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AQUACULTURE ASIA

Aquaculture business for rural women

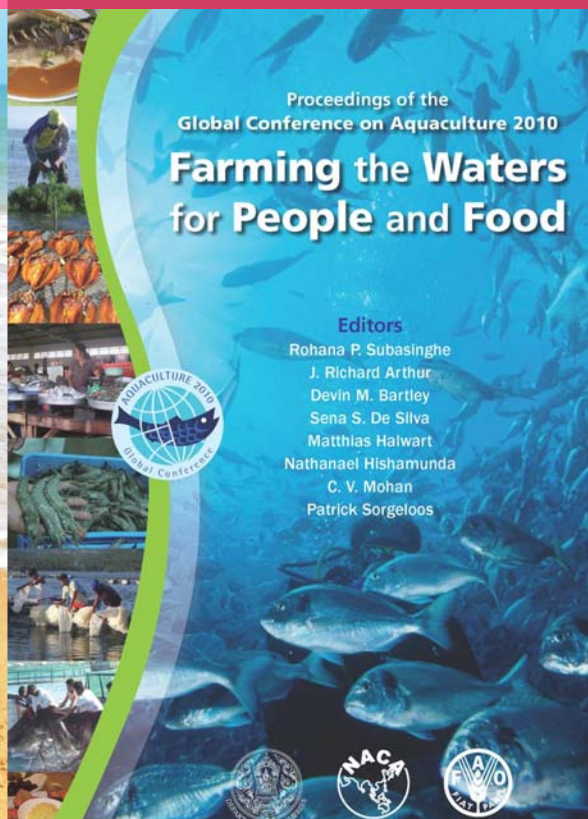
Shrimp farming in Andhra Pradesh

Soybean meal in cobia diets

Farming the waters!

Spiny lobster in sea cages

Vietnam vannamei



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Doing something about broodstock management

I covered the dire state of broodstock management in Asian aquaculture way back in July 2004. To briefly recap, aquaculture brood stock are, for the most part, effectively unmanaged in the region. In fact mismanaged might be a better term, since hatcheries commonly adopt practices that are not just suboptimal, they are downright detrimental to the integrity of their stock and the quality of the seed they produce.

Common problems include (but are by no means limited to) maintaining only enough broodstock to meet their seed production requirements but insufficient to maintain their genetic diversity across generations; recruiting "new" broodstock from their own seed supply leading over time to unmanaged inbreeding; use of group spawning techniques which may produce offspring of unexpectedly skewed parentage; inadvertent hybridisation due to use of multi-species spawning pools; and deliberate hybridisation for the sake of convenience (we ran out of species A males so we fertilised the eggs with species B instead) or due to a misplaced fascination with the supposed "benefits" of hybridisation (if you're doing this, now would be a good time to stop); and attempting to counter problems by purchasing "new" broodstock from other hatcheries that also have poor practices. Add inadequate record keeping to this genetic blender and you can see that it doesn't take long before for a hatchery has no idea whatsoever about the pedigree of their fish.

But there is hope. A scientific approach to aquaculture broodstock management is finally beginning to attract some, if insufficient, resources from government and large corporate interests. Interest in scientifically managed genetic improvement programmes for aquaculture is increasing and a handful are actually producing seed that is commercially available to some extent. Of course in terrestrial agriculture you would be hard pressed to find any unimproved crop in production at all, but still, things are slowly improving.

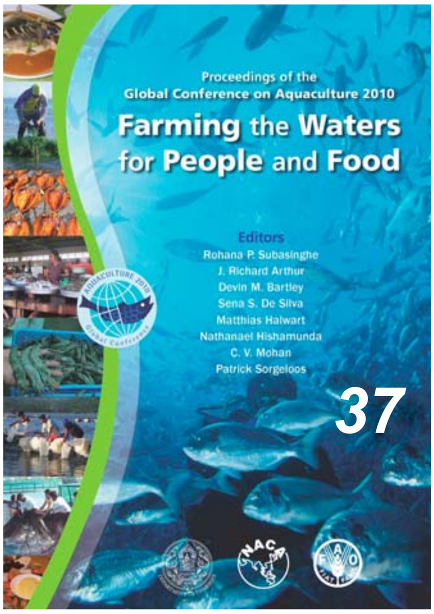
In an effort to kick things along a bit faster, NACA and the Fisheries Training Programme of the United Nations are jointly developing a short training course on the principles and practices of broodstock management in aquaculture. The course is being developed in collaboration with Nha Trang University, Vietnam; Deakin University, Australia; Holar University, Iceland; and the Victorian Department of Primary Industries, Australia.

The first run of the training course will be conducted from 18-25 March 2013 at Nha Trang University for selected participants from six to eight Asian countries. The course organisers will provide financial support to the ten most promising nominees from NACA member countries, but ten additional positions are available on a fee paying basis for other interested parties. We hope that this will become a regular offering. For more information about the course including sign up instructions, please visit:

http://www.enaca.org/modules/news/article.php?article_id=1957

Simon Wilkinson

AQUACULTURE ASIA



CONTENTS

Peter Edwards writes on

Rural Aquaculture

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Shrimp farming in Andhra Pradesh, India

I took up a kind invitation from Balasubramaniam V., General Secretary of the Prawn Farmers Federation of India, to visit shrimp farms in India in March this year. There has been considerable publicity on the success of the establishment of clusters of small-scale farmer clubs in the country so I was keen to witness this first hand. Bala guided me on an intensive two day trip to Nellore, the southernmost district of Andhra Pradesh State about a three hour drive north of Chennai, to visit half a dozen sites in different localities with a range of systems. Our local guides were staff from the local branch of Charoen Pokphand (CP), a Thai transnational company. CP started to import feed from Thailand in 1991 but by 1996 had opened its first feed mill in the country and now has two feed mills in India. I was pleased to be told that Aekapan Ratchatasattakul, a 1986 AIT alumnus, was based in India to help to set up the company operation in the late 1980s/ early 1990s. An unexpected pleasure on returning to the hotel after the first day's field visits was to be invited to a lecture by Dr. Chalor Limsuwan, a shrimp specialist from Kasetsart University in Thailand, who by coincidence was in Nellore to give a presentation on white shrimp culture to local farmers.

My guides, Bala, General Secretary, Prawn Farmers Federation of India (left) and Ganesh Murthy, Charoen Pokphand on the large shrimp farm in Kandalur Creek.

Shrimp culture has developed rapidly in India, with 60,000 tonnes total national production in 2009 more than tripling to 200,000 tonnes in 2011. The production dipped to 60,000 tonnes in 2009 from a steady 125-135,000 tonnes in previous years. It was pointed out that this is still only about a third of Thailand's national output, indicating significant potential to further expand shrimp production in India. Andhra Pradesh is the major shrimp producer in India with 60% of the national production; and CP is the single largest company providing service to shrimp farmers with 60% of the market share.

Shrimp production in India used to be dominated by black tiger shrimp (*Penaeus monodon*) with a national production of 100,000 tonnes in 2010 but today, although production has doubled, it is now dominated by the introduced Pacific white shrimp (*Litopenaeus vannamei*) as tiger shrimp

Intensive farming of white shrimp.

production has been decimated by white spot syndrome virus (WSSV) and now comprises only about 40-50%.

Although there is traditional integrated rice/shrimp culture in Kerala and West Bengal States, modern shrimp farming was introduced into Andhra Pradesh in the late 1980s and early 1990s in areas without traditional aquaculture practice. Rather than modification of existing extensive fish and shrimp ponds, as occurred initially in some SE Asian countries such as Indonesia and Thailand, shrimp ponds were constructed on coastal lands previously devastated by typhoons and on poor rice land where there was only one rain-fed crop because of limited freshwater. There is no rotation of rice and shrimp in modern shrimp culture in Nellore as the ponds are too deep to cultivate rice.

Field visits

Our first visit was to two shrimp farmers in Kavali Mungamur, a former agricultural area converted into shrimp ponds about 15 years ago and surrounded by rice fields, located about 15 km from the sea. Water was provided by a small creek supplemented by bore water. The farmers used to grow rice but changed to shrimp because of higher profit. They started with a single pond with low density culture financed by themselves, with profits from shrimp reinvested in higher density culture in more ponds. Tiger shrimp was cultured until two years ago when the farmers switched to white shrimp. Although the farmers were being serviced by CP, they told me that they were setting up a farmer group with half a dozen other farmers to be able to obtain government subsidies as well as improved technology.

One of the two farmers was interviewed in depth. He had six 0.8 ha aerated ponds and two reservoirs to treat creek water with bleaching powder before stocking shrimp. He stocked white shrimp PLs at 30/m^2 in March/April and harvested them after 110 days in June/July at 30 pieces/kg (33.3 g) with an extrapolated production of about 9 tonnes/ha. Survival was 90% and the FCR 1.4-1.5. There was no water exchange during the culture cycle after which the ponds were drained into another creek. There was no disease in this area due to high biosecurity although about 10% of the farmers in other parts of Andhra Pradesh were said to be affected. The farmer hired five full-time workers so about one worker/ha was employed on the farm.

The farmers were following the ‘30 counts in 90 days’ program popularised by CP through a campaign and promoted by their field staff. CP staff make weekly visits to cooperating farmers to monitor progress of the crop, including weighing of sampled shrimp, and to offer advice. It is not contract farming as CP, though selling specific pathogen free (SPF) PLs, feed and chemicals, does not buy back the harvested shrimp. The farmers reported that they used to get a 30 count of shrimp in 140 days but with the new program it now took only 90 days.

The 'CP 30 counts in 90 days' program according to their newsletter comprises six steps:

1. Biosecurity – crab and bird fencing, water treatment and farm sanitation protocols to prevent disease causing organisms from entering the culture system, and continuous monitoring of shrimp growth by CP staff.

2. CPF Turbo shrimp seed – stocking a CP developed genetically improved specific pathogen free white shrimp which grows fast with a high survival rate and low feed conversion ratio.

3. CPF feed management program – a CP BLANCA feeding program.

4. Efficient aeration system– paddle wheels.

5. CP probiotic program – use of a pH fixer to stabilise the plankton bloom and the pH.

6. Water quality and waste management – control of pH below 8.2 by applying a carbon source; use of minerals from Sodamix and Cal Mag to balance the mineral requirement; and use of a sludge pump or siphoning device to remove the waste from the initial stage of culture.

A group of smaller farmers, each owning a 0.4 ha pond was interviewed in Tummalapenta village in Kavali Mandal. The group of 27 farmers, the 'Gangaputra Aquafarmers Association' was set up one year ago by the National Centre for Sustainable Aquaculture (NaCSA) although they had been raising shrimp for 20 years. Previously they had farmed tiger shrimp without assistance but all had failed due to WSSV disease and now all had stocked white shrimp. The farmers had been motivated to set up a farmer group to obtain SPF seed of white shrimp and advice about better management practices (BMPs) although CP would still provide service. The group met every 15 days and invited experts to talk to them. Their main problem was marketing as they still lacked a Coastal Aquaculture Authority (CAA) license although they had applied for one a year ago. Buyers demand a licence and without it they could have difficulty in selling their shrimp as processing plants give priority to licensed shrimp farmers. The farmers told me that there were two other farmer groups nearby: 'Mundurapottimma' and 'Ommsai', both with 22-25 single pond owner members.

In Ramulupalem village there were 160 small-scale shrimp farmers most of whom were also fishers as the 150 ha site was close to the sea. Most of them owned their own land. All were now

Feeding white shrimp.

Sampled white shrimp of 25 g.

Charoen Phokphand staff monitoring shrimp growth.

raising white shrimp in aerated ponds after having failed with tiger shrimp, and again were supported by CP. They may have difficulty selling their shrimp from May to July when there is a glut in production as they lacked a license and thus were considered to be illegal with processing plants giving preference to shrimp from licensed farmers. To get a license they would need to install a reservoir and effluent treatment system. An interviewed farmer was not aware of a farmer group in the village and said that they preferred to be independent as then they could do what they wanted; clearly there is a need to teach farmers the benefits of group formation. Fishing is only a part-time occupation - it is forbidden to fish from 14 April until the end of May as this is the breeding season for the fish in the ocean and the fishing ban is to help the fish breed undisturbed but this also the monsoon season and they could not fish as the sea is too rough.

We visited Utukuru village after lunch where there were 22 farmers each with an area of 1-2 ha. Most were rice farmers who had converted their fields into shrimp ponds. Tiger shrimp was raised initially but crops had failed due to WSSV virus and some farmers had converted their shrimp ponds back to rice fields, with the shrimp pond drainage structures clearly visible along the field dikes. The whole shrimp farming area had nearly been abandoned but some farmers had recently reconverted back to shrimp again with the availability of SPF white shrimp seed.

The final visit of the day was to a large area of shrimp ponds near Gudur village with very intensive production of white shrimp, using both creek and bore water. A large farmer was getting high yields of over 20 tonnes/ha of rather small sized shrimp for India of 35 and 45 pieces/kg.

Products sold by Charoen Phokphand for intensive shrimp farming.

A group of small-scale shrimp farmers with Sunil Reddy of CP, third from right.

On the second day we visited Kandalur Creek, a major shrimp farming area. The creek has an average width of 12-13m and depth of 5m, and good water flow. The first 10 km of the creek are inaccessible swamp but shrimp ponds have been developed from rice fields along both sides of the next 10-37 km of the creek, starting in 1989. Small as well as large shrimp farms occur in the area, with 7-8 farms each covering 120 ha. The Creek also serves agriculture and at the time of our visit the salinity, normally ranging from 5-25 ppt, was zero as water was being released from a dam for crops, so stocking shrimp was being delayed. After crop harvest the flow of freshwater would be stopped and then seawater would flow up the creek. Pesticide residues in agricultural run-off were a concern of shrimp farmers.

We visited a range of farms in Kollannakuduru village about 3 km from the creek. The first farm visited was well over 100 ha in area, with over 200

A small-scale shrimp farmer and coastal fisher with the writer.

Fishers' children.

A shrimp pond reconverted back to a rice field.

ponds of 0.6ha with 2m depth in 12 sections with 17 ponds per section. Two effluent treatment ponds each of 1.2 ha were under construction. The owner was a former better-off rice farmer and he had purchased the land which had been used previously for salt pans.
At the time of the visit, only 5 sections had been stocked with white shrimp at an exceptionally low stocking density of 17 PLs/m^2, aiming at producing shrimp of 20 pieces/kg (50g). This this would give a maximum harvest of only 6-7 tonnes/ha, although of large size shrimp worth US$10/kg. Last year the farm had produced a total of 150-180 tonnes of shrimp or an average harvest of about 15-18 tonnes/ha, a very large and highly intensive farm for this region. Only one crop per year is possible as the area floods and in 'flooding years' the water level rises to 1.5 m above the level of the dikes. The farm hired a total of 90 workers, 75 labourers and 15 technicians, giving an average of 1.3 workers/ha on the 120 ha farm. The main concern at the farm was a fungal infection of shrimp probably caused by the low salinity. This was given as the main reason for changing from tiger to white shrimp.

A second farmer we interviewed in the village had four 1 ha ponds, also constructed from salt pans, and 10 ha of rice paddy at another site. Five years ago he only farmed rice but invested in shrimp culture from his savings from agriculture. His aerated shrimp ponds, stocked with white shrimp, were originally on leased land but now he had purchased the site. He learned how to farm shrimp from working on a large shrimp farm.

The last two farmers interviewed were each raising tiger shrimp stocked at a low density of 5-6/m^2 in a small 0.8-1.2 ha un-aerated pond. They had been raising shrimp for 10 years. They had no problems for the first 3-4 years but then had WSSV disease and for the next few years they lost the crop half of the time. They said that they were unable to raise white shrimp as it would require more investment for aerators. They used their savings to build their pond and purchase seed although they got feed on credit from a CP dealer. Such a small shrimp farm did not provide sufficient income, so like other small-scale shrimp farmers they were also part-time day labourers, carpenters or stone masons.

Their ponds were on government land and they had a 5 year lease. They would be unable to buy the land as the government only leased land near forests or water. They were concerned about the possibility of mortality from the fungal disease as they would not be able to overcome the disease easily.

Dr. Chalor's lecture

His evening lecture on 'White shrimp culture in India' in the hotel in Nellore was well attended by local shrimp farmers. The main point given in his opening comment was that Indian farmers should produce large-sized shrimp of 25 g or bigger as they cannot compete with Indonesia and Thailand where they produce small-sized shrimp of only 10-20 g.

Farmers should stock good quality PLs from good quality broodstock. Factors essential for successful shrimp culture are good water and pond management, good disease prevention, and a biosecurity system. He also outlined the reasons for a good feeding program: to produce good growth and to reduce the cost of production by lowering the FCR as well as the need for good water quality and a good pond bottom. Dr. Chalor then provided details relating to the above.

Concluding comments

Scale of farms

Although there are a few corporate farms in Nellore with an average size of 100 ha, most farmers have only one to two ponds with an average size of 0.7 ha. Most of the shrimp farmers were rice farmers before farming shrimp; Nellore means 'rice bowl' in the local language. Most farmers own the land on which their ponds are built. Large-scale farms mostly rent the land from small-scale agricultural farmers as is the case for carp and striped catfish farming in the State.

We interviewed a range of farmers, from very small-scale to very large-scale. Even though some of them still farm

A newly constructed effluent treatment pond on a large-scale shrimp farm.

A small-scale farmer raising whire shrimp in an aerated pond.

rice, they are best considered as 'quasi-capitalists' rather than 'quasi-peasants' based on their mode of production which is intensive pellet-fed for sale rather than for subsistence. My article in the last issue of the magazine discussed scales of farming, with relations of production being a better descriptor than farm size.

Most of the people in local villages are very poor landless labourers, the vast majority of who could not be expected to become shrimp farmers as they would not have sufficient capital. Several shrimp farmers were interviewed who had previously only farmed rice, and a few still farmed rice as well as shrimp, but they had started small from limited savings from agriculture and had gradually expanded the size and/or intensity of their shrimp farming operation. However, a small shrimp pond of only 2-3 acres (0.8-1.2 ha) would not provide sufficient income and such households would also need to have other livelihood occupations, either continuing to farm some rice or having other off-farm employment, as was observed.

Farmer clubs

Although I did meet farmers who were organised into clubs, none were those that had been set up through the MPEDA-NaCSA-NACA-project which apparently are mainly in East and West Godavari and in Krishna in central Andhra Pradesh.

There are many advantages for small-scale farmers to belong to clubs as reported in several recent publications. An issue is many farmers do not want to be organised into groups as they are individualistic, or if they do belong then they are non-compliant with the group regulations. One interviewed farmer commented that farmer clubs are of limited use because they do not provide inputs. Nor do many farmers want to contribute even a minimal subscription towards the cost of farmer club maintenance and prefer to remain as independent operators. If farmers were willing to contribute as little as US$2/month according to Bala, the sum collected could be used to establish a huge pressure group to promote the Indian shrimp sector and the welfare of the farmers. Clearly there is a need

Small-scale ponds without aeration are stocked with tiger shrimp.

to educate farmers on the benefits of belonging to a farmer club or cluster. There is still a long way to go. A national workshop on 'Better Management Practices and Cluster Management for Empowering Small Scale Farmers: Scaling Up Strategies' held in CIBA, Chennai in May 2011 recommended an evaluation of successes and failures of the MPEDA/NaCSA BMP and cluster management project to evaluate its impact and suggest ways to move forward.

Service provision

Intensive shrimp culture requires major off-farm inputs: Knowledge of BMPs to contribute towards sustainability, quality seed and feed, and a variety of chemicals and medicines. The provision of these is a major factor in successful shrimp farming. Although I was no doubt influenced by my private sector guides from CP Company, both their contacts with a wide range and large number of successful shrimp farmers and their service to farmers in the sale of farm inputs, advice and crop monitoring were most impressive. Shrimp farming like any other form of aquaculture has ultimately to be a private sector activity for it to be sustainable. Although companies have to be profitable and are thus primarily driven by money rather than ethics, it is in their best interests to provide the best service to their farmer clients. Other companies besides CP also provide similar services: Avanti in partnership with Thai Union Feedmill, Cargills and UniPresident. Perhaps the feed industry has the greatest potential to promote, serve and maintain a sustainable shrimp sector, including its small-scale farmers. The latter can be better served by being in at least geographical clusters which would facilitate provision of the full range of services required for sustainable farming, education on BMPs as well as provision of inputs.

Shrimp species

The shrimp sector was initially dominated by tiger shrimp but it almost collapsed because of disease, especially WSSV. It was saved by the introduction of white shrimp, especially SPF PLs of the species. White shrimp now dominates national production but should SPF PLs of tiger shrimp become available, many farmers would likely shift back to this species as it can be more easily grown to large size in less intensive systems without aeration than white shrimp and be more readily farmed in a less intensive and therefore cheaper way which would better suit small-scale farmers.

Shrimp seed

Farmers reported that the supply of SPF broodstock and hence SPF PLs of white shrimp was still insufficient. The Government Quarantine Centres only through which the brooders have to be imported, are grossly inadequate to handle sufficient brooders. White shrimp was introduced in 2009 and in 2010 farmers were still in a 'wait and see' mode; but having seen the success of white shrimp farming, many farmers 'jumped in' this year, leading to the seed shortage. Some hatcheries are now producing and selling PLs of white shrimp from pond raised broodstock, which could lead to the outbreak of disease. This is especially an issue for so-called 'illegal' inland shrimp farmers who have been operating for years and produce a massive amount of shrimp. Licensing is carried by the Coastal Aquaculture Authority of India (CAA) which only registers coastal farms. However, there are now guidelines for the registration of inland shrimp farms through local government.

The availability of good quality specific pathogen free (SPF) seeds was a 'welcome break for the farmers' according to Bala as previously they were stocking what they described as poor quality tiger shrimp seed from wild brood stock. The susceptibility of tiger shrimp to WSSV was the main cause of the decline in the culture of this species; its declining growth rate as perceived by the farmers has not been tested scientifically. Initiatives to develop SPF seed of tiger shrimp in India are apparently slow but should this be achieved it is believed that many farmers would revert back to growing this species as it can be grown more profitably.

Effluent treatment systems

These are now becoming mandatory for licensing. This may be a problem for the smallest farmers with only one or two ponds although several farmers in an area could build a communal waste treatment facility if they could

Tiger shrimp with a fungal infection.

work together. There is even a problem for large-scale farms as several ponds cannot be harvested at once because of insufficient storage volume for all the wastewater

Shrimp size

Indian shrimp farmers mostly produce larger and higher value shrimp as they cannot compete with farmers in other Asian countries producing larger crops of smaller shrimp which are mainly processed for value added products. Domestic consumption in India is still low with most of the crop being exported unlike in other major shrimp producing countries in Asia where there is significant domestic consumption to absorb production in excess of processing capacity. In India white shrimp is stocked at much lower densities than elsewhere, only 20-30 PLs/m to attain a size of 30-25/kg at harvest (33-40g) compared to 60-100PLs/m^2 producing below 40 count/kg (25g), which requires higher capital and operating cost although the larger harvested shrimp fetch a higher market price. As Bala commented, 'being able to grow white shrimp to a large size is a blessing for the farmers'.

Bala does not recommend as high a stocking density as CP, only 10-15 PLs/m^2, as it uses less infrastructure such as aerators and operating cost for seed and feed. According to Bala, 'the farmers are broke and they need to make a bit of money before they intensify. Low density culture produces large shrimp which make more money, and with less risk. Why convert a luxury food into a commodity he added?'

Shrimp prices

The price of shrimp crashed in India last year in because of overproduction. The price was $9/kg in March 2011 but declined to $3.2 -3.4/kg for 30 pieces/kg in July/August. The price at the time of my visit in March 2012 had risen to $5.5 -6.0/kg but at this low price the farmers were only 'hanging in'. The price should be $6.0 - 6.5/kg for farmers to make a decent profit according to Bala.

Shrimp should of course be raised in environmentally friendly and socially responsible ways but the increasing demand from the West for shrimp to be certified as such is proving to be a burden to farmers as it is driving up the cost of production and therefore the profit the farmers receive for their shrimp down. More equitable cost sharing along the value chain is needed so that farmers, and especially small-scale farmers, do not suffer.

As most shrimp are now exported, there is a need to promote market demand within India, which potentially is far greater than the export market because of India's huge and increasingly affluent population.

Processing plant capacity

Shrimp farming in India is mainly a seasonal practice which causes a mismatch between production and processing plant capacity. Most crops are harvested in June/July with shrimp supply exceeding plant capacity, leading to lower prices for farmers when there is good international market demand.

Farmers are being advised to start stocking in January/February, although the temperature and salinity in the creek water is not conducive for stocking as there are cyclones and heavy rain from October to December; farmers were also advised to stagger stocking to beat the market glut and consequent crash in prices, but this would not be easy for small-scale farmers to do as most have only one or two ponds.Clearly there is a need for increased shrimp processing capacity as well as the development of value-added products. Furthermore, there is a danger of converting what is now a high-value luxury commodity into a lower-value one through overproduction and declining prices. While this would be beneficial to consumers, it may disadvantage farmers if their profitability falls.

Small indigenous freshwater fish species in village community ponds to ensure nutritional security of rural poor in Odisha

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Small indigenous freshwater fishes are very important in the diets and livelihoods of the poor fisher communities who represent one of the lowest socio-economic strata of society, and who may frequently suffer from vitamin and mineral deficiencies. Such micronutrient deficiencies, sometimes called "hidden hunger", are not always obvious. One way to mitigate this problem of the rural poor in the developing countries is to produce fish, providing high quality, cheap and readily accessible sources of micronutrients as well as protein. In this regard small indigenous freshwater fish species may play a significant role to combat nutritional security problems as the bioavailability of micronutrients from small indigenous freshwater fish is reported to be very high.

In the past, small indigenous freshwater fish were available in large quantities in natural waters and fisher communities often used to take benefit of it as they enjoyed free access to such resources. Small indigenous freshwater fish not only provided them with a cheap food source but also enabled them to earn their livelihood. Such fish were consumed predominantly by poor sections of the population, whereas larger fish were preferred by more affluent consumers. Of late, due to habitat destruction and environmental threats the biodiversity of small indigenous freshwater fish is declining in natural water bodies. Therefore, it is worthwhile to conserve these precious small indigenous freshwater fish through captive breeding and culture. Village community ponds provide a very good habitat for some of the important species, where they can grow to maturity, breed and proliferate along with other cultured species. An attempt was made in this article to understand species diversity of small indigenous freshwater fish, its contribution to fish production especially in community based aquaculture in rural Odisha; nutritional benefits and traditional system of harvesting. The article also suggests measures to conserve small indigenous freshwater fish and means of proliferation to assist the rural poor to access such nutrient dense foods on sustainable basis.

Approach

Indigenous methods of catching small indigenous freshwater fishes from natural water resources (seasonal water sheets such as canal/road side borrow pits, village side ditches, low lying water logged paddy fields, other shallow water bodies adjoining to paddy fields and swampy seasonal waters etc.) were studied through an extensive survey in rural areas. In order to ascertain the contribution of small indigenous freshwater fish production in total grow out carps as part of community based aquaculture management, the study was carried out through focus group discussions (FGD) with community pond owners during 2009-2012 in Khurda and Puri districts of Odisha. Data with regard to species diversity, harvesting and disposal were gathered by interviewing farmers from 81 randomly selected ponds. Typical conditions were as follows: Ponds were leased for one to five years and managed traditionally by the community members. Though aquatic weeds were removed manually, small indigenous fish species including predatory fishes were not eradicated from the village community ponds. Pond embankments did not having proper outlets and inlets. At times, the area was subjected to inundation during heavy rains and/or flood. The community ponds were generally stocked with Indian and exotic carp fingerlings at varying stocking density. Ponds were made productive by applying cow dung and inorganic fertilisers. Fish were fed traditionally using locally available ingredients. Grown out carps were generally harvested using large size mesh net while small indigenous freshwater fish were harvested with the help of fine size mesh net.

While harvesting from very old village community ponds small indigenous freshwater fish generally get mixed in with decomposing debris, requiring fishers to separate them. Children from poor communities often search for very small fishes amongst the discarded debris. After segregation the small fishes were distributed for consumption or sold. In some of the village community ponds the production of *A. mola* production was very impressive. *A. mola,* being a highly preferred fish species, were sold at elevated price in local market. From some ponds carps and weed fishes were distributed, while in some cases only carps were distributed for family consumption. The availability of small indigenous freshwater fish, species diversification, reasons for decline in propagation, share of small indigenous freshwater fish in total fish biomass, nutritional aspect of small indigenous freshwater fish and benefits to rural poor, were discussed. Ways and means of conserving small indigenous freshwater fish and propagating the same, as suggested by the farmers, are presented.

Findings

Availability of small indigenous freshwater fish in nature

Small indigenous freshwater fish are caught from a wide range of water bodies in rural areas. When the fish migrate from the perennial waters such as lakes, rivers, channels and reservoirs into the flood plains to breed and spawn during the rainy season, fishers make use of these migrations by blocking the streams with various types of fishing gear. At times, these migrating fishes along with their offspring get trapped in seasonal water sheets such as canal/road side borrow pits, village side ditches, low lying water logged paddy fields and swamps. Fishers catch the small indigenous freshwater fishes using a wide range of traditional methods for their household consumption and/or for sale in the local market.

Reasons for small indigenous freshwater fish decline

Due to myriad of factors such as water pollution, habitat degradation, threats in habitat due to dams and barrages, run-off of pesticides and chemicals from agricultural fields into aquatic systems, encroachment of wetlands and other water bodies for human settlement and other developments, reduced rainfall and poor flooding, accumulation of polluted water from the surface run-off, over fishing and disregard for fishing regulations, the catch of small indigenous freshwater fishes is gradually declining and some of the species appear to be heading towards extinction, resulting in decreased accessibility of small indigenous freshwater fish to rural poor.

Small indigenous freshwater fish spectrum

Sarkar[1] (2010) reported that there are 765 species of freshwater fish in India. Among them 450 may be categorised as small indigenous freshwater fish with a maximum length of up to 25-30 cm. Of 296 species reported from northeast, 216 are small indigenous freshwater fish. Although 100 species are important for their food value, only 62 small indigenous freshwater fish are recognised as significant for food security. Some 42 small indigenous freshwater fish are used for ornamental purposes and some are considered medicinal too. However, small indigenous freshwater fish diversity differs from region to region. About 62% of small indigenous freshwater fish are highly resilient (population doubling time < 2 years), whereas 38% are medium resilient (population doubling time > 5 year).

Commonly available small indigenous freshwater fish in village community ponds

In general small indigenous freshwater fish are eradicated from composite fish culture ponds during clearing of predatory and weed fishes. However, in community ponds that are used for multiple purposes by multiple user groups, when used for carp culture the weed and predatory fishes are rarely eradicated. In cases where they are eradicated the embankments of the community ponds are usually too insecure to prevent their entry during monsoon months. Being self-recruiting species and highly resilient they proliferate in community based fish culture ponds along with fast growing Indian major carps and exotic carps. These small indigenous freshwater fish form a major component of food consumed by the village community members. Some of the major species found in village community ponds are as follows.

Weed fishes: *Amblypharyngodon mola, Macrobrachium lamarai, Puntius sophore, P. ticto, P. conchonius, Esomus danricus, Danio devario, Chanda spp., Lepidocephalichthys guntea, Rabora, Gudusia chapra, Osteobrama cotio, Oxygaster spp., Chela laubuca, Labeo bata, Cirhinus reba, Goniolosa spp., Colisa fasciotus, Aila coila, Pseudeutropius atherinrides.*

Predatory fishes: *Channa spp., Notopterus notopterus, Heteropneustes fossilis, Clarias batrachus, Mystus spp., Anabas testudineus, Badis badis, Glossogobius giuris, Macrognathus aculeatus, Mastacembelus puncalus, Xenentodon cancila, Mastacembelus armetus, Nandus nandus, Ompok bimaculatus and Clupeisoma garua*.

Small indigenous freshwater fish contribution from community ponds

Carp production in village community ponds was usually on the order of 739 kg/ha/year in one year leased ponds, 994 kg/ha/year in three-yearly leased ponds and 1,634 kg/ha/year in five yearly leased ponds[2]. The small indigenous freshwater fish contributed 20-26%, 15-19% and 5-12% of the total grow out carp fish production in one, three and five year leased community ponds respectively. Radheyshyam[3] in his study recorded 3,635 kg weed and predatory fish along with 15,500 kg carp production from 3.5 ha village community ponds from Siula village of Odisha which indicated small indigenous freshwater fish represented an additional harvest equivalent to 23.45% of total carp production. Most of the small indigenous freshwater fish were distributed among the village community members for their own consumption. However, a surplus quantity was sold locally. According to Radheyshyam[4] the availability of small indigenous freshwater fish increased significantly (weed fishes, 748%; predatory fishes, 175%) when fisher folk adopting composite culture in community ponds and accordingly consumption of small indigenous freshwater fish by community members also went up (52% weed fish; 22% predatory fish). Roos[5] also reported a successful culture of *A. mola* in seasonal village community ponds in poly culture with carps. It has been demonstrated in Bangladesh that culture of small indigenous freshwater fish along with Indian major carps increases total fish production.

Nutritional importance of small indigenous freshwater fish

In rural areas, the small indigenous freshwater fishes are the most important source of animal protein and provide essential nutrients (particularly iron, zinc and calcium) and fatty acids to rural households[6]. The bioavailability of calcium from some of the small indigenous freshwater fish is at par with that obtained from milk[6]. They are also rich in vitamin A and calcium[7]. These small indigenous fishes are generally consumed along with their bones, which further provide an opportunity of enhanced rate of calcium intake in the diet of rural population[5]. A. mola contains about 89 times more vitamins than grass carp. Esomas contains highest content of iron with the maximum bioavailability. When fish is consumed by mixing with rice, the iron bioavailability is increased considerably[8]. According to Roos et al[5] the vitamin A is found in the eye and liver of the fish. As retinoid (vitamin A-1) and dehydro-retinoid (vitamin A-2) predominantly found in the eyes and viscera[6]. Therefore, cleaning the fish reduces vitamin A content from 3000 RE (in non-cleaned) to 2500 RE in raw edible parts. Due to the sensitive to sunlight nature of vitamin A it is destroyed by sun drying. Subsequently the sun dried *A. mola* contain only 100 RE vitamin A, which is still much higher than that of silver carp *Hypophthalmychthys molitrix* (20 RE), *Labeo rohita* (30 RE) and *Puntius sophore* (40 RE). In eastern and northeast India *A. mola* is recommended for pregnant and lactating mothers due to its high nutritional value.

Poor people benefit more

These protein, vitamin and nutrient rich small indigenous freshwater fish are compatible and affordable food for rural poor. In flood plain water resources, small indigenous freshwater fish contribute 53-85% of the total fish catch and the livelihoods of the fishers are very much dependent on the availability of small indigenous freshwater fish[9]. In these flood plains areas of the country the price of such fish is high. From village community pond produced small indigenous freshwater fish are mostly consumed by the family members of that community who takes the pond on lease and operate the culture work. However, fraction of small indigenous freshwater fish is also consumed by other family members of the village when fishes are harvested and sold in local market. The small indigenous freshwater fish are traditionally known to contribute the nutritional security of the people living in the vicinity of water bodies. They are also known to support in livelihood and income of down trodden poor fishers contributing to poverty alleviation.

Conservation of small indigenous freshwater fish

Existing small indigenous freshwater fish may be allowed to grow and breed in community based fish culture ponds. When ponds are made free from small indigenous freshwater fish during pre-management of composite fish culture, the brood fish of compatible indigenous species can be inoculated in culture ponds. In due course of time they could breed and propagate along with other cultured carp species. Small indigenous freshwater fish are usually considered as trash or weed fish by aquaculture researchers and policy makers and they are given insufficient attention while gathering statistics and framing inland fishery policy. Legislative measures to ensure the conservation and production of small indigenous freshwater fish through captive seed production and culture should be adopted. It is necessary to protect natural habitats of small indigenous freshwater fish in order to conserve them. Seed production and culture technologies of the potential small indigenous freshwater fish should be developed and standardised in controlled condition. Further adaptive research work need to be undertaken for promoting multi species composite culture including small indigenous freshwater fish and fast growing Indian major carps and exotic carps. No conservation measure would be effective without active participation by the stakeholders. The fisher folk, civil society, the line departments will have to work together for conserving small indigenous freshwater fish. Role of small indigenous freshwater fish in nutritional security of vulnerable groups like pregnant and lactating women and children need to be evaluated. Access right of local fisher communities to small indigenous freshwater fish through appropriate policies and legislation should be protected. Traditional knowledge and farmer's innovations with regard to small indigenous freshwater fish resources need to be documented and promoted. Importance of small indigenous freshwater fish in local food security and nutrition to be recognised and the concept to be popularised through Public Private Partnership (PPP) approach by the Ministry of Women & Child Welfare.

Conclusion

The judicious management of community based aquaculture offers enormous scope not only in ensuring the rural farmers access to small indigenous freshwater fish but also in providing adequate quantity of quality carp fishes for rural household consumption through fish diversity conservation. The promotion of the production and accessibility of the nutrient dense small indigenous freshwater fish may lead to the use of fish in food based strategies to combat nutrient deficiencies in down trodden fisher communities. The fish biodiversity conservation is great concern to those people who are directly depending on the indigenous fish species for their household nutritional security.

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Postlarvae culture and technical status of whiteleg shrimp (*Penaeus vannamei*) hatcheries in Quang Nam Province, Vietnam

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The whiteleg shrimp industry, due to the increasing demand, has developed widely in many Vietnamese localities in recent years (MARD, 2009; Luong Van Thanh, 2008). According to 2009 statistics there were 506 whiteleg shrimp hatcheries with total production capacity of more than 8 billion postlarvae. However, demand required to support the Vietnamese industry had already reached 20 to 25 billion postlarvae per year in 2006 (MARD, 2006), and is expected to be about 50 billion in 2012. Larval supply sources are very limited compared to actual demand.

The whiteleg shrimp industry in Quang Nam Province has developed significantly and produces substantial economic benefits for farmers. In recent years this sector had had an average productivity/yield of about 4 tons/ha/crop, in some cases about 7-10 tons/ha/crop. In 2007, cultured areas throughout the province reached about 55 ha (about 4.3% of total brackish cultured shrimp areas). Economic benefits from the shrimp culture industry have helped a lot of farmers to escape hunger and reduce poverty in this province, especially between 2008 and 2009. In 2010, whiteleg shrimp represented 70% of total provincial cultured shrimp areas (1,350 ha/total 1,700 ha) with high productivity levels equal to 12,695 tons, mainly in Thang Binh, Tam Ky and Nui Thanh districts (DoFi Quang Nam, 2010).

However, the biggest challenges for the whiteleg shrimp culture industry in Quang Nam province and in many other provinces throughout the country have always been epidemic diseases that have shown increasing tendencies (DoFi Quang Nam, 2010; MARD, 2009). One of the main causes of this problem is due to poor quality of larvae (Luong Van Thanh, 2008). Larval supply sources of Quang Nam province are mainly bought from other provinces and it is very difficult for farmers to control quality and risk of diseases (DoFi Quang Nam, 2010). Taking the initiative in supplying larvae in the same province through highly controlled rearing techniques is one aim to reach in order to improve the sustainability of the whiteleg shrimp industry in Quang Nam province. We conducted an investigation in order to evaluate the technical status of larval rearing industry in Quang Nam. The aim of this study is to create the basis for building sustainable development solutions for the whiteleg shrimp farming industry in Quang Nam.

Approach

We conducted a survey between 2010 and 2011. Primary data were obtained from interviews and questionnaires administered to thirty-four whiteleg shrimp larval nurseries throughout the province. Secondary data on the status of whiteleg shrimp larval nurseries, were collected from archives of the Department of Agriculture and Rural Development (central, provincial and district levels) in Quang Nam. The collected information was related to hatchery scale, larval source, rearing techniques, and other technical information.

Findings

1. General information about whiteleg shrimp hatchery in Quang Nam

The results showed that Quang Nam had thirty-four whiteleg shrimp hatcheries in 2010. Most of the hatcheries were founded in the last two to three years after a conversion from black tiger shrimp hatcheries. Most of them were small-scale family-run hatcheries with 2-4 workers per hatchery The rearing process was built up basing on past experience and techniques applied to black tiger shrimp larval rearing.

Because of the short rearing period (10-15 days), hatcheries often reared alternately larvae of different stages in order to take full advantage of hatchery capacity. However, the rearing season runs mainly from December to July during the year. The average capacity of a hatchery was 60.94 ± 23.05 million postlarvae/year, ranging between smaller and larger hatcheries from 40 to 150 million postlarvae per/year. These hatcheries provided 1.95 billion postlarvae for grow out cultures throughout the province in 2010; however, this figure has not still met actually demand which needs 3 billion postlarvae per year. Despite this, clearly, with a supply of two thirds of the total annual demands for shrimp farming of the province, whiteleg shrimp larval nurseries play an important role in Quang Nam.

Facilities used for whiteleg shrimp larval nurseries were mainly the same as those used in black tiger shrimp hatcheries, being predominantly square

Tanks used to contain and treat sea water before its use in the hatcheries.

cement rearing tanks, with an average volume of 5 m^3. Small-scale hatcheries had on average of 14 rearing tanks with total volume of about 67 m^3. Each hatchery had between one and four containing tanks with a volume of about 17.4 m^3. These tanks are used for both containment and settlement purposes in water treatment process. The total volume of containing and treatment tanks ranged from 10-60 m^3/hatchery with an average of 32.3 m^3/hatchery.

2. Larvae

In general, almost all whiteleg shrimp hatcheries in Quang Nam bought larvae at the stages of nauplius 2-3 or postlarvae 3-5, from Khanh Hoa, Ninh Thuan and Binh Thuan provinces, rearing them until stage of postlarvae 10-15 before selling them on. However, data showed that hatcheries using nauplius stages as initial larval source did not gain high efficiency because the nauplii were often weak and sensitive to environmental changes and transportation (9-12 hours) as well as in acclimating to the new environment. On the other hand, rearing techniques in this stage were not very efficient as most of the hatcheries applied the rearing process of black tiger shrimp to whiteleg shrimp larvae. In order to improve productivity and rearing efficiency, most of hatcheries use postlarvae 3-5 as their initial larval stock.

Remarkably, larval sources bought from the mentioned provinces were not quarantined by appropriate authorities, and most of purchasers relied on long-term relationships with larval suppliers and experience on selection methods.

3. Water treatment

Water is usually pumped directly from the sea into sand filters and then contained in tanks before using chemical treatment methods. Most hatcheries use chlorine at an average concentration of about 60 ppm, ranging from 30 to 100 ppm depending on water quality. After that, water is aerated for 1-2 days in order to eliminate the remaining chlorine. After checking remaining chlorine and neutralising it if necessary, water is suitable for larval rearing.

4. Larval rearing techniques

After being transported to hatcheries by van provided with temperature control, larvae are typically temperature acclimated by putting plastic bags, containing larvae, into rearing tanks for 15-30 minutes. Some hatcheries acclimatise larvae by putting water into the plastic bags in order to quickly balance water temperature and salinity between bags and rearing tanks. After 15-30 minutes, larvae are released into rearing tanks and fed with Artemia or commercial feeds.

5. Some problems and future directions with larval quality

Besides the quite high economic efficiency that the whiteleg shrimp larval nursery industry gains, larval quality problems are always one of the most important concerns in sustainable development of shrimp farming, in particular in Quang Nam province and generally in Vietnam (MARD, 2008b). Larval supply sources originate mainly from Khanh Hoa, Ninh Thuan and Binh Thuan provinces, however, these sources are not sufficient or stable both in quality and in price. A great number of low quality larval shipments without quarantine treatment are still transferred to Quang Nam, and this creates many challenges in epidemiological management and sustainable development of the shrimp farming industry.

Future directions, in order to improve whiteleg shrimp larval quality, should focus on strengthening controls on larval quality through certificates made by appropriate authorities (MARD, 2008b), building, improving and diffusing the larval rearing process of specific free pathogen whiteleg shrimp, focusing special attention to water treatment, feeding and holding techniques.

Other important issues are disease prevention and treatments that have to be avoided and applying sustainable rearing models such as using probiotics in substitution of antibiotics and chemicals (Vu Dung Tien & Griffiths, 2009).

However, in the long term, the province needs to build some leading or first level hatcheries in order to provide high quality larvae for rearing demands in the province. All of these factors can help to control larval quality for input and output, reducing weaknesses of the current larval sources, making larval rearing from economical nauplius stage feasible.

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Postlarvae stages 13 – 15.

Jatropha meal as a promising plant protein source in aquafeed development

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Photo: Marco Schmidt.

Jatropha curcas or physic nut is a multipurpose and drought resistant shrub or small tree that normally reaches a height of 3-5 m, but can reach a height of 8-10 m under favourable conditions. Widespread all over the tropics and subtropics, it is a hardy plant, thrives on degraded land and requires limited amounts of nutrients and water. Its seeds have been extensively investigated as a source of oil and the jatropha kernel meal as a byproduct obtained after the oil extraction. The seed kernel contains about 60% oil that can be converted into biodiesel of high quality upon transesterification and used as a substitute for diesel fuel (Makkar et al., 2007). The kernel meal obtained after oil extraction is an excellent source of nutrients and contains 58 to 65 % crude protein (Kumar et al., 2010a). Furthermore, the levels of essential amino acids, except lysine, are higher in jatropha kernel meal than in soyabean meals (Kumar et al., 2010a). However, the presences of high levels of antinutrients (Makkar et al., 2008) and the major toxic components (Makkar et al., 1997) restrict their use in fish feed. Subsequently, it could be stated that besides being a source of oil, *J. curcas* also provides a meal that serves as a highly nutritious and economic protein supplement in animal feed, provided the toxins are removed (Becker and Makkar, 1998). Jatropha trees can yield up to five tons seed per year from one hectare of plantation, which can produce approximately one ton of kernel meal rich in protein (Makkar and Becker, 1997). This means that there is possibility of producing enough jatropha kernel meal to meet growing aquaculture industry demand.

Constraints in utilisation of jatropha kernel meal

Toxic and non-toxic genotypes of *J. curcas* have been reported in cultivation practices (Makkar and Becker, 2009). The nontoxic genotype exists only in Mexico while the toxic genotype is prevalent throughout the world. The use of jatropha meals prepared from the toxic genotype in animal nutrition is limited due to the presence of antinutritional components and toxic factors (table 1). The major antinutrients are trypsin inhibitors, lectin, and phytate. The main toxic factor present is phorbol esters which are highly toxic to animals. The levels of trypsin inhibitor and lectin are similar to those in soybean meal, and the level of phytate (9.4%) is approximately three times higher compared to soybean meal. The kernel has higher crude protein (22-28%) and oil contents (54-58%) (Makkar et al., 1998). Feeding experiments have displayed toxicity due to phorbol esters in mice (Li et al., 2010) rats, goats (Goel et al., 2007) and fish (Becker and Makkar, 1998), with the major organs affected the intestine, liver and kidney.

On the other hand the nontoxic genotype of *J. curcas* kernels are also rich in oil (55-58%) and protein (26-29%) (Makkar and Becker, 2009) and do not contain the toxic phorbol esters although they still contain trypsin inhibitor, lectin, and phytate at the same levels as the meal as the toxic genotype. The meal obtained from the nontoxic genotype, after heat treatment was found to be of high nutritional value when evaluated in fish (carp) and rats (Makkar and Becker., 1999). Thereby, it could be an excellent protein-rich ingredient in feeds of ruminant and monogastric animals including fish.

However, the removal of the antinutritional factors to a significant level is necessary before jatropha meal can be used as animal feed.

Chemical composition of jatropha meal

The content of crude protein, lipid, ash, neutral detergent fibre, total sugar and starch in jatropha kernel meal are similar for the two genotypes (table 2) (Makkar and Becker, 2009). The crude protein content of jatropha meal is higher than soybean meal, but comparable to fishmeal (table 2). The amino acid composition of the toxic and non-toxic jatropha meal and soybean meal is shown in table 3. The levels of essential amino acids (except lysine) are higher in jatropha kernel meal than soybean meal and castor bean meal (Makkar et al., 1998; Kumar et al., 2010a).

Jatropha curcas fruits. Photo: Ton Rulkens.

Detoxification methods for jatropha meal

Over the past two decades, several studies have been carried out for the complete detoxification of jatropha kernel meals. Ionizing radiation treatment could serve as a possible processing method for inactivation of certain antinutritients and toxic componets such as phorbol esters, phytates, saponins and lectins (Siddhuraju et al., 2002). Heat labile antinutrients, protease inhibitors and lectins are easy to inactivate by moist heating (Aderibigbe et al., 1997, Aregheore et al., 2003), but it is not possible to destroy phorbol esters by heat treatment because they are heat stable and can withstand roasting temperature as high as 160°C for 30 min. However, it is possible to reduce its concentration in the meal through chemical treatments which are economically not feasible (Aregheore et al., 2003). Furthermore, Martınez-Herrera et al. (2006) studied the effect of various treatments such as hydrothermal processing techniques, solvent extraction, solvent extraction plus treatment with $NaHCO_3$ and ionizing radiation to inactivate the anti-nutritional factors in jatropha kernel meal of both toxic and non-toxic varieties from different regions of Mexico but unfortunately could able to remove phorbol esters. Recently, a method for detoxification of jatropha kernel meal has been developed (Makkar and Becker, 2008). This detoxification method is based on extraction of phorbol esters using organic solvents and inactivation of trypsin inhibitors and lectin by heat treatment.

Dietary role of detoxified jatropha kernel meal in aqua feed

Aquaculture is growing rapidly at an average rate of 8.9% per year, compared with only 1.2% for capture fisheries and 2.8% for terrestrial farmed meat production systems (FAO, 2007). Fish meal is still a preferred protein source for fish diets corresponding to its high protein quality to meet the intensification of the aquaculture systems (NRC, 1993). However, due to high cost and limited availability in many countries (Naylor et al., 2000), the replacement of fish meal by plant protein sources is of great interest. Detoxified jatropha kernel meal is a novel and highly nutritious plant protein source. It has been reported that the levels of essential amino acids in detoxified jatropha kernel meal was either higher or comparable (except lysine) to fish meal and soybean meal (table 3) (Kumar et al., 2010a), which indicate that it may be suitable as a replacement for fish meal and soybean in fish and shrimp diets.

It was observed that 50% fish meal could be replaced by detoxified jatropha kernel meal in common carp (*Cyprinus carpio L.*), rainbow trout (*Oncorhynchus mykiss*) and white leg shrimp (*Litopenaeus vannamei*) without influencing growth rate or nutrient utilisation (feed conversion ratio and protein efficiency ratio) (Kumar et al., 2010a,b; Harter et al., 2010). Interestingly Harter et al. (2010) observed that growth

Jatropha is an important source of biodiesel. Photo: Ton Rulkens.

Jatropha trees (foreground). Photo: Forest and Kim Starr.

performance and nutrient utilisation of shrimp groups fed detoxified jatropha kernel meal (50% replacement of fish meal protein) were better than that of fish meal fed group. The higher growth response of detoxified jatropha kernel meal fed group could be due to higher protein availability from the detoxified jatropha kernel meal than fishmeal, which enhances the feed utilisation. There is a possibility of synergistic effects between the used feed ingredients (fishmeal and detoxified jatropha kernel meal); both were complementary to each other in their amino acid composition. Therefore, detoxified jatropha kernel meal protein in combination with fishmeal protein probably induces excellent nutrient and energy digestibility and lead to higher growth performance and nutrient utilisations in shrimp. A study was conducted to verify the biochemical, haematological and histological responses of adding detoxified jatropha kernel meal in common carp and rainbow trout diets (Kumar et al., 2010b, d). Blood parameters such as RBC and WBC count, hemoglobulin and hematocrit concentration, blood protein (albumin and globulin), blood ions (calcium, phosphorus, potassium and sodium), total bilirubin and total blood urea nitrogen were in the optimum range. There were no histopathological changes in intestine and liver. These studies confirm that replacing fishmeal with detoxified jatropha kernel meal has no adverse effect on the biochemical haematological and histological parameters in common carp and rainbow trout.

Conclusion

Jatropha curcas is a bio-fuel plant and its seeds are rich in oil and protein. Jatropha seed cake and kernel meal are byproducts of the jatropha biodiesel industry that are rich in protein that can be used in aqua feed. However, it should be detoxified before incorporation in fish and shrimp diet because of the presence of anti-nutritional and toxic components. Detoxified jatropha kernel meal has the potential to substitute at least some of the fish meal in the diets of common carp, rainbow trout and white leg shrimp and studies have shown levels of up to 50% replacement of fish meal did not sacrifice the growth performance, nutrient utilisation and health of the fish and shrimp. These studies enlarge the area of plant protein sources that can be used in aqua feed, and open new market opportunities for the use of a new feed resource. Additional studies with detoxified jatropha kernel meal based diets at a larger scale and under commercial pond conditions are suggested.

Photo credits

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Table 1: Levels of anti-nutritional and toxic factors in Jatropha curcas kernel meal and soybean meal.

Anti-nutritional/toxic components	Jatropha curcas		Soybean meal
	Toxic	Nontoxic	
Phorbol esters (mg/g kernel)	2.79	ND	NA
Total phenols (% tannic acid equivalent)	0.36	0.22	NA
Tannins (% tannic acid equivalent)	0.04	0.02	NA
Phytates (% of dry matter)	9.40	8.90	1.5
Nonstarch polysaccharides (% of dry matter)	16	13.6	14
Saponins (% diosgenin equivalent)	2.60	3.40	4.7
Trypsin inhibitor (mg trypsin inhibited/g sample)	21.31	26.54	23.9
Lectin activity (1/mg of meal that produced Haemagglutination/mL assay medium)	51-102	51-102	90-108

ND, Not detected; NA, Not available. Source: Makkar and Becker (2009) and Makkar and Becker (1997).

Table 2: Chemical composition, sugar and starch contents (%) of jatropha kernel meal from toxic and non-toxic genotypes and soybean meal.

	CP	Lipid	Ash	NDF	Total sugar	Starch
Toxic	60.3-62.4	1.5	9.6	18.2	7.7-10.3	9.4-11.2
Non-toxic	60.2-63.8	1.0	9.8	18.0	10.2	10.6
Soybean meal	47.42	2.8	7.08	14.9	NA	NA
Fish meal	62.0	6.5	NA	NA	NA	NA

Source: Makkar and Becker (2009); Zdunczyk et al. (1999) and Alvarez (2007).

Table 3: Amino acid composition (g kg^{-1}) of jatropha kernel meal (J-Toxic and J-nontoxic), detoxified jatropha kernel meal (detoxified jatropha kernel meal) soybean meal and fish meal.

Amino acids	J-Toxic	J-Non-toxic	DJKM	Soybean meal	Fish meal
Essential (g kg^{-1})					
Arginine	73.7	80.6	69.7	44.5	35.3
Histidine	20.6	19.2	21.7	15.6	17.7
Isoleucine	28.1	30.01	26.7	28.8	22.8
Leucine	43.2	46.2	46.7	48.2	41.6
Lysine	26.1	21.1	23.3	38	40.9
Phenylalanine	27.2	30.2	30.4	30.2	21.8
Methionine	11.9	11	10.6	7.6	16
Threonine	24.4	22.3	22	23.5	23
Tryptophan	8.18	ND	7.1	7.75	4.9
Valine	32.3	33.5	31.6	28.6	29.3
Cystine	14	9.8	2.3	10.6	4.3
Non-essential (g kg^{-1})					
Alanine	32.5	30.8	29.4	26.4	43.3
Asparginine	59.3	62	68.7	70.6	60.5
Glycine	30.7	28.8	31.5	25	59.8
Glutamine	91.7	99.4	112.1	105.6	79.4
Proline	31	23.7	32.2	30.3	36.9
Serine	30	30.1	30.6	35.4	25.5
Tyrosine	18.6	23.6	18.8	21.1	14.8

Source: Makkar and Becker (2009) and Kumar et al. (2010a) *ND: Not detected.

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Jatropha curcas - the biofuel plant. Photo: Ton Rulken.

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Fruit in cross section. Photo: Ton Rulken.

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Photo: Vinayaraj.

Use of soybean meal in diets of cobia *Rachycentron canadum*

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Rachycentron canadum.

The cobia *(Rachycentron canadum)* is a carnivorous fish. It can grow with good feed conversion efficiency in offshore net cage systems from fingerling to marketable size (4–6 kg) in 1 year. At present, commercial feeds for cobia contain protein levels around 45 % (Chou *et al*., 2001; Craig *et al*., 2006).

Aquatic animal feeds depend heavily on animal ingredients (Watanabe, 2002) and fishmeal is the main protein source used in such feeds, especially in those formulated for carnivorous species. The demand for fishmeal in aquafeeds is continually increasing. In order to maintain the rapid growth of the global aquaculture industry, it has been becoming increasingly crucial for the aquafeed industry to evaluate alternatives to fishmeal for decades (FAO, 1997).

Soybean meal is one the world's largest sources of vegetable meal and is widely used as cost – effective alternative in diet in aquaculture (Storebakken *et al*, 2000). It contains high protein content with a well–balanced amino acid profile, reasonable price and steady supply source. Although, it also contains some anti-nutritional compounds, low digestibility carbohydrates and is low in some essential amino acids such as methionine, a number of studies has shown that soybean meal can replace fishmeal up to 40 % (Chou *et al*., 2004; Zhou *et al*., 2005; Hung *et al*, 2009) without reducing growth and feed efficiency.

This paper reviews the recent advances towards the use of soybean meal as alternative protein in order to develop new types of aquatic diets through improved feed formulation for cobia.

Nutritional value of soybean meal

Nutritional values of protein ingredients are defined by their protein content and essential amino acid compositions. Among the various protein sources available for fish feeds, defatted soybean meal is universally accepted, both qualitatively and quantitatively. Soybean meal contain higher protein content than other vegetable meals (Zhou *et al*., 2004) and has a well-balanced amino acid profile compared with other plant protein sources (Zhou *et al*., 2004). In comparison with fish meal, soybean meal has poorer balance of amino acid profile, in particular being deficient in methionine and lysine. It also contains anti-nutritional factors such as proteinase inhibitors and agglutinating lectins which can be inactivated by heat treatment, but others such as saponin cannot be inactivated in this way (Zhou *et al*., 2005). However, the combination of soybean meal and fish meal can improves overall amino acid profile and enhances soybean meal utilisation (Watanabe, 2002).

Digestibility

A comparison of the apparent digestibility of fish meal and soybean meal nutrients for cobia are shown in Table 2. For dry matter and phosphorus, the apparent digestibility coefficients (ADC) of different soybean meals were significantly lower than the ADC of fish meal. There was no significant difference in crude protein or crude lipid digestibility between fish meal and soybean meal, which indicated that the protein and lipid in soybean meal could be well digested by cobia (Zhou *et al*, 2004). However, the apparent digestibility coefficient of solvent – extracted soybean meal was significantly lower than the ADC of fish meal and roasted solvent – extracted soybean meal.

Use of soybean meal in diets for cobia

Aquatic animal feeds depend heavily on animal ingredients (Watanabe, 2002) and fishmeal is the main protein source used in such feeds for carnivorous species. The demand for fishmeal in aquafeeds is continually increasing. As such, recent studies have focused on finding alternative protein source that can replace fish meal in formulated feeds.

Table 1. Nutrient composition (%) in dry matter of feedstuffs.

Ingredients	Dry matter (%)	Crude protein (%)	Crude lipid (%)	Gross energy (kcal/g)	Phosphorus (%)
Fish meal (Peruvian)	89.99	70.65	7.62	5.08	1.65
Defatted soybean meal (roasted, solvent – extracted)	91.57	49.50	0.89	4.64	1.26
Defatted soybean meal (solvent – extracted)	91.91	47.63	1.37	4.67	1.27

Table 2: Apparent digestibility coefficients in feedstuffs of juvenile cobia (Zhou *et al.*, 2004)

Ingredients	Dry matter (%)	Crude protein(%)	Crude lipid (%)	Gross energy (kcal/g)	Phosphorus (%)
Fish meal (Peruvian)	87.56	96.27	95.86	71.22	95.46
Defatted soybean meal (roasted, solvent – extracted)	70.51	92.81	95.36	60.41	90.63
Defatted soybean meal (solvent – extracted)	68.29	90.94	92.38	59.36	86.93

In cobia, many researchers have focused on replacing fish meal with soybean meal. The results of Chou *et al* (2004) indicated that up to 40% of fish meal protein can be replaced by soybean meal protein without causing reduction in growth and protein utilisation of juvenile cobia (32 g). However, quadratic regression analysis shows a growth optimum at 16.9% replacement of fish meal protein by soybean meal protein. Lipid concentrations in the cobia muscle increased significantly as dietary soybean meal increased. Muscle concentrations of free threonine and histidine decreased as use of the soybean meal increased in the diets while all other essential amino acids remained relatively constant. Zhou *et al* (2005) gained similar results in smaller cobia (8.3 g). They concluded that weight gain rate decreased significantly when the replacement level of fishmeal protein was increased from 400 g kg^{-1} to 500 g kg^{-1}. These results indicate that up to 400 g kg^{-1} of fishmeal protein can be replaced by defatted soybean meal without causing significant reduction in growth. Feed conversion ratio and protein efficiency ratio were significantly affected by the replacement level of fishmeal protein being substituted by defatted soybean meal. The replacement of fish meal by soybean meal did not significantly affect the moisture, lipid, crude protein or ash content in whole body and muscle, while lipid content in liver increased as the dietary soybean meal replacement levels increased. The optimum level of fishmeal protein replacement with defatted soybean meal was 189.2 g kg^{-1} (Zhou *et al.*, 2005). Following the results of Hung & Mao (2009), the fishmeal protein replacement levels had significant effects on fish weight gain, specific growth rate, feed conversion ratio, protein efficiency ratio. There were no significant differences in the survival and muscle composition. These results indicate that up to 40% fishmeal protein can be replaced by soybean meal protein without causing reduction on growth. The optimum level of fishmeal protein replacement with soybean meal protein determined by quadratic regression analysis was 14.6%, based on weight gain.

One problem of fish meal replacing with soybean meal is that the decrease in essential amino acids such as methionine and lysine which can cause weight gain reduction of cobia. Methionine concentrations decreased from 2.52 to 1.36 g 16 g^{-1} N as the soybean meal protein replacement level was increased from 0% to 60% while all other essential amino acids remained relatively constant (Chou *et al.*, 2004). A similar result was recorded by Hung & Mao (2009). However, the optimum requirement of methionine for juvenile cobia had been determined by Zhou *et al* (2006, 2007) which could support useful information for fish meal replacement by soybean meal studies.

In summary, soybean meal is a potential protein source to replace fish meal in diets for cobia. Many studies have shown that up to 40 % fish meal protein can be substituted by soybean meal for juvenile cobia without growth reduction. However the fish meal replacement by soybean meal had a significant effect on the amino acid profile of diets, thus causing changes in amino acid profiles of cobia muscle. In nutritional studies to date, almost all work is on juvenile cobia for short term feeding experiments. Therefore, studies in larger fish should be initiated over longer periods of time to determine clearly the potential to replace fish meal with soybean meal in diets for cobia.

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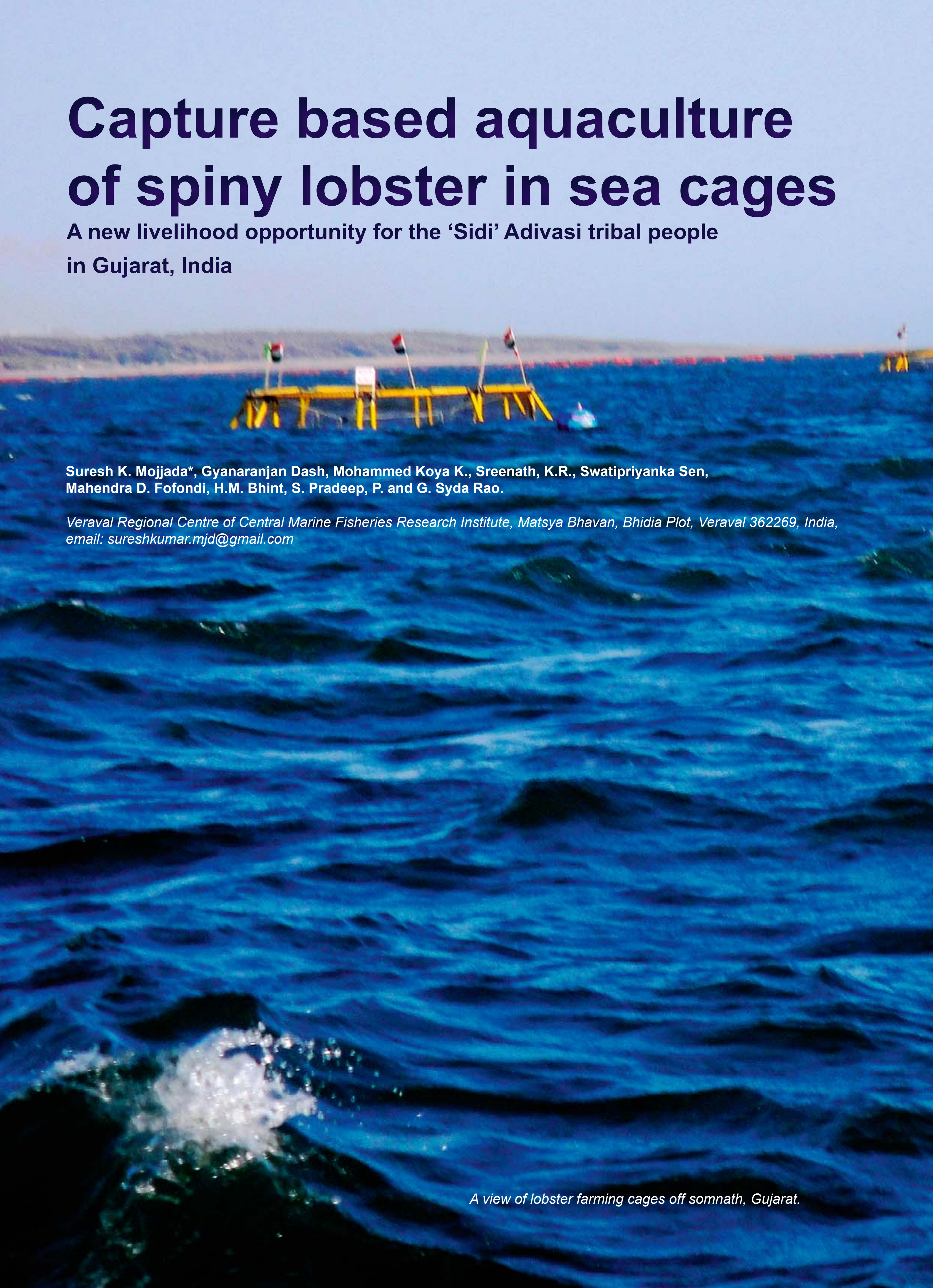
Capture based aquaculture of spiny lobster in sea cages

A new livelihood opportunity for the 'Sidi' Adivasi tribal people in Gujarat, India



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A view of lobster farming cages off somnath, Gujarat.

Global marine fish production is approaching a standstill due to declining marine capture fisheries, and India's situation is not much different than the rest of the world. Most of the wild fisheries resources have already been over exploited or are on the edge of it. Problems include overfishing of reproductive females or during the breeding season, overexploitation of juveniles and undersized fish, over exploitation of keystone species causing ecosystem disruption and destructive fishing practices, which damage habitat. Other causes of habitat destruction, anthropogenic pollution and climate change are further aggravating the situation and adversely impacting on the ecosystem.

In a country such as India, where the marine fishery resources are under an open access regime and a huge population depends upon the sector for their exclusive livelihood, it is very difficult to achieve ecological goals while jeopardising social goals. Therefore, the sustainability of marine resources in this context is another black box which is yet to be deciphered. However, despite of all these setbacks, sustainability can still be achieved if alternative methods of increasing production from the marine ecosystem system can be found, and one such alternative is mariculture.

In India the first attempt for cage culture was initiated in 2007 at Vishakhapatnam coast by the Central Marine Fisheries Research Institute (CMFRI). Subsequent to this many successful trials have already been made to standardise and demonstrate the technology to encourage adoption by coastal community. Milestones in open sea cage farming by CFMRI have included the successful demonstration of sea bass farming at Balasore[1], Chennai[2] and Karwar[2] districts; lobster farming at Kanyakumari, Tamilnadu[3], cobia farming at Mandapam, Tamilnadu[4], pearl spot farming at Cochin, Kerala[5] and pompano farming at Vethalai, Tamilnadu[6] .

However, mariculture has its own set of advantages and disadvantages. Unlike the coastal aquaculture of shrimp, open sea mariculture is less vulnerable to anthropogenic pollution and sudden fluctuation of hydrographical parameters but at the same time it is a capital intensive venture and maintenance of the cultured animals is a real challenge for the farmer. Similarly, getting the required number of seeds is another such impediment as the seed production technique for most esteemed marine fish species is still in the laboratory trial stage.

Gujarat is one of the most important maritime states of the country having the longest coast line of about 1,640 km and a very broad continental shelf. The state has been bestowed with highly productive and diversified ecosystems and considered as one of the leading marine fish producing states of India, with fisheries providing livelihoods for more than 400,000 people directly and indirectly. However, over the last few years the marine fish production of the state has been relatively static at around half a million tonnes and has been showing signs of being fully exploited. However, as the state has a wide continental self it also has significant potential for mariculture. Owing to the economic importance and availability of seeds of spiny lobster, an open sea cage culture demonstration of *Panulirus polyphagus* was carried out involving Sidi tribes as a major stakeholder.

The 'Sidi' tribe: Early adopters for mariculture

'Sidis' are a unique tribal group that has African ancestry and lives in South Asia. They are mainly found in three Indian states: Gujarat, Karnataka, and Andhra Pradesh. According to the latest census their total population size is about 250,000 with the majority living in Gujarat. Since 1956, the Sidis of six districts in Rajkot Division of Saurashtra have been designated as Scheduled Tribe (ST) and many live below the poverty line, suffering from food insecurity and malnutrition, and often being reliant on a starch-based diet.

As a single source of livelihood, traditional farm incomes on limited holdings are not enough to meet even subsistence needs. However, with adequate technology transfer and proper support, it is possible for tribal farmers to improve their incomes and thereby increase their access to food and improve their nutritional status. To improve the livelihoods of farmers, a demonstration of lobster farming in open sea cages was initiated, with the crop entirely managed by a Sidi cooperative society.

Capture based aquaculture: a new dimension in mariculture

In a multi species fishery where a wide variety of fishing gears are used, it is difficult to control the catch, whether deliberately targeted or incidental bycatch, of juveniles of economically important species. While undersized fish fetch a very small price in the market, the impact of their loss on the future sustainability of the fishery can be significant. Quite often these juveniles are sold for fishmeal production, which represents a poor return on a potentially much more valuable resource.

Capture based aquaculture is a conservative aquaculture practice in which wild caught juveniles of high value fish are grown to marketable size, thereby gaining a much better market price. As the controlled breeding and seed production techniques for most marine fish are still at an early stage, capture-based aquaculture can be a viable step towards fully closed-cycle mariculture. Unlike land based aqua-

Cage farm maintainance and under water inspection.

Cage installations.

culture, mariculture has the advantage of comparatively stable environmental parameters, continuous waste removal, lower exposure and vulnerability to pollution and a much greater scope for future expansion. Usually, floating cages are used for mariculture as they are easy for day to day management and maintenance. CMFRI in collaboration with Indian institute of technology (IIT), Kharagpur, India has developed a prototype circular cage considering the hydrodynamics of Indian seas. The prototype was further refined and presently the 6th generation of cages are being tested for their sea worthiness and ease of management.

Open sea cage farming in Gujarat

Considering the necessity and immense scope for mariculture in Gujarat, the present demonstration of open sea cage culture was conducted by the Veraval regional centre of CMFRI to create a new awareness among coastal fisherfolks. The demonstration was conducted under a co-management regime involving the Bharat Adim Juth Matsyadyog Mandali, which is a registered co-operative society of Sidi tribes under Talala Patan, Gujarat. The infrastructure and technical inputs were provided by the institute whereas the entire grow out operation was managed by the co-operative society.

Candidate species selection and seed collection

Lobsters form one of the most important natural resources of Gujarat. The mud spiny lobster species has been found to have a very good growth rate and survival in open sea grow out conditions7. In terms of seed availability, pueruli and early post-pueruli spiny lobsters are abundantly available in near shore waters along the Saurashtra coast in the post-monsoon months (mainly September to January). Undersized lobster juveniles regularly form an incidental catch in the trawl net and also in stake nets locally called as ‘wada’. As they are below the minimum legal size for export, undersized lobsters are sold at a very low price in the local market, a very low return on the resource and a missed opportunity for the economy. In constrast, the adults of these lobsters are quite expensive, fetching a price depending on size from Rs. 600 to Rs. 1,100/kg in the domestic market and US$13.30 to 30.00/kg in international markets. Due to its high availability, good survival and growth rate and high market price this species was selected for the open sea cage culture demonstration. Lobster seeds from trawl net bycatch were collected from the Veraval landing centre, Junagadh District, Gujarat. Lobster seeds caught by stake nets were also collected from Mahua, Bhavnagar District, Gujarat. The juvenile lobsters were transported on moistened sand trays wrapped in gunny bags moistened with sea water, dampened at one hour intervals to prevent drying. With this method, around 96 % survival was observed during the transportation period. The seeds thus transported were continuously stocked in the early morning hours to arrive at a final stocking density of 1,500 lobsters per cage.

Site selection

Regular surveys were carried out to select ideal site for the cage culture. Water and substrate samples were collected at regular intervals and analysed in the fisheries environment monitoring division (FEMD) laboratories using standard analytical procedures. Two sites in the sea off Prabhash Patan were selected as physico-chemical parameters were found to be in the ideal range for the culture of lobster. The detailed physico-chemical parameters of two selected sites have been mentioned in table 1.

Grow out operation

Two circular 6th generation HDPE cages of 6 metre diameter and 4 metre depth were used for the grow out operation. The bottom of each cage was modified considering the behaviour of the lobster. As the lobsters are bottom dwelling in nature, a thin meshed net made up of thick twine with two cross pipes was fitted at the bottom to keep it flat. This particular modification was provided to increase the cage surface area as lobster utilises the bottom rather then the water column. Hide outs made up of PVC pipes were fixed on the bottom of the inner net to prevent cannibalism during moulting. Two cages were installed at each site with 220 m between them to avoid collisions due to change in current direction and wave action. Lobster juveniles with a mean individual weight of 80 g were stocked at around 1,500 juveniles per cage. The entire grow out operation were managed by the Bharat Matsyadyog Adim Juth society. Tray feeding was used to observe feed consumption. The daily ration was divided into two parts: 25 % of feed was given in the early morning (07:00) and the remaining 75% was given during evening (19.00). Growth rate and survival were recorded by periodic sampling at weekly intervals.

Dignitaries observing the open sea cage lobster farm harvest.

Table 1: Physico-chemical parameters of two selected sites (mean ± standard deviation)

Parameters	Site 1	Site 2
GPS coordinates of sea cage farm	20°53'22.78"N	20°53'17.95"N
	70°23'20.06"E	70°23'25.89"E
Depth at low tide (m)	9 ±1.2	9.4±0.7
Tidal amplitude (m)	4.5	4.5
Bottom	Rocky	Rocky
Salinity (ppt)	32.8±0.20	33.2±0.39
pH	7.9±0.1	8.2±0.15
Temp (oC)	29.2±1.7	28.9±1.03
Dissolved oxygen (mg L^{-1})	4.22±0.16	4.99±0.25
Total suspended solids (mg L^{-1})	0.521±0.006	0.499±0.004
Ammonia (ppm)	0.024±0.003	0.029±0.005
Nitrate (mg L-1)	3.9±0.15	3.4±0.13
Phosphate (mg L^{-1})	0.068±0.005	0.051±0.002

Nets were also checked frequently to remove fouling and repair any damage due to wear and tear. After a culture period of 110 days, an average of 272 kg of lobster was harvested per cage. During the culture period, the lobsters grew to a mean size of 203 g with an overall survival of 93 %.

Future prospects

This successful demonstration offers new horizon for sea farming and will motivate fishermen of the region to adopt the technology for a sustainable lobster fisheries. This will create a new avenue for alternative livelihood opportunity for the coastal fisherfolk. With a sound policy for utilising the inshore waters and creek areas for marine fish farming and institutional support from the state administration, the state of Gujarat has immense potential to enhance its fish production bringing in additional revenue to the economy. Sidi tribal people who are presently working as marginal fishery workers may be able to gain a more profitable and sustainable livelihood opportunity and this will greatly help in improving their socio-economic status.

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Grading of lobsters after harvest.

Institutional linkage helping rural women of an under developed district to become self-employed

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Deogarh District is the most under developed district of Odisha State, India, with an annual economic growth of a mere 0.15per cent (2009-10). Approximately half of its total area is covered by hills, mountains and forests. Less than one-third of the gross cultivated area is irrigated. Approximately 92 percent of the total population lives in villages and 83 per cent of them are resource poor with a maximum 2 ha of land. With few industrial opportunities and limited opportunities for commercial cultivation, most of the people depend upon subsistence agriculture, livestock, mainly goats, and forest resources for their livelihoods. Ornamental fish farming, an innovative enterprise for the district came in existence during 2009-10 through the enterprise of a young unemployed graduate woman and subsequently, with the coordinated effort of various departments, bear fruit for its popularisation.

The leader with her followers.

Pankajini Pradhan, a girl of 23 years belongs to Landijhari village of Deogarh district. After completion of her graduation, she became interested for self-employment. Coming in contact with the local Assistant Fishery Officer (AFO), she came to know about ornamental pisciculture as an enterprise which not only requires few resources to start but also can be taken up in the back yard of the house. The AFO appraised her about the characteristics of various ornamental fishes and their methods of rearing. He assisted them in arrangement of fishes, to be reared, from Kolkata through a middle man of Keonjhar city. She started with it immediately and her success quickly drew the attention of the neighbours for this innovative activity and gradually the number of adopters increased. The Agriculture Management Agency of Deogarh (ATMA) assisted the entrepreneurs by providing a support of 4,000 rupees for construction of rearing tanks. The scientists of the premier fish farming institute of the nation, the Central Institute of Freshwater Aquaculture (CIFA) which lies in Odisha, were invited to the village and they provided the latest know-how of scientific management of ornamental pisciculture. Later on ATMA also conducted an exposure visit for some of the beneficiaries to CIFA where they got knowledge of water quality management, tank management, healthcare and nutrition of the fishes. Now a number of ornamental fish varieties such as red and black molly, angel fish and goldfish are being commercially produced in Landijhari village. The scientists of Krishi Vigyan Kendra, took steps in popularising the new vocation in the village by conducting awareness camps. Local press, electronic media reporters and public representatives visited the village to experience the uniqueness of Landijhari. Now more than 60 fish tanks exist in the village and the unused backyard of 35 families is being utilised for ornamental fish farming. Each fish is sold at 8 to 10 rupees in the village. Business persons passing in the Kolkata-Mumbai National Highway 6 usually purchase fish from the village. Landijhari's ornamental fishes have now captured the markets of nearby industrial cities such as Rourkela, Angul, Keonjhar and Talcher.

Busy in fish rearing.

Now the women have learnt the art of preparation of decorative aquariums. This enterprise has fetched them an income of 5,000 to 20,000 rupees per year.

Ornamental pisciculture has shown the women of Landijhari village a new horizon of self-employment. Pankajini Pradhan is a role model for all the rural youths of the district who wants to start an innovative enterprise. The women fish farmers of Landijhari are now united under the Sinha bahini and Maa Tarini Self-Help Groups. The business has drawn the attention of banking personnel and NABARD authorities who are catering to the financial needs of the groups by sanctioning loans under SJGSY for commercialisation of the enterprise in a bigger way.

It can be said that coordinated effort of various institutions has made a formerly sleepy village, Landijhari, the most vibrant ornamental fish village in Odisha.

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Putting Gender on the Programme of NACA

At its March meeting in Cambodia, the 23rd NACA Governing Council endorsed a proposal to add Gender Issues in Aquaculture as a cross-cutting theme for the NACA Work Plan. This means that gender issues will now be incorporated as a regular component of all the thematic work programmes. The proposal prepared by Dr Williams follows below.

The Gender Issues theme will be developed under the mentorship of Dr Meryl Williams, former Director General of the WorldFish Center and Chair of the Organising Committee of the Asian Fisheries Society 3rd Global Symposium on Gender in Aquaculture and Fisheries, held in April 2011, Shanghai. NACA would like to thank Dr Williams for developing the proposal and for agreeing to provide mentorship to the organisation in this regard – Ed.

Purpose

The purpose of this briefing note is to recommend that the work program of the Network of Aquaculture Centers in Asia (NACA) commits to incorporating gender dimensions. It argues that considering women and men within a gender framework fits well with the Vision of NACA, that many NACA member states and key agencies in the Network are beginning to pay greater attention to women and gender and thus NACA has the requirement to address gender in its work programme and operations, and the opportunity to lead and work with member governments to address gender in the burgeoning aquaculture sector.

Background

Aquaculture developed from a base in fisheries and agriculture and both these sectors have been erroneously identified as arenas mainly for men. In them, women's roles and contributions have been downplayed and overlooked and are not accounted for in statistics, development programs and even inside the organisations that serve them. Researchers and activists have tried to overcome these oversights but to little avail, and despite the international policy leadership in the broader society from instruments such as the 1979 Convention on the Elimination of All Forms of Discrimination against Women (CEDAW). Despite waxing and waning interest in women and gender in aquaculture, including 5 Asian Fisheries Society symposia on women/gender and aquaculture/fisheries over the last 15 years and an active website (http://genderaquafish.org/), aquaculture and fisheries institutes and national and international policies have remained at best disinterested, and at worst resistant to taking action. Conversely, major women's agencies such as UN Women pay little attention to women in sectors such as aquaculture, agriculture and fisheries as they focus on cross-cutting social issues such as reproductive rights and domestic violence. Therefore, sectors such as aquaculture will need to forge their own gender programs, tailored to their own needs. And this means that international agencies such as NACA must take a lead.

In 2011, FAO, which had previously paid little attention to the gender dimensions of its technical areas, made the gender gap in agricultural production the theme of its whole 2010-2011 State of Food and Agriculture (SOFA) report. This report also addressed aquaculture and fisheries, although not in depth. The SOFA 'gender gap' report has been galvanising, and its main conclusions are already highly cited. Briefly, FAO concluded that:

- "the yield gap between men and women averages around 20–30 percent and most research finds that the gap is due to differences in resource use.
- "Closing the gender gap in agricultural yields could bring (the number of undernourished people) down by as much as 100–150 million people."

We could expect a similar yield gap to be occurring in aquaculture, though we do not have data to support this conclusion. In addition, social equity principles should mandate that women deserve attention in any sector and should have equal opportunity.

Women or gender?

Activists and feminists will often argue that taking a 'gender approach' is inappropriate when the most severe gender problems are experienced by women who therefore should be the sole focus of empowerment and assistance efforts. However, gender experts point out that gender equity as an objective is founded on the concept that women and men's roles, including gender hierarchies and power relations, are formed by society. To change the power structures to create gender equity requires working within society. To take a women-only approach does not address the power structures and institutional constraints. In a gendered approach, women would be the focus for practical development interventions. "Gender" is more a conceptual lens. Thus, women and gender are part of the same systematic approach.

Why gender is required in the NACA program

The NACA Vision is:

NACA is an intergovernmental organisation 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. The core activities of NACA are:

- Capacity building through education and training;
- Collaborative research and development through networking among centers and people;
- Development of information and communication networks;
- Policy guidelines and support to policies and institutional capacities;
- Aquatic animal health and disease management; and
- Genetics and biodiversity.

Given this Vision, several reasons immediately indicate the imperatives for NACA to include gender in its program, as follows.

1. Intergovernmental nature of NACA: NACA has an imperative as an intergovernmental organisation to consider gender in aquaculture. Most if not all the member governments would be signatories to CEDAW and many would also have national legislation and policies on women/gender. Positive actions to ensure that women are included in NACA programs would help the member governments meet their obligations through helping make aquaculture a more equal sector. Few member governments, Cambodia being the main exception, have gender policies in the fish sectors.

2. Sustainable rural aquaculture: Women are vital in generating rural income directly through their productive activities on farm or in the supply chain, or indirectly through their so-called reproductive activities. Reproductive activities mean not just producing and bringing up children but also the support services to the family and community. Women with better skills, knowledge and training make better contributions to food production and foreign exchange earnings and are often the backbone of diversified farm production activities. Thus, women, whose roles and contributions can be similar to those of men, but may also be different, need to be fully included in order for the main tenets of NACA's vision to be achieved.

3. Core activities: Gender is a critical dimension to be understood and taken into consideration in capacity building through education and training; collaborative research and development through networking among centers and people; development of information and communication networks and policy guidelines and support to policies and institutional capacities. Even in aquatic animal health and disease management and genetics and biodiversity, women may play important roles and need training in disease recognition and management on the farm and in helping maintain and improve breed.

In short, gender is a dimension in nearly every part of the NACA Vision.

In addition, as a Network, NACA has the opportunity to show leadership to its members and help them share and coordinate their own work on women/gender in aquaculture. This opportunity for leadership could stand NACA in good stead regionally and in global and intra-regional initiatives because women/gender needs this leadership after receiving scant attention compared to fisheries, which is also only lightly served.

Finally, in its work program, NACA should be taking a lead in implementing Recommendation 5 from the 2010 Phuket Consensus of the Global Conference on Aquaculture:

"Support gender sensitive policies and implement programmes that facilitate economic, social and political empowerment of women through their active participation in aquaculture development, in line with the globally accepted principles of gender equality and women's empowerment."

What has NACA already done on gender in aquaculture?

NACA has already made a start by including materials on women in aquaculture in some of its publications, especially in stories in "Aquaculture" magazine, in some of the chapters in "Success Stories in Asian Aquaculture" and in Expert Panel Review 6.3 of Farming the Waters for People and Food, the Proceedings of the Global Conference on Aquaculture 2010 ("Sustaining aquaculture by developing human capacity and enhancing opportunities for women"). Annex 1 summarises the gender issues and opportunities from that chapter which contains many useful ideas.

How could NACA develop a gender element in its program?

NACA could embark on a development pathway for including gender in its programs by addressing four elements as steps, all done in collaboration with member government and with the help of experts as necessary. However, the short term aim would be to achieve good ownership among the membership, agencies and staff of the NACA Secretariat.

First, develop a set of specific objectives for its gender work. Second, develop a rationale that describes to its member governments and Network agencies why gender is important to incorporate. They all need a narrative to support their own moves toward greater gender awareness and inclusion in their programs. Third, consider the four following elements:

- Systematically integrate gender into NACA and partnership projects, programs and activities.
- Engage partners in gender and aquaculture research and development.
- Generate and disseminate new evidence on gender and aquaculture to inform policy and practice in the member countries and with industry partners.

- Mainstream gender into NACA's work and organisational culture.

These elements involve changes in the way NACA does its own work, in the types and substance of projects NACA does, in how it engages with partners and how it influences others. As women are already quite active in many fields of aquaculture, and more women are joining the ranks of technical experts, then the sort of shift envisaged will not be as radical and dramatic as it may appear.

However, gender and social science experts will be needed to help on the technical side of the transformation. NACA will likely need to consider its own long term staff complement to incorporate more women staffers, and to include good social scientists. Many agencies presently are making the mistake of using 'rebadged' but untrained biologists and economists to do gender work. These people rarely have the deep knowledge of social science and grasp of gender concepts needed to bring the sectoral gender work forward. To add a further constraint, such gender and social science experts are in great demand. Many agencies are tending to pick up newly graduated experts and give them strong internal support to help them succeed in working with much more senior colleagues. This could also be an option for NACA, who could also take advantage of the nearby presence in Bangkok of a strong gender department at AIT, including faculty who have worked on aquaculture in the region.

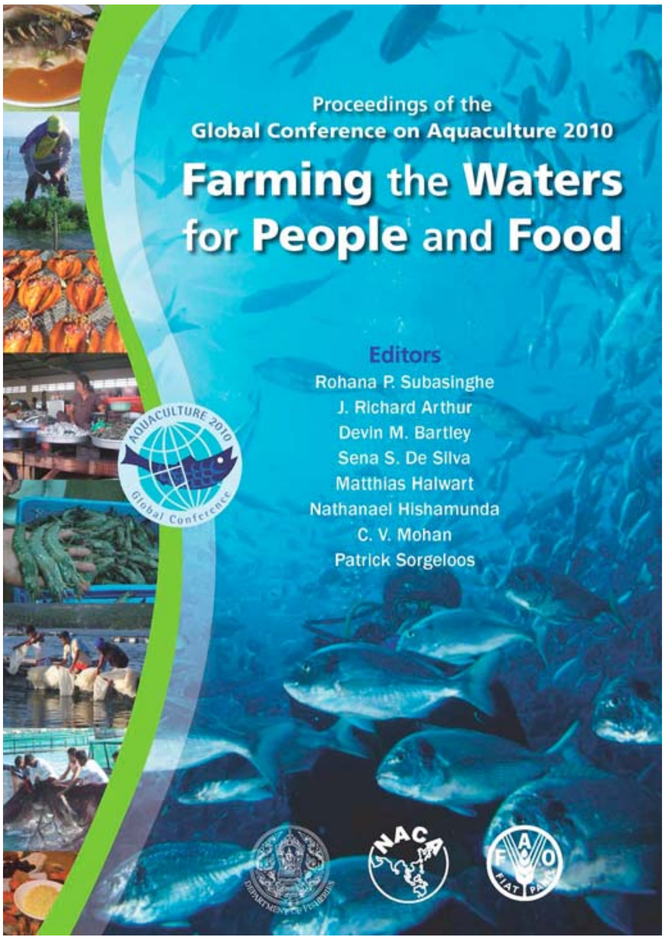
Proceedings of the Global Conference on Aquaculture 2010 available for download

The Food and Agriculture Organization of the United Nations (FAO) and NACA are pleased to present "Farming the Waters for People and Food: Proceedings of the Global Conference on Aquaculture 2010". The Global Conference on Aquaculture 2010, organised jointly by FAO, the Network of Aquaculture Centres in Asia-Pacific (NACA) and the Royal Thai Department of Fisheries (DoF), was held from 22 to 25 September 2010. It sought to bring together a wide-ranging group of experts and important stakeholders to review aquaculture progress and the further potential of this sector, as a basis for improving the positioning of the sector and its mandate within the global community.

The objectives of the Conference were to: (a) review the present status and trends in aquaculture development; (b) evaluate the progress made in the implementation of the 2000 Bangkok Declaration and Strategy; (c) address emerging issues relevant to aquaculture development; (d) assess opportunities and challenges for future aquaculture development; and (e) build consensus on advancing aquaculture as a global, sustainable and competitive food production sector.

In order to achieve these objectives, the Global Conference was conducted in four separate sessions over a period of four days. The Conference's technical programme included: (1) two keynote addresses; (2) three invited guest lectures; (3) six regional aquaculture development trends reviews and one global synthesis; and (4) 41 thematic presentations covering six broad thematic areas which included: (i) resources and technologies for future aquaculture; (ii) sector management and governance; (iii) aquaculture and the environment; (iv) responding to market demands and challenges; (v) improving knowledge, information, research, extension and communication in aquaculture; and (vi) enhancing aquaculture's contribution to food security, poverty alleviation and rural development.

The Global Conference triggered great interest among a wide range of stakeholders (including government, academia, education, research, industry and many others) and was very well attended. Over 650 delegates representing 69 countries from the aforementioned sectors participated. In fact, registration was closed two weeks prior to the commencement date, once the full holding capacity of the meeting rooms had been attained.



The regional aquaculture trends reviews and the global synthesis have already been published and are also available online.

This publication comprises all other presentations and reviews of the Conference, which have been subject to peer review by a panel of experts. The Report of the Global Conference on Aquaculture 2010, which is available at the same site, provides a detailed account of the conduct of the Conference along with its technical recommendations.

As a modest step towards reassuring the support to sustainable aquaculture development, the Global Conference adopted the Phuket Consensus, a document which reaffirms commitment to implementing the Bangkok Declaration and Strategy which had been adopted during the Conference on Aquaculture in the Third Millennium held in 2000. The Phuket Consensus confirmed that the progress towards sustainable aquaculture development at the global level has been made possible largely by efforts made in line with the Bangkok Declaration and Strategy. The latter Strategy thus continues to be highly relevant to the aquaculture development needs and aspirations of FAO member countries; however, there are elements of the Bangkok Strategy that require further strengthening in order to enhance its effectiveness, achieve development goals and address persistent and emerging threats. The participants of the 2010 Global Conference therefore reaffirmed their commitment to the Bangkok Declaration and Strategy for Aquaculture Development and made several recommendations that since the early 1980s are outlined in the Phuket Consensus, as elicited at the end of this volume.

FAO and NACA have been collaborating on sustainable aquaculture development at the global level since the early 1980s, and significant contributions have been made jointly by FAO and NACA towards aquaculture development. With increasing poverty at the global level and the increasing demand for fish to feed a growing global population, much needs to be done to augment the contribution of aquaculture to global food and nutrition security. This volume, yet another joint effort of FAO and NACA, presents the much needed clear and comprehensive technical information that will assist in the mobilisation of global efforts to alleviate poverty and improve food and nutrition security through sustainable and responsible aquaculture.

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Download the proceedings from:

http://www.enaca.org/modules/wfdownloads/singlefile.php?cid=220&lid=1055

Download the regional aquaculture trends reviews and the global synthesis from:

http://www.fao.org/fishery/regional-aquaculture-reviews/aquaculture-reviews-home/en

Peter Edwards to mentor the new Sustainable Farming Systems Programme

At its recent meeting in Cambodia, the 23rd Governing Council endorsed some significant changes to the NACA Work Plan. One of the key changes is the formation of the Sustainable Farming Systems Programme, which will incorporate the former Inland Aquaculture and Coastal Aquaculture Programmes. One of the key issues the new programme will address is sustainable intensification, seeking to increase the productivity of farming systems through gains in efficiency, rather than only through additional resource inputs. As the global population continues to grow, feeding the world without further degrading the environment is a key challenge that must be met.

We are pleased to announce that the Sustainable Farming Systems Programme will be mentored by Prof. Peter Edwards, who will already be well known to many people in the network. Prof. Edwards is an Emeritus Professor at the Asian Institute of Technology, where he founded the aquaculture programme and he has 36 years of experience in aquaculture education, research and development in the Asian region. He will also be familiar to readers of Aquaculture Asia Magazine, for which he has written a regular column on rural aquaculture for many years.

NACA wishes to welcome Prof. Edwards and looks forward to his assistance with the development of the Sustainable Farming Systems Programme.

International Fisheries Symposium (IFS 2012), 6-8 December, Can Tho, Vietnam

Aquaculture and Fisheries industry are increasingly playing important roles in the world. Reportedly, the total world aquaculture and fisheries production is continuously increased which is approaching 150 million tons. The South-East Asia has been showing as a very dynamic and important region for aquaculture and fisheries which is significantly contributing to sustainable development of global aquaculture and fisheries.

Aquaculture and fisheries sciences and technology are rapidly developed in the South-East Asian countries to meet its missions and to due with newly immerged issues for sustainable development. Sharing knowledge in aquaculture and fisheries sciences and technology is thus really important and necessary for the region.

This is the second time, six universities, Universitas Airlangga (Indonesia), Can Tho University (Vietnam), Kasetsart University (Thailand), Nong Lam University (Viet Nam), Universiti Malaysia Terengganu (Malaysia), Prince of Songkla University (Thailand), are jointly organising the International Fisheries Symposium. As its objectives, the subject of this annual symposium is "Sharing knowledge for sustainable aquaculture and fisheries in the South – East Asia".

This will be a wonderful opportunity for scientists, technicians, businessmen, farmers and managers from the South- East Asian countries and from the worldwide countries to gather and to share knowledge and information on Aquaculture and Fisheries Science and Technology. Students are highly welcomed to attend the symposium.

This annual symposium will be organised at Can Tho University, Viet Nam, the third largest producer of the world aquaculture production. This will give you a great chance to explore deeper aquaculture and fisheries industry in this country.

We strongly believe that this symposium is not only an opportunity to share knowledge, but also a great chance to promote further international collaboration in research, education, technical transfer and other business activities.

On behalf of the organisers, we warmly welcome you to Can Tho University, Viet Nam, and do hope that you will have wonderful time of staying here during the symposium.

For more information please visit the symposium website for the scientific programme, abstract submission procedure and registration forms:

http://www.ctu.edu.vn/colleges/aquaculture/ifs2012/index.php?option=com_content&view=article&id=89&Itemid=102

Broodstock management training course launched by NACA and UNU-FTP

Although the aquaculture sector in Asia has grown considerably over the last three decades, currently accounting for over 90 percent of the global production of approximately 62 million tonnes, there is reason to believe that the rate of growth is declining. One possible reason for this decline is a decrease in the quality of seed stocks of many of the major species cultured. Few hatcheries have personnel trained in broodstock management or effective broodstock management plans in place. The situation has been further exacerbated in countries that are dependent on alien species where the sector is witnessing the deteriorating quality of broodstock, which in most instances are based on small imported founder populations that have been maintained in captivity for many generations without genetic management. Establishing capacity in broodstock management is a prerequisite for the development and maintenance of improved, more productive strains desired by many countries. These problems and related issues have been acknowledged in many fora, including the Asia Regional Ministerial Meeting on Aquaculture for Food Security, Nutrition and Economic Development (2011), the FAO/NACA/DOF Global Conference on Aquaculture (2010) and the FAO/NACA Expert Consultation on the Use and Exchange of Aquatic Genetic Resources (2009). Capacity building in broodstock management has been requested at every annual meeting of the NACA Governing Council since 2006.

A long term solution in this regard has not been explicitly thought out nor put in place; the most common approach to the problem has been to replace existing broodstock sourced from the wild, where possible, and in the case of alien species request the original donor countries for fresh replenishments. The latter is becoming more and more difficult with most countries becoming increasingly conscious of biodiversity concerns, trans-boundary pathogens and the up-coming access and benefit sharing protocols, all leading to a relative reluctance on sharing germplasm. As the science of broodstock management comes to light more explicitly, with increasing application of molecular genetic tools, such knowledge has to be applied as a long term or sustainable solution to the problem.

In the region one of the major weaknesses of the sector lies in the fact that science of broodstock management is not well understood and rarely applied in practice. Neither is it a component of the curriculum in courses on aquaculture in tertiary institutions. In most countries in the region there is a dearth of capacity in broodstock management principles and practices, hatchery personnel almost always concentrating on paying more attention to the immediate needs of producing seed stocks required, but less so on its quality and or on aspects of preserving the genetic diversity of the parental stocks and the manner in which the best results could be obtained, in respect of quality of seed stock in each production cycle.

In addition, stock enhancement of inland waters is conducted as a routine practice in many countries for cultural purposes (e.g. water festival activity) and increased food fish production. In these practices little or no attention has been paid to interactions of the hatchery produced (hence the origin of the broodstock) stock and wild stocks, and potential impacts on genetic diversity of the latter. This again is an area where capacity building, which could be coupled with broodstock management in aquaculture, in relation to such impacts could bring about long term benefits of such wild stocks.

As such capacity building, among broodstock and hatchery managers, as well teachers in leading tertiary institutions providing aquaculture training, on the science of broodstock management warrants urgent attention.

NACA and the Fisheries Training Programme of the United Nations University (UNU-FTP) have jointly launched a project in collaboration with Nha Trang University Vietnam and Holar University Iceland to develop and test a short training course on principles of finfish broodstock management, to hatchery managers and key in-service personnel associated with hatchery operations drawn from six to eight countries in the Asian region. The course development started with communications coordinated by NACA among a group of experts and collection of technical inputs of a number of relevant expertise. The experts are from Iceland, NACA, Australia and Vietnam with their specialties covering fish nutrition, genetics, health management, breeding, and other husbandry aspects. Through the initial communication the group had successfully generated a draft design and outline of the training course, and a set of PowerPoint presentations. A preparatory workshop for the training course was then organised from 30 May to 5 June 2012 at Nha Trang University, Vietnam, during which the course outline was revised, PPTs reviewed and modifications for improvement suggested. The group agreed to develop full sets of training materials, including session plans, visual aids, reading handouts, broodstock management planning exercises, and structured cases studies.

It is expected that the test-run of the training course should be implemented early next year for a group of selected participants from 6 to 8 Asian countries. Hopefully dissemination of the training materials and continuation of the training course in the future by NACA, UNU-FTP and their partners will contribute to capacity building in broodstock management and ultimately contribute to aquaculture development in the region. For expressions of interest or more information, please contact yuan@enaca.org.

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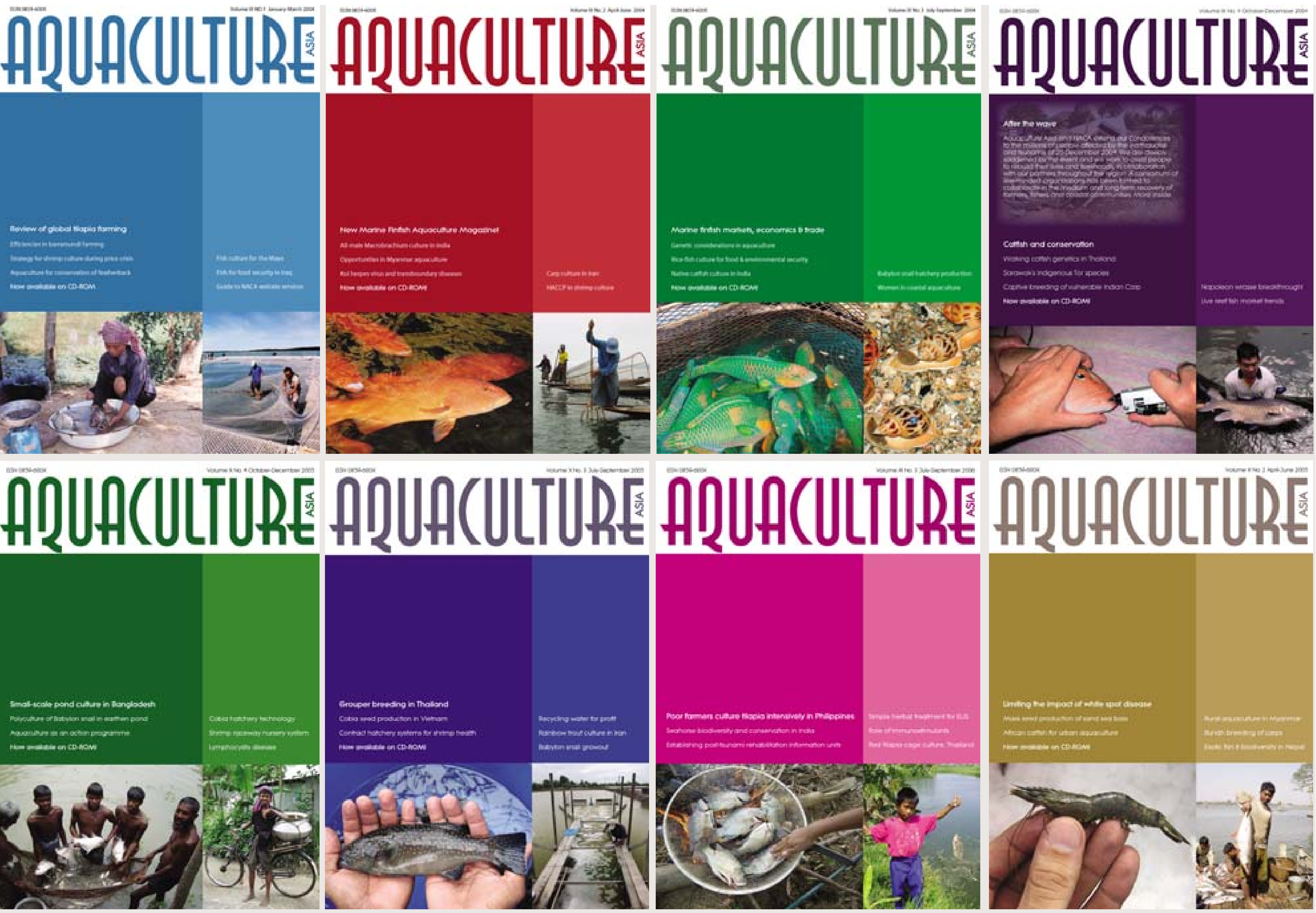
NACA is a network composed of 18 member governments in the Asia-Pacific Region.

The Sultanate of Oman Embarks on Aquaculture Development

The Sultanate of Oman, with a coast line of 2092 km, pristine at that, and a large extent of land area is embarking on an ambitious aquaculture development program, primarily coastal, for food security and generation of employment opportunities as well as earning export income, targeting the adjacent countries in the region. The government has already taken many preliminary steps towards this development strategy and is determined to make it sustainable and environmentally friendly and most of all not repeat the mistakes that had occurred, too often elsewhere.

Among the steps taken to meet its strategic plans it has already identified coastal sites in eight regions, having taken into consideration all relevant climatic, topographical, water quality characteristics and social issues, to be allocated for aquaculture development in each, and made this information available in the Atlas of Suitable Sites for Aquaculture Projects, Sultanate of Oman. In addition, the government has custom built a state of the art Aquaculture Center, which will coordinate the envisaged activities and act as the main research provider, including demonstration units, and proceeded to formulate guidelines for prospective investors to bit for the proposed sites, spelt out in the Investment Guidelines. The aquaculture centre has proceeded to prepare and distribute information profile booklets on species suitable for the designated areas.

As a prelude the Sultanate of Oman convened the first ever conference on aquaculture, “International Conference on Sustainable Aquaculture Development in the Sultanate of Oman- Investment Opportunities”, which brought together specialists in various sectors from all over the globe (Australia, Italy-FAO, Norway, US, UK, New Zealand, Vietnam etc.), prospective local and foreign investors on 10/11th of December in Muscat. The aquaculture development strategy was floated at this Conference. The Conference was presided by His Excellency the Minister for Agriculture and Fisheries Wealth, Dr Fuad Jaffer Al-Sajwani, and the government’s commitment to the proposed development was most evident by the fact that his Excellency was in attendance throughout the two days of the conference and led the final discussions sessions. The keynote speaker at the conference was the former Director General of NACA, Professor Sena S De Silva, who spoke on “Current trends in commercial aquaculture in Asia & relevance to emerging aquaculture nations”.



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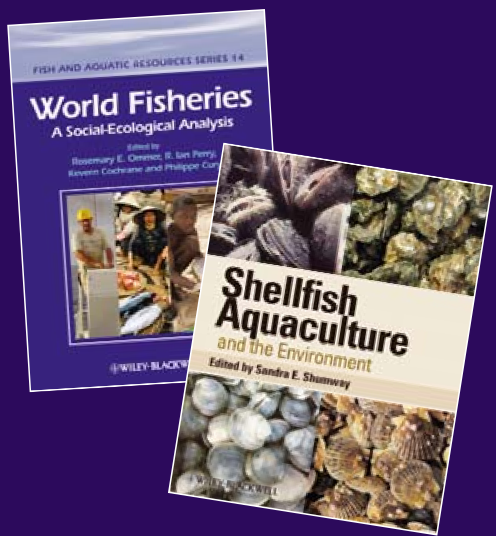

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