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AQUACULTURE ASIA

Fish Farmer Field School, Indonesia

Ornamental fish for self-help group, India

Spirulina aquaculture

Lactic acid bacteria

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AQUACULTURE ASIA

Aquaculture Asia

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

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NACA

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.

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Workshop on Mainstreaming Gender in the Network of Aquaculture Centres in Asia-Pacific

The 4th Global Symposium on Gender in Aquaculture and Fisheries was held in conjunction with the 10th Asian Fisheries and Aquaculture Forum, from 1-3 May in Yeosu, Korea.

NACA took advantage of the presence of a number of gender in aquaculture experts to hold a workshop on mainstreaming gender within the organisation, supported by NORAD. This activity was conducted in response to a 2012 decision by the NACA Governing Council to mainstream gender within the NACA work programme.

The workshop made the following recommendations:

- NACA should develop a thematic gender gap report for Asia-pacific aquaculture, drawing on regional expertise, which should summarise existing gender initiatives in member countries and identify areas that need more attention, with a view of raising awareness of existing activities and raising NACA's profile as a champion on gender in aquaculture.

- NACA should prepare and disseminate clear messages in plain English on why women are important in aquaculture highlighting problems and solutions to enhance the participation of women in aquaculture and to encourage relevant organisations and policy makers to work towards these goals.

- NACA should develop a project targeting women entrepreneurs in aquaculture at the small-medium enterprise level, within the Sustainable Farming Systems Programme.

NACA has undertaken to implement these recommendations and is discussing resource mobilisation with partners and donors to initiate a concerted and expanded work programme on gender issues in aquaculture.

The report of the symposium, which includes a summary of the gender mainstreaming workshop, is available for download from the Gender in Aquaculture and Fisheries website:

http://genderaquafish.org/gaf4-2013-yeosu-korea/special-session-4th-global-symposium-on-gender-in-aquaculture-and-fisheries/

NACA would like to thank the workshop Chairs Dr Meryl J Williams (mentor to NACA on gender issues) and Bodil Maal (Senior Gender Advisor, NORAD), the participants and NORAD for financial support.

Further developments will be posted on the NACA website, www.enaca.org, in due course.

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Rural Aquaculture

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

Cultivation of spirulina in India

When our dear late colleague Dr Nandeesha learned that I was planning a trip to visit shrimp farms in India (reported in my column in Aquaculture Asia 17, 2: 3-14, 2012), he suggested that I also visit small-scale spirulina farms which I readily accepted as it promised to be a trip down 'memory lane'. While in Chennai, Dr Dhanuskodi Manikandavelu of Tamil Nadu Veterinary and Animal Sciences University (TNVASU) kindly guided me to visit two nearby farms producing the blue-green alga, or perhaps more correctly expressed, the cyanobacterium spirulina (*Arthrospirulina platensis*).

Memory lane

My earliest academic career was in seaweed ecology and taxonomy, but I've had a long standing interest in microalgae. My major professor at the

Manual mixing of spirulina culture in a tank, Nallayan.

University of Texas (UT) where I received my doctorate was Harold Bold who's main research area was green microalgae, or 'little round green things' as they were affectionately referred to by our colleagues in the UT Department of Botany. Furthermore, a few years later I gave a graduate-level course on Algal Ecology and Physiology when I was teaching in the Department of Botany at Rutgers University in New Jersey. It was at this time that I learned about John Ryther's inspiring work on microalgae and especially his large-scale outdoor pilot sewage treatment system involving marine microalgae or phytoplankton at Woods Hole, Massachusetts, which I visited, met John and discussed his research.

When I was seeking possible universities to join in the tropics where plants grow much faster than in temperate New Jersey, I saw a paper in a seaweed symposium proceedings by Mike McGarry then based at the Asian Institute of Technology (AIT) on culture of microalgae on sewage (McGarry, 1972). To 'cut short' a further long series of serendipitous events, I joined AIT in 1976. After a very brief and unsuccessful attempt to secure a research grant to continue with my old area in seaweeds, by another coincidence I was awarded a research grant by Mike who had left AIT a few years earlier to work for IDRC, Canada, and who was then directing a global research program in wastewater reuse through aquaculture. The research on the AIT campus involved treatment of sewage in a high-rate stabilisation or oxidation pond (HRP) and investigation of the removal of the resulting dense phytoplankton in the treated wastewater stream by filter-feeding Nile tilapia

Above: Checking the density of spirulina with a Secchi disc, Nallayan. Below: Draining excess water from harvested spirulina slurry harvested in a muslim cloth frame, Nallayan.

Further draining water from slurry under a 50 kg weight.

(*Oreochromis niloticus*). Although the research my colleagues and I carried out at AIT eventually proved to be a 'dead end', it resulted in several papers (Edwards, 1981; Edwards and Sinchumpasak, 1981; Edwards et al. 1981 a,b) but more importantly eventually lead on to more useful R&D in rural aquaculture.

A bowl of spirulina after two stages of dewatering, Nallayan.

During the wastewater-fed aquaculture project at AIT I visited two microalgae projects in India in 1977 en route from a meeting of the IDRC funded project network in Nairobi, Kenya. Dr L.V. Venkataram, who unfortunately was unable to respond to my request when preparing this column for a discussion due to ill-health, was directing the research program on microalgae at the Central Food Technological Research Institute in Mysore through the All India Coordinated Project on Algae as well as an Indo-German Algae Project. The program involved microalgae production in HRPs, the results of which on spirulina were

Passing dewatered spirulins through a noodle manufacturing tool, Nallayan.

subsequently published in a monograph (Venkataraman, 1983). I also visited the late Dr. C.V. Seshadri at the Shri A.M.M. Murugappa Chettiar Research Centre in Chennai where he was developing low-cost technologies to culture spirulina appropriate for villages, including manually stirred polyethylene-lined tanks which are in use today in India.

Last but far from being least, during my early days at AIT I visited the Thai-German Algae Project on the Kasetsart University Campus in Bangkok where I met my wife Darunee who was a researcher in the university Algae Laboratory.

Do forgive me for this rather personal digression but microalgae have clearly played a most important role in my life as well as in my career.

Mass cultivation of microalgae

Microalgae, especially the green alga *Chlorella*, began to be promoted more than 60 years ago, before the advent of the Green Revolution, as part of a possible solution to world hunger because it has a high protein content and a productivity many times higher than that of conventional agricultural crops such as soybean. The story is told with a great sense of humour in a seminal paper entitled ‘Algae burgers for a hungry world? The rise and fall of *Chlorella* cuisine’ (Belasco, 1997). He writes of ‘a watery slime promising to feed the millions... and...people who tried to eat algae talked about the

Dr Manu having a spirulina drink behind a manual spirulins pill making machine, Nallayan.

Laying out noodle-like strands of spirulins to dry, Nallayan.

Various spirulina products, Nallayan.

Gag Factor’. Subsequently, ‘promoters finally stopped talking about eating the vile stuff directly...but...adding it to other foods’. But because of the huge capital investment to build and operate microalgae farms, ‘fascination with algae burgers and plankton soup blew away like summer smoke’.

Today only a few species of microalgae are cultivated in open tank systems, mainly the single cell green algae *Chlorella* and *Scenedesmus* for a rather expensive dietary supplement and health food and as an additive to ornamental fish feed, and *Dunaliella* for beta carotene.

Women make up the major part of the work force, Nallayan.

Spirulina culture in a paddle wheel driven tank, Nallayan.

Overview of spirulina and its cultivation

Spirulina is also mainly cultivated for a dietary supplement and health food as well as an additive to ornamental fish feed. However, spirulina can be more easily produced than single-cell green algae as it is a long spiral multicellular filament which makes it easy to harvest and process. Although most of the world's production of spirulina is from large-scale commercial farms in several countries including China, India, Israel, Taiwan, Thailand and the USA (California and Hawaii), it is also grown relatively cheaply in India to provide a nutritional supplement for poor communities with an inadequate staple diet as I witnessed during my visit. FAO has recently commissioned a review on spirulina because of its food and feed value (Habib et al. 2008).

Dried spirulina contains about 50-70% complete protein containing all essential amino acids though with reduced

Close up of the paddle wheel and the dense spirulina culture, Nallayan.

Below: Spirulina being sun-dried, foreground and spirulina culture tanks, background, Mullai.

amounts of methionine, cysteine and lycine compared to the proteins of meat, eggs and milk although its protein is superior to that of legumes. It is rich in the polyunsaturated fatty acid, gamma-linolenic acid, contains many vitamins and minerals, and is rich in beta carotene that can overcome eye problems and blindness caused by vitamin A deficiency. It has been demonstrated that a tablespoon a day provides remarkable health benefits to undernourished pregnant and lactating women and children.

Spirulina occurs naturally in alkaline tropical and subtropical lakes with high pH and high carbonate and bicarbonate concentrations and has been consumed safely for hundreds of years. It was harvested by the Aztecs from Lake Texcoco (where the world's first large-scale spirulina production plant was set up in the 1970s) until the 16th century and today it is still harvested around Lake Chad in Africa where it is dried into cakes to make broth for human consumption.

Small-scale spirulina production in India

Spirulina Production, Research and Training Centre

The Nallayan Research Centre for Sustainable Development (Spirulina Production, Research and Training Centre), Navallor village, Kanchipuram District in Tamil Nadu was established a decade ago by the Organisation For Eelam Refugees Rehabilitation (OfERR) to protect Sri Lankan refugees (children and pregnant and lactating women) from malnutrition with assistance from a Canadian NGO, The Primate's World Relief and Development Fund (PWRDF). PWRDF has helped to set up another three regional spirulina farms and tank culture systems in more than 50 refugee camps to help to combat chronic undernutrition. The tanks are managed by trained members of the community who sell the spirulina to OfERR which then gives it to people running the nutrition programs in more than 100 refugee camps. Spirulina has been distributed to refugees as a nutrition supplement to pregnant and nursing women and children since 2002, 2 g/day either as a dry powder or wet slurry mixed with lime juice, milk or any other cold drink.

According to Mr. Retna Raja Singam, the Income Generation and Spirulina Cultivation program Coordinator who guided me around the Nallayan facility, there was 0.2 ha of spirulina production with nine mostly women workers. The centre started with 5 x10 feet tarpaulin covered wooden frame tanks, then doubled them to 10 x 20 feet tanks and was using concrete sided tanks during my visit. They had also installed a paddle-driven HRP, 60 x 20 feet with a capacity of 20m^3 producing 15-20 kg of spirulina slurry/day, a further incremental improvement. The centre produced a total of 100 kg of slurry/day, with production 10% higher in the dry than the rainy season.

The 10 x 20 feet 25 cm deep tarpaulin lined wooden frame tanks contained 4 m^3 of water. A weight of 4 kg of 'mother' culture was added to each tank filled with well water to which was added Zarrouck's medium, several inorganic salts

Below: Women also outnumber men in the workforce, Mullai.

Manual mixing of the spirulina tank, Mullai.

formulated for microalgae. Starting 10 days later 2.5 kg of spirulina slurry was harvested daily. The culture was manually stirred every 30 minutes. After 10 days spirulina was ready for harvest. Six months later the cycle was repeated. Production was year round with the tanks shielded by sheets during rainfall.

The algae was harvested using small plastic buckets and poured into a mounted muslin cloth filter, which drained the excess water. The drained spirulina was then wrapped in clean muslin cloth and pressed under a 50 kg weight to further drain moisture. It was then put in a small machine (used in noodle manufacturing) and squeezed to the form of noodles. It was placed on a dry, clean cloth and laid on a concrete drying platform under the sun to dry for 2-3 hours after which it was ground in a machine similar to a flour machine and the powder was sent to the lab for testing. It was then packed in small airtight plastic covers, ready for consumption.

As spirulina has an unpleasant taste, about 1g of spirulina powder should be mixed in 200 ml of cold water with any fruit juice or ice cream and sugar before being consumed. As well as powder the farm also sold tablets and capsules as well as products such as creams, jam, soap, shampoo. Capsules were made manually, 100 at a time by pressing powder through a small machine into capsule shape after which they were placed in a gelatin capsule.

The spirulina products were sold throughout India (80%) as well as being exported (20%) to many countries such as Jordan, Malaysia, Netherlands, Phillipines and Singapore. The main issue was said to be the market as local awareness about spirulina was considered to be low.

The Nallayan Centre had also given hands-on training to more than 1,000 people over the past 7 years, including people from Brazil, Iran, Italy, Jordan, Malaysia and Sri Lanka. More than 50% of local trainees had set up spirulina production tanks, including Mullai Spirulina Farm visited and outlined below.

Mullai Spirulina Farm

The farm located in Bodaparai village in Vellore District, Tamil Nadu, had received training from both the Nallayan Centre and the University and used the same method of production as the Nellayan Centre, cultivating spirulina in 10 x 20 feet tarpaulin covered wooden frame tanks. The farm employed 9 female workers and also had a supervisor who visited occasionally. The farm sold similar products to the Nallayan Centre locally as well as exporting to Ghana, Kenya, Malaysia, Oman, Saudi Arabia, Singapore and Sri Lanka.

The main concern was again the market. As India still has a major malnutrition problem, the Indian Government gives free meals to school children, including five eggs per week. However, the children would benefit by being given 2 g of spirulina per day which would also create local employment.

Tamil Nadu Veterinary and Animal Sciences University

While there are lots of water bodies in the state, they are mostly shallow and hold water for only 3-4 months of the year. However, small-scale spirulina culture units can be maintained year round to produce a food supplement for humans, livestock and/or fish. Dr Manikandavelu informed me that he is working with 300 farmers to culture spirulina at the village level throughout Tamil Nadu State.

The University had a spirulina culture facility at its field centre where a 2 day training program had been given to farmers and other interested people on the importance of spirulina, how to cultivate it indoors as well as outdoors, how to maintain the mother culture, value added products and economics. The training course had been given eight times with 20 participants each time. The course was advertised in a popular magazine.

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Spirulina powder, left, and Spirulina capsules, right, Mullai.

Fish Farmer Field School: Towards healthier milkfish / shrimp polyculture and fish farmer empowerment in South Sulawesi

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'Tambak' is the common Indonesian name for a brackish water fish pond, classically supporting a polyculture of milkfish (Chanos chanos) and brackish water shrimp. There is historical evidence of 400 year old tambak in South Sulawesi, naturally constructed in the lower meanders of river estuaries. Not until 1964, in response to increasing demand from Japan for shrimp (a result of post-World War II affluence) did large-scale expansion and intensification of culture occur in tambak. In 1984/85, the Indonesian central government developed policies to ramp up expansion and intensification, through the INTAM program, which targeted twelve provinces in Indonesia. Much of the increase in tambak coverage took place in mangrove forests, as both mangroves and tambak require tidal flooding and adequate drainage.

Tambak can be a massive feature in the coastal landscape, understood by anyone flying into a major deltaic city in Indonesia such as Jakarta, Surabaya, Lampung or Makassar. The 16,000+ hectare tambak complex owned by PT CP Prima Genjot (a subsidiary of the Thai conglomerate Charoen Pokphand) in Lampung is the largest contiguous aquaculture complex in the world, having displaced a mangrove system itself worth an estimated USD 436 – 574 million when one considers the value of mangrove goods and services (Sathirathai and Barbier, 2001).

As mangroves were replaced by tambak, a new set of social, economic and environmental problems arose. Services once provided by mangroves, such as flood control, salt water buffering, and natural primary productivity were lost. Mangrove detritus (leaf-fall, dead roots and twigs) provides a food source for numerous plankton, animals and bacteria, which drives the near-shore or coastal food chain. Especially notable was the reduction in beneficial animal plankton, including copepods, which are an important food for shrimp and juvenile fish.

Measuring shrimp fry as part of weekly field school studies

Experimental ponds built for farmer field school - donated for use by participants.

Lacking the basis of natural primary productivity, fish farmers must resort to external sources of nutrients to drive food production. Two of the most expensive purchases for fish farmers include both fish feed and fertiliser. With regards to feed, the majority of fish feed for milkfish and prawn production in Indonesia is imported. To "increase competitiveness" of aquaculture product exports, milkfish and prawn feed enters the country tariff-free, a policy which in practice reduces the likelihood of domestic production of these inputs. Resultantly, fish farmers become fully reliant on external, imported resources.

With regards to fertiliser, traditional milkfish farmers historically applied organic sources of nitrogen to develop an algal mat on the tambak bottom, algae being the main food source for milkfish. However, semi-intensive and intensive ponds required higher levels of production, so government aquaculture extension agents promoted the application of urea (along with TSP, industrial feed, antibiotics and pesticides) in an aquacultural intensification effort known as the "Blue Revolution" (see boxed text). Continued use of and reliance on industrially produced inputs have numerous downsides for rural fish farmers. On average, fish farmers in South Sulawesi have increased their use of urea 10-fold over the past decade, reaching heights of one tonne of urea per hectare at a cost of US$ 200. Less than half of urea is actually nitrogen (46%), with the other half composed of filler, useless as a fertiliser, which can be harmful to beneficial biological, chemical and physical properties of the pond substrate. One member of a fish farmer field school in South Sulawesi

Tilapia poisoned intentionally in preparation for conventional fish farming.

likened these additives to cement, hardening pond bottoms, and killing off beneficial bacteria and other organisms which would normally enhance a ponds ecology and productivity.

Due to the high cost of imported fish feed, Indonesian farmers sometimes use expired noodles and crackers as a replacement, which have little nutritional or protein value. Resultantly, farmers are finding themselves continuously facing low growth rates coupled with high incidence of disease and mortality.

Since the late 1990's, indeed, tambak farmers in South Sulawesi have found themselves at constant risk of losing much or all of their harvest to death and disease, without fully understanding the reasons why.

Research from the 1990's revealed a pair of common shrimp viruses afflicting *Penaeus monodon* (tiger prawn) the most commonly cultured shrimp. The government's eventual response was to promote alternate species of shrimp, which in recent times includes promotion of the use of *Litopenaeus vannamei*, a white shrimp native to the Pacific coast of the Americas from Mexico to Peru, which is often claimed (incorrectly) to be "disease resistant". The introduction of vannamei, as it is locally known, has actually introduced additional diseases to Indonesian waters, such as Taura syndrome virus.

The answer to shrimp disease is not likely the introduction of genetically "resistant" stocks but rather related to environmental factors. Several authors have expressed that ecological collapse is likely in mangrove areas, where more than 20% is converted for other uses such as aquaculture development (Saenger et Al, 1983;Primavera, 2008). Yet the twelve provinces mentioned as targets for aquaculture development in the INTAM program already experienced an average of 60% conversion of mangroves to aquaculture during by 1982, with half of those provinces having already experienced 80-99% conversion. (Silvius et al., 1987).

The continued unbalanced use of exotic species and external, industrial inputs in this system, without a move back towards naturalness (a mosaic of land uses include native habitats and development of organic aquaculture practices) can only lead to further degradation of ecological links, reduced productivity, and increased incidence of disease.

Since the spread of the above mentioned viruses, rearing shrimp has high risk of mortality. Still, many fish farmers try to achieve higher production, by adding more urea to their ponds, up to one tonne per hectare per cycle.

Haji Haruna has farmed fish in Bontomanai Village, Pangkep District, South Sulawesi for the last 40 years. He says the last 15 years have been difficult. Like his neighbours, he had continued to increase use of urea (about ten times as much in ten years) without notable increase in yields, and with high risk of losing the crop to disease. A few years back he experienced a three year period where his crop failed entirely and he made no income from fish farming. He suspected overuse of urea was harming his pond, either the water quality or substrate. He began, on his own, to use chicken manure instead of urea, and could once again grow fish and shrimp in his ponds. He joined a fish farmer field school two years ago (in 2011), and has continued use of organic inputs only. He is happy that he can farm again, while all other

Imported feed used in conventional milkfish/shrimp polyculture.

Above, below: Part of a field day - where fish farmers answer questions posted around their ponds.

neighbouring farmers who still use urea and other industrial inputs have experienced high and even total mortality in the past two years.

Fish Farmer Field Schools

Unregulated, uncontrolled use of industrial fertilisers, synthetic feed and pesticides can have negative impacts on yields of aquaculture products, and more generally environmental and human health (both consumers and producers) when used irresponsibly. These issues gave birth to the development of Fish Farmer Field Schools, with the overall goals of providing opportunities for fish farmers to develop critical thinking skills through hands-on trials and analysis, and to develop improved methods for sustainable aquaculture production.

"A Farmer Field School for Aquaculture," was suggested by A. K. M. Reshad Alam and Kevin Kamp in "Utilising Different Aquatic Resources for Livelihoods in Asia: A Resource Book." (IIRR, 2001).In it Alam and Kamp sketch out a transformative process to re-empower fish farmers adhering to the following principles:

- **Extensionists must believe that farmers can be experts**. Without this fundamental belief in the capabilities of farmers, it is unlikely that a program to enhance their abilities will succeed.

- **Rethink technologies and practices**. Focus learning efforts on understanding the basics of aquatic ecosystems.

- **Make the invisible visible**. Develop methods that will allow farmers to actually see, feel and hear what is going on under the surface of the water.

- **Provide opportunities for farmers to put concepts together**. Develop possible practices and technologies and test them with the farmers as a group. Encourage farmers to set the research agenda. This may mean ensuring a number of small pits, ditches or ponds are available. Planning, implementing, monitoring and evaluating together can be a powerful experience for farmers and can provide them with valuable skills. Group work also acts as an information, education and communication tool. More people will be reached by this method and will want to take part in the learning process.

More field day questions.

Beyond the Blue Revolution

Aquaculture intensification in tropical developing nations, beginning the 1980's is frequently referred to as the "Blue Revolution," the goals of which were the development of a "critical source of high-quality animal protein, essential to feed growing human populations in light of stagnating or declining marine stocks." The contribution of aquaculture to the total quantity of fish available for human consumption grew from 12 per cent to 22 per cent between 1984 and 1993 and was presumed by CGIAR to increase to more than 50 per cent of the total value of the global food catch between 1995 -2010. In many ways this Blue Revolution was analogous to the Green Revolution in agriculture. As the Green Revolution was acclaimed as the means to end world hunger, the Blue Revolution was promoted as a way to increase incomes and the available supply of affordable food among the poor in the third world.

Yet Susan Stonic (2000), in "Stoning the Blue Revolution" points out "The potential of aquaculture to improve the nutrition and incomes of the poor has been impeded by the emphasis on the cultivation of high-value, carnivorous species destined for market in industrial nations. The primary motives are generating high profits for producers and input suppliers and enhancing export earnings for national treasuries. This is particularly true of industrial shrimp farming-the cultivation of shrimp in brackish water ponds along estuaries and other coastal zones. Goals of broadening the economic base of rural areas, generating local employment, and enhancing food security are minor compared to the overarching objectives of shrimp farming."

When pulling back to look at the global fisheries perspective, we see that aquaculture provides nearly 50% of the world's supply of seafood employing an estimated 24 million people (FAO, 2012). Capture fisheries, providing the other 50% of world seafood, is considered as stagnant from a production standpoint, (ibid) but still accounts for the employment of at least 200 million people who depend directly upon coastal and oceanic fishing for their livelihoods and another 60-80 million involved in post-harvest processing (USAID, 2012). As the production of the capture system relies on healthy coastal resources (75% of nearshore fisheries in the tropics being linked to mangroves habitats), we see that the only way for both systems to not only co-exist but thrive, is through improved management; which needs to simultaneously ensure sustainable production of existing ponds, reduce the risk of degrading or converting productive natural systems, and involve not only the formal fisheries sector but rural and vulnerable fisherfolk as well.

The role of a participatory aquaculture extension approach, such as fish farmer field schools in helping to achieve a sustainable balance cannot be under-estimated. Such an approach has proven scalable on land (millions of rice farmers having participated in farmer field schools across the world), and has the capacity to achieve those broad goals of equity and food security mentioned above. From what we are learning at the most local of levels - the field schools themselves - is that farmers are encouraged by early results, are adopting and disseminating learned practices, and are continuing to experiment. It may well turn out that the balance between mangroves and aquaculture is achieved by the practitioners themselves, and isn't that the way it should be.

- Develop strong management tools that farmers know how to use. Farmers need tools to quickly and easily monitor the "health" of the pond, the results of which will encourage and support management decisions.

- Enhance farmers' expertise to ensure the sustainability of aquaculture and institute a process by which farmers take the lead in innovation and development of new technologies. The role of the extension worker will be to support the farmers' learning opportunities on a regular basis.

However, in practice, a farmer field school approach has only been commonly adapted to fish/rice polyculture, and seldom to brackish water systems. With over 450,000 ha of tambak in Indonesia, and more than half of them abandoned or unproductive, it seems clear that a new approach to extension is needed. This is especially important to avoid continued expansion of new tambak in order to achieve short-term economic targets, a strategy recommended by the Indonesian Ministry of Fisheries if intensification efforts fail.

Fish Farmer Field School trials in South Sulawesi

As part of the five year Restoring Coastal Livelihoods Project in South Sulawesi, Mangrove Action Project - Indonesia, in partnership with the Provincial Departments of Agriculture and Fisheries, has run 71 Coastal Field Schools with 1,600 coastal villagers from four districts. Several of these field schools have tambak-based farming systems as their central theme, with the dual objectives of 1) building critical thinking skills among fish farmers and, 2) developing improved methods of brackish water milkfish/shrimp polyculture emphasising locally produced, organic inputs. During a fish farmer field school, farmers learn principles of sustainable aquaculture and factors that ensure long-term success of their agronomic practices. The Restoring Coastal Livelihoods Project runs from 2010-2014 and is supported by CIDA, OXFAM-GB, with implementation by OXFAM-GB, Mangrove Action Project - Indonesia and Yayasan Konservasi Laut.

The focus in the RCL project has been on use of organic fertilisers in order to improve the biological, physical and chemical quality of the pond bottom and water column. Farmers undertake studies to compare the effects of organic versus non-organic fertilisers on pond bottoms, and undertake studies on the effects of "living" pond bottoms on their fish yields.

During a fish farmer field school, the management of a pair of 0.5 ha ponds, experimental and control, are compared side by side. Experimental ponds are prepared by scraping their existing substrates (heavy in non-organic residue) and dried for a week. The substrate is then turned with use of a hand-tractor, and then fertilised with 120kg of organic compost, made by the group themselves from local materials.

Collecting samples for copepod observations.

The pond is flooded slowly to 50-75 cm depth, after which an additional 130kg of organic compost is added, this time mixed with 10 litres of homemade effective microorganism solution, to speed up decomposition.

Fertilisation of the pond supports the growth of an algal mat, which acts as the primary food source for grazing milkfish throughout the production cycle. After a week, 10,000 milkfish fry and 2,000 shrimp fry are added. Additional fertilisation of 250 kg of organic compost takes place during the second and third month.

Control ponds are also scraped and fertilised with urea and triple super phosphate (TSP). Stocking densities are identical to the experimental pond.

Over an entire production cycle, a number of studies are performed. Growth of the fish and shrimp is monitored over time. Simple water quality tests are performed, including turbidity readings (using a Secchi disk or turbidity tube), temperature, and qualitative oxygen readings based on fish behaviour. Other physical changes in the pond are noted.

Specialised studies are also under-taken. These include simple soil tests on the substrate, predator prey studies in aquaria, and feed trials. A range of curriculum modules have been developed by the farmers and trainers themselves, which may be used as a special study topic throughout the season. These modules are being compiled, and made available to aquaculture extension agents through training of trainer programs, for future up-scaling. The key to a fish farmer field school is that the farmers themselves are at the centre of all lessons, developing the experiments and tests, undertaking the research, analysing the data, reflecting on their experience and applying their knowledge to the continued management of both the tests ponds as well as their own ponds.


Preparing effective micro-organism solution.

Results

The tables (next page) depict the results of a pair of typical 0.5 ha trial ponds managed during fish farmer field school (control: non-organic, and experimental: organic). Both ponds were considered by fish farmers to be representative of a successful crop. The organic pond outperformed the neighbouring non-organic pond in terms of survivorship, yield and duration of grow-out period.

A new hope

IbuSaharia, a fish farmer from Pitusunggu Village, Pangkep had lost all hope of continuing to raise fish and shrimp in her family's ponds. When she heard that her village was hosting a fish farmer field school, however, she was eager to sign up for the season long course. Her husband was not initially enthusiastic about her joining the course, and throughout the field school commented that she was wasting her time making organic fertiliser and effective microorganism solution. Much to her husband's surprise, after only four months of endeavour, the family was able to harvest shrimp and milkfish again from their own ponds, at a higher yield than they had ever experienced.

Fish farmer field school participants have been noticing similar results across the districts of Barru, Pangkep and Maros. They are more confident than before that they can make a living again from aquaculture, and are becoming aware that they need to restore some of the original functions of a natural environment, which in the future may include increasing mangrove coverage, to restore a more ecological balance in the agro-ecosystem. The table below is a summary of fish farmer observations regarding their previous, non-organic aquaculture system and the use of organic inputs in shrimp/milkfish polyculture.

Looking ahead

What next? If we look back at the way rice farmer field schools began and accelerated in Indonesia, we see that there is still the need for many individual fish farmer field school trials, successes and failures. Although initial work is encouraging, it is just a small drop in a very large bucket; a complex of ponds of measuring at least 450,000 hectares.

Linkage with the government will be essential for the future scaling-up of the endeavour. Currently, government aquaculture extensionists (PPL) with fisheries background, lack the set of skills and experiences needed when facilitating participatory processes. They can be helped by their fellow extensionists from the Department of Agriculture (PHT and PPL) but also by a growing core of fish farmers themselves who are learning to become field school trainers. Pak Syukri, a Bugis fish farmer field school alumni from Boddie Village, Pangkep District, South Sulawesi was recently invited by the East Kalimantan Fisheries Department to lead a 10 day training for fish farmers and extensionists, many of whom originated from South Sulawesi as well. That government extensionists are engaging fish farmers to lead training is an encouraging sign that collaboration and communication are the order of the day.

Over the next ten years, we may map out some larger goals and objectives of fish farmer field school:

- Fish farmer empowerment.
- Gender equity in aquaculture production.
- Food security.

Table 1: Analysis of successful organic and non-organic milkfish/prawn polyculture in Pangkep District. 1 USD = Approx IDR 9,000.

Item	Non-organic	Organic	Notes
1. External labour 50 are (0.5 ha) @ Rp 75.000/month Note: Labour of the owner's family not considered in this calculation	600,000	300,000	Harvest of organic shrimp/milkfish = 4-5 months. Harvest of non-organic shrimp/milkfish = 8-10 months
2. Shrimp fry 10,000 @ Rp 25	250,000	250,000	10 day old fry
3. Milkfish fry 2,000 @Rp 40	80,000	80,000	
4. Fertiliser	510,000	500,000	Organic 500 kg x 1000Rp Non-organic: Urea 2 – 50kg sacks x 100,000, TSP 3 – 50 kg sacks x 110,000
5. Pesticide	90,000	30,000	Organic: Uses homemade 15 litres of effective microorganism bacteria Non-organic: 2 cans of Akodan- 35 – Endosulphan (broad band insecticide) @ 30.000, 1 can of Dursban (Chlorpyrifos – highly toxic for aquaculture; ordered for phase-out by USEPA) @ 30.000.
6. Feed	165,000	70,000	Organic: rice bran 30kg x 1000Rp, golden snail (*Pomacea canaliculata*) 40 kg x 1000 Non-organic: Commercial pellets
Operating costs - 0.5 ha	1,695,000	1,230,000	
7. Shrimp yield per cycle (kg)	50.0	95.5	Organic: Approx mortality = 25 % Non-organic: Approx mortality = 50 %
8. Shrimp value per cycle (Rp.)	3,500,000	6,685,000	70,000 Rp/kg
9. Milkfish yield per cycle	545	557	From ponds with low mortality (1-5%)
10. Milkfish value per cycle (Rp.)	8,175,000	8,355,000	15,000 Rp/kg
Total value of fisheries products	11,675,000	15,040,000	
Profit per cycle	9,980,000	13,810,000	Organic: 4-5 month harvest Non-organic:8-10 month harvest
Cycles per year	1	2	Depending on water availability
Potential annual profit per hectare	**19,960,000**	**55,240,000**	Profit does not consider labour provided by pond owner/family

Table 2:Physical farmer observations between the non-organic and organic systems

Fish farmer observations	Non-organic system	Organic system
Resilience to virus and disease	Low	High
Cost of fertiliser	High	Low
Total requirement of fertiliser	Increasing	Will decrease over time
Mortality	High	Low
Smell of milkfish	Muddy smell	No smell
Taste of milkfish	Good	Very Good
Storage/freshness	Rots more quickly	Keeps longer
Brightness of scales	Duller	Bright
Flesh of milkfish and shrimp	Not Dense	Dense

- Community education.
- The protection of human health.
- Ecosystem improvements.
- Policy Reform.

These multiple objectives have arisen from a growing recognition - among governments, NGOs, donors and fish farmers themselves - of the interdependence of different aspects of development, and the need to put people at the centre of the development process.

Government invited for ceremonial harvest.

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Taking turbidity with a secchi disk.

A success story of Maa Tarini Self Help Group Ornamental Fish Unit, Purunia Village, Keonjhar District, Odisha, India

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Ornamental fish keeping has developed into an enticing hobby, popular world-wide. It has in turn generated a growing demand for these fishes to fill aquaria in millions of households and public places all over the world. In recent years the demand for ornamental fish has surged in national and international markets and the industry has a strong potential to create alternative livelihoods for small scale farmers and traders.

In fact, in India the practice of ornamental fish trading was mostly concentrated in metro cities but in recent years, developing states such as Chhattisgarh, Kerala and Assam in addition to Orissa have also begun developing ornamental fish industries. Due to its increasing demand, research achievements the availability of technologies to the common people and their popularisation, an enabling environment has been created that offers good opportunities for the economic betterment of rural farmers including women. Unlike other aquaculture systems, ornamental fish farming can be undertaken with little space, small investment and early rapid returns, characteristics well suited to adoption by small-scale farmers. The basic need is the knowledge of fish habits and their biology, which can permit their breeding and rearing even in the backyards or on roof tops in rural and urban areas. The most common infrastructure facilities used for culture of ornamental fish are cement cisterns, glass aquaria, earthen ponds and pots. Seven to eight cement cisterns are sufficient for a small scale rearing unit, built above ground level for easy drainage. Profit of ornamental breeding and rearing unit depends on the carrying capacity, species, management practices and infrastructure facilities available for culture.

With research achievements, the Central Institute of Freshwater Aquaculture (CIFA), Bhubaneswar, has ventured in disseminating the technical know-how on ornamental fish breeding to rural women farmers under NAIP for their empowerment through self-help groups (SHG) and individual assistance. The technology dissemination has been successful and is generating economic benefits for the farmers.

Maa Tarini Self Help Group with SRF working at the field.

Livebearers ready for sale.

This article is a report of one such success story concerning the Maa Tarini Self Help Group from Purunia Village, Keonjhar District, Odisha, which was established in 2008. The group comprises of 10 women farmers, mostly housewives. Mrs Mandakini Mohanta and Mrs Dharitri Mohanta are the President and the Secretary of the group respectively. In order to create awareness of ornamental fish breeding and culture techniques to provide sustainable livelihood opportunities an effort has been initiated by CIFA under the NAIP livelihood project to extend the necessary technology and management support (Component 3).

After an intensive round of consultations, motivation and exposure visits, the group members had decided to adopt ornamental fish breeding for livelihood generation. The women farmers gained skills through continuous capacity building programmes for successful adoption of the technology on their own in a collective approach. Field demonstrations of breeding techniques were also conducted in order to enhance their knowledge, confidence as well as skill through practice.

Breeding and culture

Operating in a private-public partnership mode, the self-help group members had constructed a cement platform of 5 x 7.5 metres with eight tanks each of 1.5 x 1 x 0.6 meters through an investment of Rs 10,000 (US$ 158) from their group account. From the project fund eight rectangular tanks of 450 litre capacity and a circular hatchery 675 liters specially designed for breeding of live bearers and some of the egg layers along with hand nets, pelleted feed and prophylactic medicines were provided as free input. The planting of hydrilla in pots inside the tank had created a better natural habitat for the fishes.

The group was provided with livebearers like guppy (*Poecilia reticulate*); molly (*Poecilia latipinna*), swordtail (*Xiphophorus helleri*) and platy (*Xiphophorus maculates*). Livebearers release young ones in batches and are easy to breed throughout the year except the winter months. Mature males and females are identified by presence of gonopodium or bulging abdomen respectively. The mature male and females are reared in a ratio of 1:3 species wise in separate tanks and after the gestation period the gravid females are placed in breeding traps with tiny slots in the sides, allowing water movement inside but also allow the newborns to escape from predation. The young ones are collected and reared in separate tanks for a period of 3-4 months to reach marketable sizes. The brood stock, after participating in breeding activities, are kept separately for further care and allowed to grow for a month for second breeding cycle.

With the laudable effort of the self-help group members and supervision from the project breeding was successful in the production unit. Every week 10 to 20% of water along with faecal matter was siphoned out to create a healthy environment. The water was replenished with aerated ground water in the production tanks. During the breeding and rearing demonstration, members acquired skill in various aspects of ornamental fish culture such as broodstock management, larval care, feeding, maintenance of water quality and overall management of production units.

Ornamental fish farming through self help group mode.

The water samples of the tanks were analysed and parameters were maintained within permissible limits throughout the culture period. The average temperature of the water in the breeding and rearing tanks prevailed between 18-26°C, pH varying from 7.2-7.7 and alkalinity within the range of 126-151 mg/l. Proper aeration through portable aerators was provided in the tanks during the period of culture.

Feeding of ornamental fishes

Live food is essential for achieving good survival rates of larvae. In addition to live food like cladocerans collected from nearby ponds, they were provided with powdered prepared feed made from groundnut oilcake and rice polish. Once the larvae reaches 10 mm size they were provided with live food like Tubifex or sludge worm, mosquito larvae and chopped earthworm. Records of feed use, frequency of feeding, growth, feed intake, mortality and the labour put by the women farmers on the job were recorded in note books. The details of the production and other activities were monitored by Senior Research Fellows engaged under the project. By following the proper rearing and management practices, two crops are harvested by the self-help group members in the first year. Dull-coloured fishes were generally culled from time to time as one of the management practices.

Marketing

For easy marketing of the fishes, local traders were given responsibility for purchasing of livebearers from the farmers at a fixed price. The model yielded good results. Once the fry attained marketable size, members contacted the trader for sale with the price of fish ranging from Rs. 6-8/- per piece depending upon the size and colour. From this venture, the group of ten women made a gross average income of Rs. 65,000 over two cycles, taking eight to nine months. In spite of low literacy levels, the women showed keen interest and were successful in running the project on their own. CIFA researchers provided technical guidance and helped the women folk in management of the production units. The rural women were employed seasonally as agricultural labour, with the project creating employment of additional 100 person-days for the self-help group. Time factor analysis showed that the project did not add to the burden of the women as they utilised their leisure time to manage the ornamental fish units, which have strengthened their economic condition. After each harvest of ornamental fish, the revenue collected was deposited in the group's account. This new enterprise was led by women and, hence, considered to be a significant step towards gender mainstreaming.

Factors contributing to success

Technical support and co-operation of NAIP-CIFA team: The exposure visit to CIFA had built awareness among the farmers and the technology was chosen by the farmers on their interest. Mostly women farmers were interested to adopt the technology after the exposure visit. The technology was disseminated on private public partnership mode, the platforms and few cement tanks, as per specification, were constructed by farmers to help develop their sense of ownership. FRP circular and rectangular tanks were installed and accessories were provided free of charge for breeding and rearing of ornamental fishes in the unit. In the initial stage farmers were closely guided since they were learners. The constant technical support by the scientists for the capacity building of women farmers and regular supervision by the SRFs on habitat maintenance, brood stock care and water quality maintenance had contributed to the learning process of the group members for successful adoption of the technology. Proper management with required nutrition had contributed in better health of the fishes in culture tanks. Through constant support and guidance live bearers were successfully bred, reared and marketed.

Co-ordination and keenness among the self-help group members: The technology was disseminated via a group as it was expected it would be easier to learn with group members providing mutual assistance and reinforcement of the training, and also because a group approach offered the opportunity for low income participants to take part. Cooperation among the members in carrying out the regular work of feeding, siphoning, water filling in the tanks and proper management in the production units had helped in rearing the young ones to adults. The group has now become a satellite learning center assisting to disseminate knowledge to surrounding farmers.

Linkages with line departments: The involvement of line departments such as State Fisheries, Agricultural Technology Management Agency (ATMA), Krishi Vigyan Kendras and traders have contributed to more benefits for the farmers along with immediate and effective solution to the problems and sustainability of the programme during and after the project period.

Growing demand of aquariums in rural and urban areas: Aquariums have become a part of decoration in most of households now a days. With the increased preference for aquariums as a hobby the demand for the product is growing day by day. Not only in urban areas but in rural areas it has become popular also.

Needs of self-help group

Better marketing facility: The ornamental fishes produced in the units are sold through linkages with local traders. Since the local market is developing and due to transportation bottlenecks, the distant town and cities could not be linked in the trade chain, so profit there will be marginal. Wider market linkage will definitely increase profit margins and farmers will be encouraged to increase their scale of production.

Exposure visits: Farmers are interested to visit production units located outside the state to improve their knowledge and skills.

Red sword tail, being reared by the self help group.

Lessons learnt

The technology was successfully implemented by the rural and tribal women of Odisha. The difficulty in initial support has turned to be a successful venture with an income for the farmers. The technology has been found to be profitable as a backyard activity. Use of locally available perforated plastic baskets was found to be successful in reducing larval cannibalism. Chopped earthworms used as live food were found to be palatable and also help in developing colour.

Future strategies

Capacity building of farmers for technological improvement for production of egg layers has been initiated and successful farmers have been encouraged with technical support for large scale production.

New interested farmers are encouraged for adopting the technology through horizontal expansion under the NAIP programme.

The farmers are encouraged to take the benefits prevailing under existing government schemes and linkages with Sate Fisheries, ATMA, KVK etc for improved support and income.

Better marketing linkages with the pet shops in the local and distant towns has been envisaged. Buyback trade linkages with local traders has proved profitable for farmers. Aquarium making capacity building programme has been initiated for more income generation.

Conclusion

The success of the project is largely due to its homestead status. Ornamental fish farming is an activity, which not only provides aesthetic pleasure but is also an easy way to financial gains. The present initiative of NAIP- CIFA to link gender with credit, technology, infrastructure, skill development and trade could turn into a viable business model in enhancing economic returns, improving sustainable livelihood and above all social security to women in tribal communities.

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Scientists interacting with the self-help group.

Scientists interacting with the self help group.

Use of lactic acid bacteria in fish farming

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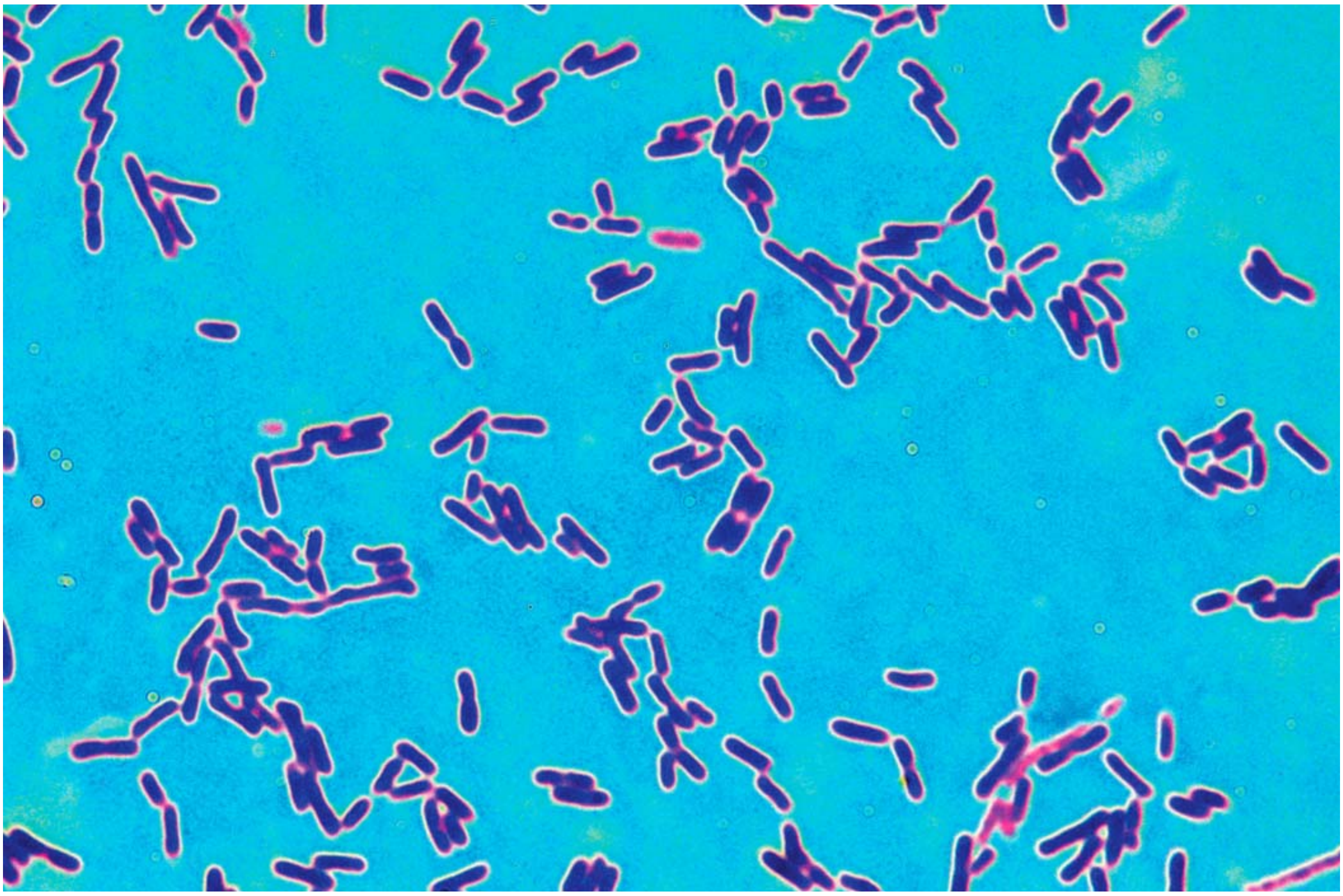
Aquaculture is the fastest food producing sector in the world. Worldwide, people obtain about 25% of their animal protein from fish and shellfish and are expected to consume 165 million tonnes by 2030. The stagnant or diminishing wild caught fisheries together with growing world population have led to increasing reliance on aquaculture to meet the demand. During the past few decades, production growth has been driven by intensification with the introduction of many new species. Modern day semi-intensive and intensive aquaculture is making use of artificial feeds, growth promoters and other additives to boost productivity. However, there are concerns about the sustainability of these practices[1]. The use of chemicals, in particular of antibiotics, has further become questionable because of the increase in antimicrobial resistance among pathogenic bacteria.

An alternative strategy that avoids such side effects is the use of probiotics[2]. In recent years increasing attention has been paid to the dietary manipulation of gut microflora to improve the overall health status of cultured species. Probiotics are essentially microbes with beneficial effects. These microorganisms generally modify the intestinal microflora assemblage after consumption, and may outcompete or reduce potentially harmful microbes, delivering enzymes and other beneficial substances into the gut.

Probiotics are becoming widely used in aquaculture to improve growth and disease resistance, although their use is not without controversy given that manufacturer claims concerning their benefits and effective dose/usage are seldom rigorously or independently tested. The range of probiotics used is considerably wider in aquaculture practices as compared to terrestrial agriculture. In aquaculture practices, apart from the common health benefits[2, 3], certain probiotics when supplemented as water additives can also play a significant role in decomposition of organic matter, as well as control of hydrogen sulfide, ammonia and nitrite[4].

Some probiotics can in feed conversion efficiency and live weight gain, while others may modulate physiological and immunological responses in fish and confer protection against pathogens by competitive exclusion for adhesion sites, production of organic acids (acetic acid, formic acid, lactic acid), and other compounds such as antibiotics, peptides, bacteriocins, siderophores, lysozyme[5,6,7]. However, probiotics



Lactobacillus sp. Image by Riccardoariotti (Creative Commons Attribution Unported License 3.0).

are believed to differ markedly in their mode of action. Different probiotics as monospecies or multispecies combinations are commercially available for aquaculture practices. The commonly used probiotics in fish culture practices belongs to lactic acid bacteria group, *Saccharomyces*, *Clostridium*, *Bacillus*, *Shewanella*, *Aeromonas*, *Pseudomonas* and several other species.

Lactic acid bacteria

Lactic acid bacteria (LAB) are a phylogenetically diverse group, comprise a clade of gram-positive, non-sporulating, non-respiring rod or cocci that secrete lactic acid as the major end product of sugar fermentation[8]. This functional classification includes a variety of important genera, including *Lactococcus*, *Enterococcus*, *Aerococcus*, *Oenococcus*, *Pediococcus*, *Streptococcus*, *Leuconostoc*, and *Lactobacillus* species. LAB are widespread in nature as they can adapt to grow under widely different environmental conditions. They are usually associated with mucosal surfaces, particularly the gastrointestinal tract of different animals ranging from terrestrial to aquatic animals. Besides, they are also found in a plethora of niches, including dairy products, fermented meats and vegetables, sourdough, silage, beverages, sewage and plants.

LAB in fish

LAB colonise very early the gastrointestinal tract of terrestrial animals where they constitute subdominant to dominant microflora. However, the case of fish is different. Over the years considerable interest has been expressed to study the association of LAB with epithelial surfaces in the digestive tracts of fish[9]. However, identification of these bacteria through conventional microbiological techniques is often tedious, labour intensive and time consuming. Successful application of recent molecular biological tools especially 16S ribosomal ribonucleic acid (rRNA) analysis and sequencing have confirmed their occurrence in the normal intestinal flora of different fish such as salmon, arctic char, Atlantic cod, rainbow trout, Indian major carp and other species[9,10,11]. The common LAB members found in the intestinal tract of fish belong to *Lactococcus*, *Lactobacillus*, *Enterococcus*, *Carnobacterium*, *Leuconostoc*, *Pediococcus*, *Streptococcus* and *Vagococcus* species. However their presence and abundance is often found to vary with diet, age, season and other conditions.

Common LAB group of probiotics used in fish

Some LAB have proven to be very useful probiotics in different animals including fish/shellfish. The promising probiotic strains of LAB include the members of genera *Lactobacillus*, *Lactococcus* and *Enterococcus*. The representative species include *Lactobacillus acidophilus*, *Lactobacillus casei*, *Lactobacillus plantarum*, *Lactobacillus rhamnosus*, *Lactococcus sakei*, *Enterococcus faecalis* and *Enterococcus faecium*. Several other strains of LAB are also used in aquaculture.

Beneficial effects of LAB

LAB were among the first micro-organisms to be used in manufacturing of food and play crucial roles in the manufacturing of fermented milk products, vegetables and meat, as well as in the processing of several other products. The probiotic effects of various LAB are well established for terrestrial animals. Some of the beneficial effects include improved digestion and nutritional value of food and control of intestinal infections. In past few years, there has been great interest in the use of LAB and their metabolic products as potential probiotics in aquaculture[9,12]. The involvement of LAB in nutrition, physiology, immunity, disease resistance and other beneficial activities in fish has already been documented. LAB either individual or in combination with other LAB member and/or probiotic bacteria are reported to exert these beneficial effects in many fish species.

The enhancement of growth of the cultured fish species can provide advantages for aquaculture practices by shortening production times and controlling product availability. Probiotics can be very effective in enhancing the growth of host. Dietary supplementation of LAB can lead to significantly higher growth performance such as specific growth rate and relative growth rate, nutrient utilisation such as protein efficiency ratio, feed conversion ratio and survival in fish[3]. Furthermore, supplementations of LAB through live carriers like *Artemia* and rotifers can increase growth and immunity[13,14]. Carnevali et al.[13] reported better growth of sea bass juvenile by using *L. delbrueckii* via rotifer carriers and *Artemia* nauplii for a period of seventy days. Similarly LAB can improve haematological indices such as hemoglobin concentration, haematocrit percentage, total erythrocytes counts, total leucocytes counts, total serum protein, globulin, glucose, and cholesterol level in fish. Nevertheless, their potency to stimulate the systemic and local immunity of teleosts is noteworthy. Several immunological studies have confirmed the ability of some LAB to stimulate fish immune systems. LAB as either monospecies or multispecies supplementation have been found to elevate several immunological parameters like phagocytic activity, lysozyme level, peroxidase/anti-peroxidase level, complement activity and respiratory burst activity in teleosts[15].

Probiotic therapy offers an alternative to overcome the adverse consequences of antibiotics and chemotherapeutic agents for controlling pathogens. Probiotics belonging to LAB group can be useful in preventing the pathogens to establish lethal infection in host through a variety of mechanisms. They have been found to inhibit a wide range of fish pathogens both under in vitro and in vivo conditions[16]. Dietary supplementation of LAB species has been reported to successfully lead to protection against important fish diseases like edwadsiellosis, aeromoniasis, enteric red mouth disease, furunculosis, lactococossis, and streptococcosis. However, the protective effect varies with respect to fish, pathogen, species and strain. For example Gildberg et al.[17] demonstrated that *C. divergens* decreased the mortality rate of Atlantic cod fry challenged with *Vibrio anguillarum* but not the mortality of salmon fry challenged with *Aeromonas hydrophila*. Other strains of LAB belong to *Carnobacterium* species when administered to fingerlings and fry of Atlantic salmon, reduced the mortality caused by *Aeromonas salmonicida*, *Vibrio ordallii*, and *Yersinia ruckeri*[18]. Furthermore, probiotics such as *Pediococcus acidilactici* have also been found to be effective against the syndrome vertebral column compression syndrome in rainbow trout. Specific strains of probiotic bacteria may therefore offer specific benefits, rather than providing a "blanket protection" as often suggested by probiotic suppliers.

Pathogenic potential of LAB

LAB are usually safe to use but certain members are exclusively found to be associated with diseases of fish. During the past few decades, members of LAB have been associated with sporadic and epidemic outbreaks of fish diseases in many parts of the world. Pathogenic forms of LAB have been detected from ascites, kidney, liver, heart and spleen of diseased fish. Common LAB pathogens include *Streptococcus parauberis*, *Streptococcus iniae*, *Streptococcus difficile*, *Lactococcus piscium*, *Vagococcus salmoninarum Lactococcus garvieae*, and *Enterococcus seriolicida*. Amongst *Lactococcus garvieae*, *S. iniae*, *S. agalactiae* and *S. parauberis* are often associated warm water infections. The most important and devastating LAB mediated disease is *Lactococcosis* caused by *L. garvieae* in both freshwater and marine fish species throughout the world[19].

Concluding remarks

Over the years several candidate probiotics strains of LAB from autochthonous as well as allochthonous sources are being introduced into culture practices and have proved to be beneficial both in laboratory and culture conditions. Although, allochthonous LAB derived from terrestrial animals are effective in fish, autochthonous probiotic LAB strains could be more useful for aquaculture practices as the chance of re-establishment of such probiotics in the gut of fish hosts is high. However, special attention is required to evaluate the safety of newly introduced candidate species as well as to standardise their appropriate dose, duration of supplementation and the long term effects in different fish species.

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NACA Newsletter

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Call for applications (2nd round): FK Norway South-South Aquaculture Professional Exchange Programme

NACA is pleased to announce the initation and implementation of an aquaculture professional exchange programme in partnership with the Independent Mission for Development and Education in Madagascar (MIDEM). The programme, entitled "Integrated farming of Nile tilapia and Asia-Africa network strengthening" aims to strengthen the technical competence of young professionals in aquaculture, particularly in tilapia farming, through professional exchange between Asian and African countries to share and gain experience. This will contribute to institutional capacity building, development and improvement of extension systems in aquaculture. It will also contribute to developing a new generation of dynamic young leaders and improve cultural understanding and cooperation between the two regions. This exchange programme is being carried out with generous financial support from Fredskorpset (FK) Norway. The programme will be implemented in three rounds over three years, starting from April 2013.

MIDEM is an open, non-profit NGO in Madagascar aiming to provide a sustainable solution to the needs of the Malagasy population stricken by extreme poverty and social injustice in suburban and rural areas in the Tamatave region, East coast of Madagascar. MIDEM's mission is to improve livelihoods by implementing projects on education, rural development including fish farming, entrepreneurship and social development.

Fredskorpset is the Norwegian branch of the international Peace Corps. It is an integrated part of Norwegian development cooperation and a Norwegian governmental body under the Ministry of Foreign Affairs. FK Norway promotes reciprocal exchanges between a diverse range of institutions and organisations globally. This fosters mutual learning, development of capacity, change for the common good with the values of Challenge, Respectful, Passionate and Professional.

NACA and partners are now pleased to announce the second call for applications for young professionals in Asia to participate in the first round of this dynamic exchange programme.

The partner and host institution in Africa: MIDEM, Madagascar. The duration of the first round exchange is from August 2013 - April 2014.

Applications

If you are interested in participating in the programme please complete the application form linked below and return it before 14 June 2013. Please see the programme brochure for more information about arrangements.

Successful applicants will be required to:

- Sign agreements with NACA and MIDEM.
- Attend the participant preparatory course in Bangkok from 29 July to 9 August 2013.
- Go to Madagascar in late August 2013 for your exchange programme, which will last for eight months.

For application forms and further information about the programme, please visit the NACA website at:

http://www.enaca.org/modules/news/article.php?article_id=1977

AFSPAN field surveys underway!

Interview with a freshwater prawn farmer, Bangladesh.

Data collection for the AFSPAN Project has commenced, with field surveys underway in eleven countries spanning Asia, Africa and South America. The project will survey around 120 farms and 120 households in each country, working throughout Bangladesh, China, India, the Philipppines, Viet Nam, Kenya, Uganda, Zambia, Brazil, Chile and Nicaragua.

The surveys are collecting data concerning farming practices and the importance of aquaculture to household employment and nutrition. The farm surveys are examining production issues including labour and time usage patterns, major costs and income generated on farms across a variety of scales. The surveys target several important species in each country to achieve a broad overall coverage that includes freshwater catfish, prawns carps and tilapia, and marine shrimp, milkfish, salmon, shellfish and seaweeds. The household surveys are gathering data on household demographics, food consumption, employment and income from aquaculture and other jobs and expenditure patterns.

The data generated by these surveys will allow the project to develop a better understanding of the contribution of aquaculture to food security, nutrition, employment creation, income generation and women's empowerment. For more information, visit www.afspan.eu.

4th Global Symposium on Gender in Aquaculture and Fisheries

The 4th Global Symposium on Gender in Aquaculture and Fisheries will be held in conjunction with the 10th Asian Fisheries and Aquaculture Forum, which will be held from 30 April to 4 May in Yeosu, Republic of Korea. The symposium will be held over two to three days of the forum (dates to be advised). Papers for the symposium are being sought on thefollowing themes:

- **Gendered change**: Capabilities and vulnerabilities with respect to changes (environmental, social, cultural, economic, livelihood). Gendered change (for women, men, girls, boys) is an important characteristic of the major changes occurring in aquaculture and fisheries. However, the gendered nature of change is little recognised, little studied and rarely measured. How can it be researched, measured and how should different agencies (e.g., fisheries departments, development agencies, NGOs) address it? Chair: Dr Hillary Egna, Co-Chair – to be advised. Lead speaker and contributed papers.
- **Gender assets, spaces and roles**: Qualifying and quantifying gender assets and roles, and the gendered use of space in aquaculture and fisheries (or) Unique spaces for women in aquaculture and fisheries. Co- Co-Chairs – to be advised. Lead speaker and contributed papers.
- **Meeting future needs**: Policy and advocacy related to gender in aquaculture and fisheries – research, development, decision making bodies (governments, public spaces), and the human capacity requirements. Chair, Co-Chair – to be advised. Lead speaker and contributed papers.
- **Status and contributions of women to aquaculture and fisheries**: A session in honor of Dr M.C. Nandeesha. This Session will contain tributes and papers in honour of the late Dr M.C. Nandeesha, the initiator of the AFS Gender in Aquaculture and Fisheries activities.

The symposium will also include several mini workshops and focus group discussions on the following themes:

- **NORAD-NACA workshop on mainstreaming gender in NACA**: How can the Network of Aquaculture Centres in Asia-Pacific (NACA) mainstream gender into its work program and what strategies can it develop to achieve this? As NACA approaches its 25th year and examines its future directions, this facilitated workshop will examine how this important regional intergovernmental body, comprised of the world's largest aquaculture producing countries, can address gender in its ongoing and planned programs and regional partnerships. Chair: Dr Meryl Williams. This workshop is being funded by the Norwegian Agency for Development Cooperation (NORAD).
- **ASEM Aquaculture Platform focus group discussion on future research needs**: What are the most important areas to cover in ASEM (Asian-Europe Meeting) future research (methodology, subjects of interest, types of beneficiary) concerning gender and aquaculture. Chair: Dr Zumilah Zainalaludin.
- **Gender research methods roundtable**: Qualitative and Quantitative methods in gender research and writing gender papers eg: research design for comparative analysis of seaweed farming and gender. Mini Workshop: Chair: Dr Marilyn Potter, + Co-Chair – to be advised.
- **Women, gender networks and associations for aquaculture and fisheries**: To explore why establishing and maintaining women and gender in fisheries and aquaculture networks and interest groups has proven difficult in all countries and regions. From experience, lessons learned, better understanding the needs and challenges, and brainstorming new pathways, explore options for future action in research, advocacy and development support. Chair: to be advised.
- **CGIAR mini-workshop on developing a gender transformative approach to research**: Different gender research approaches affect not only what kind of data are obtained, but if these will lead to meaningful increases in gender equality and to what extent. The CGIAR Research Program on Aquatic Agricultural Systems seeks to develop and use a gender transformative approach. This participatory mini-workshop will encourage participants to think through the key dimensions of a gender transformative research framework (i,e. research methodologies, questions and tools), and when and how it could be applied. Chair: Dr Miranda Morgan.

For more information, including on the process for submission of abstracts, please visit www.genderaquafish.org.

An anti-viral treatment for healthier black tiger prawns

CSIRO scientists in Australia have developed an antiviral capable of preventing prawn mortality from Gill-Associated Virus (GAV).

GAV is a virus which commonly infects black tiger prawns (*Peanaeus monodon*) in eastern Australia. It can cause disease and death in prawns, and reduce the productivity of prawn farms.

CSIRO scientists Dr Melony Sellars, Dr Jeff Cowley and their team explored the possibility of inhibiting GAV replication, which would reduce the effects of the virus and/or have an antiviral effect on the prawns.

Customised double stranded ribonucleic acid (dsRNA) can be cleverly used by a prawn's natural cellular pathway as antivirals. The cellular pathway targeted in this work is called the RNA interference (RNAi) pathway.

The team's work produced a highly-effective GAV antiviral – containing many small pieces of genetic code identical to that of the virus – which is capable of slowing virus replication and preventing prawn mortality when injected into the tail muscle of black tiger prawns.

"The viral protection works as a result of RNAi, an intelligent in-built cellular pathway that prawns naturally have," said researcher, Dr Melony Sellars.

"This means when fragments of the genetic code of the virus are injected into the prawn tail-muscle, the prawn induces a highly specific antiviral response that allows it to protect itself from the virus."

The same method has been shown to work for other known viruses of commercial importance to aquaculture farmers, including White Spot Syndrome, Taura Syndrome, Yellow-Head and Mourilyan viruses. Components of the discovery have now been patented by CSIRO, providing access to the technology that will benefit the Australian prawn farming industry.

The new antiviral provides black tiger prawn breeders with a means of clearing viral infections from their prawn breeding populations (broodstock) prior to spawning to break transmission cycles.

As part of a CSIRO Food Futures Flagship and Seafood Cooperative Research Centre initiative the technology will be tested at commercial companies in May 2013 for the first time, with tail muscle injection of the antiviral into broodstock black tiger prawns.

"We are really excited to know the technology will be commercially tested by our industry partners for the first time in May 2013 in black tigers," said Dr Sellars.

CSIRO scientists are now in the process of further improving the pieces of genetic code used to produce the anti-viral.

Given the potential to deliver substantial positive economic implications for Australian prawn farmers, future R&D will focus on investigating alternative delivery methods, including oral delivery.

"Once more commercially-friendly methods are discovered, the applications of this technology will become seemingly endless and would most certainly result in significant financial benefits for prawn farmers," Dr Sellars said.

This research is being funded by the Seafood Cooperative Research Centre, the Fisheries Research and Development Corporation and CSIRO's Food Futures Flagship.

For more information on aquaculture research read CSIRO aquaculture research news or review Dr Sellars' journal article.

Jungle perch on the comeback trail

Researchers at the Queensland Department of Agriculture, Fisheries and Forestry's (DAFF) Bribie Island Research Centre have bred the first ever, captive jungle perch (*Khulia rupestris*) fingerlings.

Research leader Dr Michael Hutchison said the 35mm fingerlings were reared from fertilised eggs through to a size suitable for stocking into rivers over a period of 60 days.

"Previously no larvae have been reared beyond six days old and a few millimetres long," Dr Hutchison said.

"Over the years, jungle perch have become very scarce but now there is the potential to reintroduce this species to rivers in South-eastern Queensland and in the Mackay-Whitsunday region.

"There are still significant challenges ahead to improve early larval survival and the production of sufficient quantities of fingerlings for viable restocking, but we have made tremendous progress to reach this point.

"This breakthrough is very exciting news not only for the sustainability of the species, but for the broader community and recreational fishers. Restocking our rivers with jungle perch would provide a big boost to local recreational fishing."

David Nixon, Queensland Department of Agriculture, Fisheries and Forestry Technician with a 3.1 kg jungle perch at the Bribie Island Research Centre.

Jungle perch are an iconic angling fish reaching more than 3kg in weight. Their habitat includes coastal rivers and streams from Cape York to Northern

New South Wales. They spend most of their life in freshwater but migrate to salt water to spawn.

The jungle perch project is co-funded by the Fisheries Research and Development Corporation. On completion, the production technology will be provided to private commercial hatcheries.

Latest fisheries information is also available via Twitter - www.twitter.com/fisheriesQLD or find us on Facebook at www.facebook.com/FisheriesQueensland

For more information, contact Mark Hodder, email mark.hodder ‘at’ daff.qld.gov.au.

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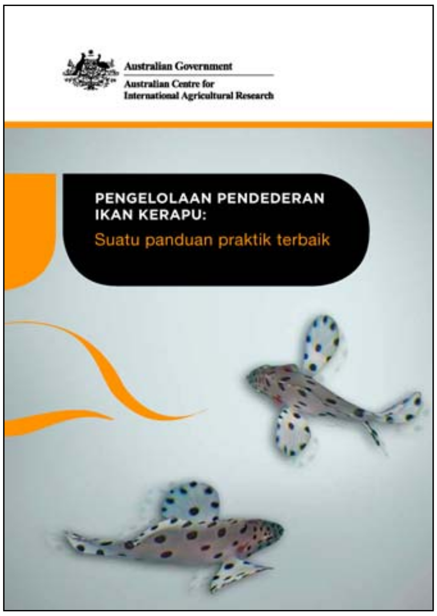
http://www.daff.qld.gov.au/30_22521.htm

Nursery management of grouper: A best-practice manual [Indonesian translation]



Suko Ismi, Tatam Sutarmat, N.A. Giri, Michael A. Rimmer, Richard M.J. Knuckey, Anjanette C. Berding and Ketut Sugama

This is the Indonesian translation of a manual that provides practical guidelines for those engaged in the nursery culture of groupers in Indonesia as well as elsewhere in the tropics.

The nursery phase is an intermediate step between hatchery production of seed (ACIAR Monographs No. 149 and 149a) and stocking of grow-out farms. It involves growing delicate juvenile fish of 2–3 cm long through to physically robust animals of 5–10 cm long. The manual provides information on husbandry of groupers in the nursery phase, to reduce losses due to disease and cannibalism, and thus to increase the profitability of grouper nursing.

Download the manual for free (or purchase a hard copy) from: http://aciar.gov.au/publication/MN150a. The English version is also available from: http://aciar.gov.au/publication/MN150.

Hatchery management of tiger grouper (*Epinephelus fuscoguttatus*): A best-practice manual [Indonesian translation]

Ketut Sugama, Michael A. Rimmer, Suko Ismi, Isti Koesharyani, Ketut Suwirya, N.A. Giri and Veronica R. Alava

This is the Indonesian translation of a hatchery manual that provides guidelines for the production of tiger grouper fingerlings. It outlines best-practice methods for broodstock maintenance, spawning, egg incubation and rearing of larvae through to 2–3 cm, fully metamorphosed juveniles.

The manual provides a valuable aid for improving the availability of grouper seed stock to support sustainable small-scale aquaculture in the Asia–Pacific region.

Download the manual for free (or purchase a hard copy from) http://aciar.gov.au/publication/MN149a. The English version is also available from: http://aciar.gov.au/publication/MN149.

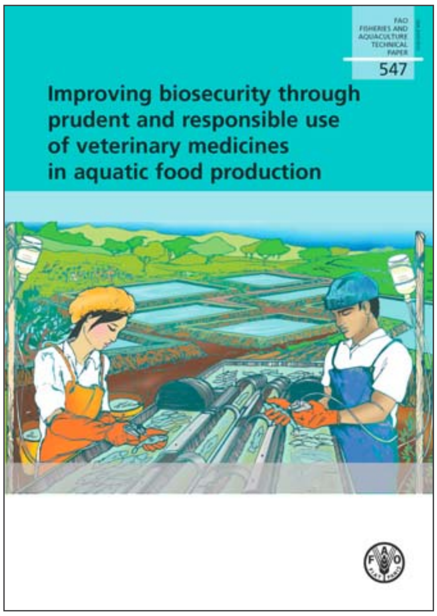
Priority adaptations to climate change for Pacific fisheries and aquaculture: reducing risks and capitalizing on opportunities

Johnson, J., Bell, J. & De Young, C. 2013.

This publication includes:(i) a summary of the technical presentations provided to the workshop participants on the implications of climate change for Pacific fisheries and aquaculture; and (ii) the outcomes of discussions by participants on the priority adaptations that Pacific island countries and territories (PICTs) can implement to reduce risks and take advantage of opportunities.

The workshop was hosted by the Secretariat of the Pacific Community (SPC) as the culmination of 3.5 years of work to assess the vulnerability of Pacific fisheries and aquaculture to climate change. It also formed part of a series of climate change awareness-raising and adaptation planning workshops around the globe financed through a Japanese-funded, and FAO-implemented, project "Climate Change, Fisheries and Aquaculture: Understanding the Consequences as a Basis for Planning and Implementing Suitable Responses and Adaptation Strategies" GCP/INT/253/JPN). The technical presentations and range of possible adaptations and supporting policies presented were based on SPC publications. Discussions focused on priority adaptations for economic development and government revenue, food security and sustainable livelihoods for Melanesian, Micronesian and Polynesian nations. The adaptations identified reflect the different fisheries participation rates and importance of fish to economic development and as a source of local food and income n these different regions.

The workshop discussions recommended immediate action by all PICTs to manage fisheries resources sustainably now and into the future, to establish systems to minimise impacts of various drivers facing the sector now and from future climate change, and to capitalise on opportunities. Cooperation between PICTs and partnerships among governments, regional and international organisations and communities were highlighted as important ways to implement effective adaptation.



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Improving biosecurity through prudent and responsible use of veterinary medicines in aquatic food production

Bondad-Reantaso, M.G., Arthur, J.R. & Subasinghe, R.P., eds. 2012.

The FAO/AAHRI Expert Workshop on Improving Biosecurity through Prudent and Responsible Use of Veterinary Medicines in Aquatic Food Production was convened in Bangkok, Thailand, in order to understand the current status of the use of antimicrobials in aquaculture and to discuss the concerns and impacts of their irresponsible use on human health, the aquatic environment and trade. Such discussions became the basis for drafting recommendations targeted for both government and private sectors and for developing guiding principles on the responsible use of antimicrobials in aquaculture to be considered as part of future FAO Code of Conduct for Responsible Fisheries (CCRF) Technical Guidelines on Prudent and Responsible Use of Veterinary Medicines in Aquaculture.

Because aquaculture is expected to continue to increase its contribution to the world's production of aquatic food, offer opportunities to alleviate poverty, increase employment and community development and reduce overexploitation of natural aquatic resources, appropriate guidance to aquaculture stakeholders on the responsible use of veterinary medicines has become essential. Safe and effective veterinary medicines need to be available for efficient aquaculture production, and their use should be in line with established principles on prudent use to safeguard public and animal health. The use of such medicines should be part of national and on-farm biosecurity plans and in accordance with an overall national policy for sustainable aquaculture.

This publication is presented in two parts: Part 1 contains 15 technical background papers presented during the expert workshop, contributed by 29 specialists, and which served as a basis for the expert workshop deliberations; Part 2 contains the highlights of the expert workshop.

Download it from the FAO website: http://www.fao.org/docrep/016/ba0056e/ba0056e.pdf

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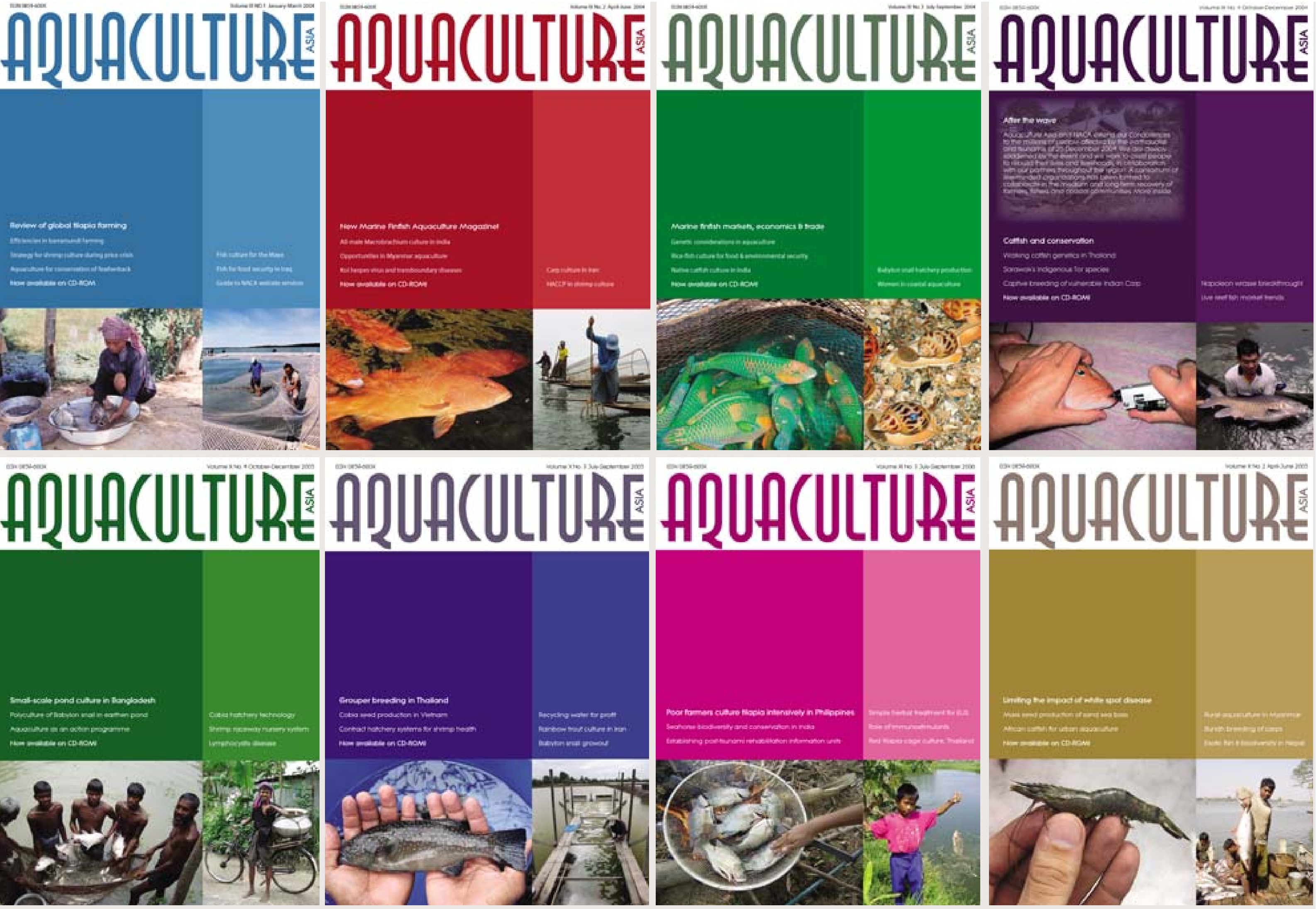
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FAO - APFIC - NACA Regional Consultation on the Sustainable Intensification of Aquaculture in Asia-Pacific
The objective of the consultation was to develop a regional strategic policy framework to guide national governments and regional organisations in promoting sustainable intensification of aquaculture in the Asia-Pacific region. The consultation specifically focussed on intensifying aquaculture through more efficient use of resources and environmentally sound practices. Farm productivity and environmental performance must be improved through a combination of forward-looking policies, better management practices and technological improvements, rather than by increasing inputs to the system.

Emergency regional consultation on acute hepatopancreatic necrosis syndrome
Recently, an emerging disease known as acute hepatopancreatic necrosis syndrome has caused significant losses amongst shrimp farmers in China and Vietnam (2010), Malaysia (2011) and Thailand (2012). The disease affects both Penaeus monodon and P. vannamei and is characterised by mass mortalities during the first 20-30 days of culture, an abnormal hepatopancreas, corkscrew swimming, loose shells, pale colouration and slow growth. The cause is unknown at this time. Considering the severity of the disease, NACA and the Australian Department of Agriculture, Fisheries and Forestry convened an emergency consultation in Bangkok, 9-10 August 2012, involving international shrimp health experts, regional governments and industry to share information on this emerging disease, its occurrence, pathology and diagnosis, and to develop a coordinated regional response to the issue. The recordings in this collection are the technical presentations made at the consultation.

Global Conference on Aquaculture 2010
The conference was the third in a series of aquaculture development conferences, following on from the Conference on Aquaculture in the Third Millennium held in Bangkok 2000, and the FAO Technical Conference on Aquaculture, held in Kyoto 1976. The programme included seven regional and global reviews on aquaculture development, nine plenary and invited guest lectures, and twenty expert panel discussions across six thematic sessions. This audio collection represents the entire conference proceedings.

Expert Workshop on Inland Fisheries Resource Enhancement and Conservation in Asia
FAO and NACA convened an expert workshop to review inland fisheries resource enhancement and conservation practices in Pattaya, Thailand, 8-11 February. Experts from 10 Asian countries attended the meeting to share experiences and lessons learned.

Free to download or listen/watch them online!