime is applied to increase pH and to improve the total alkalinity to about 40 mg/l. If total alkalinity of the water remains above 60 mg/l, the pond should not be treated with lime. If ponds are prepared using bleach powder, lime need not be applied. Old ponds should also be de-silted to reduce sediment containing a heavy load of organic matter. During drying period of old ponds or newly constructed ponds, the bottom can be harrowed using a tractor to increase the oxygenation of the soil. In case of old ponds, the harrowed bottom can be treated with lime and should be exposed to sun for 10-15 days to remove toxic gases and kill pathogens. Ponds with high pH can be treated by adding calcium sulphate (gypsum) to maintain total hardness at around 50-100 mg/l. About 2 mg/l gypsum is needed to increase total hardness by 1 mg/l.

To increase the fertility and productivity of the ponds, base manuring is used. Base manure may include both organic and inorganic fertilisers. Raw cow dung is applied at 2-3 tonnes/ha or poultry droppings at 0.5-1.5 tonnes/ha along with 100 kg/ha single super phosphate and 60 kg/ha urea in newly constructed ponds. In old freshwater prawn ponds the application of organic manure is discouraged. Chemical fertilisers are more dependable than organic manure. The limiting nutrients in prawn ponds are phosphorus and nitrogen, which need to be applied in a balanced form. The optimum ratio of nitrogen : phosphate in fertiliser needs to be about 2:3 in prawn ponds. During the culture period fertiliser can be applied at 4-8 kg nitrogen and 5-12 kg phosphate/ha at monthly intervals[9].

Increasing surface area

Like many other crustaceans, *M. malcolmsonii* shows strong territorial defence and hiding behaviours. During moulting there is always the risk of predation by larger dominant prawns. Hence to reduce predation an increase in habitat surface area and hiding substrates are required in grow out ponds. Bushes, palm- and coconut-leaves, bamboo trees, tiers, tree branches etc are used indigenously to provide substrates for prawns to cling to and hide in. Alternatively 1,000-1,500 pipes/ha made from plastic, earthenware or concrete, around 40 cm long and 9 cm diameter, may be placed in the pond as prawn habitats, although this interferes in cull-harvesting. Nylon screens or stretch nylon nets can also be placed vertically or horizontally in ponds as substrates. Increasing the habitat surface area improves overall prawn recovery and growth rates, resulting in higher prawn yields.

Stocking

After ponds have been prepared and the water conditioned to contain a supply of desirable natural food, the prawn seed may be stocked. However, it is impractical to stock 1-2 week old post larvae (PL) directly in grow out ponds as most of them are lost through predation. Therefore PL should be reared separately in nurseries for 1-2 months to become hardier juveniles of around 2-3 g before release into grow out ponds. Such juveniles are less vulnerable to predation and more tolerant of high pH and ammonia than PL. Although juveniles are more costly than PL, they have better survival and require a shorter time to reach marketable size. Grading juvenile prawns before stocking has significant advantages. It increases the average harvest size and total pond production. Size grading is a way of separating out the faster growing prawns. After grading, large and nearly equal sized prawn juveniles are stocked.

Sudden changes in temperature and pH may cause mortality at prawn seed stocking, hence before release into the pond prawn juveniles need to be gradually acclimatized with the pond water. Lower stocking densities tend to result in larger average size of prawns in relation to higher stocking densities. Higher stocking density can provide greater yields but smaller average size. Stocking density needs to be adjusted depending upon the pond productivity, the level of management and desired market size.

In monoculture *M. malcolmsonii* juveniles can be stocked at 30,000-50,000/ha whereas, in poly-culture with fast growing compatible carps such as catla *Catla catla*, silver carp *Hypophthalmichthys molitrix*, rohu *Labeo rohita*, or grass carp *Ctenopharyngodon idella*, they should be stocked at 15,000-20,000/ha. Healthy and disease free carp fingerlings or yearlings can be stocked at 2,500-3,000/ha. Stocking larger sized carp fingerlings of 5-10 g and stunted yearlings of 100-200g is recommended for prawn-carp polyculture. The stocking ratio of carps may be decided based on the management practices and availability of natural food in the ponds. The stocking ratio of *C. catla* or *H. molitrix*, *L. rohita* and *C. idella* is typically 5:4:1. Bottom feeding carps like mrigal *Cirrhinus mrigal* and common carp *Cyprinus carpio* are not recommended for prawn-carp polyculture.

Feed and feeding

M. malcolmsonii is an omnivorous bottom dwelling prawn and naturally feeds on decomposing plants and animals, small worms, insects and their larvae. They are also cannibalistic in nature and may consume freshly moulted conspecifics in pond environments. At the beginning of stocking *M. malcolmsonii* juveniles rely on natural productivity of the ponds enhanced through the initial addition of inorganic fertilisers and/or organic base manures. In extensive farming, the prawn juveniles mostly rely on the availability of natural foods in the rearing ponds, which tends to lead to very poor prawn yields. However, successful semi-intensive *M. malcolmsonii* farming requires supplementary feeding. Providing feed from the beginning of the *M. malcolmsonii* rearing period improves performance and is cost-effective. Application of feed and fertilisers from the beginning of the *M. malcolmsonii* rearing not only increases the availability of natural food but also decreases the water transparency, therefore reducing the growth of weeds.

For grow out culture of *M. malcolmsonii* high protein diets of 50% plant origin and 50% animal origin are required. Locally available cheaper feed ingredients such as broken rice, rice bran, groundnut oilcake, mustard oilcake, soybean meal, sorghum, barley, maize etc. of plant origin and poultry viscera, wastes from abattoirs and processing plants, fishes, fish meal, snails or mussel meat etc. can be used in suitable combination for preparing farm made feeds for grow out[10]. The composition of formulated feed includes 15% fish meal, 15% soybean meal, 42% groundnut cake, 26% rice bran and 2% vitamin and mineral premix. In addition to above ingredients amino acid balance and essential fatty acids (highly unsaturated fatty acids (HUFA n-3) are also added in formulated feeds of prawns[11]. Supplementary feed is provided in the form of pellets. Juveniles are fed with formulated starter diet containing higher protein and lipid in crumble form. Size of the formulated feed should be 1.2 mm for starter-2, 2 x 4 mm for grower and 2 x 5 mm for booster. *M. malcolmsonii* feed should have 28-32% protein, 3-6% fats, 31-34% carbohydrates and 6-7% fibre during grow out for optimal growth and survival. As there is a lack of formulated feed in pellet form, *M. malcolmsonii* can be fed with a mixture of groundnut oil cake and rice polish in the ratio of 1:1. The feed mixture may be made into small balls applied after sun drying.

Prawns are nocturnal in habit and feed more actively at night. Hence, feeding is done mostly during late evening and early morning. Feeds are generally broadcast evenly along the marginal area of the pond. Feeding is also sometimes done via feeding trays or baskets placed in different locations in the pond, which is helpful in monitoring consumption and adjusting feeding rates. Pellet feeds are given at 3-15% of the body weight of prawn daily thrice (60-75% at late evening). Initially a higher percentage (15%) of feed is given and at final stage of culture it should be reduced to 3-4% of the body weight. Monthly sampling should be conducted to estimate the standing prawn biomass in pond, based on which feeding rate is decided for the coming month. In prawn-carp polyculture the formulated feed should contain ingredients accepted by both the prawns and carps. Grass carps are fed with aquatic weeds such as *Hydrilla* and tender terrestrial grasses or wastes of cabbage leaves on platforms. The faeces of grass carp accelerate plankton production and enrich the detritus food chain for other carps and prawns.

Water quality management

In grow out ponds it is essential to maintain desirable water quality throughout the culture period. With continuous culture operations, there is gradual accumulation of organic matter and nutrients from feeds, fertilisers, dead organisms and the metabolites of culture organisms in the pond bed. This deposited sediment decomposes to release nutrients into water to stimulate phytoplankton production. However, excessive silt deposition impairs water quality of the pond leading to prawn stress, slow growth, susceptibility to disease, prawn mortality and possible failure of the crop. Therefore, to maintain suitable water quality periodical monitoring is done. The favourable range of water quality in *M. malcolmsonii* culture ponds is in the range: water temperature 26-32°C, water transparency 30-60 cm, pH 7.0–8.5, dissolved oxygen > 5 mg/l, free CO_2 < 8 mg/l, hardness 100-50 mg/l, total alkalinity 80–150 mg/l, $NH4^+$-N 0.02–0.20 mg/l, calcium 30–80 mg/l, phosphorus 0.01–0.90 mg/l and nitrogen 0.05–90.5 mg/l[12]. Freshwater prawn ponds should be free from hydrogen sulphide. Sub-lethal stress level of hydrogen sulphide in pond water occurs as low as 0.1-0.2 mg/l and prawns die instantly at 3 mg/l or greater level in pond[9]. To maintain good water quality, frequent exchange with pollution-free water and aeration is essential.

Health management

Being an indigenous species *M. malcolmsonii* is more tolerant to environmental fluctuations and comparatively more resistant to pathogens. However, due to intensification of culture practices *M. malcolmsonii* may suffer from disease due to a combination of pathogenic, nutritional, physiological and environmental factors. These diseases may be viral, bacterial, fungal, nutritional and environmental in origin. Prawn disease can be prevented by maintaining scientific rearing practices, avoiding high stocking and over feeding, de-silting of pond bed followed by harrowing and exposure to sun-drying between the culture cycles, frequent water exchange of 30-50% and aeration etc.

In freshwater prawn juveniles the nodavirus pathogen (MrNV) (see Aquaculture Asia Vol. XIII, No. 4) causes whitish tail or milky white muscle leading to mass kills. This pathogen is transmitted from broodstock to larvae to PL to juveniles and adult prawns. Infectious hypodermal and haematopoietic necrosis virus (IHHNV) is also an emerging disease in PL and juveniles causing mass mortalities. Reddish discoloration of cuticles, muscular atrophy, growth retardation and deformities are main symptoms of this disease. *Macrobrachium* muscle virus (MMV) causes weakened swimming ability and inclination to stay on aquatic vegetation[13]. To prevent viral diseases in grow out ponds, infected or diseased juveniles should not be stocked.

Vibriosis bacterial diseases are prevalent in prawn eggs, larvae and PL. These luminescent bacteria can cause massive losses in prawn hatcheries. Water should be treated with 20-30 ppm chlorine or formalin to check bacterial diseases. Shell diseases are the most common bacterial disease in crustaceans causing white spot, black spot and rust disease. Prawns may also suffer fouling by microbial epibionts such as filamentous algae, bacteria or protozoans, which may affect the appearance and market value of prawns. Fouling is particularly common in larger prawns which moult less frequently. Treatment with 20-30 ppm formalin is effective and safe to control it. Fungal diseases may occur in ponds associated with accumulation of organic matter and eutrophication. Good environmental management can effectively control many diseases and external fouling; hence proper feeding, frequent water exchange, aeration etc are important considerations in health management.

Appendage deformity syndrome (ADS), slow growth syndrome (SGS) and branchiostegal blister disease (BBD) have also been reported in freshwater prawns in Andhra Pradesh. Idiopathic muscle necrosis (IMB) has been reported in *Macrobrachium* larvae, PL and sub adults. Black gill disease can be caused by melanisation of gills due to high concentrations of nitrite and nitrate in the pond environment. It can be prevented by appropriate feeding practices or increased exchange to maintain water quality in grow out ponds[13].

Culture types

Based on the degree of farm management, the *M. malcolmsonii* monoculture can be categorised into extensive, semi-intensive and intensive culture systems. Extensive culture is typically carried out in large ponds and water impoundments such as reservoirs, irrigation ponds and rice fields. They are stocked naturally in ponds or fish farmers stock at very low stocking density with juveniles collected from wild sources. In this culture system water quality, prawn growth and health is generally not monitored. Supplementary feeding and organic fertilisers are rarely applied. Prawn production is limited to about 200-400 kg/ha/year[1].

In semi-intensive farming systems *M. malcolmsonii* ponds are made free from predators and competitors. Fertilisation is used and a balanced feed ration is supplied. Juveniles are stocked at 30,000-40,000/ha. Water quality, prawn health and growth rate are monitored. Prawn production for such systems is in the range of 500-1000 kg/ha/year[3,4,14,15]. This form of culture is the most common in tropical areas.

Intensive *M. malcolmsonii* culture can be done in small earthen or concrete ponds (0.05- 0.2 ha). Prawn juveniles are stocked at more than 40,000/ha under controlled conditions in predator free ponds. There is strict control over all aspects of water quality and continuous aeration is provided. Pond water is exchanged frequently. Prawns are fed with nutritionally complete diet, as the system is unable to provide sufficient natural food to support the prawn biomass. A high degree of management is required to achieve higher production of 2,000-3,000 kg/ha/year. This form of culture is not common practice as it requires more research, particularly on quality management.

Prawn harvesting management

M. malcolmsonii reaches a marketable size of 30 - 40 g after six to seven months of rearing. Prawns are typically harvested by reducing the water level and repeatedly seining the pond. Finally ponds are drained and the remaining prawn crop is harvested. On complete draining prawns accumulate in deeper zones or the marginal trench of the pond from where they are collected by hand.

M. malcolmsonii do not grow at same rate. Males grow bigger than females, and even in the same sex there exists heterogeneity in growth. Those that grow faster tend to become dominant, while others remain stunted. Such heterogeneous individual growth of prawn results in different market prices. To reduce heterogeneous individual growth problems, ponds are stocked only once and partial harvesting of large size prawns can be done continuously for sale, leaving smaller once to grow with less heterogeneous individual growth. Periodic harvesting is done using bag seine nets of suitable mesh size. After several partial harvests, ponds are drained to harvest all remaining prawns within 9-12 months. In tropical perennial ponds where temperature remains at optimum levels regular stocking of freshwater prawn juveniles and selective harvesting (culling) of marketable size prawns (multi-stocking and multi-harvesting) can be practiced. However, in cull harvesting it is not possible to harvest all the bigger size prawns available in pond. If large dominant prawns escape harvest they may cause negative impacts through predation on subsequently stocked juvenile prawns. For complete harvesting the ponds are completely drained occasionally.

Polyculture

Prawn polyculture is practiced with fast growing compatible carps such as catla (surface feeder), rohu (column feeder) and grass carp (plant eater). If ponds are prone to phytoplankton abundance, silver carp can be incorporated in culture. Grass carp are stocked subject to availability of preferred aquatic weeds or terrestrial grasses for regular feeding. Bottom feeder carps such as mrigal and common carp are not used in prawn poly-culture. Prawn production in this kind of polyculture system varies according to level of management, but ranges from a few tens of kilos to > 700kg/ha/year[4,16,17]. In addition to the prawns, 3,000-4,000 kg/ha/year of various carp can be also produced under semi-intensive management practices. Better production can be obtained using stunted yearlings.

References

1. Mukhopadhyay, S. K. and Sarangi, N., 1985. Survival, growth and production of freshwater prawn *Macrobrachium malcolmsonii*. Environ. Ecol., 3(2): 198-201.
2. Kanaujia, D. R. and Mohanty, A. N., 1996. Prospects of both mono and mixed culture of *Macrobrachium malcolmsonii*. Fishing Chimes, 15(12): 33-35.
3. Kanaujia, D. R., Mohanty, A. N. and Tripathi, S.D., 1997. Growth and production of Indian river prawn *Macrobrachium malcolmsonii* (H. Milne Edwards) under pond culture. Aquaculture, 154: 79-85.
4. Radheyshyam, D.R. Kanaujia and A.N.Mohanty, 2008. Growth and yield of *Macrobrachium malcolmsonii* and carps in mono and poly culture under different stocking size of carps in rural area (Communicated for publication).
5. Reddy, R., Ramakrishna, R. and Rao, K. G. 1988. Polyculture of *Macrobrachium malcolmsonii* (Milne Edwards) and Asiatic carps. Proc. of the First Indian Fisheries Forum, Mangalore, Karnataka, pp. 21-23.
6. Durairaj, S. and Umamaheshwari, R., 1991. Polyculture of freshwater prawn *Macrobrachium malcolmsonii* (H. Milne Edwards). Proc. Of National., Symp. on New Horizons in freshwater Aquaculture, CIFA, Bhubaneswar 23-25 January, 1991. pp. 244-245.
7. Langer, R. K. and Somalingam, J., 1993. Experimental culture of freshwater prawn in ponds at Powerkheda, Hoshangabad. Proc. of Third Indian Fisheries Forum, 11-14 October, Pantnagar, U.P. pp. 65-66.
8. Rashid, A. and Behera, M. K., 1998. Culture of freshwater prawn in undivided Sambalpur District of Orissa. Fishing Chimes, 18(7): 20-23.
9. Adhikari, S. 2008. Water and soil quality management in freshwater prawn farming. In: National Training Course Manual on Seed Production and Grow out Culture of Freshwater Prawns, CIFA, Kausalyagang, Bhubaneswar: 32-37.
10. Kanaujia, D.R., 2006. Freshwater prawn breeding and culture. In: Handbook of Fisheries and Aquaculture, ICAR, New Delhi, Publication: 293-306.
11. Mohanty, S.N., 2006. Nutrition of Fin-fishes and Shell-fishes. In: Handbook of Fisheries and Aquaculture, ICAR, New Delhi, Publication: 488-410.
12. Mohanty, A.N., 2006. Limnology and water quality of freshwater prawn culture ponds. In: Training Course Manual on Seed Production and Grow out Culture of Freshwater Prawns, CIFA, Kausalyagang, Bhubaneswar: 65-78.
13. Sahoo, P.K., 2008. Diseases in freshwater prawns and their management. In: National Training Course Manual on Seed Production and Grow out Culture of Freshwater Prawns, CIFA, Kausalyagang, Bhubaneswar: 61-67.
14. Rajyalakshmi, T., Reddy, D. R., Appa Rao, A. and Ramakrishna, R., 1983. Growth and production of riverine prawn of India, *Macrobrachium malcolmsonii* (H. M. Edwards) in pond culture, Andhra Pradesh, India. In: Technical Paper, The World Mariculture Society, Washington, 9-10 January (Abstract).
15. Gopal Rao, K., Reddy, O.R., Rama Rao, P.V.A.N. and Ramakrishna, R., 1986. Monoculture of Indian freshwater prawn, *Macrobrachium malcolmsonii* (Milne Edwards). Aquaculture, 53: 67-73.
16. Thangadurai, A. J., 1992. Culture of freshwater prawn *Macrobrachium malcolmsonii* in Tamil Nadu - A case study. Proc. of the National Symp. on Freshwater Prawns (*Macrobrachium* spp.), Kerala Agricultural University, Kochi, pp. 187-188.
17. Rao, K. V., Rao, K. J., Raju, T.S.R. and Bose, P.S.C., 1979. On the culture of Indian river prawn *Macrobrachium malcolmsonii* (Milne Edwards) at Badampudi, Andhra Pradesh. In: Symposium on Inland Aquaculture, CIFRI, Barrackpore, India (Abstract).

Breeding and seed production of butter catfish, *Ompok pabda* (Siluridae) at Kalyani Centre of CIFA, India

Chakrabarti, P.P.*, Chakrabarty, N.M. and Mondal, S.C.

Regional Research Centre, Central Institute of Freshwater Aquaculture, Kalyani Station, A – 5 (Phase III), Santalpara, Kalyani 741 235, West Bengal, India, email dipapartha@yahoo.co.in

Pabda (Ompak pabda) brooder.

Ompok pabda (Ham.) popularly known as 'butter catfish' is a freshwater species native to India, Bangladesh, Pakistan, and Myanmar. The fish has a wide geographical distribution covering Afghanistan, the Indus plain and adjoining hill area of Pakistan, the North East States of India in Bihar and West Bengal. Open beels/mauns connected with rivers are common habitats. *O. pabda* has fine flesh with a soft meat texture, good taste and high nutritional value. It is commonly sold fresh locally or ice preserved. The species supported a strong fishery in North Bihar and West Bengal during the early 1970s, but in the early 1980s sharp falls in catches were observed, indicating swift declines in those areas. Consequently, *O. pabda* has been listed as an endangered fish species in India due to its decrease in abundance and restricted distribution. Causes of the decline are likely to be indiscriminate fishing during the breeding season, wide use of pesticide and insecticides from agricultural fields causing pollution and siltation in habitat.

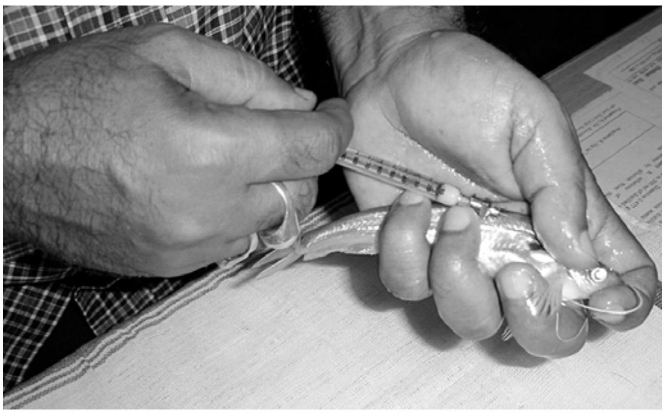
Pabda is a highly priced, delicious and nutritious catfish and well preferred fish because it contains relatively few bones. It has not received much attention in aquaculture mainly due to non-availability of information regarding its breeding and culture technique. However, success have been achieved in breeding and seed rearing of pabda in India[1,2,3,4,5,6]. The Regional Aquaculture Research Centre of Central Institute of Freshwater Aquaculture at Kalyani, West Bengal, India has been successful in breeding and mass seed production of pabda (*O. pabda*), so that the fingerlings can be produced locally for grow out culture to overcome the constrain of procurement of seed from wild sources. The price of pabda is above Rs 300/- per kg (US$1 = Rs 45/-) and is highly sought after in the entire North East region.

Broodstock management

Scaling up of farming requires a consistent supply of good quality seed, necessitating captive breeding, careful broodstock management and larval rearing. Broodstock can be managed in ponds to promote gonad development. In the present study they were fed trash fish and boiled chicken viscera at about 5 – 10% of total body weight per day. A weekly water exchange of 50 – 100% was made to maintain water quality parameters within favourable ranges. Broodstock matured at PH 7.4 – 7.8.

Spawning technique

The fish attained maturity at the end of the first year. Males matured earlier than females, which became mature at 30 – 40 g in weight. Fertilisation is external and spawning occurs



Administering hormone to broodstock.

once a year during the monsoon season (June – August) with a peak in July. Fully ripe females and males were segregated and used in induced breeding. Females can be distinguished by a rounder, fuller abdomen, reddish vent colour and rounded genital papilla. Males have an elongated and pointed genital papilla. We used Ovaprim to promote induction of spawning. Ovaprim was applied at 1 – 1.5 ml/kg body weight for females and 0.5-1.0ml/kg body weight for males, applied in a single injection. Females were stripped for spawning 8 – 10 hours after hormone injection and the eggs were collected in a tray. Milt was obtained from males by surgically removing the testes, which were macerated to produce a suspension to be mixed with the eggs for fertilisation. Eggs were subsequently washed thoroughly with clean water and transferred to a fibreglass/cement tank for hatching, with constant aeration.

Embryonic development

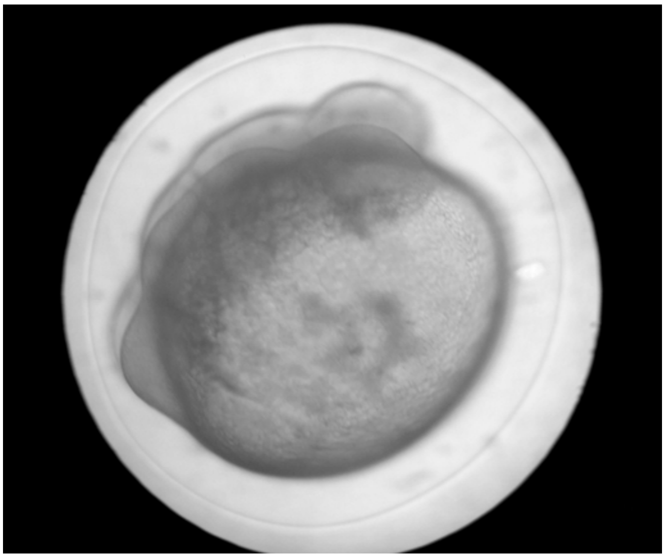
- 30 minutes after fertilisation the blastodisc begins to form over the yolk, following first, second and third cleavage.
- Sixty four cell stage was observed after 70 minutes post-fertilisation followed by morula stage in two hours.
- Yolk plug stage appeared after five hours.
- The cephalic and caudal end of the embryo had differentiated after 10 – 15 hours.
- After 16 – 21 hours the gut had faintly appeared posterior to the yolk sac, leading to the anus, and movement of the embryo could be seen within the egg.
- After 22 hours movements of the embryo were observed.
- The eggs began to hatch after 23 hours.

Larval rearing

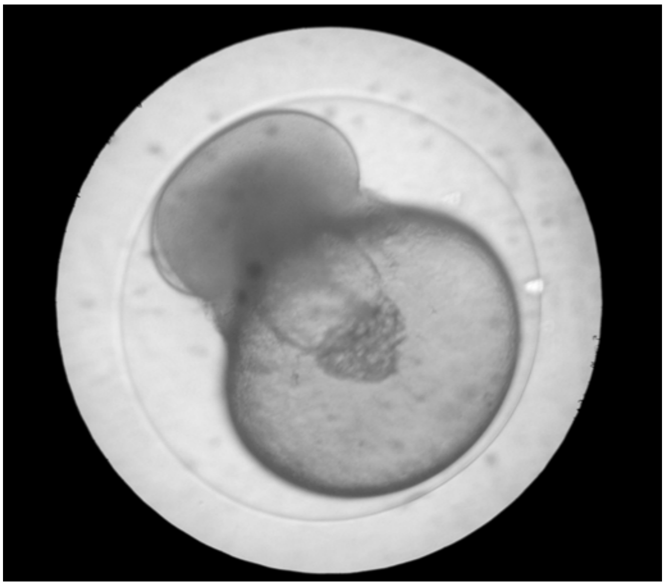
Newly hatched larva can be reared in fibre glass tanks and cement cisterns as well as in nurseries using pond water. Suitable water parameters are temperature 25 ± 3° C, alkalinity 120-150 mg l^{-1} and dissolved oxygen in the range 3 –5 mg l^{-1}. Initially the water level of containers was maintained at 3 – 4 cm, and gradually increased to 15 – 20 cm after one week. Water levels were adjusted at different stages of rearing to minimise the stress to larva. Aquatic weeds such as *Hydrilla* can be provided to give cover for the larvae.

Feed

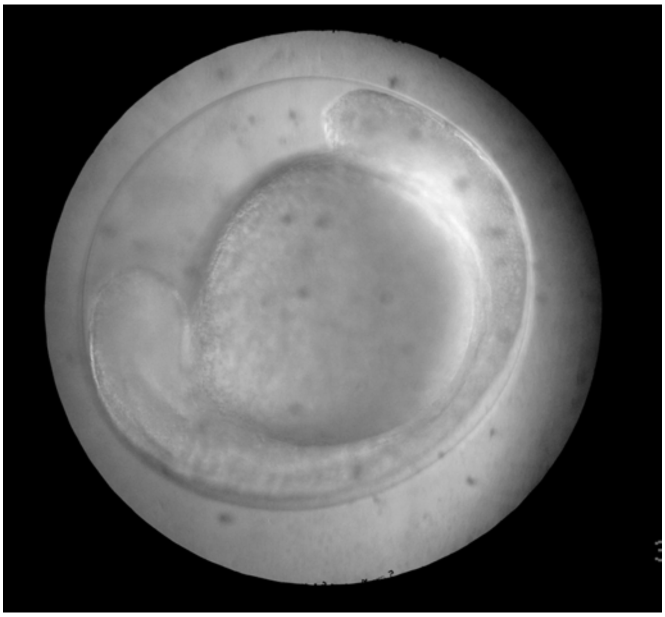
Yolk sacs were absorbed in around three days. Early spawn were cannibalistic, attacking and devour others. It was necessary to reduce the density of the stocked population to reduce cannibalism. Mixed zoo plankton, *Tubifex* worm, and egg custard were provided as larval feed. Larvae accept zooplankton up to day 15. In fry stages and onwards the fish can be fed with compound feed (rice polish, silk worm pupae and boiled egg) at 100 % of body weight of the population. The average size of fry was 1.1 – 2.0 cm in length and 0.6 – 2.0 g in weight. Fry can also can be reared in fibre glass tanks and cement cisterns fed with both zooplankton 2.0 – 3.0



Embyonic development at 1 hour and 10 minutes.



Embryonic development at 1 hour and 42 minutes.



Embryonic development at 11 hours and 40 minutes.

ml on alternate days and *Tubifex* worm as a live feed. Fry attained 5.0 – 6.0 cm and 3.0 -5.0 g after a rearing period of 40 days, which is a good size for stocking in grow out ponds.

Conclusion

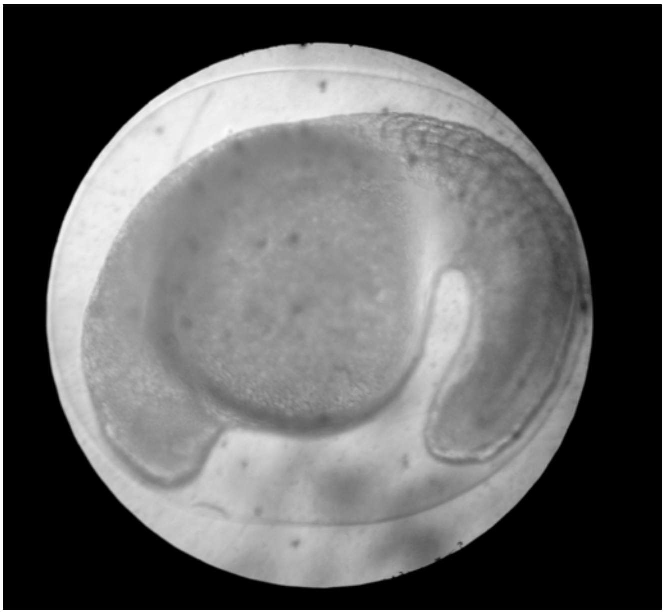
Pabda fetches a relatively high market price and are a fish popularly sought after in eastern Indian states. Spineless, except a soft vertebral column, the fish has good quality flesh and taste and is widely accepted by the consumers of East Asian countries. The technology for breeding and seed production has been developed and we anticipate that a pabda grow out industry will emerge among progressive fish farmers in due course.

References

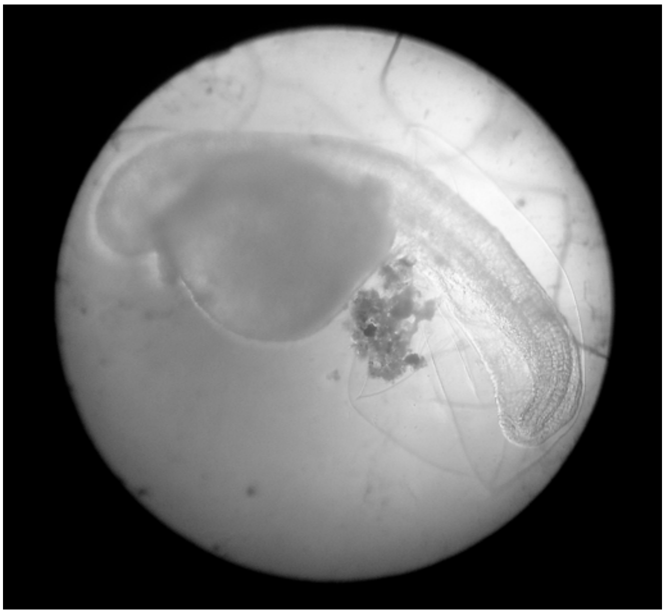
1. Sridharan S., Vijoykumar, C. and Haniffa, M. A., 2004. Induced spawning and establishment of captive population of an endangered fish *Ompok bimaculatus* in India. Centre for Aquaculture Research and Extension. St. Xavier College., Palayamkottai, India.
2. Bhowmick, M.L., Mondal, S.C. Chakrabarty, P.P., Das, N.K., Saha, R.N. and Ayyapan, S., 2000. Captive breeding and rearing of *Ompok pabda*. A.G. Sarkar (Ed) Fish biodiversity of North East India. NBFGR NATP Publ.
3. Mukherjee, Madhumita and Das Samik 2001. Artificial propagation of a siluroid fish *Ompok pabda* (Ham) Fishing Chimes, 26 (1): 75 – 77.
4. Chakrabarty, N.M., Chakrabarty, P.P. and Mondal, S.C., 2006. Mass seed production of pabda and their farming – a challenging step for sustainable utilization of the vulnerable fish species. Fishing Chimes, 26 (1): 133 – 135.
5. Chakrabarty, N.M., Mondal, S.C. and Chakrabarty, P.P., 2007. Artificial breeding seed production and rearing of butter fish *Ompok pabda* – A significant mile stone in technology advancement Fishing Chimes, 26 (10): 134 – 136.
6. Hussain, A., 2006. Seed production of *Ompok pabda* (Ham) in hatchery of C.G. Co-operative Fish Federation. Fishing Chimes, 26 (1): 136 – 139.

Pabda culture in cement cistern.

Pabda culture in earthen pond.



Embryonic development at 15 hours.



Gut begins to appear posterior to the yolk sac.

Harvested pabda.

Asia-Pacific Marine Finfish Aquaculture Network

Magazine

SKRETTING

Use of fish in animal feeds: a fresh perspective

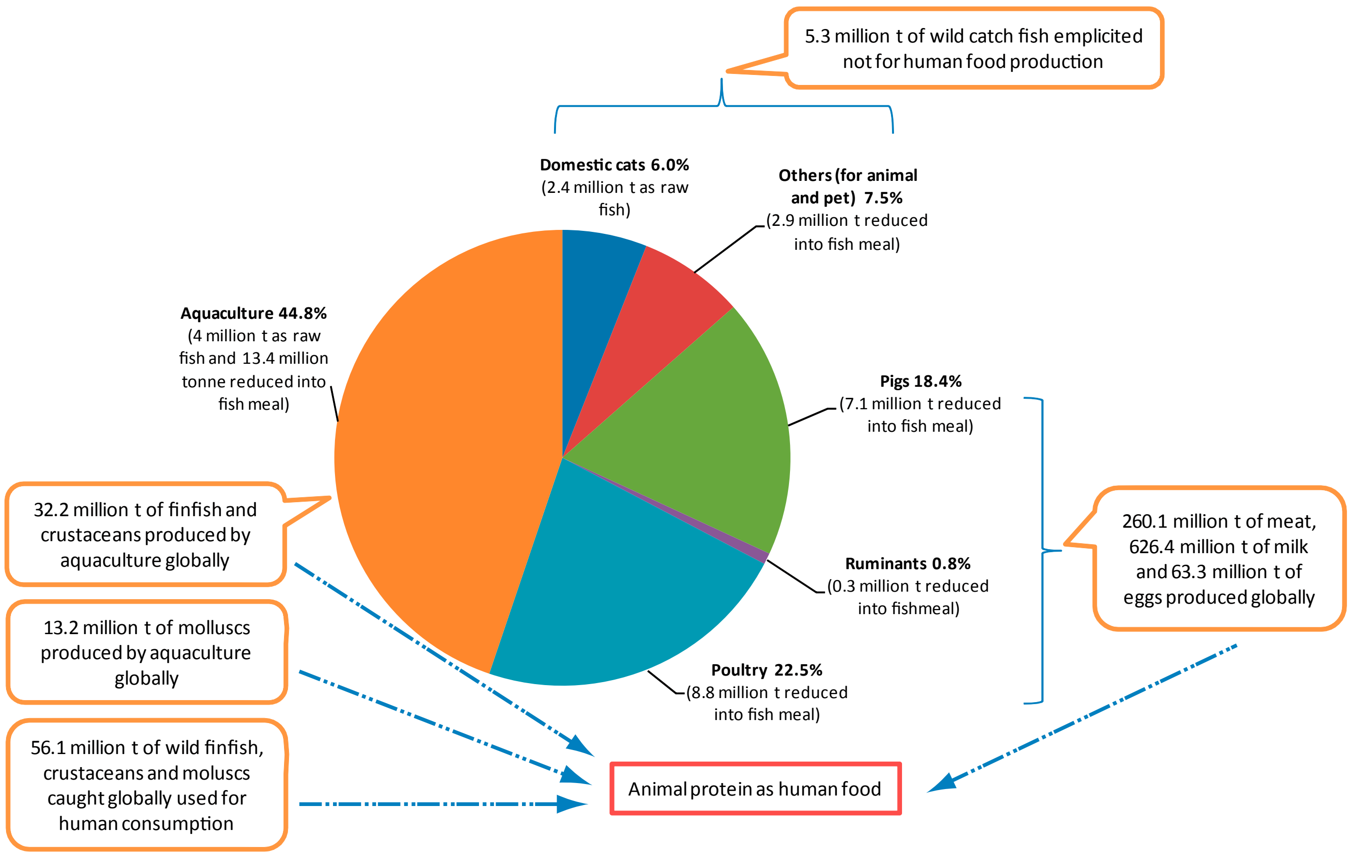
Aquaculture is often criticised by lobby groups because it uses about 43 percent of global fish meal production and 85 percent of fish oil. Industrial production of fish meal and fish oil are based on what is termed as a reduction process, using smaller sized fish species commonly termed 'trash fish', although 'low-value' fish is probably a more accurate description. In essence, nearly 25 percent of the global marine fish catch is used for these purposes, predominantly consisting of species such as the Peruvian anchovy, capelin, menhaden and sand eel, amongst others.

There is a growing view that the fish resources used in the reduction industry should be channelled for feeding humans directly in developing countries; an ethical stance that is gaining increasing momentum. An alternate interpretation of this view is that valuable protein sources should not be used to convert to higher cost proteins that are inaccessible to the poor.

In aquaculture fish meal and fish oil usage is mostly for the culture of high valued species such as salmon and shrimp, which together account for about 16 percent of the global aquaculture production, and to a much lesser extent other finfish species. Similarly, a large quantity of fish meal is used in feeds for other livestock, mainly poultry.

Aquaculture is commonly condemned, in spite of the fact that it provides millions of livelihood opportunities in poor rural communities, contributes to food security and poverty alleviation, and currently provides approximately 50 percent of total global food fish consumption. However, what seems to have gone unnoticed by its critics is that a very substantial quantity of fish is used for non-human food production purposes, principally for pet food production, and an unknown but significant quantity for feeding animals farmed for the fur trade.

Figure 1: Fish meal and fish oil consumption by sector.



It is in the above context that Professor Sena S De Silva and his colleague Dr. Giovanni Turchini set about to estimate the quantities of fish used in the above sectors. They were able to make a rather conservative estimate of the use of fish in the pet food industry, in particular cat feeds, covering only certain parts of the globe (for example China was excluded). The results were staggering, very conservatively estimated at 5.3 million tonnes, almost certainly a gross underestimation (Figure 1). The detailed analysis is published in the Journal of Agriculture and Environmental Ethics (2008; Volume, 21, pp. 459–467).

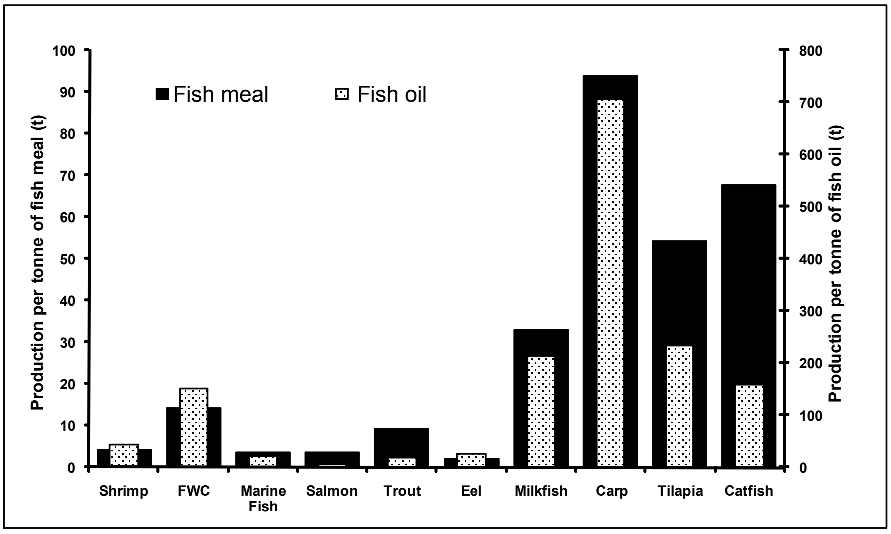
This article generated a lot of coverage in the press and in particular in the Australian media as the study was primarily based on basic information on cat feeds from Australia. The study demonstrated that on average an Australian household cat consumes more fish than the average Australian citizen.

The main point the authors raised was that it is not a question of pets versus aquaculture - human food - but the fact that a common biological resource that could be channelled for direct food consumption (at least a good proportion of it) is being used for non-human food production; and that there needs to be a global dialogue with regard to the sharing and channelling of this resource for various purposes. Furthermore, that aquaculture, which uses fish meal and fish oil for producing human food should be considered in context of other uses of these resources, and not be singled out.

NACA's mandate is to facilitate sustainable rural aquaculture development involving millions of small scale farmers, who own, operate and manage relatively small units, which are essentially the backbone of Asian aquaculture and account for over 85 percent of global production. Although Asian aquaculture accounts for a significant usage of global fish meal production its use of fish oil is relatively small, and the returns in production terms for both are considerably higher for those species/species groups cultured in Asia (Figure 2). Accordingly, it would be incorrect to extend the same arguments with regard to such usages "lock, stock and barrel" to Asian aquaculture. However, NACA does accept the need to reduce use fish meal and fish oil in Asian aquaculture and is taking steps in conjunction with its member countries in this direction.

It is in the above context that NACA calls for a global dialogue on the use of fish resources in the reduction industry as well as on fish meal and fish oil usage in aquaculture.

Figure 2. Aquaculture production per tonne of fish meal and fish oil used in the different cultured groups that are provided with aqua feeds containing these commodities From De Silva & Soto, in press).



Reference

De Silva, S.S. and Turchini, G.M. (2008). Towards understanding the impacts of the pet food industry on world fish and seafood supplies. Journal of Agricultural and Environmental Ethics 21: 459-467.

New book 'The Aquaculture of Groupers'

The recently released book 'The Aquaculture of Groupers' provides an overview of grouper aquaculture in Asia. This new reference book is authored by Dr I-Chiu Liao and Edward Leaño, and has been jointly published by the Asian Fisheries Society, the World Aquaculture Society, the Fisheries Society of Taiwan, China and National Taiwan Ocean University, China.

The first five chapters deal with research and development to improve production technology (hatchery, nursery and grow-out) in Japan, Taiwan China, Korea, Indonesia and the Philippines. The following five chapters review the status of grouper aquaculture in India, China, Hong Kong, Thailand, Malaysia and Australia. These chapters review culture methods employed for larval rearing, nursery and grow-out, constraints to grouper aquaculture development, and trade and market issues. Two more chapters describe aspects of fish health, including studies on reducing the impacts of the major viral diseases of groupers (nodavirus and iridovirus), and the final chapter provides an economic analysis of grouper aquaculture in Taiwan, China.

Chapters are as follows:

- Reproduction and larviculture of seven-banded grouper, *Epinephelus septemfasciatus*, in Japan.
- Developing techniques for enhancing seed production of *Epinephelus coioides* in Taiwan, China.
- Grouper aquaculture research in Jeju Island, Korea.
- Hatchery and grow-out technology of groupers in Indonesia.
- Grouper aquaculture R&D in the Philippines.
- Groupers: current status and culture prospects in India.
- Grouper aquaculture in mainland China and Hong Kong.

- Overview of grouper aquaculture in Thailand.
- Status and prospects of grouper aquaculture in Malaysia.
- Grouper aquaculture in Australia.
- Nutrition, immunology and health management of groupers.
- Prophylaxis for iridovirus and nodavirus infections in cultured grouper in Taiwan, China.
- Technical efficiency of the grouper industry in Taiwan, China.

'The Aquaculture of Groupers' is available from the Asian Fisheries Society (http://www.asianfisheriessociety.org).

NACA post-graduate fellowships, Aceh, Indonesia

Following the tsunami disaster of December 2004, NACA has been involved in rehabilitation of aquaculture and related livelihoods in Aceh, in partnership with various donor and development agencies. Most of the donor assisted programs are now coming to an end.

Recognising the need for further capacity building in Aceh, NACA wishes to institute a fellowship for a post graduate program for one or two competent young people. The fellowship will be open only to people from Aceh who are below 40 years of age and working in government or private institutions related to aquaculture. The two year fellowship can be utilised to study in any of the ASEAN Universities in the chosen field of interest of the selected candidate, and will include a monthly stipend, two international return air-fares, tuition fees and a book allowance.

Priority will be given to the following areas of specialization:

- Aquaculture and fisheries.
- Fisheries and or aquaculture business management.
- Policy and legislation in relation to fisheries and aquaculture.
- International trade with special reference to cultured aquatic commodities.
- Socio-economics in aquaculture.

Interested candidates should send their CV along with a letter of intent indicating the chosen field of interest and the preferred regional university for study, to NACA before 30th April 2009 to Dr. C.V. Mohan, Research & Development Program Manager, NACA, email mohan@enaca.org.

Capacity building is a core NACA activity.

NACA is an intergovernmental organisation with 17 members. NACA seeks to improve rural incomes, increase food production and ensure livelihoods through sustainable aquaculture. NACA promotes regional cooperation in aquaculture and small-scale fisheries development, and provides technical assistance throughout the Asia region in partnership with governments, donor foundations, development agencies, universities and a range of non-government organizations and private sector organisations. The ultimate beneficiaries of NACA activities are farmers and rural communities.

National strategies for aquatic animal health management

Mohan, C.V.

Network of Aquaculture Centres in Asia-Pacific, PO Box 1040, Kasetsart University Post Office, Jatujak, Bangkok 10903, Thailand, email mohan@enaca.org

Introduction

Globally, capture and culture fisheries contribute significantly towards food security, poverty alleviation, economic development and supporting livelihoods. In 2004, total global fish production was in excess of 140 million metric tonnes valued over US$ 80 billion. Aquaculture contributes more than 45% of global fish food consumption and is the fastest growing food producing sector. The annual growth rate for aquaculture is 8-10% compared to 3% for live stock and 1.6% for capture fisheries. Hand in hand, the global trade in fish and fishery products is expanding and is worth over US$ 70 billion. Rapidly developing aquaculture and ever expanding global trade, in the era of globalization and trade liberalisation, presents several challenges. One of the key problems is the emergence and spread of serious aquatic animal pathogens. Intensive aquaculture practices tend to provide a platform for the emergence of pathogens, while global trade in aquatic animals and their products offer avenues for trans-boundary spread of pathogens. The risk of pathogen transfer is generally considered greater for movement of live aquatic animals than for movement of dead product. Irrespective of the disease risks involved, aquaculture and global trade will continue to intensify and expand.

Aquatic animal diseases are a major risk and a primary constraint to the growth of the aquaculture sector in many countries in the Asia-Pacific region. The epidemic spread and devastating impacts of aquatic animal diseases such as epizootic ulcerative syndrome (EUS) in freshwater fish; viral nervous necrosis (VNN) in marine fish; white spot syndrome virus (WSSV) in penaeid shrimps; white tail disease (WTD) in *Macrobrachium rosenbergii* and the emerging Taura syndrome virus (TSV) in *Penaeus vannamei*; in Asia have clearly demonstrated the vulnerability of aquaculture systems to infectious disease emergencies. More recently, the widespread mass mortalities of koi and common carp in Indonesia and Japan due to infection with koi herpes virus (KHV) have re-emphasized the impact that emerging diseases can have on local economies. The increasing globalisation and trade volume of the aquaculture sector has created new mechanisms by which pathogens and diseases may be introduced or spread to new areas. Known and unknown disease problems may arise quickly in any country's aquaculture sector, often with serious economic, social and ecological consequences, but may be difficult or impossible to eliminate once established.

Regional and international agreements and standards

Over the years, several regional and international instruments have been developed to help national governments to meet the international standards set by the World Trade Organization under the Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement). The WTO-SPS Agreement sets out the basic rules for food safety and animal and plant health standards. The basic aim of the SPS Agreement is to maintain the sovereign right of any government to provide the level of health protection it deems appropriate, but to ensure that these sovereign rights are not misused for protectionist purposes and do not result in barriers to international trade. For animal (including aquatic animal) health and zoonoses, the WTO recognises the standards developed by the World Organisation for Animal Health (Office International des Epizooties, or OIE) as a reference within the SPS Agreement. The OIE develops normative documents relating to rules that its member countries can use to protect themselves from diseases without setting up unjustified sanitary barriers. The main normative documents produced by the OIE for aquatic animals are the Aquatic Animal Health Code (Aquatic Code) and the Manual of Diagnostic Tests for Aquatic Animals (Aquatic Manual). The aim of the Aquatic Code is to assure the sanitary safety of international trade in aquatic animals (fish, molluscs and crustaceans) and their products. The code provides details of health measures to be used by the veterinary or other competent authorities of importing and exporting countries so that the transfer of pathogenic agents for animals or humans is minimized but unjustified sanitary barriers are avoided. The Aquatic Code provides general and disease specific provisions that OIE Member Countries can adopt to prevent and control aquatic animal disease.

A framework for animal health management in the Asia-Pacific region has been developed by NACA and partners such as FAO and OIE. The Asia Regional Technical Guidelines (TG) provides the most comprehensive framework available for development and implementation of national strategies to address aquatic animal health issues at different levels – local, provincial and national. Three regional guiding documents that take into full consideration the provisions of the WTO-SPS Agreement, the OIE Aquatic Animal Health Code, as well as the FAO Code of Conduct for Responsible Fisheries, were developed and adopted by 21 Asian governments: (i) The Asia Regional Technical Guidelines on Health Management for the Responsible Movement of Live Aquatic Animals and the Beijing Consensus and Implementation Strategy provide the basic framework and guidance for national and regional efforts in reducing the risks of diseases due to trans-boundary movement of live aquatic animals; (ii) the Manual of Procedures, which contains the background material and detailed technical procedures to assist countries and territories in the Asia region in implementing the 'Technical Guidelines' and (iii) the Asia Diagnostic Guide to Aquatic Animal Diseases which contains comprehensive information for disease diagnosis to support implementation of the Technical Guidelines. The Technical Guidelines identify several components for a national strategy, which needs to be in place and operating effectively in trading countries if the risk of international disease spread within the region is to be reduced.

Key components of a national strategy

The national strategic plan normally provides the basic framework and principles on which to implement a comprehensive health management strategy. The strategic plan covers most of the issues that needs to be implemented at the farm/state/national level. The national strategic plan usually identifies the roles and responsibilities of different stakeholders at the state and national levels. The following section provides a brief insight into some of the key components that are essential in a national strategy.

Competent authority

A competent authority (CA) as mentioned in the OIE's Aquatic Animal Health Code means the national veterinary services, or other authority of a member country, having the responsibility and competence for ensuring or supervising the implementation of the aquatic animal health measures recommended in the OIE's Aquatic Animal Health Code (e.g. issuing health certificates, disease surveillance and reporting, quarantine, risk analysis, zoning). Key institutions identified under the CA should have the capacity and expertise to develop national policy and legislation and support implementation of various elements contained in the national strategies on aquatic animal health management and bio-security. The CA must ensure effective networking and communication with relevant institutions and stakeholders for the purpose of implementing effective national aquatic animal health strategies.

Legislative support

Legislative support in the form of written legal documents outlining the powers of the CA to facilitate implementation of national aquatic animal health strategies is very important. The laws in aquatic animal health should cover aquatic animal movement, import-export, quarantine and health certification procedures, destruction of diseased stock, compensation, etc. Countries that have environmental or conservation policies or regulations, which impact upon the movement of live aquatic animals, must take these policies and regulations into consideration when framing separate aquatic animal health protection legislation. Legislation that covers aquatic animal health issues must also clearly address jurisdictional responsibility and ensure that it is consistent with international standards and obligations (e.g., the OIE's International Aquatic Animal Health Code and the World Trade Organization's Agreement on the Application of Sanitary and Phytosanitary Measures (SPS Agreement)).

National Advisory Committee

The National Advisory Committee for Aquatic Animal Health is a forum for communication and coordination among government, academia, industry, private sector and other concerned groups for consideration of issues of aquatic animal health, disease control, and welfare. The objective of establishing a national advisory committee is to provide a formal mechanism to drive the process of national strategy development and implementation. Members of such a committee should have a broad understanding of the concept of health management. They should be also aware of the negative consequences of not having a national strategy on national economies, trade and livelihood of fish farmers. Among others, the benefits of having national committee include:

- It highlights the importance a country places on aquatic animal health.
- It provides a formal framework and process to drive the development and implementation of national strategy.
- It identifies roles and responsibilities of different stakeholders.
- It ensures some degree of implementation of aquatic animal health programmes.
- It provides for wider participation and ownership to different institutions.

National list of diseases

The national list of diseases is a tool to collate and disseminate information on diseases of national importance for the purpose of developing national disease control strategies, and complying with regional and international disease reporting requirements. Having a national list of diseases allows the development of national strategies (e.g. surveillance, contingency planning) around some of these diseases. When developing a national list, considerations must be given to some of the following key criteria:

- Cultured and traded species in the country.
- Economic impact of diseases on farmers and the national economy.
- Diseases exotic to the country.
- Diseases present in neighbouring countries in view of shared watersheds and porous land borders.
- Existing international (OIE) and regional (QAAD) disease lists.

Surveillance and disease reporting

Surveillance is defined as a systematic collection, analysis and dissemination of health information of a given population of aquatic animals and is an ongoing process involving handling of health information from different sources, including surveys.

Surveillance is not same as surveys. Passive (general) surveillance is the collection, analysis and dissemination of existing disease information. It includes all the routine disease investigation activities that may be undertaken in a country/state such as field investigations of disease incidents and results of laboratory testing. It is important that passive surveillance is undertaken on a continuous basis throughout a country/state and that the disease information produced is effectively captured, analysed and used for mounting an early response.

Active surveillance (targeted surveillance) refers to active collection of disease data following a structured surveillance design, often targeting specific diseases. Active surveillance collects specific information about a defined disease or condition so that its level in a defined population can be measured or its absence reliably substantiated. Disease surveillance should be an integral and key component of all national aquatic animal health strategies. This is important for early warning of diseases, planning and monitoring of disease control programs, provision of sound aquatic animal health advice to farmers, certification of exports, international reporting and verification of freedom from diseases. It is particularly vital for animal disease emergency preparedness. Information generated from surveillance systems must be housed in a national database, from where the CA will be able to make use of the surveillance data for the purpose of implementing national disease control programs or for meeting regional and international disease reporting obligations.

Implementation of surveillance systems will directly and indirectly contribute to improved disease diagnosis, better research collaborations, reliable advice to primary producers, capacity building at the level of extension workers and primary producers, development of an early warning and emergency preparedness system.

Disease reporting and information sharing can go a long way in minimizing the impact of serious aquatic animal health emergencies. By international agreement, diseases listed by the OIE should be reported by member countries and are subject to specified health measures that are intended to limit disease spread and assure sanitary safety of international trade in aquatic animals and their products. The NACA/FAO/OIE Quarterly Aquatic Animal Disease (QAAD - Asia-Pacific) reporting system lists all diseases listed by the OIE plus diseases of concern to the region. The information generated through the regional reporting system, participated by 21 countries, provides information on important diseases in the Asia-Pacific region and also serves as an early warning system for emerging pathogens (e.g. KHV, TSV).

Emergency preparedness and contingency planning

A disease emergency exists when a population of aquatic animals is recognized as undergoing severe mortality events, or there is otherwise an emerging disease threat where urgent action is required. Infectious disease emergencies may arise in a number of ways, including: introductions of known exotic diseases, sudden changes in the pattern of existing endemic diseases, or the appearance of previously unrecognized diseases.

A contingency plan is an agreed management strategy and set of operational procedures that would be adopted in the event of an aquatic animal disease emergency. This should be developed during “peace time” (i.e. not at time of emergencies). When there is an emergency, the response should proceed according to the plans that have been developed. For effectively dealing with aquatic animal health emergencies, governments should have the capability to develop contingency plans and build the required operational capacity to effectively implement the plan. Through a well-documented contingency action plan agreed upon by all major stakeholders, it would be possible to minimize the impact of an aquatic animal disease emergency. Mere establishment of contingency plan without appropriate skills and capacity development would be of little value.

The aim of early warning is to allow the recognition of a potential threat and a rapid detection of a disease emergency. For establishing an effective early warning program, a strong technical capability is a fundamental requirement in the areas of disease diagnostics, disease surveillance, epidemiological analysis, aquatic animal health information systems, national and international disease reporting and information communication and sharing. Early response is identified as all actions that would be targeted at rapid and effective eradication/containment/mitigation of an emergency disease outbreak. The responses may be of different types depending on the disease agent and the likely impact. Operational capabilities at different levels (farm/village/province/national) are vital to mount an effective early response.

Quarantine and health certification

Quarantine is defined as maintaining a group of live aquatic animals in isolation with no direct contact with other aquatic animals, in order to undergo observation for a specified length of time and, if appropriate, conducting tests and treatment, including proper treatment of the waste waters. Quarantine process involves pre-border, border and post-border activities, including pre-movement certification, movement, confinement on arrival, checking during confinement, releases, and subsequent monitoring as appropriate. The purpose of applying quarantine measures is to facilitate trans-boundary trade in living aquatic animals, while minimizing the risk of spreading infectious diseases. An effective system of quarantine measures also increases protection of surrounding resources (e.g., harvest fisheries, non-exploited species and other components of the environment).

Health certificates are documents issued by the CA of the exporting country attesting to the health status of a consignment of live aquatic animals. A health certificate is a legal document which is used especially for the purpose of applying quarantine measures in trans-boundary trade of live aquatic animals and their products, for minimizing the risk of spread of infectious diseases. Health certification is also one of the strategies aimed to protect the natural environment and native fauna from the deleterious impacts of exotic species and/or diseases. Because of the diversity of species, the purposes for which the aquatic animals are being traded (import-export, local market), and other variable factors, health certificates should be comprehensive and be able to accommodate all the required information. Model health certificates are provided in the OIE Code.

Import risk analysis

The importation of live aquatic animals always involves a degree of disease risk to the importing country. Import risk analysis (IRA) is the process by which hazards (e.g. pathogens) associated with the introduction of a particular animal are identified, the paths and likelihood of introduction and establishment are described, consequences are defined and management options are assessed. The results of these analyses are communicated to the CA and stakeholders (importer/exporter). Typical risk analysis process involves four components: hazard identification, risk assessment, risk management and risk communication. Import decisions based on scientific risk analysis will minimize the risk of introducing exotic pathogens to the country.

Zoning

Zoning is a program for delineating areas within countries on the basis of aquatic animal disease status. The advantage of zoning is that it allows for part of a nation's territory to be identified as free of a particular disease, rather than having to demonstrate that the entire country is free. In the past, outbreaks of disease could impact on trade from the entire country, but by zoning, restrictions may only apply to animals and products from the infected area. Zoning is particularly helpful for diseases where eradication is not a feasible option.

Role of NACA

NACA is an intergovernmental organization, owned by its member governments, of which there are currently 17. The objective of NACA is the expansion of sustainable aquaculture and small-scale aquatic resources management, through the promotion of science-based best practices in policy, sector management and farm management. NACA operates under the principle of Technical Cooperation among Developing Countries. The regional program is formulated by the governments, through its Governing Council; with the advice of a Technical Advisory Committee; and a wide range of government, industry and non-government stakeholders, and implemented by the Secretariat and network participants. Aquatic animal health management is one of NACA's core programmes, through which support is provided for cooperation, capacity building and improved communications among countries in addressing aquatic disease problems. The purpose of NACA's regional Aquatic Animal Health Program in the 21 participating countries is to "Reduce risks of aquatic animal disease impacting on livelihoods of aquaculture farmers, national economies, trade and human health". The regional health program of NACA provides technical assistance to countries to implement practical national aquatic animal health strategies.

Conclusions

Strong national commitment and continuous awareness and capacity building at producer, disease support and decision making levels are critical for ensuring effective implementation of a national aquatic animal health strategy. National governments should specifically address issues of developing a sustainable process to suit the existing resources of the country. Countries should consider strengthening national aquatic animal health networks, make effective use of the existing information (e.g. research publications, reports of research institutions, reports in meetings and conferences, reports of private sector laboratories), improve communication between CA and aquatic animal health personnel, build capacity and awareness on diagnosis and implement simple and practical surveillance systems. Commitment and proactive approaches by national governments can only make implementation of responsible aquatic animal health management strategies a reality. Implementation of national strategies including surveillance, disease reporting and contingency planning should be seen as national programs and not as projects of individual institutions or organizations in which all stakeholders have a role to play.

International Cosmos Prize for Professor Phan Nguyen Hong, National University of Education of Vietnam

"Professor Phan Nguyen Hong from the National University of Education of Vietnam has won the international Cosmos Prize for his contribution to saving mangrove forests.

The most significant fact is that Hong's work has helped revive many Mangrove forests destroyed in war time".
Hong was selected from 131 candidates from 25 countries to become the first Vietnamese scientist to receive the award - and prize money of US$380,000. The award ceremony was held in the Japanese city of Osaka. The prize is awarded annually by the Expo 90 Commemorative Foundation to an individual or team who contributes to the interdependence of life and the global environment.

"His 40-year research project plays an important role in protecting bio-diversity and reducing global warning," said Mai Sy Tuan, dean of the National University's Faculty of Biology. "It helps humans discover the best way to preserve harmony with nature." Nguyen Lan Dung, chairman of the General Biology Association, said the prize was an honour for all Vietnamese scientists. "The most significant fact is that Hong's work has helped revive many mangrove forests destroyed in war time," he added.

The 73-year-old professor is a pioneer in the study of the bio-ecology of tropical wetlands in Vietnam. He began his research in 1964 to solve the long-term effects of the chemical war on mangroves. Hong went on to establish Can Gio Province's Biosphere Reservation Centre. He also helped local residents replant mangrove forests in eight different provinces and improved their living standards by using the forest wetlands to raise aquatic products. He established more than 400 classes in 10 coastal provinces to train fishermen in new ways of raising sea products and planting mangroves. Hong has published 20 books about preserving the mangrove ecosystem and become a top-ranking expert in Asian wetland systems.

He intends to continue his studies on coastal forest conservation and Contribute to marine resource protection and poverty reduction. "I'll donate part of my prize money to support scientific research for university teaching staff and students," said Hong.

Source: Vietnam News.

NACA Newsletter

Published by the Network of Aquaculture Centres in Asia-Pacific, Bangkok, Thailand

ISSN 0115-8503

Volume XXIV, No. 1
January-March 2009

9th Technical Advisory Committee meeting and 30th anniversary of FFRC

NACA's 9th Technical Advisory Committee (TAC) meeting was hosted by the Regional Lead Centre for China, the Freshwater Fisheries Research Center (FFRC), from 30 October to 1 November 2008. The meeting was attended by 32 participants drawn from member countries and participating research centres, and chaired by Dr Ambekar Eknath. The meeting coincided with the 30th anniversary celebrations for FFRC, which serves as the NACA Regional Lead Centre for China.

The TAC meeting is convened every two years to identify high priority and emerging issues of common interest, and to develop a plan of work for the period 2009-2011 and beyond. The meeting also considered mechanisms for cooperation and funding, including how to increase the participation and ownership of centres in the development and implementation of the work plan.

The Director General (DG) and NACA professional staff made presentations on the major elements of the work program, giving the background and a summary of recent activities, covering coastal aquaculture, inland fisheries and aquaculture, aquatic animal health, genetics and biodiversity, training and education and communication. The DG emphasised the importance of aquaculture as a mechanism for addressing poverty alleviation and rural development in the region, particularly given that the sector was comprised principally of small-scale producers. Selected high priority issues and recommendations of the TAC are summarised below. The full report of the meeting is available for free download from the NACA website at:

http://www.enaca.org/modules/wfdownloads/singlefile.php?cid=151&lid=969.

Participants in the 9th Technical Advisory Committee Meeting, Wuxi, China.

Key issues and recommendations

NACA had become involved in climate change through preparation of a review on the impacts on aquaculture for FAO. Based on the consultation a policy brief had been prepared to be submitted, together with those from other agricultural sectors, to a high level policy dialogue of FAO members. Climate change was expected to have a significant impact on aquaculture, particularly in low lying areas such as the delta regions in Vietnam, Bangladesh and Myanmar. The TAC recommended that NACA conduct further work to anticipate the likely impacts and to assist farmers to adapt; and also that NACA establish a new work programme to address emerging global issues.

Food safety has long been a significant trade issue in both domestic and international markets and the long term trend is for increasingly stringent regulatory controls. There is a clear need to help small-scale producers comply with food safety standards and adapt to changing requirements, while maintaining their market competitiveness. The group/cluster-based management approach piloted in India had proven to be an effective mechanism for improving animal health and environmental management practices amongst small scale farmers. The TAC indicated that cluster approaches would also be an effective mechanism for assisting small-scale producers to meet food safety requirements. The TAC further recommended that NACA establish a new work programme on food safety in aquaculture.

Translocation of germplasm was noted as both a persistent and increasingly problematic issue. The Secretariat frequently received requests for assistance, however the Governing Council had previously instructed the Secretariat not to facilitate such transfers unless an adequate risk assessment had been conducted and the risk deemed acceptable by the authorities, due to the risk of introducing exotic disease agents and the substantial economic losses that had been suffered from such incidents in the past. The TAC recommended that protocols be developed for the responsible transfer of germplasm of species that were already established within the receiving country, and more stringent protocols if a translocation would involve the introduction of an alien species to a new locality. It was noted that the introduction of unknown alien strains should in principle be treated along similar lines to the introduction of an alien species and that transfers should be consistent with international conventions such as CITES.

TAC noted that there had been a significant amount of costly overlap and duplication in genetic research being undertaken in the region. A survey form would be distributed to institutions active in genetic research, and the information consolidated in an online database, to increase awareness and facilitate collaboration. TAC also suggested that a platform for collaboration in aquaculture genetics be established; this recommendation has already been acted on (see adjacent story on formation of a Consortium on Freshwater Fish Genetics and Breeding).

TAC recommended that the ongoing work on development and promotion of "Better Management Practices", and documentation of "success stories" in aquaculture should be continued and strengthened, to facilitate adoption at farm and policy levels. Similarly, further attention should be given to policy studies and practical guidelines for the improvement of culture-based fisheries, co-management and use of cage culture in inland water bodies to improve production and livelihoods.

The TAC endorsed a proposal to convene a ministerial meeting among emerging aquaculture countries in 2009 or 2010, to raise the profile of the sector and discuss opportunities for collaboration. The TAC also endorsed a second proposal to convene a follow up to the conference on Aquaculture in the Third Millennium in conjunction with FAO.

The final work plan will be made available on the NACA website in the second quarter of 2009, after its consideration at the next NACA Governing Council meeting.

30th FFRC anniversary

A tree planting ceremony was held to mark the 30th anniversary of FFRC. The centre has played a key role in NACA, providing strong technical support to other members over the past two decades. The centre has notably provided intensive training in integrated rice-fish culture, sponsored by the Government of China. NACA would like to thank FFRC for many years of support, and looks forward to ongoing collaboration in the years ahead.

Training Workshop on the Use of Molecular Genetics in Conservation held at USM, Malaysia

Participants in the genetics workshop, USM.

The Universiti Sains Malaysia (USM) in conjunction with Ministry of Science and Innovation Malaysia (MOSTI) and NACA co-organised the Training Workshop on the Use of Molecular Genetics in Conservation at the School of Biological Sciences, Universiti Sains Malaysia, Penang from 17 – 22 November 2008. The workshop was anchored by Dr Thuy Nguyen from NACA and two facilitators, Dr Siti Azizah Mohd Nor and Dr Latiffah Zakaria from the School of Biological Sciences, Universiti Sains Malaysia. The workshop was specially designed for post-graduate students, academicians and scientists who are working in the field of biodiversity and conservation with the objective to build capacity for Malaysian scientists and policy makers.

Twenty participants from various universities and research institutions in Malaysia and Brunei participated in the six-day workshop. These included participants from Universiti Putra Malaysia, Universiti Malaysia Terengganu, Universiti Brunei Darussalam, Forest Research Institute of Malaysia, Fisheries Research Institute, Malaysian Agricultural Research and Development Institute and Department of Chemistry, Malaysia.

During the training workshop, a series of lectures on molecular markers, phylogenetics and conservation were conducted. In addition to the main facilitators a guest speaker, Dr Geoffrey Chambers from the Victoria University of Wellington, New Zealand also shared his considerable experience and knowledge on conservation genetics. Hands-on training in PCR-based methods including polymerase chain reaction (PCR), direct sequencing, and microsatellites were also conducted as well as hands-on data analysis using software packages of MEGA, GENEPOP, STRUCTURE and ARLEQUIN.

The workshop was officially ended with a closing ceremony, officiated by the Chairman of the Organising Committee, Dr Siti Azizah. During the closing ceremony, all participants received a certificate of attendance presented by Dr Thuy Nguyen. Certificates were also given to facilitators and students helper who assisted in making the workshop a successful event.

Japan International Award for NACA Staff

Dr. Thuy T.T. Nguyen, the Coordinator of NACA's Genetics and Biodiversity Programme was one of the three recipients of the Japan International Award 2008 for Young Agricultural Researchers. The award, from the Ministry of Agriculture, Forestry and Fisheries (MAFF) in Japan is administered by the Japan International Research Centre for Agricultural Sciences (JIRCAS). The award was presented to Dr. Nguyen by Dr. Eitaro Miwa, Chairman of the Agriculture, Forestry and Fisheries Research Council and Dr. Kenji Iiyama, President, Japan International Research Centre for Agricultural Sciences (JIRCAS), at a ceremony held at the United Nations University Auditorium, Tokyo, on the 11th of November. The ceremony was attended by over 150 dignitaries.

Dr Nguyen receiving award from Dr Eitaro Miwa (centre), Chairman of the Agriculture, Forestry and Fisheries Research Council and Dr Kenji Iiyama (right), President, Japan International Research Center for Agricultural Sciences.

The award is intended to recognise and reward the contributions of young agricultural researchers to technological developments that improve food security and the environment in developing countries. Dr. Nguyen has been working with NACA on the application of molecular genetic tools in aquaculture aiming to minimise the impacts of aquaculture on local biodiversity.

Amongst the dignitaries present at the awards ceremony were agricultural researchers from Japan, accompanied persons of the award winners and representatives from the respective embassies of the award winners. From the Vietnam Embassy in Japan, Mr. Le Anh Thu, Second Secretary, attended on behalf of the Ambassador.

At the ceremony, Dr Nguyen was requested to make a 15 minute presentation on her work. She highlighted her recent contribution on the development of broodstock management plans for mahseer species in Sarawak, Malaysia and that of the critically endangered Mekong giant catfish, and their implications for conservation of biodiversity.

Other award winners were Dr Xiaoyuan Yan, from Institute of Soil Science, Chinese Academy of Sciences People's Republic of China on his research Developing greenhouse gasses emission inventories for croplands and evaluating their environmental impacts; and Ms. Maryam Ambundo Imbumi, Kenya Resource Centre for Indigenous Knowledge (KENRIK), Republic of Kenya on Promotion and research on African leafy vegetables for improved nutrition, health and incomes.

Consortium on freshwater finfish genetics and breeding

In recognition of the growing body of genetics research pertaining to aquaculture, within the region, NACA together with NACEE (the Network of Aquaculture Centres in Central and Eastern Europe) convened a consultation to discuss the formation of a consortium on fish genetics and breeding. The objective of the consortium would be to encourage collaboration and sharing of resources, and to identify and prioritise key researchable issues/projects on fish breeding and genetic resources management. The consultation was hosted by the Research Institute for Aquaculture No. 2, Vietnam.

The welcome addresses were delivered by Dr. Nguyen Van Hao, Director of RIA2; Prof. Sena De Silva, Director General of NACA; and Dr. Laszlo Varadi, Director of HAKI on behalf of NACEE. The meeting was attended by representatives of institutions throughout the NACA and NACEE networks, including from Bangladesh, China, Czech Republic, Hungary, India, Indonesia, Poland, Russia and Vietnam, as well as from the FAO and the WorldFish Centre.

Participants delivered a series of presentations on the status and research needs in common carp genetics and breeding, including:

- Country perceptions/needs in research and development for common carp genetics and breeding in Bangladesh.

- Common carp genetics and breeding in China.
- Overview of common carp genetics resources in the Czech Republic.
- Carp genetics and breeding in Hungary.
- Some experiences in common carp breeding and genetics research, India.
- Present status of common carp genetics and breeding at MCFAD, Sukabumi, Indonesia.
- Carp farming in Poland.
- Carp breeds cultivation in the Russian Federation.
- Complex of breeds and cross-breeding hybrids (F1) of the Cherepet carps intended for industrial warm-water aquaculture.
- Improving performance of common carp in Vietnam by selective breeding and molecular markers.
- Common carp breeding and genetics - involvement and contribution of WorldFish and partners.

The presentations are available for download from the NACA website at:

http://www.enaca.org/modules/news/article.php?storyid=1789.

Participants at the consultation, which was hosted by the Research Institute for Aquaculture No. 2), Ho Chi Minh City, Vietnam 3-4 December 2008.

Participating institutions expressed strong support for the establishment of a consortium on freshwater fish genetics and breeding. It was agreed that the collaborative activities of the consortium would initially focus on common carp, as it is of considerable interest to most countries in Asia and Central and Eastern Europe, and also due to the economic and cultural significance of this species. Proposed initial collaborative activities include:

- Preparation of a review on previous/current R&D activities.
- Inventory and documentation of common carp strains.
- Establishing a catalogue on common carp strains in Asia, in conjunction with an existing catalogue in development for Central and Eastern Europe.
- Facilitate exchange of expertise, including through inter-regional meetings.

Funding is now being sought to support formation of the consortium and initial collaborative activities. For more information, including expressions of interest in participation, contact thuy.nguyen@enaca.org or jeneyz@haki.hu.

Shrimp Farming eNews

NACA's Shrimp farming eNews, an electronic newsletter service, has restarted publication.

The newsletter provides the latest information on shrimp farming, trade, environment, market prices, and technology and industry development, obtained from NACA partners and media monitoring services.

Contents for the December issue includes:

- Revival of abandoned shrimp farms in Krishna District of Andhra Pradesh, India
- *Litopenaeus vannamei* in India: Challenges and opportunities for Indian small scale farmers and the role of BMP Programs
- Implementation of BMPs for Traditional Shrimp Farming in Bireuen and Aceh Utara Indonesia
- Progress on the IFC/NACA Aceh Shrimp Project
- WWF-Indonesia's Shrimp Aquaculture Program
- Application of PCR for improved shrimp health management in the Asian region
- "Shrimp Network" facilitating small scale farmer to access market through online database
- Improving capability for shrimp virus PCR testing laboratories in Vietnam
- Supporting Small scale farmer group in Thailand to Access EU market
- Market Information
- Upcoming Events

To subscribe/unsubscribe to this free eNews service, visit:

http://www.enaca.org/cgi-bin/mojo.cgi.

Seventh Meeting of the Asia Regional Advisory Group on Aquatic Animal Health

The seventh meeting of the Asia Regional Advisory Group (AG) on Aquatic Animal Health (AGM-7) was held on 15-17 December 2008 at NACA Secretariat in Bangkok, Thailand. The meeting, attended by 10 Advisory Group members and two additional co-opted members, addressed key aquatic animal health issues in Asia, including:

- Emerging crustacean, fish and mollusc diseases in the region.
- Outcomes from the OIE General Session (May 2008) and the Aquatic Animal Health Standards Commission meeting (October 2008).
- Global issues of relevance to aquatic animal health.
- Import requirements for the European Union.
- Regional Quarterly Aquatic Animal Disease Reporting System (QAAD).
- New OIE disease list for 2008 and proposed list for 2009.
- List of diseases for 2009 QAAD reporting.
- Implementation of the Asia Regional Technical Guidelines on Health Management and the Responsible Movement of Live Aquatic Animals.

The Asian Regional Advisory Group on Aquatic Animal Health.

- Functioning of the three tier regional resource base.
- Ways to further strengthen regional and international cooperation in Asian aquatic animal health management.

The AG constituted by NACA governing council in 2001, has been providing advice to Asian governments and NACA on aquatic animal health management matters in the region. Members are experts from government and the private sector with representatives from FAO, the Aquatic Animal Health Standards Commission of the OIE, the OIE Regional Representation for Asia and the Pacific, SEAFDEC and NACA. The final report is available for free download from the NACA website at: http://www.enaca.org/modules/wfdownloads/singlefile.php?cid=132&lid=968.

Sri Lankans learn pisciculture at CIFA

The Central Institute of Freshwater Aquaculture, India, will host a group of 21 fish farmers and three government officers from Sri Lanka, who are visiting to learn fish culture techniques at the institute. The trainees will be exposed to recent advances in fish breeding, fingerling rearing and pond culture.

CIFA has been engaged in capacity building of the officers of Department of Fisheries of Indian states and also of neighbouring countries, as a contribution to regional cooperation, brotherhood and friendship. The visiting group is headed by Sh. H.A.M. Kulatilaka, the Assistant Manager of Reservoir Fisheries Management under the Sri Lankan Ministry of Fisheries and Aquatic Resources. The trainees will visit the institute for eight days.

The training will be imparted through “seeing is believing” and “learning by doing”. Participants will gain firsthand experience in key aspects of hatchery management, selection of broodstock, hormone injection, spawn collection and nursery pond management. To overcome language barriers, interpreters will be provided. The training will be coordinated by Dr J.K. Jena, Head of Division and Dr Kuldeep Kumar, Senior Scientist of the Institute.

Incoming Sri Lankan trainees.

India's Central Institute for Freshwater Aquaculture observes 33rd Foundation day

The Central Institute of Freshwater Aquaculture, Bhubaneswar, Orissa, observed its 33rd foundation day on 3 January 2009. Retired directors, scientists and other staff members of the Institute assembled to celebrate the occasion. Speakers included Dr Ambekar Eknath, the present Director; Dr. R. K. Jana and Dr. N. Sarangi, retired directors; Dr. S.D. Gupta, Dr. R.K. Dey and Dr. D.R. Kanaujia, retired principal scientists of the institute. Recalling the early days of the institute, the founders expressed their happiness that the seed sown some three decades ago has flourished into a world-class research institute. Participants lauded the contribution made by the institute towards the growth of the aquaculture sector and the well being of the fishing community.

The institute began its journey in 1977 as the Freshwater Aquaculture Research and Training Centre. Subsequently, it became a constituent of the Indian Council of Agricultural Research (an autonomous body under Ministry of Agriculture, Government of India). During the last three decades, the Institute developed and disseminated several key technologies for freshwater aquaculture production. Dr Ambekar Eknath, the present Director indicated that the R&D backup provided by the institute has contributed to a significant increase in inland fish production, which has touched 3.8 million tonnes during 2006-7. Notable recent accomplishments of the institute include the cloning and characterization of GnRH and GtRH of rohu; off-season breeding of Indian major carps; commercialization of some of the institute's technologies; training and capacity building of over 3,000 farmers and entrepreneurs including many foreign nationals; popularisation of aquaculture technologies in Orissa and in north eastern states. Dr Eknath called upon the staff to continue working towards scientific research that will underpin the sustainable growth of the freshwater aquaculture sector.

A scientist-farmer interaction was held as a part of the celebrations, during which a large number of farmers solicited advice to solve production problems and increase productivity. A CIFA helpline (0674-2111849) has also been established to extend advisory services to farmers in local language. Sri Murali Dhar Bhoi (age 74) of Nakhaur Patna Village in Khurda District, one of the participants of the first ever year long training on aquaculture held during 1977-78 said that CIFA had shown him and many others "a way of life".

With his able leadership in the community, the whole village has now come to be regarded as a model fisheries village.

Network of Aquaculture Centres in Asia-Pacific

Mailing address:
P.O. Box 1040,
Kasetsart University
Post Office,
Ladyao, Jatujak,
Bangkok 10903,
Thailand

Phone +66 (2) 561 1728
Fax +66 (2) 561 1727
Email: info@enaca.org
Website: www.enaca.org

NACA is a network composed of 17 member governments in the Asia-Pacific Region.