ISSN 0859-600X

Volume XV No. 3 July-September 2010

AQUACULTURE ASIA

"Low value" fish and markets

Small indigenous fish

Rice field eel

Tilapia in Chiang Mai

Women self help groups

Lobster diets


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

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Scand-Media Co., Ltd.

AQUACULTURE ASIA

Volume XV No. 3 **ISSN 0859-600X**
July-September 2010

Bottom of the food chain

This issue we are heading a bit further down the food chain (ok, apart from the lobsters) to look at so-called “low value” species, the associated market chains and their contribution to the livelihoods of rural people. I prefer the term “low cost” species myself, as it more accurately reflects their non-financial values.

Low cost species aren’t fashionable. Governments generally prefer to talk about “high value” species and export earnings, but the fact is that low cost species are in many ways more important. They offer some compelling advantages in the medium and long term.

In January 2009 I highlighted concerns about rising energy prices and the impact this will have on the price of food. We had a glimpse of this in the lead up to the financial crisis, when oil tripled its January 2007 low of US$ 55 to reach nearly US$ 150 a barrel. It has already recovered to around US$ 90.

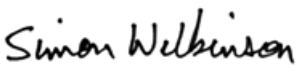
Most low cost species tend to feed further down the food chain, being primarily herbivorous or omnivorous. They are not immune to energy-related price increases in farm inputs and feed, but they can be fed cheaper feeds and cost substantially less to produce than carnivorous fish, a differential that will become more pronounced as energy prices recover.

Low cost fish are therefore very important from a food security standpoint, being one of the most accessible sources of animal protein to rural communities in Asia, and often the only one that they can afford. As food prices increase, low cost species will become increasingly important as staple foods, and if tra catfish is any indication, not just to the rural poor, but also to consumers world-wide.

Secondly, low cost species are very important from a social standpoint. Their production provides employment for millions of farmers throughout Asia and elsewhere in the world, and for associated agriculture, supply and service industries. Most of these jobs are in rural areas, where employment opportunities are hard to come by.

Lastly, the economics of low cost species are not trivial. While mainstream media coverage tends to focus on shrimp, salmon and trout, the clear majority of global aquaculture production is actually low cost herbivorous and omnivorous species. Tra catfish production in Vietnam is an example of a low cost species generating more than US$ 1 billion in exports.

As with “trash fish”, the term “low value” appears to be an unfortunate misnomer and I hope readers will endeavour to kill it off at every opportunity lest we get stuck with it. There are many aspects to value of a thing beyond the almighty dollar. Cheap food is priceless.



AQUACULTURE ASIA

CONTENTS

Relative efficacies of lobsters (*Panulirus ornatus* and *P. homarus*) cultured using pellet feeds and "trash" fish at Binh Ba Bay, Vietnam

Hung, L.V., Khuong, D.V., Phuoc, T.V. and Thao, M.D.

Faculty of Aquaculture, Nha Trang University, Vietnam, email: hungdhts@gmail.com or khuongaquatic@gmail.com

Panulirus ornatus.

Aquaculture feeds and feeding regimes play a major role in determining the potential environmental impacts of finfish and crustacean farm effluents[1]. In aquaculture, on-growing of wild-caught juvenile spiny lobsters (Palinuridae) to market size is an emerging sector in Asia, Oceania and Central America but most notably in Vietnam[2]. In Vietnam, lobster culture commenced in the 1990s[3] and is regarded as the biggest lobster culture industry with a production of 1,800 tonnes in 2005[4]. The main culture areas are Khanh Hoa, Phu Yen and Ninh Thuan provinces[5] for species of *Panulirus ornatus* and *P. hormarus*[3,6]. However, the use of artificial feeds for lobster culture is still limited in the world and it is so in the case of Vietnam also. This sector has developed for more than 20 years but none of aquafeed companies produce artificial feeds for lobster[7]. Traditionally, lobster is fed "trash fish" or "low valued fish" such as snails, green mussel, clams, crabs, lizardfish, red big-eye, which are thought to contribute to environmental degradation and disease issues[5].

The aim of this research is to survey the environmental and economic efficiency of lobster culture in Binh Ba Bay in the traditional manner using trashfish and pelleted feed (product of the national research project KC.06.23/06-10).

Approach

This research was carried out from May 2009 to June 2010. Six sampling sites were chosen for surveying environmental quality (Table 1). Water and mud samples were collected regularly every two-months and transported to the laboratory of Environmental Management, Faculty of Aquaculture, NhaTrang University for determining the total suspended solids (TSS), biochemical oxygen demand (BOD), total nitrogen and phosphate concentration, organic matter in mud by using standard protocols[8]. Surface temperature, salinity, pH, dissolved oxygen (DO), depth, and transparency were measured at site.

Table 1. Environmental sampling sites at Binh Ba Bay.

Site code	Characteristics	Latitude	Longtitude
(TAV)	Site for lobster (*P. ornatus* and *P. homarus*) cultured using pelleted feed	11°50'42.59N	109°13'25.55E
(100M)	Site without lobster cages	11°51'01.10N	109°13'38.64E
(CAT)	Site for lobster culture using trash fish / low value fish	11°50'37.50N	109°14'00.75E
(DC)	Binh Ba Port	11°50'23.08N	109°14'19.66E
(CN)	Small gate (to the Western sea)	11°51'09.45N	109°14'49.39E
(CL)	Large gate (to the Western sea)	11°48'17.45N	109°13'36.69E

Table 2. The result of environmental analysis at sampling sites in Binh Ba Bay.

Sampling site	TAV	CAT	100M	DC	CN	CL
Depth (m)	22.0	19.5	16.0	5.2	3.7	(-)
Salinity (‰)	34.33 ± 1.37	34.37 ± 1.47	34.00 ± 1.67	34.17 ± 1.47	34.50 ± 1.38	34.17 ± 1.47
Surface temp.(°C)	27.78 ± 1.88	28.01 ± 1.47	27.72 ± 2.10	28.04 ± 1.62	28.11 ± 1.45	28.14 ± 1.21
DO (mg/L)	7.79 ± 0.67^{bc}	7.31 ± 0.58^{ab}	7.34 ± 0.57^{ab}	6.78 ± 0.61^{a}	7.25 ± 0.70^{ab}	8.10 ± 0.23^{c}
BOD (mg/L)	2.30 ± 0.41	2.41 ± 0.76	2.39 ± 0.55	1.89 ± 0.55	1.22 ± 0.79	0.65 ± 0.34
pH	7.82 ± 0.22	7.54 ± 0.45	7.86 ± 0.23	7.75 ± 0.20	7.78 ± 0.29	8.08 ± 0.10
$P\text{-}PO_4^{3}$- µg/L)	0.766 ± 0.023	0.763 ± 0.025	0.758 ± 0.017	0.762 ± 0.020	0.756 ± 0.017	0.742 ± 0.019
$N\text{-}NO_3$- (µg/L)	0.522 ± 0.016	0.515 ± 0.004	0.506 ± 0.023	0.510 ± 0.014	0.507 ± 0.010	0.504 ± 0.018
Transparency (m)	7.2	7.1	6.3	To bottom	To bottom	12.4
TSS (mg/L)	0.400 ± 0.191	0.378 ± 0.206	0.353 ± 0.180	0.338 ± 0.240	0.326 ± 0.183	0.284 ± 0.133
Benthic organic (%)	0.0292	0.0186	0.0244	0.0100	0.0125	(-)

Data in the same row with different superscripts are significantly different (P < 0.05); (-): no data collected.

Efficiency of traditional lobster culture, biology and economics, was also evaluated using rapid rural appraisal (RRAs) methods[9] to preliminarily compare with those cultured using pelleted test feed.

Results were expressed as mean ± standard of deviation (SD) and group mean difference compared using one – way ANOVA. When there were differences, the group means were further compared using Duncan's multiple range test. All computations were performed with SPSS 16.0. A significant level of P < 0.05 was employed in all cases.

Formulated test feed.

Findings

Environmental quality and efficiency of lobster culture in Binh Ba Bay

Results of analysis of samples collected from sites in Binh Ba Bay indicated that there were no significant differences (P > 0.05) of the environmental parameters (except for dissolved oxygen) between sites with lobster cages and others. The fluctuation of these factors was not high during the year of 2009 – 2010 (Table 2).

According to Lellis and Russell[10], the optimal temperature for post-larval lobster growth is above 27°C and below 33°C. Lobster can only develop when the salinity is above 20 ppt. Like other marine animals, the optimal pH range for lobster is from 7.5 to 8.5[11]. Therefore, the ranges of these factors were still in the suitable ranges for lobster growth.

Compared to other coastal water bodies of Khanh Hoa province such as Van Phong – Ben Goi[12,13], Nha Phu lagoon, Binh Cang and Nha Trang bays[12] and Cam Ranh Bay[13] there was no major differences in the water quality and environmental parameters given in Table 2.

The total solid suspended (TSS) at lobster culture sites (TAV: 0.400 mg/L, CAT: 0.378 mg/L) was higher than others. As Le and Le[14] concluded that the most marked environmental effect of lobster cage aquaculture in Van Phong Bay was the output of suspended solids, dissolved nutrients, organic matter and bacteria. The highest TSS was observed in the rainy season of November, 2009 (0.643 mg/l) and the lowest in the dry season of May, 2010 (0.161 g/L).

The same trend in TSS was observed for biochemical demand (BOD), when it was considerably higher at lobster culture sites TAV and CAT (Table 2) than at the small and large gates to the western sea: CN and CL (Table 2)

Panulirus homarus.

Estimated FCR for *P. ornatus* and *P. homarus* fed by trash/low value fish was 26.60±5.02 and 26.00±1.41. Most of the solid wastes came from mollusc and crustacean species which accounted for 80% of trash fish composition. In addition, their shell weight was approximately 70% fresh body mass. Therefore, to produce one kg of *P. ornatus* and *P. homarus* a discharge of around 15 kg of solid waste to Binh Ba Bay and surrounding areas occurs. Consequently, in a large area close to the Binh Ba Port (DC) and concentrated lobster culture areas that used trash fish/low value fish (CAT) there was a lot of solid wastes such as plastics, broken bricks, and shells of shellfishes. These materials covered a thick layer on the seabed. In contrast, at the testing site (TAV) for pelleted feed the sea bed is only mud and the water current easily washed it to the ocean.

The environmental issues were not only limited to solid wastes but also dissolved nutrients such as nitrogen and phosphorus. Le and Lai[15] stated that the waste nitrogen (N) from rearing lobsters using the fresh fish diet was 402 g N/ kg lobster, and is comparable to that calculated for of lobster cage cultured in Xuan Tu Village, Van Ninh district where

Table 3. Economic efficiency to produce 1 kg lobster (*P. ornatus* and *P. homarus*) using "trash" fish compared to pelleted test feeds (product of KC.06.23/06-10 project).

Parameters	"Trash fish" composition (%)				Pellet feed[21,22]
	Squid	Lizard fish	Crabs	Mussels	
Average price for 1 kg of each "trash" fish composition (1000 VND)	20.00 ± 0.00	16.00 ± 4.10	20.18 ± 2.56	5.7 ± 1.92	
Proportion (%) in "trash" fish	2	18	50	30	
Average price for 1 kg of feed (1,000 VND)	APTF = 2% x 20.00 + 18% x 16.00 + 50% x 20.18 + 30% x 5.7 = 15.08				40.00
FCR of *P. ornatus*	26.60±5.02				4.7
FCR of *P. homarus*	26.00±1.41				4.3
Total cost of feed to produce 1 kg of *P. ornatus* (1,000 VND)	401.12±75.70				188.00
Total cost of feed for produce 1 kg *P. homarus* (1,000 VND)	392.08±21.26				172.00

there is an apparent over loading of nitrogen since 2003. This issue is also the main concern of lobster farmers there[16]. The number of lobster cages in Van Ninh has increased to 16,080 cages and total nitrogen discharge was estimated 223 tons[17] and phosphorus 3.352 tons[18].

More than 100 species of marine trash fish comprising of small molluscs, crustaceans and echinoids are used as an aquaculture feed or aquaculture feed ingredient in Vietnam[19] and the supply has become scarer because of over-exploitation[20]. The total amount of trash fish used for aquaculture in Vietnam was estimated to be between 176,420 – 363,440 tons[19]. Therefore, finding alternative sources of protein, lipid, and carbon hydrate compounds from products of plant origin to replace trash fish is needed from a biodiversity conservation view point.

Economic efficiency

According to Le et al.[6,19], the average price of "trash fish" for lobster in 2000 was around 5,000 VND/kg. However, our survey in Binh Ba showed that this price has increased rapidly up to 5,700, 16,000, 20,000, and 20,180 VND/kg for mussels, lizard fish, small squid, and crabs, respectively. The composition of "trash fish" is typically 2% squid, 16% lizard fish, 20.18% crabs, and 30% mussels. Therefore, the average price for 1 kilogram of "trash" fish (APTF) can be calculated in Table 3 to estimate the production cost of lobster. Result of testing pelleted feed was also obtained from Lai[21,22] for comparing the economic efficiency (Table 3).

By using these pelleted feeds, lobster farmers can save around 213,120 VND (11 USD) and 220,080 VND (11.34 USD) to produce 1 kg *P. ornatus* and *P. homarus*, respectively. In Vietnam a US$90 million per annum lobster industry flourishes[2], therefore if pelleted feeds is used in mass production it could bring about great benefit for lobster farmers, contribute to reduce the effect of aquaculture on environment.

Acknowledgement

The authors would like to express their gratitude to Mr. Dinh Van Quan, Ms. Nguyen Thi Quynh and Ms. Nguyen Thi Sam for providing research assistance.

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Peter Edwards writes on

Rural Aquaculture

Tilapia in Chiang Mai, Northern Thailand

Hatchery trays at Chiang Mai Pattana Farm.

Chiang Mai, the capital of the former Lanna Kingdom of Northern Thailand, is a major tourist destination located some 700 km north of Bangkok. As it is about 10 hours by road from the nearest major seaport of Samut Prakhan, tilapia, especially red tilapia, has become a major fish in city restaurants.

I was invited by Randy Bevis of Chiang Mai Aquatic Development Farm, and Walter Nigh of Logos Farms to visit their farms and those in the surrounding area in August, 2009. Chiang Mai Aquatic Development Farm was the only tilapia hatchery in the province and had been in operation for 12 years. They were under a social welfare foundation called the Northern Thailand Foundation for Enablement. One of the ways they helped local farmers was to create a subcontracting nursery farm system in which the farmers were provided with red fry and feed on credit and then Chiang Mai Pattana farm bought them back as large fingerlings as outlined below in the next section, and resold them to the cage farm industry mostly in the Ping River south of Chiang Mai.

Logos farm was set up two years ago by Walter Nigh to also nurse fingerlings for the cage market. Both Randy and Walter combined a partnership between business in tilapia and Christian ministry, providing fingerlings to stock grow-out ponds and cages in the province.

I also visited small-scale tilapia farms in Chiang Mai which illustrated various aspects of the development and promotion of rural aquaculture, and especially the problems faced by small-scale farming households. I visited farms with ponds and also with cages in an irrigation canal, a reservoir, and the Ping River.

Chiang Mai Aquatic Development Farm

This was the first tilapia hatchery established in Chiang Mai, by Randy Bevis based on a model developed at the Asian Institute of Technology following his graduation from the Institute in 1993. The farm occupied a total area of approximately 24 ha with two sites, one for breeding black tilapia and one for the reds. The market for black fry (2 cm) was larger than that for red fry but the reds made up the majority of the fingerling market. Graded red fingerlings were sold individually at Baht 3.5 for size 1 (38 individuals/kg), Baht 2.5 for size 2 (43 individuals/kg) and Baht 2 for size 3 (60 individuals/kg). Black fingerlings sold for less (US$1 = Baht 32 approximately).

Randy had set up a nursing network with neighbouring rice farmers to whom he sold fry and bought back fingerlings. Thirteen farmers owned a total of 60 ponds with most families having 3-5 ponds. A 600 m2 pond was stocked with 25,000 fry which were nursed for 2.5 – 3.0 months. This required 35 sacks each weighing 20 kg of 32% protein pelleted feed costing Baht 500/sack. Farmers made a profit of Baht 7,000-10,000/pond. Financial assistance was provided to the farmers for a bad crop, which tended to happen every year in the cool season. Twenty percent of profits on profitable ponds were then applied to the debt from bad crops. Profitability had gone down in the last year or two due to new fish diseases and probably also due to declining water quality as the ponds were getting older.

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: pedwards1943@gmail.com.

Breeding hapas at Chiang Mai Pattana Farm.

Buy back prices were recently raised to try to help the nursery famers do better and larger fry were being stocked as well.

Logos Farms

The farm had 14 1,000-1,200 m^2 nursery ponds and has since my visit last year constructed a small red tilapia hatchery. Tilapia fry were mainly purchased from Randy's farm although also from Po Jalem Farm in Central Thailand and the Thai National Fishery Department in Bangkok and Khamphaeng Phet if the Chiang Mai Development Farm could not fill his orders. He bought 2 cm red tilapia fry and nursed them for 3 months before grading them into the three fingerling sizes and then sold them to pond or cage grow-out farmers. Tilapia fry are usually stocked at 35/m^2 in static water ponds in Thailand but Walter stocked at 50/m^2 as he aerated the ponds using roots blowers and superchargers through 10cm air-stones. Fertilization was initially done bi-weekly with a liquid commercial fertilizer of 12-38-0 at the rate of 1 US gallon/acre. However, pond fertilization had been discontinued for the past year because Logos Farms ponds became green naturally after pond preparation and filling with fresh water. The pond was prepared using hydrated lime, dried for about 2 weeks and was then filled with water following which the pond began to turn green within 24-48 hours. Fish were grown to a large fingerling size suitable for stocking grow-out ponds or cages of an average size of 25 g (range 15-30 g) in 2-2.5 months, 1.5 and 2 months growth in the cool and warm seasons, respectively, with 0.5 months for pond preparation.

A commercial 32% protein pelleted feed was used beginning from about 4 weeks of age, or when the fish were large enough to eat the small pellet. For the first 3-4 weeks the fry were fed a 1:1 mix of rice bran and 62% fish meal which provided about a 35 - 40% protein diet. The fish were fed at a reducing average body weight (ABW) rate of from 20% with the rice bran and fish meal diet down to about 5% ABW when the fish had reached about 20 g body weight. With all 14 ponds in full production, about 100,000-120,000 fingerlings/

Nursing in a small-scale farmer's pond.

month were produced although during the cool season this will drop by about 20%. Under optimal conditions it took only about 2 months to nurse a 0.35 g fry to a 30-35 g fingerling.

The farm was in the process of building a Christian Training Center where 1-2 month courses on small-scale fish culture would be available for current and future Christian Pastors, leaders and workers. Trainees would also be able to access loans and on-going support to establish their own fish farms on completion of their programme. This training programme should be available from mid- 2011.

Walter who was a printer by profession was encouraged by Milton Coke, an American who works in development mostly in Bangladesh and has two tilapia hatcheries there, to develop the fish farm to provide a profitable base to support their activities. Randy advised Walter to set up a fish nursery as it is more profitable than grow-out. Walter told me that initially he thought that aquaculture would be easy as well as profitable but now he realized that it

Making hapas at Chiang Mai Pattana Farm.

Large black tilapia fingerlings being packaged for sale at Chiang Mai Pattana Farm.

is labour and management intensive, and with increasing incidence of disease in tilapia, also technically intensive. It is 'not just digging a hole, water, fish and feed' he lamented.

Mae Khet Luang

The village in San Sai district was the only major area in Chiang Mai with fish ponds. Although irrigated it flooded and so was ideal for conversion of agricultural land to fish ponds. There were about 80 farming households organized into three cooperatives which helped the farmers to work together to market their fish through middlemen and get standard prices. The lady farmer I interviewed outlined an interesting background history indicating several issues concerning the role and future potential of small-scale aquaculture. The family initially farmed rice but diversified first into cut flowers and then into aquaculture with their first three ponds dug 26 years ago. They took out a loan from the government Bank of Agriculture and Agricultural Cooperatives (BAAC) to become a contract chicken farmer to integrate the birds with the fish ponds. The major initial expense was construction of two bird sheds over fish ponds to house 5,000 birds/cycle. Following the outbreak of bird flu a few years ago the government

Close up of small red tilapia fingerlings.

banned integration of chicken/fish integration although it has since been allowed providing that the bird sheds are enclosed in netting to prevent entry of other birds. However, the lady farmer had not restarted chicken rearing as she said that she had a bad back. Her husband had a full-time off-farm job as a technician at a local factory. Neither of their two children was interested in farming, the son working in a bank after studying information technology and their daughter was still at university studying computer management. This interview illustrated the widespread phenomenon of small-scale faming households diversifying their sources of income, both on- and off-farm, and their children usually not wishing to follow in their parents' farming footsteps.

To partially replace the chicken manure, 10 cattle were purchased and grazed on the pond dikes. The woman said that they had lost money on the cattle operation as well. They nursed their own fry using green manure and buffalo manure although transferring fish was said to be hard work. The husband, being a skilled machinist, had constructed a small-scale on-feed manufacturing plant and used a formula provided by the Department of Fisheries (DoF) to produce a feed with 18% protein containing cassava, rice bran, maize, soybean meal, fish meal, bone meal, leucaena meal and calcium phosphate. The feed cost Baht 250/20kg compared to Baht 300 for purchased feed. They still obtained the same farm production of 6-7 tonnes/crop as when previously integrated with chickens but the grow-out period from 2 cm fry to table-size fish increased from 8 to 10 months. Unfortunately, like most of the fish farmers in the area, the lady farmer was in debt to the tune of Baht 1 million, although most farmers had a more modest debt of about Baht 100,000.

Small red tilapia fingerlings arriving at Logos Farms from Chiang Mai Pattana Farm.

Nursing red tilapia fingerlings at Logos Farms.

Irrigation canal farms

The local government in Poh Thong Chalerm village in Doi Saket district provided 50 families each with one cage, taught them how to raise fish and provided them with fingerlings and one bag of pelleted feed. As the location was in an urban area, they were not farming households. Each household-level 2 x 4 x 0.8 m cage was stocked with 500 tilapia fingerlings. Fish attained inconsistent sizes of 0.3 – 0.5 kg as they were not fed regularly, due in part to families later having to buy their own feed. Unfortunately most of the cages were washed away by a flood with only about 12-15 remaining during my visit. Some of the fish were sold, Baht 80/kg for black tilapia and Baht 120/ kg for red tilapia, but mostly they were consumed by the households. The household I interviewed said that they were waiting to see if the local government would redo the project. At the time of my visit the level of the water in the irrigation canal was low, with the Department of Irrigation (DoI) releasing water twice/month. Cage farming in irrigation canals designed for agriculture may be constrained by insufficient or irregular supply of water.

Reservoir cage farms

Mae Ngat reservoir is a large reservoir in Sri Lanna National Park in which only a small number of farmers were allowed to operate by the DoI. There was also a high cost of Baht 100,000 investment to buy rights to farm in the reservoir. The farmer I interviewed used to be an engineer but won the lottery and bought the cage farm from his sister. Fry of 2 cm length purchased from Randy's farm were stocked 4 months before my visit and would be harvested after another 2 months. Only 10% of the stocked fish were lost to disease. Because of recent widespread disease in tilapia fingerlings in Chiang Mai, reported to have been introduced from fingerlings imported from Central Thailand, the farmer expected to obtain a good price of Baht 80/kg. The fish would also be of high quality because of the excellent water quality in the reservoir.

Ping River farms

Cage culture of tilapia began on the Ping River about 10 years ago. Technology and loans were provided to farmers initially by BAAC who took potential farmers to see cage culture elsewhere, but subsequently Bangkok Bank and various projects helped farmers to develop cages. Most farmers were organized in groups, each related to an important person who was normally a village leader with connections. Most of the groups had arrangements with certain feed companies to provide feed on credit although there were also some individual farmers with larger scale operations who bought their own feed.

Aquaculture was a secondary occupation for most cage farmers with lam yai (longon fruit) orchards being the most common primary activity. Cages extended along the river for about 25 km with 6-7 households involved in each village from San Pa Tong to Chom Thong. At the peak there were

Harvesting large red tilapia fingerlings at Logos Farms.

about 4,000 cages but the number had declined recently due mainly to disease. According to the farmer I interviewed in Ma Kampom, Doi Loo area, there used to be 70 families with cages in his cooperative but there were only about 30 remaining with about 300 cages in total at the time of the interview.

Cage dimensions were 3x3, 3x6 and 4x4 m with a depth of 2 m. Fingerlings were obtained from Randy and Walter in Chiang Mai, Tong Chai (another nursery in Chiang Mai); and also from hatcheries in Central Thailand which were believed to be the source of the disease. Some farmers had ponds to nurse seed; and a few farmers also nursed in cages but the survival was poor. A total of 1,500 fingerlings were stocked in a 4x4m cage and harvested at 0.9-1.0 kg size. Mainly red tilapia were farmed. Fish disease started in April/May 2009 and in a single day all farmers lost about 70 % of their stocked fish. They restocked but up to 50 % of the stocked fish died over a 1 month period after stocking which was the reason why so many cages were not stocked with fish during my visit.

Beef cow (foreground) and derelict poultry shed (background).

Lady farmer and her daughter who is studying computer management.

Cages in an irrigation canal.

Cages in a reservoir.

The farm-gate price for red tilapia had been static at about Baht 45/kg for many years but earlier in the year had risen to Baht 70/kg for the Ping River cages due to a shortage in the market although the price had declined at the time of my visit to Baht 60/kg. Black tilapia had a farm gate price of Baht 51/kg, again for a fish of 0.7-1.0 kg. Local people could differentiate between usually better quality cage-raised black tilapia and pond- raised black tilapia with a much higher chance of off-flavour as the former were much more plump in shape.

Barbecued tilapia

CP had established a franchise selling barbecued fish in the city of Chiang Mai. A sum of Baht 8,000 was required for an operator to start the business and be provided with a cart to barbecue the fish. Operators bought their own charcoal, vegetables and sauces. They bought red tilapia of about 1 kg size at Baht 60/fish and sold the barbecued fish at Baht 90, making a daily profit of about Baht 600/day from selling 20 fish.

A small-scale franchise selling red tilapia.

Cages in the Ping River.

Marketing of low-valued cultured fish in Bangladesh: An evaluation of value chain

Ahmed, N.

Department of Fisheries Management, Bangladesh Agricultural University
Mymensingh 2202, Bangladesh; e-mail: nesar_2000@yahoo.com

Bangladesh is considered one of the most suitable countries in the world for freshwater aquaculture, because of its favourable resources and agro-climatic conditions. A sub-tropical climate, vast areas of pond, low-lying agricultural land and seasonal semi-closed shallow water provide ideal conditions for fish production. The freshwater inland aquaculture production in Bangladesh is the second highest in the world after China (FAO, 2009). The total annual fish production was estimated to be 2.56 million tons in 2007-08 (Bangladesh fiscal year: 1 July-30 June), of which 1.00 million tons (39%) were obtained from inland aquaculture, 1.06 million tons (41%) from inland capture fisheries, and 497,573 tons (20%) from marine fisheries (DOF, 2009). The main production systems for freshwater aquaculture in Bangladesh are extensive and semi-intensive pond polyculture of Indian major carps and exotic carps which accounts for 80% of the total freshwater aquaculture production. The remaining 20% were mainly from catfish, tilapia, small indigenous fish and rice-fish farming (ADB, 2005).

In Bangladesh, bighead carp (*Aristichthys nobilis*), common carp (*Cyprinus carpio*), grass carp (*Ctenopharyngodon idella*), silver carp (*Hypophthalmichthys molitrix*) and sutchi catfish (*Pangasianodon hypophthalmus* - locally known as pangas) are commonly known as low-valued cultured fish, all are exotic species. These species are of foreign origin and introduced to Bangladesh during the last few decades to supplement fish production (Table 1). Among these species, silver carp is fast growing, reaches 300-400 g within three months of stocking. Silver carp contributes around 20-23% of total aquaculture production and has become an important food fish for the poor, together with other exotic carps. All of these exotic carps have contributed substantially to commercial aquaculture in Bangladesh, an average 28% of the total aquaculture production (De Silva et al., 2006). These exotic carps including pangas have become important food fish for the poor and contribute significantly to the food security.

Low-valued exotic species for aquaculture is becoming an increasingly important food production process in many Asian countries (De Silva et al., 2009).With rising population and demand, expansion of fish supplies to maintain food security has emerged as a priority concern for Bangladesh. In order to meet the soaring demand for food, there is a huge potential of low-valued fish farming in Bangladesh, because

Harvesting of pangas.

of many positive culture attributes including no significant adverse environmental impacts (ADB, 2005). However, while farming of low-valued fish species has huge potential in Bangladesh, their commercial viability and sustainability depends on markets. The market is associated with strong demand, driven by continued increases in population. Mainly due to population growth there is a growing gap between supply and demand of fish in markets. Narrowing the gap not only requires increasing production but also improvements of all aspects of fish marketing and distribution systems (Kleih et al., 2002; Ahmed and Sturrock, 2006; Ahmed, 2007 and 2008). It is therefore worthwhile to understand existing marketing systems of low-valued cultured fish. Aside from a better understanding of fish marketing systems, it seems important to identify marketing inefficiencies that have negative impacts on poor farmers, traders and associated groups.

This article describes the existing marketing systems of low-valued cultured fish with its value chain analysis. The aim of this paper is to highlight key issues determine efficient marketing systems of low-valued cultured fish to enhance

Table 1. Low-valued cultured fish introduced in Bangladesh (Source: Banglapedia, 2009).

Common name	Scientific name	Country of origin	Introduced from	Year of introduction
Bighead carp	*Aristichthys nobilis*	China	Nepal	1981
Common carp	*Cyprinus carpio*	Temperate Asia, China	India	1960
Grass carp	*Ctenopharyngodon idella*	China	Hong Kong	1966
Silver carp	*Hypophthalmichthys molitrix*	China	Hong Kong	1969
Sutchi catfish	*Pangasianodon hypophthalmus*	Southeast Asia	Thailand	1989

food supply. It is assumed that sustainable marketing of low-valued cultured fish can provide food and nutrition to the people of Bangladesh.

Harvesting of low-valued cultured fish of exotic carps.

Common carp with other fish for marketing.

Methodology

Study area

The study was conducted in Trishal and Bhaluka sub-districts under Mymensingh district of north-central Bangladesh. Geographically both areas have been identified as the most important and promising for low-valued fish farming, because of the availability of hatchery-produced fry, favourable resources and climatic conditions, such as the availability of pond, warm climate, fertile soil, and cheap and abundant labour. As a result, there has been a dramatic increase in low-valued fish production over the last few years. Table 2 shows average productivity and culture systems of low-valued fish in the study areas.

For the market survey, two important fish markets in Mymensingh town, namely Machua Bazaar (i.e. fish market) and Nutun Bazaar (i.e. new market) were selected based on market history, supply of low-valued fish, number of traders involved, and the duration of trading season. Similarly, two important fish markets in the capital city of Dhaka, namely Kawran Bazaar and New Market were selected to carry out comparative studies of low-valued fish marketing between Mymensingh and Dhaka.

Data collection methods

Data were collected for a period of three months from December 2008 to February 2009. Primary data were gathered by field survey. This survey involved the inspection of the study area in terms of low-valued cultured fish distribution and marketing systems. A combination of participatory, qualitative and quantitative methods was used for primary data collection. A total of 12 Focus Group Discussion (FGD) sessions were conducted with fish farmers in Trishal and Bhaluka sub-districts (6 FGD in each area) where each group consisted of 6-12 farmers (total 97 farmers) and the duration of each session was approximately three hours. FGD was used to get an overview of existing low-valued cultured fish harvesting and marketing systems, farm-gate prices and constraints of fish marketing. For questionnaire interviews, a total of 60 fish traders (15 in each market x 4 markets) were conducted in Mymensingh and Dhaka markets. The interviews, lasting about an hour, focused on low-valued fish marketing systems, pricing mechanisms, marketing costs and margins, and

Table 2. Farming systems and average productivity of low-valued cultured fish.

Fish species	Culture system	Productivity (kg/ha/yr)	Reference
Bighead carp Common carp Grass carp Silver carp	Polyculture with Indian major carps Small-scale extensive (80%) and semi-intensive (20%) Low input farming system Using locally available feeds: rice bran, wheat bran, mustard oilcake and fish meal	3,000-5,000	Ahmed (2009)
Pangas	Mainly monoculture Extensive (60%), semi-intensive (30%) and intensive (10%) farming system Using home-made, locally available feeds or industrially manufactured pelleted feed	4,000-8,500	Ahmed (2009)

identification of bottlenecks. For the validation of collected information, a total of 25 key informants were interviewed including wholesalers, informed farmers, government fisheries officers, policymakers and researchers. Collected data were coded and entered into a database system using Microsoft Excel software to produce descriptive statistics. Results from the data analysis, in combination with qualitative information collected through different methods, were used to describe low-valued cultured fish marketing systems.

Harvesting and marketing of fish

Harvesting of low-valued fish starts as soon as fish reach marketable size. The peak fish harvesting season is from August to December. Most farmers harvest fish by themselves although a few large farmers depend on commercial harvesters. Normally, fish are harvested at very early hours in the morning. Most farmers practice partial harvesting of larger fish which allows smaller fish to grow, while a few farmers practice total harvest. Farmers harvest fish by using cast nets and seine nets. Harvested fish are cleaned with tube-well water and kept in aluminium and plastic containers or bamboo baskets until they are sold.

Almost all produced low-valued fish is marketed internally for domestic consumption. Depending on the transaction volumes, farmers sell their fish to the local agents or suppliers. Vans and rickshaws (i.e. pedal tricycle) are commonly used to transport fish from remote villages to the main road side which takes 30 minutes to an hour, depending on distance. According to the survey, 65% of fish are transported to the capital city of Dhaka, around 75-100 km south from the fish producing areas. The rest (35%) of the fish are transported to nearby Mymensingh town markets (10-25 km north from the fish producing areas). The farm-gate prices of fish depend on their species, quality, size and weight, supply and demand, and seasonality. The average farm-gate price of fish was estimated at US$ 0.70 per kg, varied between US$ 0.59 and 0.81 per kg (Table 3).

A number of constraints were reported by farmers in marketing of fish, including poor road and transport facilities, higher transport costs, inadequate knowledge on marketing systems, low market price and exploitation by intermediaries. Farmers are in a particularly weak position (i.e. no bargaining power on price) in relation to intermediaries of fish marketing. Farmers often feel exploitation by the intermediaries as the prices they received for fish do not adequately reflect the prices paid by the consumers.

Table 3. Average farm-gate prices of low-valued cultured fish.

Species	Product share (%)	Price (US$/kg)*	Total average price US$/kg)
Bighead carp	5	0.76	
Common carp	12	0.70	
Grass carp	8	0.81	0.70
Silver carp	35	0.66	
Pangas	40	0.59	

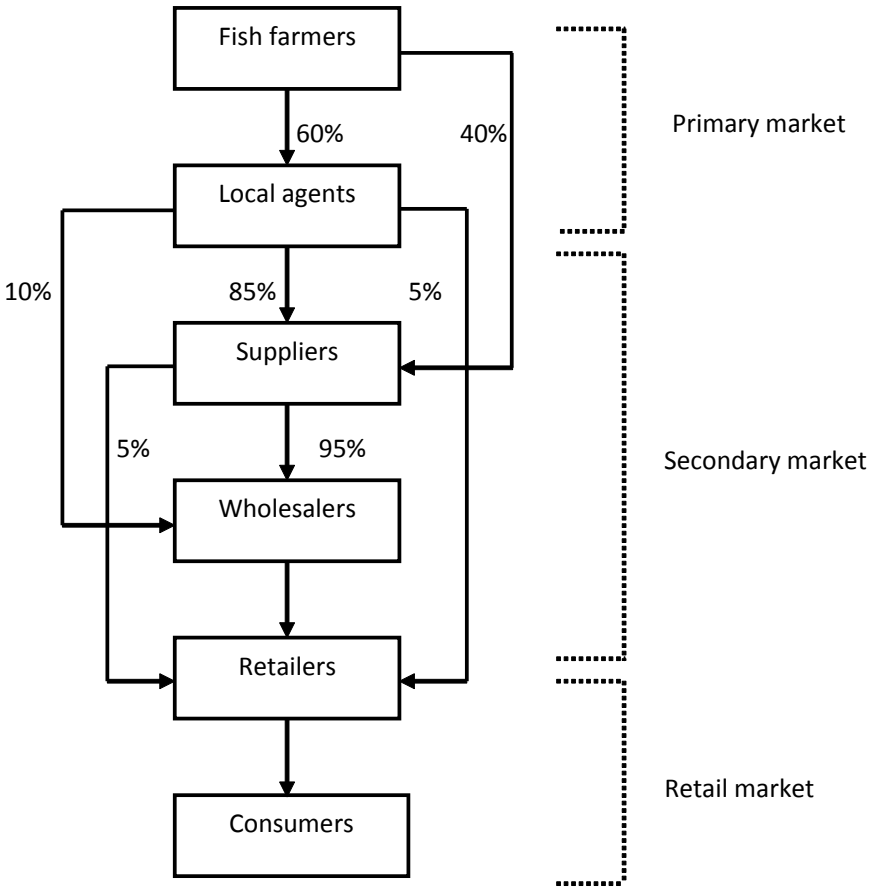
** Price estimated for 1 kg size of fish; US$1 = Tk 68 in February 2009.*

Table 4. Average prices (US$/kg) of low-valued cultured fish in retail markets.

Species	Mymensingh market	Dhaka market	Total average
Bighead carp	1.34	1.56	1.45
Common carp	1.27	1.51	1.39
Grass carp	1.32	1.59	1.46
Silver carp	1.24	1.50	1.37
Pangas	0.97	1.18	1.07
Average	1.23	1.47	1.35

Price estimated for 1 kg size of fish.

Figure 1. Low-valued cultured fish marketing systems from producers to consumers.



Fish marketing systems

The fish marketing system is traditional but plays a vital role in connecting the farmers and consumers, thus contributing significantly in the value adding process. A large number of poor people find employment in the fish marketing chain as farmers, local agents, suppliers, transporters, traders and day labourers including women and children. Farmers are the primary producers in the fish marketing systems. With a few exceptions, farmers never directly communicate with consumers. The market chain from farmers to consumers encompasses mainly primary, secondary and retail markets, involving local agents, suppliers, wholesalers and retailers (Figure 1). The demand for fish is high in markets but supply is limited, and a strong network has developed with intermediaries and traders. Communication between the suppliers and wholesalers is generally good and takes place by mobile phones. Suppliers are tied to a limited number of wholesalers. Suppliers commonly use trucks, buses, pickups and taxis to transport fish to wholesale markets in Mymensingh and Dhaka, which takes 1-4 hours depending on distance and mode of transportation.

As soon as the suppliers land fish in the wholesale market, the wholesalers take care of landing, handling and auctioning by species and size-groups. A number of day labourers work with the wholesalers to perform post-landing tasks that include cleaning, sorting, grading and icing of fish. Normally, the auction sale is made by heaps and wholesalers follow the incremental price system. It is the most competitive form of auctioning and ensures better prices. Auctioneers get commission at different rates of the sale proceeds, normally 2-5% of the auction price, for their services and costs involved. Auctioneers appointed by wholesalers, call out bid loudly in the presence of buyers (i.e. retailers). Retailers often take temporary credit from wholesalers, buying fish one day and paying one or two days later. Retail sales are made at stalls in fish markets. Fish are traded whole, gutted and fresh without processing, apart from sorting and icing.

Weighing of pangas for marketing.

Harvested silver carp contributes significantly to aquaculture production.

Fish trading in retail markets

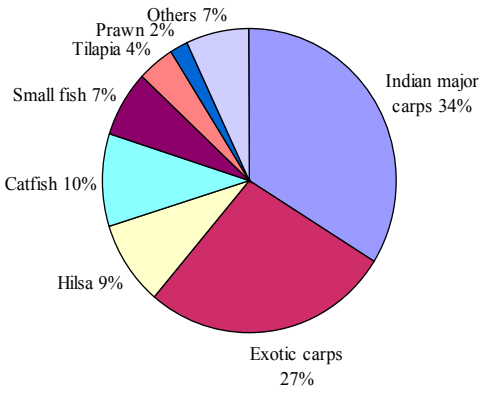
According to the survey, a typical retailer in Dhaka markets sold an average of 34 kg/day low-valued fish during the peak season from August to December, while in Mymensingh markets sold an average of 25 kg/day. The supply of fish in Dhaka markets was higher due to the higher number of traders and consumers associated. On the other hand, the supply of fish in Mymensingh markets was lower due to the lower number of consumers involved. Nevertheless, it was estimated that 27% of market share was exotic carps in Mymensingh markets while it was 24% in Dhaka markets (Figure 2). Among catfish, 70-80% comprises pangas in market share.

Low-valued cultured fish are sold according to species. The retail market prices of fish depend on quality, size and weight, season, supply and demand, and market infrastructure. The average price of fish from traders to consumers was estimated to be US$1.35 per kg, ranging from US$0.97 to 1.59 per kg (Table 4). Overall, the prices of fish were considerably higher in Dhaka markets than Mymensingh due to a larger concentration of consumers and superior family incomes.

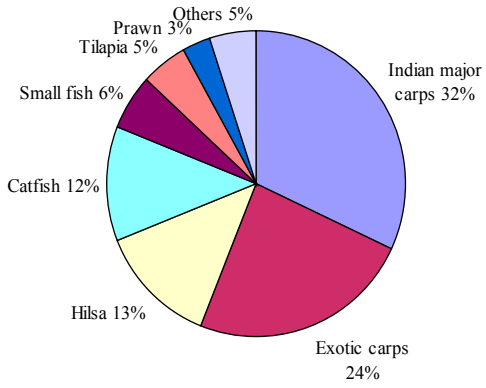
The consumption of low-valued cultured fish at household level has been increasing. It was reported by the traders that consumers usually prefer fresh fish without ice. In general, the high income groups (i.e. high officials and rich businessmen)

Figure 2. Market shares of different groups of fish in retail markets.

Mymensingh market:



Dhaka market:



buy large fish, and the middle-class is able to afford medium-sized and small fish. The large segments of poor people also buy small fish. Nevertheless, most consumers preferred larger fish due to taste, but normally purchased smaller because of lower market price.

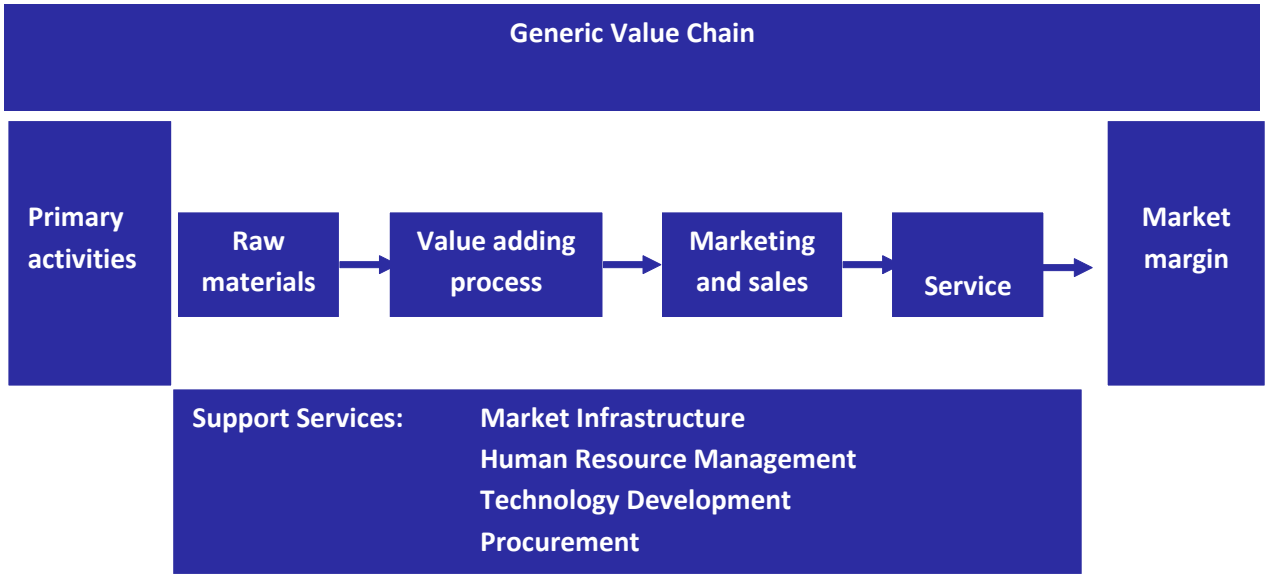
Value chain analysis

The value chain describes the full range of activities which are required to bring a product or service from conception, through the different phases of production, delivery to final consumers (Kaplinsky and Morris, 2000; Jacinto, 2004). In fish marketing systems, value chain is a structure of physical, economic and social transactions between individuals and organisations engaged in raw material transformation into end products (Figure 3). Flows of fish products and money are exchanged through value adding transactions driven by profit and allocation.

In marketing of low-valued cultured fish, farmers can not earn a good profit because they have a limited access to market and they do not have enough knowledge on where to sell for their products. It was calculated that farmers received an average 52% of the retail price which is unduly low. The farm-gate prices of fish are low due to exploit by intermediaries. The intermediaries avail the opportunity and exploit both the farmers at the farm-gate level and consumers at the retail point. Farmers profit margins get reduce with the increase in number of intermediaries in the fish marketing channel. This implies that prices go up with increasing number of transactions in the fish marketing channel. Presence of intermediaries in the marketing channel mainly due to lack of government control over the trade.

For value chain analysis of low-valued cultured fish marketing, variables like marketing costs and margins, number of intermediaries in the marketing channel, distance between primary and retail markets, and consumers' behaviours on price are important factors. Amongst the intermediaries in the fish marketing channel, the highest average marketing margin per kilogram of fish was received by the wholesalers. As such, the highest average marketing profit per kilogram of fish was found in secondary market,

Figure 3. The concept of a value chain (adapted from Trondsen et al., 2004).



Fish distribution and marketing starts at the pond side.

Fish transporters at primary market.

Fish assembling centre at the road side.

followed by retail and primary market (Figure 4). Thus, the secondary market was identified as most responsible for price increase to the consumers.

Sustainable fish marketing

Despite importance of food supply, a number of constraints were identified for long-term sustainability of low-valued cultured fish marketing, including poor road and transport facilities, higher transport costs, insufficient supply of ice, unhygienic conditions, lack of credit facilities and poor infrastructure of markets (i.e. inadequate drainage systems, poor supply of water, limited ceiling and flooring space). This situation is further aggravated by the lack of transparency in the price formation process and asymmetric information flow, lack of capital for investment, and inadequate post-harvest infrastructure. Political disturbances such as strikes and road blocks also affect fish marketing.

In order to develop sustainable fish marketing systems, it is necessary to improve marketing strategies, including production, promotion, distribution and pricing strategy – all are important parameters of marketing mix (Figure 5). Better marketing facilities, transportation, fish marketing infrastructure, especially market centers and facilities would help to improve the situation. Efficient distribution systems for fish should be set up to serve the consumers better. It is also worthwhile to establish strong coordination between farmers and market actors to ensure a smooth supply of fish to the consumers.

In Bangladesh, low-valued cultured fish have great potential in terms of food supply. The sustainable marketing of low-valued cultured fish has a favourable impact on food supply to meet the growing demand for fish among consumers, including the poor. In order to sufficient supply of low-valued cultured fish in markets, it is worthwhile to provide institutional and organisational support, government support, extension services, more researches and public-private partnership for sustainable fish marketing.

Acknowledgements

The study was supported by the Food and Agriculture Organization (FAO) of the United Nations, and Network of Aquaculture Center in Asia-Pacific (NACA). This article was presented in a conference on ‘Market chains and issues associated with biosecurity of low-valued cultured commodities in Asia’ held in Siem Reap, Cambodia during 23-26 February 2009. The opinions expressed herein is the author and do not necessarily reflect the views of FAO or NACA.

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Figure 4. Value chain analysis of low-valued cultured fish in marketing channel.

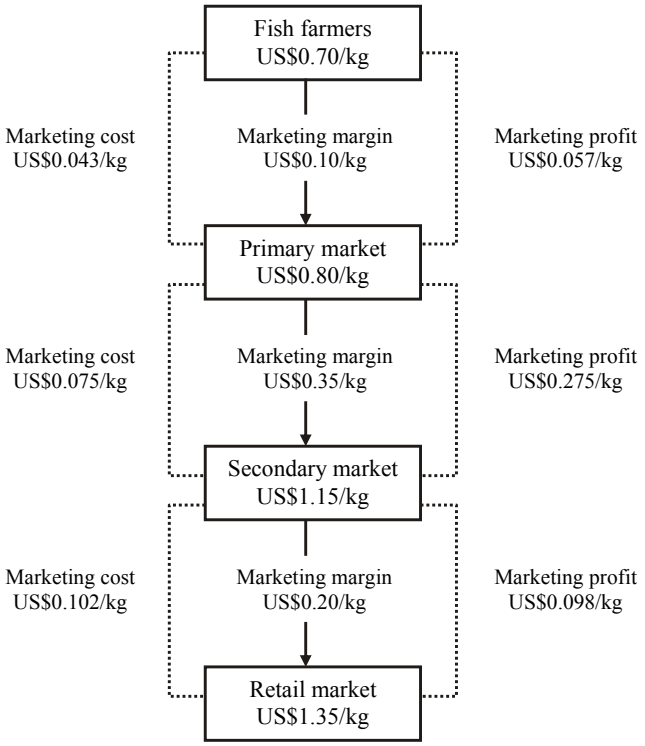

Figure 5. Components of the marketing mix for sustainable fish marketing (adapted from Rosenbloom, 2004).

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Low-valued fish trading at retail market.

Live pangas marketing – the cheapest fish in Bangladesh.

Low-value freshwater fish market in the south central Vietnam, a case study from Khanh Hoa Province

Hung, P.Q.

Faculty of Aquaculture, Nha Trang University, Vietnam. Email: pqhungait@yahoo.com

Khanh Hoa is a coastal province in south central Viet Nam and well-known for its tourist industry and with availability of diversity of good quality seafood. However, freshwater aquaculture plays an important role in contributing to total production of aquaculture and providing protein sources for communities living far from the sea. Therefore, to help better understanding about the low value freshwater fish market in the south central Vietnam, we investigated freshwater fish market in Khanh Hoa province as a case study representing in the southern coastal provinces in region. The current study was undertaken with an emphasis on consumption, species composition available in local markets and the use of low-value freshwater fish in households in the province. The present study hopes to contribute to better understanding a picture of freshwater fish market in coastal provinces in Vietnam, where marine finfish dominates and freshwater becomes minor in comparison to Red River delta at the north and Mekong River Delta at the south in the country.

We conducted a survey in nine markets. Six key markets were in Nha Trang city, and the other three were in Cam Ranh, Dien Khanh and Ninh Hoa districts in Khanh Hoa province. There were three visits each to the respective markets at monthly intervals in October, November and December, 2008. The total fish sellers interviewed in October, November and December were 31, 30 and 29, respectively. Questionnaire was prepared based on issues related to market. Direct interview at the market was applied to collect information. In each market, three to five freshwater fish sellers were interviewed. Data were analyzed using descriptive statistical methods.

Findings

Species composition

There was a wide range of freshwater species composition available in markets in the locality representing different commodities such as finfish, crab, mollusk and frogs. The survey, however, indicated that main species found in most markets were snakehead (*Channa* spp), tilapia (*Oreochromis niloticus*), common carp (*Cyprinus carpio*), paddy eel (*Mastecembelus* spp.), climbing perch (*Anabas testudineus*) and Tra catfish (*Pangasianodon hypophthalmus*). Those species were sold in highest quantities compared to others in

All fish sellers in the local markets were women and they were small-scale retailers with the age varied between 23 and 60. These were quite different from Bangladesh, where men were key traders at the markets (ADB, 2005). Earnings from selling fishes are main income source for their families.

the local markets. The daily estimated percentages of species consumed in the locality were 26, 14, 16, 14, 8, 12 and 10 % for snakehead, eel, tilapia, common carp, climbing perch, tra catfish and other species, respectively. Snakehead seemed to be consumed in the highest quantity for the local people. Paddy eel was a good choice, but quite expensive for the local people. Fishes are mainly sold alive in these markets.

Snake head was the best sale, while the climbing perch was sold in smallest quantity. The other species took up 10 % of total consumption referred to grass carp, silver carp, big head carp, walking catfish, snail, mussel, crab and frog. Those were sold in a small quantity for each species and volume sold each day was not included in this article. In general, the species compositions available in the local markets were not different in comparison with other countries in the Southeast Asia region (Silva, 2008).

Consumption of fish in the locality

There were about 5-8 freshwater fish sellers in each market selling on average of 400-600 kg/day/market for the central market and 200-300 kg/day/market for the regular markets. It was estimated that there were about 1,400-2,100 kg of freshwater fish sold each day in Nha Trang City, where the population is around 362,000. The survey also indicated that in district areas a market could sell out about 240-320 kg of freshwater species per day. It was estimated that there were over 10 markets in each district. These resulted into account of over 2,400-3,200 kg of fishes sold out each day.

The selling prices of species were not significant differences among the markets and among sellers in the city. Moreover, when it was compared with markets in the districts, there were not differences of prices between the city and districts with the same species and sizes. The selling prices were higher than usual during the period from September to March covering the holiday season, especially during Tet or New Year holiday. This was found similar to the context of neighbor countries like Laos and Cambodia (Phillips, 2002). These were because that this season is typhoon and marine fish became expensive and rare. During the summer, restaurant's owners contracted with fish sellers in local markets to supply fishes in large quantity since tourists often visit Nha Trang in this season. The average prices selling to the local consumers of main species per kilogram were snakehead: 40,000 VND; tilapia: 30,000 VND; common carp: 35,000 VND; paddy eel: 65,000 VND; climbing perch: 25,000 VND; and Tra catfish: 25,000 VND.

Foreground: Snakeheads.

Snails.

In general, the species sold in local markets were quite common and prices were not widely varied. The highest price was found for paddy eel, while the lowest ones were Tra catfish and climbing perch. However, the prices fluctuated over time and depended on the sizes of fishes. The prices of freshwater fishes in the locality were not different in comparison to Laos and Cambodia, with snakehead was an example (Ingthamjitr, 2005; Nam, 2005). Market sizes of fishes were found to be not different among markets. The average sizes selling in local markets of main species per fish were snakehead: 0.5-1 kg; tilapia: 0.2-0.3 kg; common carp: 0.2-0.35 kg; paddy eel: 0.04-0.05 kg; climbing perch: 0.015-0.02 kg; and Tra catfish: 0.8-1.2 kg.

Market chains in the locality

The freshwater fish market in the locality mostly operates in the morning only from 4:00 AM to 12.00 AM daily. It was quite difficult to make a distinction between wild caught and cultured fish. No wholesale market was found in the province. Normally, the fish sellers in the markets purchased fishes from local farmers and culturists. The farmers catch fish on the rivers, reservoirs or in the wet fields at night and bring them to the markets for fish sellers in the early morning. The ways that farmers trapped fished on rivers or the fields were quite diverse and as described as Nguyen et al, 2007. For culturists, the fish sellers have to come to their farms to buy. Wild fish production was limited and unstable. The majority of fishes sold in the local markets were from small-scale ponds owned by local households. In some cases, the fish sellers can obtain fish for sale from local middlemen, who collected fish from farmers in locality or from HCMC and Mekong Delta some days before.

Most fishes were consumed by local households. The other channels could come to local restaurants, but this pattern was not typical since it could change over time and season. There was a little bit amount going as livestock feeds, which was considered as “really low-value” fishes or could not be considered as human foods.

To help better understand the business of a fish seller in a regular local market, the following simple economic assessment based on a typical seller in a day. It was assumed that about 25 kg fish could be sold in a day on an average basis.

Table 1: An economic assessment for a fish seller in a day.

Items	VND		
Expenditure			
Water and electricity	7,000		
Seat reservation	10,000		
Tax 180,000/month	6,000		
Hygienic fee	500		
Administration fee	12,000		
Total dues	35,500		
Total amount of fish sold a day (kg)		25	
Earnings from each kg of fish sold		5,000	
Total revenue (5,000 x 25)		125,000	
Profit per day (125,000 – 35,500)			89,500
Profit per month (30 x 89,500)			2,685,000

Table 2: Average expenses in a typical family with 4 members in a month.

Expense items	Households in city		Households in districts	
	VND	%	VND	%
Total expenses for food	2,000,000	100	1,500,000	100
Spent on marine fishes	550,000	27.5	400,000	27
Spent on freshwater fishes	350,000	17.5	200,000	13
Meat and others	750,000	55	900,000	60

Household consumption

In general, most local people prefer eating marine fishes to freshwater fishes because of many reasons. This is a coastal province, so there are a lot of marine fishes. Selling prices of marine fishes are often cheaper than freshwater ones. Their flesh is rather delicious. Freshwater fishes are not only consumed daily by families but also in restaurant since Nha Trang is a tourist city. Most of the fishes sold are farmed fish rather than wild caught, originating from local culturist and the Mekong Delta (for Tra catfish). Local families usually eat 2-3 times with 2 kg of freshwater fish in a week at a cost of 50,000-70,000 VND per week. Basically, local people buy fishes and cook daily rather than keep frozen. The consumers found it difficult to differentiate farmed

and wild caught fish. Local consumers were awareness of the health benefits of eating fish as others around the world (Ardjosoediro, 2008). They are, however, concerned about using antibiotic and toxic chemical in prevention and treatment of diseased fish during farming period.

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Beside the major species available in all markets, there were diverse commodities available in local markets, such as snail, mussels, crabs and frogs. Availability of such items fluctuates between markets in the locality.

Current practices of rice field eel *Monopterus albus* (Zuiew, 1793) culture in Viet Nam

Khanh, N.H., Ngan, H.T.B.

Research Institute for Aquaculture No.3, Vietnam

Rice field eel *Monopterus albus* is native to sub-tropical and tropical Asia, and is widely distributed in many countries from India to China, Japan, Malaysia, Indonesia, Bangladesh (Froese & Pauly, 2008; Guan et al., 1996), Thailand (Thongrod et al., 2004) and Vietnam. The fish, which is considered a nutritious and tasty species, is also a valued remedy in oriental medicine (Nguyen Van Thong, 2008). Raising eels is presumed a low-cost enterprise to farmers. Raising this species is easy to do and achieves more profit than some other small size fish-culture activities (Lu et al., 2005; IIRR et al., 2001). In recent years, the marketable rice field eel culture has increased strongly in some areas of Vietnam with the farm gate price of 85,000-100,000 VND per kg eel at 200g per individuals and over, seasonally. They are consumed mainly by domestic market and some by export.

Because of the high eel seed demand, many government and private sector people have studied it. On our June 2009 visit to An Giang Fishery Hatchery Center, a project on reproduction of rice field eel was being undertaken there. About 500 fingerlings produced initially but the rearing of them was not effective. An earlier study of Can Tho University on biological, feeding habitat and natural reproduction characteristics of rice field eel conducted. The ambition of this was to find out spawning season and other targets of eel's reproduction (Nguyen Anh Tuan et al., 2007; Ly Van Khanh et al, 2008). Besides, they also examined to induce spawning of the rice field eel (*Monopterus albus*) by injection of HCG (1,000; 1,500 and 2,000 UI kg^{-1} fish) and LH-RHa (50, 100 and 150 µg kg^{-1} fish). Results were that eels in all treatments spawned but in different ratios. The eels injected with 150 µg LH-RHa kg^{-1} fish had the highest spawning rate, 75%. The highest fertilisation rate was 86% for the eel injected with HCG of 2,000 UI kg^{-1} fish (Do Thi Thanh Huong et al. 2008). However, the commercial seed production of *M. albus* has been unsuccessful.

During 2008-2009, we also carried out a study on small-scale seed production of *M. albus*, which was financed by the Sustainable Development of Aquaculture Component (SUDA). Because it can breed in captivity without using any chemical stimuli, natural-reproduction (eel are reproduced naturally in raising tank) is considered the most optimum solution (IIRR et al., 2001).

Reproductive biological characteristics

We have studied the reproductive biology of the rice field eel for establishing technology for seed production. We found that showed that:

Rice field eel nest.

- The gonadal development of the fish includes six stages and is not uniform. There are eggs at the different stages in the same ovary.
- The spawning season of rice field eel mainly occurs in March and September with two spawnings every year.
- The average absolute fecundity of *M. albus* was 589 eggs per female (range from 236 to 1,328 eggs female) and relative fecundity was 9.9 eggs/g per female (range from 3.9 to 18.5 eggs/g per female).
- The real fecundity ranged from 38 to 625 eggs female, average 295 eggs per female.

Eggs after 3-3.5 day of incubation.

- Ripe eggs are non-adhesive and spherical with a diameter of 3 - 4 mm. They swell in water. At a a temperature of 28-31°C, the fertilised eggs hatch after 140 hours of incubation with average hatching rate of 92.8%.

- Eggs began to hatch after 5-6 days of incubation and yolk-sac was completely absorbed by the larva 7-9 days after that. The hatching rate varied from 84% to 97.5%.

Maturation culture

All broodstock *M. albus* used in our experiments were obtained from healthy cultured eel. Mean body weight of males was above 250g per animal or above 50 cm in total length (TL). Mean body weight of female range 40-100g per animal or 30-40 cm TL (to make sure that these eels haven't reversed sex yet). We found that the most suitable density for mature culture was 10 animals m^{-2} with male to female ratio of 1:2. For sexual re-maturation the most suitable ration was 4 animals m^{-2} at a male to female ratio of 1:1. Culture of eel broodstock for maturation included two steps, fattening period and maturation culture:

- **Period 1** (the fattening period): the fishes was fed adequately at about 3-5% of body weight once in the late afternoon daily. This period lasted about 1.5 months.

- **Period 2** (maturation culture): when testing the eels found that they had stage 3 ovaries, maturation culture started. The quantity of food needs to be decreased to about 60-70% of period 1. Before transferring the fishes to breeding tanks, feeding should be stopped five days in advance.

Natural propagation

After two months of maturation culture, broodstock were transferred to breeding tanks. We have carried out many experiments with different densities that were 2, 4, 8, 10, 20 and 30 animals m^{-2} with three-replicates per treatment. The experimental unit was two 7 m^2 nylon tanks. Male and female ratio was 1:1 and 1:2. During this period, they were fed once in the late afternoon every two days by home-made feed (including trash-fish- 70% combined with commercial feed,

Floating feeding tray.

Freshly hatched eel.

Cargill 30% P- 30%), at about 2-3% of body weight. Water exchange regime was 2-3 times per month in the morning, with 100% exchange of fresh water.

Result of these studies suggested that the most effective density for natural propagation was 4 animals m^{-2} at the male and female ratio of 1:1. The average spawning rate was 61.9% with 752 seeds kg per female.

Fry rearing

Fingerlings were collected and moved from breeding tank to rearing tank by net racket. The process of fry rearing included two periods:

- Period 1 (from newly collected fingerlings to 2 g body weight): The suitable stocking density was 100 individuals m^{-2}. The average survival rate was 92%. Over 3 months of rearing, seed eels obtained 157.6 mm in length and 2.04 g individuals in weight.

- Period 2 (from 2 g to 20 g per individual): The suitable stocking density was 50 individual m^{-2}. The average survival rate was 71%. The daily weight gain of *M. albus* was 0.15 g per day.

After seven to eight months of rearing, the eels obtained a size of 50 individuals per kg. They can be fully harvested (drain water and and remove materials as hiding place from the tank) or partially harvested depending on demand. The seeds must be collected quietly, avoiding scratches for good seed quality.

Grow-out practices of farmers

We had two trips to six provinces of the Mekong Delta in each year of 2008 and 2009 financed by SUDA for surveying eel-farming practices. We found that the total number of households raising eel in An Giang, Can Tho, Dong Thap and Hau Giang province was above 1,600 with an area of 10 ha and a production of about 600 tonnes per year. Among them, Chau Thanh district of An Giang province and Vinh Thanh

Grow-out tank.

district of Can Tho city had 1,000 households with an average production of 348 tonnes per year and 400 households had an average production of 192 tonnes per year, respectively.

Rice field eels can be raised all year round, with main stocking duration from July to February of the following year in the lunar calendar. In the Mekong Delta, the stocking crop is relative to the time of occurrence of natural seed of *M. albus* in the flood season. After harvesting cultured eels they are sorted into three categories: fishes at 200g and over which fetch high price, fishes from 100 g to below 200g which fetch lower price, and fishes below 100g that are restocked about three or four months to gain marketable size (the secondary crop). The rice field eel is stocked at many different densities by various farmers. In general, the most popular density is from 1-2 kg eels m^{-2} with 54% of farmers. And the production achieved is from 5-8 kg m^{-2}.

The eel is fed home-made feed with various materials depended on the season and locality. In An Giang province, golden snail combined with commercial feed for fish was used to feed them. First, the golden snail is boiled to take the snail meat out of the shell. The commercial feed is softened by a little water. After that, the ingredients are fixed together with an addition of digestive enzyme, vitamin C and some adhesive. This mixture is finely ground and rolled into balls before putting on feeding trays. The ratio of golden nail meat and commercial feed was 8-10:1. In Can Tho province, the way of making M. albus feed is similar to An Giang farmers. However, golden snail meat was replaced by mussel. Meat of mussel and commercial feed ratio ranged from 4-6:1. The average feed conversion ratio (FCR) was 6.1, with min of 4.5 and maximum of 11 among farmers surveyed (n=35). Disease often occurs in cultured *M. albus*. In the early time of stocking, the mortality of the fish is rather high ranging from 20-100% depending on seed quality and the farmer's technique. After 5-6 months of culture, the eels attain about 200g per animal weight and harvesting starts. The main method is to drain off water and remove materials as hiding place from the tank, then catch the fish. They are transported to the market live. The mean production cost and profit for each household were 14 million VND and 8.7 million VND, respectively. 86.3% of the surveyed farmers showed that they had profit and 52.8% of the total got a profit of more than 5 million VND per household. Thus, rice field eel is an aquaculture species that can bring good income to farmers with low risk.

Grow-out trial results

From 2008 to 2009, we conducted some experiments raising rice field eel at different densities (0.5, 1, 2 and 3 kg m^{-2}) and feeds (fresh feed, home-made feed and pellet feed).

The results showed that stocking density affected growth performance and survival rate of *M. albus* raised in nylon tanks with layers.

The daily weight gain of M. albus at densities of 0.5 kg m^{-2} (1.00 g day^{-1}) and 1 kg m^{-2} (0.99 g day^{-1}) were significantly higher than that of the other two treatments (0.86 and 0.68 g day^{-1} for 2 and 3 kg m^{-2} density, respectively) ($P<0.05$).

The average survival rate was 92.1, 91.5, 73.1% and 73.5% for the fishes stocked at densities of 0.5, 1, 2 and 3 kg m^{-2}, respectively.

The daily weight gain of the eels fed with pellet feed was significantly lower than the ones fed with home-made and fresh feed (0.78, 1.06 and 1.08 g day^{-1}, respectively). No significant survival rate differences were found among the feed treatments.

This study recommended that stocking densities ≤ 1 kg m^{-2} and using fresh or home-made feed are suitable for cultured *M. albus* in nylon tanks.

Discussion

Although rice field eel isn't a new farming species and is popularly being raised in Mekong River Delta now, there are very few documents published for it.

In captivity, competition for feed and hiding places between eels is strong because they are carnivorous. It is recommended to use a density of 1 kg m^{-2} for commercial practices in nylon tank. As for feed, the eels are able to eat fresh feed, home-made feed or pelleted feed. In the treatment using pelleted feed, food conversation ratio of 3.68 obtained was worse than the food conversation ratio of 1.29 reported by Qin et al (2001) for rice field eel cultured by commercial feed. Accordingly, if the FCR value decreases similar to that of Qin, farming eel will result high economic efficiency. High FCR for pellet feed might be due to inadequate nutritional value of the diet or bad feed management. According to Liu et al (2000), the best diet for eel growth contained 35.7% protein, 3-4% lipid, 23-24% glucose and the ratio of dietary protein to energy (E/P) of 31.6 to 38.9. On the other hand, using pelleted feed in mixing with home-made feed isn't an optimal method, although it is really convenient and being applied widely by farmers. Therefore, study of feed formulas to mix feed from locally available and crude materials (rice bran, coconut cake, golden snail, trash fish, mussels) is necessary for reducing the cost of production. Furthermore, pelleted feed for rice field eel needs to be produced for development of farming the species on a large scale.

Rice field eel after the harvest.

Beside the seed production of rice field eel, we should utilise properly abundant natural seed sources. Also, there is a need to assess the status of natural eel resources and improve fishing equipment to improve the quality of the seed.

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Table 1. Growth performances of *Monopterus albus* cultured at different stocking densities in experimental nylon tanks for 6 months. Data are mean values. Values with different superscripts in the same row are significantly different ($P<0.05$).

Parameter	0.5 kg/m^2	1 kg/m^2	2 kg/m^2	3 kg/m^2
Initial body weight (g)	25.1a	25.3a	25.1a	25.1a
Final body weight (g)	197.5a	195.8a	172.8b	143.2c
Daily weight gain (g day^{-1})	1.00a	0.99a	0.86b	0.68c
Specific growth rate (% day^{-1})	1.19a	1.18a	1.12a	1.01b
Survival rate (%)	92.1a	91.5a	73.1b	73.5b
Food conversion ratio	5.1a	5.2a	7.2b	6.2ab
Average yield (kg m^{-2} $crop^{-1}$)	3.8a	7.9b	9.9c	11.1c

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Self help group makes fisherwomen self-reliant: A story of success

Vimala, D.D., Ravisankar, T., Kumaran, M., Rengarajan, S. and Krishnan, M.

Central Institute of Brackishwater Aquaculture (ICAR)
R. A. Puram, Chennai – 600 028,Tamil Nadu, India

In India, women constitute about one third of the labour force. In the total population of 5.4 million active fishers, 3.8 million are fishermen and 1.6 million are fisherwomen. Fish marketing and processing are two major activities in which fisher women contribute significantly. The involvement of women in these activities generates supplemental income to support their families. 'Self help groups' are small, economically homogenous collectives of rural poor, formed voluntarily to save and mutually agree to contribute to a common fund to be lent to its members as per group decision (Jayaraman, 2008). This article provides some examples of how self help groups have improved the economic prosperity, saving and banking habits of their members and addressed other constraints spanning gender dimensions, infrastructural facilities and high interest rates.

We conducted a case study with several groups using a check list consisting of general profile, marketing activities, technical strength, financial strength and constraints faced by the collectives as primary data.

Marketing fish to Taj

Procurement at the landing centre.

In the present study, about 67 % fisherwomen belonged to the age group 21-35 years which is the most productive period. About 53% of the respondents had secondary education followed by primary (20%) and College (20%). About 93%were married. Distribution of faith showed that majority of them (about 87%) were Hindus and about 13% were Christian. Out of the group members 26 % were engaged in fish retailing and others engaged in alternative economic activities such as fruit sales and other petty vegetable trade. All households had electricity, LPG, communication and sanitation facilities. Income ranged from Rs 1,000 / month to Rs 3,000 / month. The contribution of income varied from 25 to 50%. In some cases, women's income was better and more stable than men's income and it supported the family. Their working experience ranged from 3-6 years. Out of 15, none of them had attended any training programme.

Activities of economic empowerment through fish marketing

The Thenkumari Self Help Group was organized in 2003 with 15 members. They were assisted by the Magalir Membattuthittam (Women's Development Programme) of Government of Tamil Nadu and CII (Confederation of Indian Industry). This group received Rs. 10,000/- from one of the projects and availed loans of Rs.7,000 from the Indian bank, Chennai, to be used as capital for fish marketing.

Their day started by 4 a.m. in the morning. The Kasimedu Village landing and auction centre is located in north Chennai and is easily accessible by regular public transport. This group is engaged in fish marketing for 4 to 14 hours a day and 5 to 7 days a week. In addition, the women procure fish from auction and indulge in group purchase at Chindadiripet market. The mode of payment to the auctioneers is by cash and at Chindadiripet market is on loan basis and sometimes by cash. Labourers are engaged for cleaning and dressing the fish and storing it in insulated ice boxes. Then the insulated ice boxes are transported mainly by auto rickshaw to the city. Usually, the women try to sell the fish while it is still fresh. Only the leftovers are dried. The species purchased from the Kasimedu market include Seer fish (*Scomberomorus guttatus*), Parai (*Carangoides chrydophrys*) White pomfret (*Parastromateusargenteus*) , Black pomfret (*Parastromateus niger*), Indian whiting and Anchovy (*Stolehorus waitei*). The quantity purchased per day varied widely across the day due to various factors.

Technical strength

Thenkumari group undertook a pilot project to supply fresh seafood to a corporate customer (Taj Coramandal) at Chennai on contract basis. Taj made it clear to the Thenkumari group that it was looking at the supply arrangement as a business venture and not as a charity programme. Taj emphasized the need for high quality products and time delivery. The fisherwomen in Thenkumari were then trained on issues such as quality, hygiene, delivery and cost management. The fish supplied by Thenkumari always passed stringent

quality parameters at Taj. The fresh and packed produce were frequently inspected for microbial content. They started supplying 50kg/day initially for three days in a week and now the quantity supplied by them has increased to 1,200kg/month. Taj management gave the best vendor award for the year 2008 to the Thenkumari Magalir Self Help Group. Other key customers of this group are Taj Connemara, Fishermen's Cove and MGM. This project has been a win-win situation for both hotel and self help groups. The hotel gets quality products directly from the self help groups which benefit from sustained business. Initially cash payments were made. Now all the payments are made by a cheque and each woman is proud signatory to her own bank account. This business, which started out as corporate social responsibility initiative between a five star hotel and self help groups, is turning out to be a profitable business model.

Financial strength

The Indian Bank offered short term loan of Rs 70,000 for a period of 10 months at 8.75% interest, followed by Rs 150,000 at 11% for a period of 20 months in 2006 and Rs 300,000 at 13.25% for a period of 20 months in 2007. The members have shared equally the amount of loan (Rs 300,000/-) drawn from the bank. The repayment records of the members in general were observed to be exemplary. Lending institutions such as Indian Bank have confirmed that the repayment record of the self help groups has been almost one hundred percent and Thenkumari self help group was awarded a commendation by NABARD for timely repayments. Concurrent loans from the same branch were encouraged and increased from Rs 70,000 to Rs 300,000. Jayaraman (2000 and 2002) found the fisherwomen self help groups performing well in availing microcredit, utilising it and repaying it in time.

Cleaning is performed by labourers.

Packing.

Constraints faced by the self help group

Gender dimensions

Members were highly undervalued by their own community people and often eyed with suspicion since they start their day by 4 A.M in the morning and continued to work 4 to 14 hours per day. Even in the market place, men treat the women as second class citizens. The impact of market on the fisherwomen community, the injustices faced by them in the markets and various forms of denial of rights were noticed.

Infrastructure facilities

High on the women's priority list was the need for mini trucks than the private autos for transporting fish to required places. Private transport hiring rates are high and sometimes drivers reject transporting fish baskets unless the fish is well packed and free of odour. In such cases, the self help group fish traders find it difficult to reach markets in time to due to stiff competition.

Presently they use thermocool boxes are used costing Rs 240/- to transport the fishes from Kasimedu to the star hotel. The capacity of the thermocole box is 5 Kg (fish & ice together). Self help group members reported that the boxes are susceptible to breakage and the fishes get easily damaged and contaminated and the fishes might be rejected by the buyers. In order to avoid the loss due to non availability of insulated boxes, it is very

important to determine the additional infrastructure required for self help groups to develop common services such as transport and infrastructure. It was therefore concluded that without subsidies, a mini truck would give self help group no economic advantages.

Additional Income

Members expressed their desire to start modern fish retail stalls similar to Spencer and Reliance in upmarket areas for income generation, so that their leisure time could be wisely invested to earn additional income which could improve their standard of living and socio economic status in society.

Usurious interest rates of informal creditors (speed interest)

Exorbitant rates of interest have long been charged by non-institutional credit agencies (Kurien, 1978). Some money lenders collect the rate of interest not in terms of percentage per annum but in terms of Rs100/- 120/- for every Rs. 1000/- per day. This transaction is called “speed interest”.

Conclusion

Thenkumari Self Help Group efforts have played a positive role in helping the fisher folk in their socio-economic development, emancipation and empowerment. Their technical knowledge has improved and their interpersonal and financial management skills have been sharpened. The entrepreneurship helped them to express their individuality and also increased self confidence among members.
As Muhammad Yunus, founder of Grameen Banks of Bangladesh succinctly points out, “women have plans for themselves, for their children, for their home and the meals. They have a vision. A man wants to enjoy himself” (Yunus, 2008).

Acknowledgement

The authors are grateful to Dr A.G.Ponniah, Director, Central Institute of Brackishwater Aquaculture, Chennai 600 028, for his critical suggestions and encouragement.

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Loading the fish for transport.

Quality and microbial checks by Taj.

Small indigenous freshwater fish species of India: Significance, conservation and utilisation

Sarkar, U.K., Lakra, W.S.

National Bureau of Fish Genetic Resources, Canal Ring Road, P.O. Dilkusha, Lucknow -226002, U.P, Email: usarkar1@rediffmail.com

In India 2,319 species of finfish have been recorded as per the database developed by NBFGR of which 838 from freshwater, 113 brakishwater and 1,368 from marine environment. Small indigenous freshwater fish species (SIF) are defined as fishes which grow to the size of 25-30 cm in mature or adult stage of their life cycle. They inhabit in rivers and tributaries, floodplains, ponds and tanks, lakes, beels, streams, lowland areas, wetlands and paddy fields. Although rural population depend highly on indigenous species of fish for nutrition in many parts of India, very little attention has been paid on their role in aquaculture enhancement, nutrition, processing, biology, captive breeding, livelihood security and conservation needs. Consequently, many small indigenous fishes have become threatened and endangered due to pollution, over exploitation coupled with habitat destruction, water abstraction, siltation, channel fragmentation, diseases and introduction of exotic varieties. In order to achieve sustainable utilisation, appropriate planning for conservation and management strategies are of utmost importance. This article addresses the untapped potential of the small indigenous fishes of India and challenging issues for sustaining biodiversity, management, aquaculture, nutrition and livelihood security and highlights the future priorities.

Diversity of SIF's, status and importance

In India, out of 765 native freshwater fish species documented by NBFGR, about 450 may be categorized as small indigenous freshwater fish species. The maximum diversity of the SIF's has been recorded from the North East region followed by Western Ghat and Central India. Based on the assessment of NBFGR, of about 450 SIF's in India about 23% (104 species) are highly important as food and other local significance and also play a significant role in aquarium trade and in providing local livelihood security. Again, of the 104 species, about 62 species have been categorized as food fish while 42 species as ornamental value.

Small indigenous fishes traditionally occupy an unenviable position and an inseparable link in the life, livelihood, health and the general well being of the rural mass, especially the poor. It has been reported that some species such as mola (*A. mola*), dhela (*O. cotio cotio*), darkina (*E. danricus*) and kaski (*C. soborna*) contain high amount of vitamin A and other micronutrients and minerals (Thilsted et al., 1997). Studies in Bangladesh and Cambodia showed that small fish species make up 50- 80% of all fish eaten during the production season. Two species from the genus *Esomus* (*E. danricus*, *E. longimanus*) are rich in high iron content (Thilsted 2010). Review of literature shows that research efforts on the information on the status of small indigenous fishes and potential utilisation in India is very limited. Small scale aquaculture of *A. mola*, *Puntius sophore*, *Osteobrama cotio*, *Cirrihinus reba*, *Labeo bata*, *Gudusia chapra* alongwith Indian major carps have been reported (Ayyappan and Jena 2003, Roos et al 2003, Jena et al., 2008). Successful captive breeding of several SIF's have been reported under National Agricultural Technology Project (NATP) -NBFGR projects (Singh and Kapoor 2004) and also by several workers (Sarkar et al., 2009). Recent trend on pattern, and abundance of SIF's of the Ganga basin and associated protected areas have been studied by NBFGR (unpublished data) and the results shows that the minnows (*Chela* sp., *Rasbora* sp. *Amblypharyngodon* sp., and *Salmophasia* sp.), barbs (*Puntius* sp.), scheilbids (*A. coila* and *Eutropichthys* sp.), clupeids (*Goniolosa manmina* and *G. chapra*) and bagrids (*H. menoda* and *Mystus* sp.) were the dominating groups of fishes (Figure 1).

Potential cultivable indigenous small fishes

Among SIF's, many species are cultivable with high demand, cultivable and can be introduced as a candidate species in freshwater aquaculture system. These are *Amblypharyngdon mola*, *A. microlepis*, *Notopterus notopterus*, *Puntius sarana*, *Labeo bata*, *Puntius ticto*, *Cirrhinus reba*, *Salmostoma bacaila*, *Nandus nandus*, *Anabas testudineus*, *Esomus danricus*, *Puntius chola*, *P. sarana*, *Glossogobius giuris*, Danio devario, and Chanda nama etc. Other potential species for aquaculture diversification includes *Labeo gonius*, *L. bata*, *Labeo boggut*, *L. dussumeri*, *L. fimbriatus*, *Barbodes carnaticus*, *Puntius pulchellus*, *P. kolus*, *P. sarana* and *Cirrhinus cirrhosa*. Some of these species are being cultured at minimum scale, mostly based on wild seed collection. The air-breathing and non air- breading species, *Channa marulius*, *C. striatus*, *C. punctatus*, *C. gachua*, *Channa bleheri* , *C. aurantimaculatata* ,*C. stewartii* have not been taken up for the aquaculture at large scale. With the technology available for seed production and culture of air breading (*Clarius batrachus*, *Heteropnustes fossilis*), non air breading cat fish (*Mystus seenghala, Mystus aor*, *Horabagrus brachysoma*, *Notopterus notopterus*, *Ompok pabda*, *O. pabo*, *Ailia coila*), farming needed to be popularized and expanded. Research and policy support for domestication of potential cultivable food and ornamental indigenous fishes as well as value added products from aquatic organisms is also required.

Threats

Freshwater aquatic environments are experiencing serious threats to both biodiversity and ecosystem stability and many strategies and priorities have been proposed to solve this crisis. The major threats to the SIF's are as: loss of natural

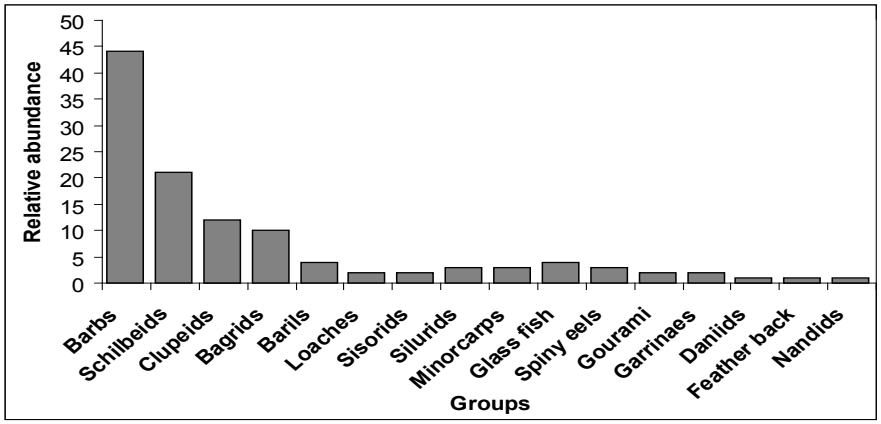
habitats, use of small mesh sized gears, dewatering, use of insecticides and pesticides, industrial and domestic pollution, siltation of water bodies, invasion of exotics and disease.

Conservation and management

Knowledge of indigenous fish species and communities reveal crucial facts necessary to the arrangement of ecosystem and habitats as well as to the identification of important genomes and genes. Out of 104 important SIF's documented by NBFGR, Lucknow, 6 species have been listed under endangered and 16 species under vulnerable category. However, Management of small indigenous fish is still a virgin area of enormous importance as of now and therefore requires a lot of dedicated approach to thrash out problems and issues relating to their promotion and conservation. The conservation of SIF is essential to maintain ecological/nutritional and socio-economic equilibrium. The NBFGR has taken considerable efforts under various research programmes. The following suggestions and strategies may be adopted for the conservation and enhancement of SIF's;

- More research and extension work on low cost small indigenous species culture, diversification, up-scaling of breeding and its role in nutrition and livelihood at different regional scale to be strengthened including its auto stocking possibility to hatchery production.
- Environmental flow requirement of all rivers systems to be worked out and the enact policy that ensure minimum environmental flow.
- It is essential to ban indiscriminate and destructive fishing practices to protect the young and juvenile fish. Catching should also be regulated to conserve the brood stocks of SIF and other fish species.
- Urgent need to develop repositories of genetic resources including registered germplasm accessions, accessions of genetic stocks discovered/ varieties discovered.
- Existing laws and regulations should be enforced properly to protect fish from destructive fishing.

Figure 1 . Pattern of relative abundance of SIF groups in Ganga basin (2007-2009).



- Conservation and enhancement of existing gene pools of native fish and SIF's in floodplains, natural depressions, rivers and other related water bodies through establishment and maintenance of fish sanctuaries on fishing areas.
- Public awareness of the necessity of conservation of indigenous fish diversity and wise management of habitats needs to be created through mass media.
- Strengthen studies on nutrient analysis, processing and therapeutic properties of SIF's. Economic valuation provide a means for measuring and comparing the various benefits of fisheries and aquatic resource and their ecosystem and can be a powerful tool to aid and improve their wise use and management.
- Policy document and develop Institutional mechanisms to promote culture, consumption and conservation of SIF's.
- Avoidance of introduction of exotic species unless completely justifies and supported by fool proof environment impact assessment.

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NACA Newsletter

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

ISSN 0115-8503

Volume XXV, No. 3
July-September 2010

Vietnamese catfish – better management practices update

A number of farmers have volunteered to trial the draft better management practices (BMPs) developed by the catfish BMP project, for the purpose of evaluation and demonstration. The draft BMPs were developed following extensive surveys of industry practice and stakeholder meetings convened by the project team in October 2009 in Cao Lanh City, Dong Thap Province (Chaired by Provincial Agricultural Office and the Director RIA 2, Dr. Nguyen Van Hao), and in Can Tho City (Chaired by Professor Nguyen Than Phuong).

Eleven 'BMP demonstration farms' have been setup in partnership between farmers and the project team and are about three months into the six-month production cycle. These include seven grow out farms (three in Can Tho, one each in An Giang, Hau Giang, Vinh Long and Dong Thap), three nurseries (two in Dong Thap, one in Can Tho) and on hatchery in An Giang.

In addition, extension material on BMPs and the advantages of a cooperative approach to farm management amongst locally clustered farms have been prepared and distributed. Overall there has been a very good response from farmers with clusters being organised in certain communities. An evaluation of the effectiveness of the BMPs as part of the demonstration farm trials is being undertaken by the project team in collaboration with the Department of Resource Management and Geography, Melbourne University, Australia. The evaluation will focus on Can Tho and An Giang provinces, with specific emphasis on economic, environmental and social impacts of BMP implementation as part of the demonstration trials.

In the mean time, the findings from the project's field studies and associated surveys which led to the formulation of the draft BMPs are being published in peer reviewed scientific journals, thereby subjecting the collated information on the catfish farming sector in Vietnam to the scrutiny of the scientific world. It is expected that these publications will have a bearing on the subsequent development of certification standards for the sector by a wide range of independent organisations, and thereby enabling a more pragmatic approach to be adopted. The publications generated by the project to date are:

- De Silva, S.S., Ingram, B.A., Phuong T. Nguyen, Bui Tam T., Gooley, G.J., Turchini, G.M., 2010. Estimation of nitrogen and phosphorus in effluent from the striped catfish farming sector in the Mekong Delta, Vietnam. Ambio.

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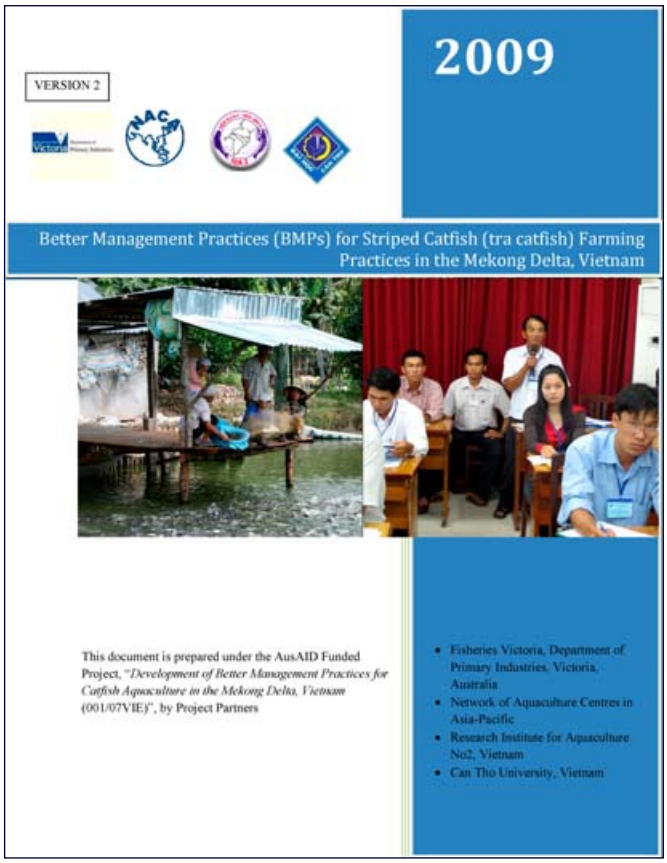


- Phan Lam T., Bui Tam M., Nguyen Thuy T.T., Gooley Geoff J., Ingram Brett A., Nguyen Hao V., Nguyen Phuong T. De Silva Sena S., 2009. Current status of farming practices of striped catfish, *Pangasianodon hypophthalmus* in the Mekong Delta, Vietnam. Aquaculture, 296: 227-236.

The BMP project is also linked to a study on climate change impacts on the catfish sector in the Mekong Delta. In this instance, the network of farmers that have been involved in the initial BMP surveys and at various stakeholder meetings are also cooperating with the climate change project to assess and evaluate the perception of climate change and potential adaptations to mitigate impacts. In addition, an attempt is being made using available models to determine the extent of catfish farming activities that are likely to be impacted from salinity intrusion resulting from expected sea level rise.

For more information, please visit the catfish BMP project webpage, at:

http://www.enaca.org/modules/inlandprojects/index.php?content_id=1.

Is this the perfect prawn?

After 10 years of careful breeding and research, scientists have developed what could be the world's most perfect prawn.

CSIRO scientists and the prawn industry have bred an improved black tiger prawn which is producing record yields in aquaculture farms and winning awards.

So good are these prawns that they have won five gold medals at the Sydney Royal Easter Show in the past two years, including 'Champion of Show', the highest award possible.

The scientists from CSIRO's Food Futures Flagship have used DNA technology to ensure the breeding program captures the very best black tiger prawn stocks that nature can provide and boost the performance of stocks each breeding season.

With about 50 per cent of all prawns sold in Australia currently imported from countries such as China and Vietnam, developing an Australian prawn that breeds in captivity and is completely sustainable is a major gain for both the local prawn industry and consumers wanting to buy Australian seafood.

After eight generations of selective breeding, one of CSIRO's industry partners, Gold Coast

Marine Aquaculture, has this year achieved average yields of 17.5 tonnes per hectare – more than double the industry's average production. Several ponds produced 20 tonnes per hectare and one produced a world record yield of 24.2 tonnes per hectare.

The Australian average industry productivity for farmed prawns is five tonnes per hectare. The new prawns produced an average of 12.8 tonnes per hectare in 2009.

Leader of the CSIRO Food Futures Flagship prawn research project, Dr Nigel Preston, said this specially bred prawn has the potential to revolutionise the local and international prawn farming industry.

"The new prawn's yield has exceeded all our expectations. The average industry productivity for farmed prawns is only five tonnes per hectare, so this year's average yield of 17.5 tonnes per hectare is a major leap forward," Dr Preston said. "These huge yields can be replicated year after year which means consistent supply of a reliable and high quality product - all vital factors for the long-term growth and prosperity of the Australian prawn farming industry."

If the rest of the Australian black tiger prawn industry adopted the new breeding technology Australia's production could increase from 5,000 tonnes to 12,500 tonnes, adding $120 million annually to the value of the industry by 2020.

The general manager of Gold Coast Marine Aquaculture (GCMA), Mr Nick Moore, said the partnership with CSIRO had assisted GCMA to breed successive generations of prawns in captivity, transforming their business from one plagued with seasonal fluctuations into a reliable primary producer with consistent and predictable output.

"Thanks to outstanding work by the staff here, aided by close collaboration with our partners at CSIRO, we have just finished a prawn breeding season that can only be described as staggering," Mr Moore said.

"Not only have we achieved national and international yield records with no reduction in quality or taste, these prawns are grown in a specially designed, environmentally sustainable

The new prawn is producing record farm yields which are leading to increased supplies of top quality, sustainably produced seafood

production system. This production system and the new breeds have produced a perfect prawn with beautifully textured meat, rich colour, robust size and a great taste.

"The awards (Sydney Royal Easter Show) are professionally judged on many criteria including size, colour, taste and texture, so the results speak for themselves."

Director of CSIRO's Food Futures Flagship, Dr Bruce Lee, said the results were a phenomenal achievement for the industry and for CSIRO.

"Our main goal is to add real value to the profitability of the Australian agrifood industry," Dr

Lee said. "With Australia's population predicted to reach 35 million by 2050, the challenge is to help Australia secure its own food supply, contribute to the food supply of the region and be competitive in global food markets. This result is just the tip of the iceberg for us and represents a major opportunity for the growth of sustainable marine aquaculture in Australia and with global partners.

"Of particular significance to Australia is that marine aquaculture is a drought-proof industry and there's huge potential for the environmentally and economically sustainable expansion of pond-based aquaculture farms right around the Australian coastline."

Until recently, Black Tiger prawns found in oceans and estuaries could not be bred in captivity, so prawn farmers had to rely entirely on trawlers to catch wild prawn parents to stock farm ponds with their progeny each season.

The project received critical funding in 2008 when the Queensland Government provided the CSIRO with a $500,000 Smart State Innovation Projects Fund grant to advance their research. This grant enabled CSIRO to expand its work with Gold Coast Marine Aquaculture to Australian Prawn Farms (near Sarina) and Pacific Reef Fisheries (near Ayr).

Queensland Treasurer and Minister for Employment, Economic Development and Innovation Andrew Fraser said the Innovation Projects Fund was part of the Queensland Government's $300 million Smart State Futures funding program.

Dr Nigel Preston, CSIRO.

"Queensland's prawn farmers produce an average of 3,200 tonnes of farmed prawns a year, worth about $50 million to the State's economy. With increasing demand for produce, especially from South-East Asia, our capacity to meet that demand has, until now, been limited," he said.

"Improving the quality of produce and increasing farm yields will give Australian prawn farmers a real market advantage. It will certainly boost Queensland's aquaculture industry and pay major economic dividends to the State."

Photo credit: All images courtesy of CSIRO Australia.

Specially designed tanks at Gold Coast Marine Aquaculture that house black tiger prawn breeding stock.

Fish Oil Replacement and Alternative Lipid Sources in Aquaculture Feeds

Edited by Giovanni M. Turchini, Wing-Keong Ng and Douglas R. Tocher

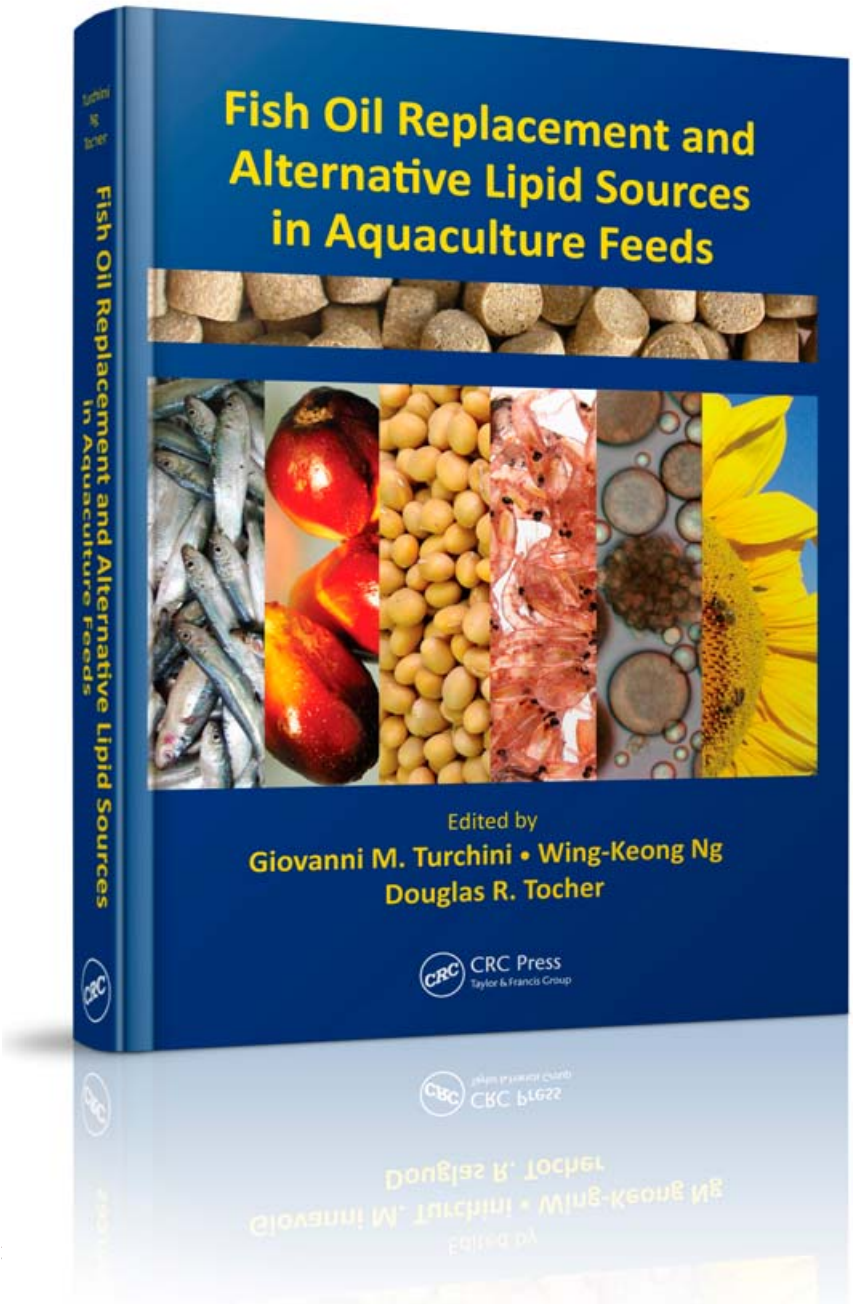
The First and Only Book Specifically Addressing This Issue

Experts are predicting that demand for marinefish oil will soon outstrip supply, creating extreme urgency within the global aquafeed industry tofind viable alternatives. Fish Oil Replacement and Alternative Lipid Sources in Aquaculture Feeds is the first comprehensive review of this multifaceted, complex issue. It also addresses the crucial questions about whether or not the aquaculture industry will be able to meet increasing worldwide demand for fisheries products.

Written by Leading Scientists and Industry Authorities

With contributions from more than 30 international experts, the book provides a global perspective on the production, rationale, and use of fish oils, vegetable oils, and animal fats in relation to the aquaculture and aquafeed industries. After a detailed discussion on alternative lipid sources, the book discusses groundbreaking research on the use of these lipid sources as fish oil substitutes, as well as their potential advantages and challenges for use in aquafeeds.

Rounding out its solid coverage, the book then explores the important physiological effects of various lipid sources and their components on growth, lipid metabolism, health, and postharvest qualities of the farmed fish. Both timely and pertinent, Fish Oil Replacement and Alternative Lipid Sources in Aquaculture Feeds is the most authoritative and comprehensive review on the substitution of fish oil in aquaculture feeds addressing the issues, science, and future directions of using sustainable alternatives. Available through www.crcpress.com – enter promotional code 757CC to receive a 20% discount.



Multilingual CD-ROM of FAO cultured aquatic species fact sheets

Our readers may well be aware of the excellent FAO Fact Sheet series available on the Fisheries and Aquaculture Department's website. Now you can get them offline as well.

This CD-ROM contains 50 cultured aquatic species fact sheets produced by the Fisheries and Aquaculture Department of the Food and Agriculture Organization of the United Nations. The fact sheets are written in simple technical language and focus on the practical aspects of aquaculture, from seed supply to farming systems including harvesting techniques and marketing issues.

All fact sheets are available in five FAO languages (Arabic, Chinese, English, French and Spanish), divided by groups of species and easily accessible through an introductory page and printable. For further information please contact: Mr Valerio Crespi – E-mail: Valerio.Crespi@fao.org.

Aquaclimate Annual Progress Report 2010

The annual report for the Aquaclimate project summarising project achievements of the project in its first year is now available for download from the NACA website.

The Annual report covers Aquaclimate project activities from March 2009 to March 2010 and was confirmed by the project project partners at the annual project meeting. The annual meeting was held at Can Tho University (a national project partner of the project) in Can Tho City, Vietnam (the heartland of Tra catfish farming – a key case study of the project).

Participants at the meeting discussed the progress of work done in the past year and agreed on a work plan for the next 12 months.

The progress and work plan are described in the annual report (which can be downloaded from the NACA website) and outputs are included as annexes to the report.

Key outputs from the first year of the project include:

- Report of the inaugural inception workshop of the project.
- Aquaclimate generic case study methodology.
- Perception of climate change impacts and adaptation of catfish farming in the Mekong Delta, Vietnam. Farmer focus group discussion and stakeholder workshop.
- A review of climate change model predictions and scenario selection.
- Aquaclimate technical brief: Vulnerability and adaptation to climate change on catfish farming: Stakeholder analysis in Can Tho Province, Vietnam.
- Aquaclimate technical brief: Reducing the gap between science and policy development: Creating scenarios together with catfish farmers in the Mekong Delta, Vietnam.
- Shrimp farming in Vietnam focus group discussion and stakeholder workshop report.
- Milkfish farming in the Philippines focus group discussion and stakeholder workshop report.
- Shrimp farming in India focus group discussion and stakeholder workshop report.
- Impact of extreme climatic events on brackishwater aquaculture in India.
- Multi-agency Policy Brief on fisheries and aquaculture for COP15.
- Food and Agriculture Organization (FAO) technical reports on the impacts of climate change on fisheries and aquaculture.

Network of Aquaculture Centres in Asia-Pacific

Mailing address
PO Box 1040,
Kasetsart University Post Office
Ladyao, Jatujak,
Bangkok 10903
Thailand

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

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

For more information, please visit the Aquaclimate Project webpage at the link below. All reports and publications produced as outputs of the project are available for free download at:

http://www.enaca.org/modules/inlandprojects/index.php?content_id=10

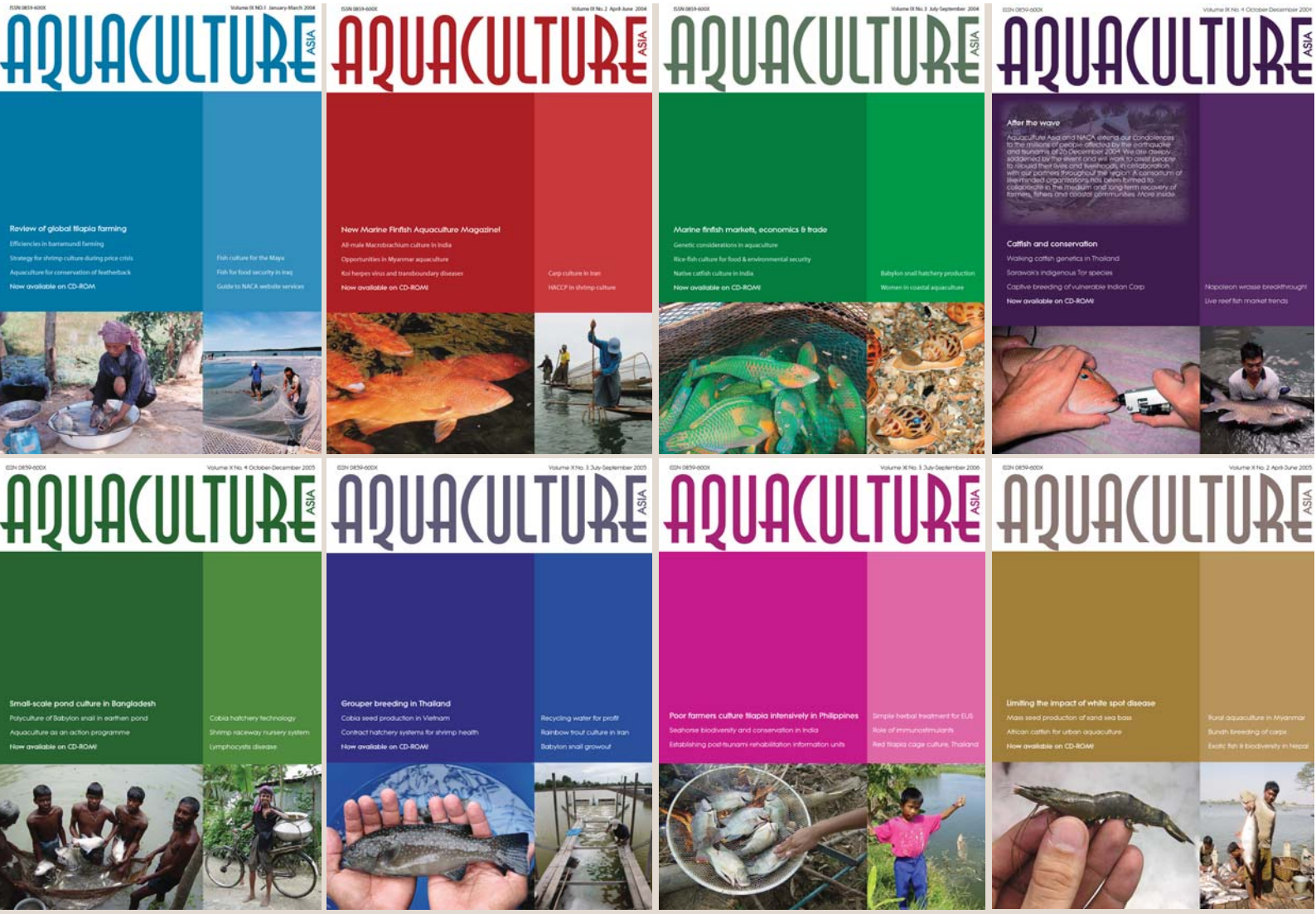
Training course on application of business management principles in small-scale aquaculture

A training course on business management principles for small-scale farmers will be held from 1-10 August in Nha Trang University in Vietnam (NTU). The course is organised by NACA, NTU, Holar University of Iceland and sponsored by the United Nations University Fisheries Training Programme.

The course aims to assist small-scale farmers to acquire additional business skills that will help them improve their efficiency and profitability and competitivness in an increasingly globalised market.

The course will initially be offered to 15 participants drawn from six countries, ie. Bangladesh, India, Indonesia, Myanmar, Thailand and Vietnam. The course will be refined based on feedback and experience for subsequent offerings and wider use throughout the region. Please see the promotional brochure on the NACA website for details at:

http://www.enaca.org/modules/news/article.php?storyid=1873



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