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From the Editor's desk

Shrimp anti-dumping dispute escalates

Another aquaculture trade dispute is looming and this time the target is shrimp. A US industry group largely representing US shrimp fishing interests - the "Southern Shrimp Alliance" - has filed a complaint alleging six countries of dumping shrimp on the US market - namely Brazil, China, Ecuador, India, Thailand, and Vietnam.

The Southern Shrimp Alliance claims that the domestic price of shrimp has fallen significantly in response to the 'dumping' of 'unfairly priced' imported product on the US market. Their petition proposes the introduction of tariffs ranging from 30-267% against the countries named above. Exporting countries prefer to use the term 'competetively priced' and point to the substantially lower production costs in Asia and South America. The ITC will release a preliminary decision on 17 February.

One significant difference between the looming shrimp dispute as compared to the recent action against Vietnamese catfish is that this time US producers face strong opposition to their position at home. Much of the US seafood processing industry is reliant on imported shrimp product as domestic production is not sufficient to meet demand. Many processors and retailers are opposed to the introduction of tariffs that are likely to hurt their businesses.

We expect that the blow will fall hardest on the many people in Asia and elsewhere whose livelihoods depend on shrimp aquaculture, should the case ultimately be successful. In response to this challenge, there is a need for enhanced information exchange, and coordinated and effective actions. Several NACA members have taken legal assistance, and a vigourous defence of the charges is expected. In response, NACA will enhance its shrimp media monitoring program, aiming to bring regular news of the anti-dumping case, from within Asia, and the US, to NACA members. We hope this will prove useful to members in monitoring developments and taking action on this important challenge. The service is available free by subscribing to the newsletter through the NACA web site. NACA will continue to respond to member requests for further information on the antidumping case, and to encourage and support as far as possible sharing of experiences and coordinated action among our members to address this major challenge to our aquaculture industry in Asia.

On a more postitive note, the new NACA website has been launched. This time its 'more than just a website' - we are moving towards the establishment of an 'online community' for the network. The people in participating NACA centres are widely seperated by the tyranny of distance, so we have endeavored to provide a 'virtual place' where they can 'meet' to discuss issues, share information and collaborate online. To this end we have made the website interactive - you can submit your own local news, events and stories online to share with your colleagues all over Asia. We will also shortly activate some discussion forums where you can post questions and talk to your colleagues from throughout the network. Please register as a member of the site to create your own personal website account.. It is of course, completely free.

The NACA website may be found at http://www.enaca.org.

Simon Wilkinson

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

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

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

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Notes from the Publisher

Farmers Organizations: Growing up to authority

Pedro Bueno is the Director-General of NACA. He is the former Editor of Aquaculture Asia

"Apart from staying viable and being cohesive, negotiating effectively is the best way farmers' organizations can serve their members."

At the Global Forum on Agricultural Research conference in Dakar, Senegal in May 2003, the farmer representatives in that conference:

- Stressed the importance of farmer participation in priority-setting and decision making processes, particularly at the grassroots level;
- Insisted that extra efforts are needed to ensure legitimacy of representation and accountability to the constituents; representatives must be chosen by the farmer organizations themselves and not appointed by other stakeholders, governments or research bodies;
- Said that extension needs to be more effective, and the results of agricultural research need to be more accessible and user-friendly to the average farmer;
- Wanted better access to research results and to build on local knowledge,
- Requested assistance in building their leadership skills to ensure effective representation, advocacy and policy formation, and improving their communication and information-dissemination capacities.

These conditions, if fulfilled, would make farmers truly and effectively participate in the development process. But that is a big "if". If farmers were to be taken seriously as stakeholders in the development process they must organize and, beyond building their capacity, attain a status of authoritativeness. A limited survey done by NACA in mid-2003 of different types of aquaculture farmer or producers organizations in five Asian countries - while it was not aimed to find support to this statement – turned up some examples by which farmers organizations could attain an authoritative stature.

The surveyed associations are legally established, have the requisite statutory constitutions and the structure and systems including financial, to operate properly. They are generally professionally managed although no clear indication is given on whether they are seriously engaged in organizational and professional development other than expanding membership or training members. The associations have memberships that comprise representatives of the industry sub-sectors and, in one case, the input (feed and chemicals) suppliers. This multi-sector membership endows some power in being able to claim a wide representation of the sector, and a fair amount of authoritativeness if the association's opinions and advice offered to government or to its own ranks, are informed by science-based sources and objective debates of issues. Legitimacy is also seen as the association representing the various scales of producers, but in particular (in the Asian context) the numerous small farmers.

Not surprisingly, none claimed to have adequate funding. The associations raise funds through various means that include organizing conferences and trade fairs, leveraging support from industry sponsors and government, sale of or commission from sale of members' products. Running conferences, seminars and trade exhibitions are a common and accepted way to raise revenue by societies. It also gains them credibility by being seen as providing opportunities for industry, government, scientific community and NGOs to discuss issues dispassionately. Leveraging support from government through collaborative activities, or for grants, is largely an acceptable means although it raises a critical issue. It may give the association greater credibility if it maintained a great degree of independence. That said, most Asian farmer associations are probably more dependent on government than their counterparts in developed regions. This works both ways on sustainability: On the one hand, government support can come in handy in keeping associations viable and enabling them to operate, as with grants, support to conferences, support to promotional activities, restructuring of taxes, etc. On the other hand, dependence on government risks fostering subservience or stifling initiatives to seek other ways of sustaining the association. Some degree of dependence on government, in the context of a developing country, is unavoidable. It has benefits, but it could suppress initiative, at best. At worst, it could lead to passivity and thus vulnerability to particularized demands. An association in such a state cannot be expected to contribute well to development processes; it would be its own worst enemy for its vulnerability to being used as a tool to stronger interests.

Apart from alliances or partnership among themselves and with government, the survey did not indicate whether the associations have formed alliances with other associations or societies in other countries in or outside the region. However, some individual members of the shrimp associations are also members of the Global Aquaculture Alliance as well as the ASEAN Fisheries Federation. The Philippines seaweed industry association cooperates with international seaweed associations like MARINALG and the International Seaweed Association, and is active in the ASEAN Carageenan Industry Club. It engages experts from

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Growth enhancement of carp and prawn through dietary sodium chloride supplementation

P.Keshavanath, B. Gangadhara and Savitha Khadri

Department of Aquaculture, College of Fisheries, University of Agricultural Sciences. Mangalore — 575 002. India

Success in aquaculture depends to a great extent on sound nutritional practices based on the knowledge of nutrients required by the species cultured. It is estimated that the total feed cost in culture accounts for 30-70% of the production cost, depending upon the type of culture and the intensity of feeding[1]. There is a limit to the maximum growth rate beyond which further increment is possible only through genetic manipulation or administration of growth promoters that act pharmacologically to improve metabolic and / or digestive processes[2]. Supplementation of diets with growth inducing substances has the potential to be profitable because of the improved growth rate or reduced culture period. A wide range substances including hormones, antibiotics, nutrient mixtures and herbal products have been tested on farmed fish for their growth promoting potential when fed at graded levels. Varying levels of success have been reported. The fear of residues remaining in the end product is a serious issue with consumers and can result in restrictions being placed on access to export markets for entire nations.

Nearly 44% of the farmers in Andhra Pradesh, a southern state of India having the highest area under aquaculture, use common salt as an additive in fish feeds without really understanding its role in nutrition[3]. The use of common salt in aquaculture feeds is a regular practice in China also[4]. A few studies have been conducted to test the dietary role of sodium chloride, especially in the freshwater fish[5,6]. Freshwater fish take up salt from the surrounding water to maintain their osmotic balance, a process that consumes energy. Dietary supplementation of sodium chloride could be helpful in reducing the energy utilized for this purpose thus freeing energy that could be channeled into growth instead[7].

In order to study the influence of sodium chloride (common salt) on growth, body composition and digestive enzyme activity of carps and prawns, we carried out four separate experiments of 120-day duration each in 25m³ (5x5x1m) outdoor cement tanks without soil base, at the College of Fisheries, Mangalore. We used the commonly cultured species-rohu (*Labeo rohita*), mrigal (*Cirrhinus mrigaia*), common carp (*Cyprinus carpio*) and freshwater prawn *Macrobrachium rosenbergii* as test subjects. Diet (30% protein) consisting of fish meal (25%), groundnut cake (25%). rice bran (39%), tapioca flour (10%) and vitamin and mineral mixture (1%) was formulated[8] to which sodium chloride (E-Merck India Ltd.) was incorporated at graded levels of 0%, 0.5%, 1.0%, 1.5% and 2.0%. Fish of mean initial weight ranging from 0.56 to 1.60g (Table 1) stocked at 25 per tank (10,000/ha) and prawn of 1.1g stocked at 30 per tank. (12,000/ha) were fed the prepared diets once daily in the morning at 5% body weight. Feed quantity was readjusted every fortnight based on the weight recorded at each sampling. Water quality parameters like dissolved oxygen, pH temperature and total alkalinity were monitored at fortnightly intervals. On termination of the growth trials the activity of intestinal and hepatopancreatic protease, amylase and lipase was estimated and carcass proximate composition analyzed. A short-term study was also conducted to determine nutrient digestibility, using crude fiber as the marker for calculating apparent digestibility. The data generated for various parameters was subjected to analysis of variance (ANOVA), followed by Duncan's multiple range test[9].

The range of different water quality parameters monitored over the experimental duration was within tolerable limits for the species cultured. The levels of sodium chloride that induced the best growth differed with the species, it being 1% in rohu. 1.5% in mrigal and common carp and 2% in prawn (Table 1). Thus variation in response to sodium chloride was seen even within closely related fish species (carps). Higher weight gain with 2% sodium chloride supplementation was recorded in the eel Anguilla japonica[10] and juveniles of red drum[7,11]. Dietary salt is reported to influence growth by increasing food conversion efficiency in rainbow trout[12]. In our study, an improvement in food conversion and protein efficiency ratio was observed in the case of rohu and mrigal fed optimal level of dietary salt. Dosages above the optimum resulted in lower weight gain and food conversion in carps. Salt appears to affect growth rate inversely when the level of supplementation interferes with the balance of other essential dietary components. Further, low digestibility and faster evacuation of food have been associated with high levels of sodium chloride in diets[13].

Dietary salt also influenced body composition. Higher carcass protein and fat was recorded in sodium chloride fed rohu and common carp (Table 1). Increases in protein and fat content on feeding salt mixtures has been reported in rainbow trout and common carp[5,14]. Enhanced digestive enzyme activity was recorded in the

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Table 1: Major growth parameters observed in carps and prawn fed salt incorporated diets

Species/parameter	Salt level				
	0%	0.5%	1.0%	1.5%	2.0%
Rohu (*Labeo rohita*)					
Final mean weight (g)	51.12^{a}	62.50^{b}	75.69^{c}	56.96^{ab}	51.52^{a}
Weight gain over control (%)	-	22.26^{c}	48.06^{d}	11.42^{b}	0.78^{a}
FCR	1.77^{b}	1.56^{a}	1.47^{a}	1.79	1.85^{b}
PER	1.89^{a}	2.16^{ab}	2.29^{b}	1.88^{a}	1.82^{a}
Survival	88	88	84	88	86
Carcass protein (%)	13.03^{a}	14.30^{b}	14.99^{c}	14.99^{c}	14.08^{c}
Carcass fat (%)	7.24^{a}	8.45^{b}	10.13^{c}	9.73^{c}	7.95^{b}
Mrigal (*Cirrhinus mrigala*)					
Final mean weight (g)	57.28^{a}	69.69^{b}	78.46^{c}	95.7^{4}	70.91^{b}
Weight gain over control (%)	-	21.66^{a}	36.98^{b}	67.14^{c}	23.79^{a}
FCR	1.76^{d}	1.46^{c}	1.29^{b}	1.06^{a}	1.44^{c}
PER	1.88^{a}	2.30^{b}	2.59^{c}	3.17^{d}	2.38^{b}
Survival	90	88	92	88	94
Carcass protein (%)	14.84^{b}	16.72^{d}	15.69^{c}	15.31^{c}	13.92^{a}
Carcass fat (%)	5.25^{d}	3.26^{b}	3.03	3.71^{c}	2.15^{a}
Common carp (*Cyprinus carpio*)					
Final mean weight (g)	56.17^{a}	61.16^{b}	64.50^{bc}	68.81^{c}	66.86^{c}
Weight gain over control (%)	-	8.88^{a}	14.83^{b}	22.50^{d}	19.03^{c}
FCR	2.07^{b}	2.03^{ab}	2.00^{ab}	2.01^{ab}	1.93^{a}
PER	1.59^{a}	1.65^{a}	1.67^{a}	1.68^{a}	1.71^{a}
Survival	82	80	80	88	92
Carcass protein (%)	14.81^{a}	14.88^{a}	15.39^{b}	16.41^{c}	15.86^{b}
Carcass fat (%)	5.12^{a}	4.97^{a}	5.72^{b}	6.90^{d}	6.20^{c}
Freshwater prawn (*Macrobrachium rosenbergii*)					
Final mean weight (g)	23.55^{a}	24.33^{a}	27.05^{b}	31.76^{c}	36.83^{d}
Weight gain over control (%)	-	3.31^{a}	14.86^{b}	34.86^{c}	56.39^{d}
FCR	2.95^{c}	2.90^{c}	2.89^{c}	2.76^{b}	2.53^{a}
PER	1.13a	1.15^{b}	1.16	1.21^{c}	1.32^{d}
Survival	40	35	42	43	45
Carcass protein (%)	15.37^{a}	15.44^{a}	16.84^{b}	15.68^{a}	15.40^{a}
Carcass fat (%)	0.56^{a}	0.58^{a}	0.57^{a}	0.53	0.51^{a}

* The average initial weights of rohu, mrigal, common carp and prawn were 1.600, 1.20, 0.56 and 1.11g respectively
Note: Figures in the same row with the same superscript are not significantly different (P>0.05)

Table 2: Digestive enzyme activity* in the gut of carps and prawn fed salt incorporated diets

Species	Enzyme	Tissue	Salt level				
			0%	0.5%	1.0%	1.5%	2.0%
Rohu							
	Protease	Intestine	3.30^{a}	3.07^{c}	5.62^{d}	4.43^{b}	4.17^{b}
		Hepatopancreas	3.37^{b}	4.35^{c}	4.21^{c}	3.50^{b}	2.51^{a}
	Amylase	Intestine	14.33^{b}	15.82^{d}	16.59^{c}	13.98^{a}	15.00^{c}
		Hepatopancreas	11.83^{c}	12.17^{d}	12.46^{c}	11.60^{b}	11.12^{a}
	Lipase	Intestine	2.82^{a}	5.03^{b}	8.31^{c}	3.32^{a}	2.90^{a}
		Hepatopancreas	6.32^{b}	6.43^{b}	6.43^{b}	6.12^{b}	5.21^{a}
Mrigal							
	Protease	Intestine	1.02^{a}	1.51^{b}	3.06^{c}	1.95^{c}	2.32^{d}
		Hepatopancreas	2.84^{b}	1.66^{a}	1.91^{a}	3.04^{b}	3.61^{c}
	Amylase	Intestine	12.13^{a}	12.27^{a}	14.00^{b}	15.31^{b}	14.43^{b}
		Hepatopancreas	12.83^{a}	15.35^{c}	12.80^{ab}	15.02^{bc}	12.04^{a}
	Lipase	Intestine	2.38^{a}	2.23^{a}	2.61^{a}	2.54^{a}	2.62^{a}
		Hepatopancreas	2.14^{a}	2.33^{a}	3.00^{b}	4.51^{d}	4.00^{c}
Common carp							
	Protease	Intestine	16.62^{a}	21.71^{c}	23.07^{d}	24.22^{c}	19.31^{b}
		Hepatopancreas	23.06^{a}	22.12^{a}	21.97^{a}	26.87^{b}	22.34^{a}
	Amylase	Hepatopancreas	23.74^{a}	24.20^{a}	23.73^{a}	26.12^{ab}	28.45^{b}
		Intestine	32.16^{a}	33.45^{b}	33.12^{b}	33.32^{b}	44.56^{c}
	Lipase	Hepatopancreas	2.32^{a}	5.92^{b}	7.03^{c}	12.43^{c}	9.06^{d}
		Intestine	11.22^{b}	7.43^{a}	8.05^{a}	10.32^{b}	11.22^{b}
Prawn							
	Protease	Intestine	2.27^{a}	2.68^{a}	2.69^{a}	2.25^{a}	0.19^{a}
		Hepatopancreas	0.39^{a}	0.66^{b}	0.39^{ab}	1.32^{d}	0.92^{c}
	Amylase	Intestine	23.32^{a}	22.26^{a}	32.09^{c}	31.13^{c}	29.10^{b}
		Hepatopancreas	9.71^{a}	11.80^{b}	12.63^{c}	13.46^{d}	16.41^{c}
	Lipase	Intestine	0.84^{a}	2.10^{b}	4.10^{c}	4.90^{d}	4.10^{c}
		Hepatopancreas	0.40^{a}	0.61^{b}	0.78^{c}	0.31^{a}	1.19^{d}

* Enzyme activity expressed as u miles of product liberated/minute/10mg tissue protein at 28C
Figures in the same row with same superscript are not significantly different (P>0.05)

Fertilization, soil and water quality management in small-scale ponds:

Fertilization requirements and soil properties

S. Adhikari

Central Institute of Freshwater Aquaculture, Kausalyaganga, Bhubaneswar 751002, India, Email sadhikari66@indiatimes.com

Since most of the potential areas for inland aquaculture have already been explored in India, additional production can only be achieved through successful manipulation of available resources that influence the productivity of various aquaculture systems. One of the main ways this is achieved is through maintenance of adequate levels of nutrients in the pond environment. Pond management in fish culture is mainly concerned with fertilization requirements and strategies; and with good management of pond soil and water quality.

Fertilization requirements of fish ponds

The natural productivity of a fish culture system depends largely on the availability of natural food organisms and on favorable environmental conditions for the fish.

Phytoplankton, the floating microscopic plants that give water its green color, are the first step in the food chain of fish ponds. Other organisms also feed on them and multiply, increasing the availability of natural food for fish stocked in the pond. In addition to carbon dioxide ($C0_{2)}$, water and sunlight for carbohydrate synthesis, phytoplankton need mineral elements including nitrogen, phosphorus, potassium, calcium, sulfur, iron, manganese, copper and zinc for their growth and nutrition. To promote phytoplankton growth and maintain the optimum natural productivity of ponds, the water must contain adequate amounts of these nutrients. Managing the pond soil and water effectively can therefore help provide an adequate amount of natural food for stocked fishes, promoting the healthy growth of fry and fingerlings.

Pond soil plays an important role in regulating the concentration of nutrients in the pond water. Knowledge of the nature and properties of pond soil can help a farmer to develop efficient management practices that will boost production. The most important chemical properties of bottom soil influencing the nutrient management practices of ponds are as follows:

Properties of pond soils

Soil reaction (pH)

The pH of soil is one of the most important factors for maintaining pond productivity since it controls most of the chemical reactions in the pond environment. Near neutral to slightly alkaline soil pH (7 and a little above) is considered to be ideal for fish production. If the pH is too low (strongly acidic) this can reduce the availability of key nutrients in the water and lower pond fertility.

Organic carbon content

Organic carbon acts as a source of energy for bacteria and other microbes that release nutrients through various biochemical processes. Pond soils with less than 0.5% organic carbon are considered unproductive while those in the range of 0.5-1.5% and 1.5-2.5% to have medium and high productivity respectively. Organic carbon content of more than 2.5% may not be suitable for fish production, since it may lead to an excessive bloom of microbes and oxygen depletion in the water.

Carbon to nitrogen ratio

The carbon to nitrogen (C:N) ratio of soil influences the activity of soil microbes to a great extent. This in turn affects the rate of release of nutrients from decomposing organic matter. The rate of breakdown (mineralization) is very fast, moderately fast and slow at C:N in the range of less than 10, 10-20 and more than 20 respectively. In general, soil C:N ratios between 10-15 are considered favorable for aquaculture and a ratio of 20:1 or narrower gives good results.

General nutrient status

Nitrogen, phosphorus and potassium are the major nutrients required by phytoplankton. Inorganic fertilizers can be applied to provide these nutrients. The appropriate dosage depends on the amount of individual nutrients present in the pond soil in an available form. Generally, relatively small amounts of potassium are needed in fish ponds. However, newly constructed ponds or those situated on poor soils may need potassium application. The single most critical nutrient for the maintenance of pond productivity is the available phosphorus content of pond soil and water. Pond soils with 30 ppm, 30-60 ppm, 60-120 ppm and more than 120 ppm available phosphate (P2O5) are considered to have poor, average, good and high productivity respectively. Ponds with less than 250 ppm available soil nitrogen are considered to have low productivity while concentrations in the range 250-500 ppm and above 500 ppm are considered to be medium and highly productive respectively.

Fertilization schedule of nursery ponds

Nursery ponds

The natural productivity of nurseries is often unsatisfactory due to a deficiency of one or more of the nutrient elements in soil and water, which may be caused by other environmental conditions. Correction of deficiencies by application of manures or fertilizers containing these nutrients in suitable form and in optimal amount is necessary to accelerate biological production and enhance productivity. Accordingly, small shallow ponds are preferred for nurseries for easy management and manipulation of environmental conditions.

Use of organic manures

Both organic manures and chemical fertilizers are widely used for improving the productivity of nurseries. Cow dung is the most widely used organic manure in many areas and is typically applied at a rate of 5,000-15,000 kg/ha in one installment well in advance of stocking with spawn, preferably at least a fortnight prior. The amount is reduced to 5,000 kg/ha when mohua oil cake is used as a fish toxicant in shallow nursery ponds. Sometimes, to hasten the process of decomposition of added manures, nurseries are limed ($CaCO_3$) at a rate of 250-350 kg /ha after the application of manure. Sometimes spaced manuring with cow dung at a rate of 10,000kg/ha 15 days prior to stocking followed by subsequent application of 5,000 kg/ha seven days after stocking has been practiced for sustainable production of zooplankton in nurseries. When more than one crop is raised, nurseries may be manured with cow dung at 5,500 kg/ha immediately after the removal of the first crop. Besides the cow dung, a combination of mustard oil cake, cow dung and poultry manure in the ratio of 6:3:1 at 1,100 ppm have been successfully used for the culture of zooplankton for carp spawn.

Inorganic fertilizers

Inorganic fertilizers containing a fixed percentage of individual nutrient elements or a combination of more than one element are also able to enhance the productivity of nurseries. A ratio of nitrogen : phosphorus ration (N:P) of 4:1 is considered most effective for increased production in nurseries. Weekly application of nitrogen : phosphorus: potassium mixture (N:P:K) in the ratio of 8:4:2 ppm is suitable for increased production of fish food organisms. Use of N:P:K in the ratio of 18:8:4 at 500 kg/ha after liming at 200 kg/ha is quite effective in enhancing the production of slightly acidic and unproductive soils used for nurseries.

Nitrogenous fertilizers containing different forms of nitrogen (amide, ammonium-cum-nitrate and ammonium) are suitable for management of nurseries. These three forms of fertilizers (e.g. urea, calcium ammonium nitrate and ammonium sulfate) are effective for slightly acidic to neutral, moderately acidic and alkaline soils respectively and a rate of 80 kg nitrogen/ha is most suitable for rearing of rohu spawn in nurseries.

Combining organic and inorganic fertilization

The combined use of both organic and inorganic fertilizers is another strategy for increased production of either fish food organisms or fry. The combination of mustard oil cake and 6:8:4 :N:P:K inorganic fertilizer on equivalent nutrient basis (at 12 kg nitrogen/ha) is suitable as compared to either organic to inorganic for nutrient management of nurseries. However, on an equivalent nutrient basis (N:P:K) organic manure (cow dung) is the most suitable fertilization strategy for management of carp nurseries compared to either inorganic fertilizer or combined use of organic and inorganic fertilizer.

Fertilization of rearing and stocking ponds

Acidic pond soils reduce microbial activity and the availability of nutrients in pond water and may render fertilization ineffective. Therefore, the application of lime is the first step of management for all stages of fish culture. Liming raises the soil pH to a desirable level (near neutral) and establishes a strong buffer system in the aquatic environment, improving the effectiveness of fertilization.

Liming stimulates the microbial decomposition of organic matter, supplies calcium to the pond, increases nitrate content in the pond and maintains sanitation in the pond environment. Generally, ground limestone is extensively used and spread over the dry bed or broadcast over the water surface in a single dose at least 15-20 days before stocking. On the basis of soil pH, the following dosages of lime are usually applied to ponds. Besides initial application, some compensatory applications of lime in the range of 100-200 kg/ha may also be made in the stocking pond from time to time to neutralize the acidity developed through application of acid-forming inorganic fertilizers and organic manures and also when fishes are diseased or distressed.

In India, organic manures are more commonly used than inorganic fertilizers. A variety of agricultural wastes, including cow dung, poultry droppings, pig manures and biogas slurry etc. can be used as organic manures. In rearing ponds, application of raw cow dung or biogas slurry is observed to give better results. Depending on the organic carbon content of pond soil in the rearing pond, application of raw cow dung or biogas slurry in the range of 3-7 or 5.5-12 t/ha respectively and addition of 2.5-5 t/ha/year of cow dung or 10-30 t/ha/year biogas slurry or 5-15 t/ha/year poultry droppings respectively in stocking ponds give good results. In rearing ponds, usually 50% of the total requirement is given 15-20 days prior to stocking of fry and the remaining in two equal monthly splits during rearing period. In stocking ponds, on the other hand, 20% of the total requirement is applied initially and the rest is given in equal monthly split. But if the ponds are treated with mohua oil cake to eradicate unwanted fishes, the initial application of the organic manure can be dispensed with in both the culture system.

The efficiency of nitrogen fertilizers in enhancing the productivity of ponds depends largely on their forms. The commonly used nitrogen fertilizers are

Shrimp pond maintenance. Photo: U Win Latt

urea, ammonium sulfate and calcium ammonium nitrate. Among these, urea is suitable for slightly acidic to neutral soil, ammonium sulfate for alkaline soil and calcium ammonium nitrate for acidic soil. Depending on the available nitrogen content of the pond soil, application of 50-70 kg nitrogen/ha (i.e. 108-152 kg urea/ha; 200-280 kg calcium ammonium nitrate/ha; 250-3 50 kg ammonium sulfate (ha) in rearing ponds and 75-150 kg/ha/year (i.e. 163-326 kg urea /ha/year; 300-600 kg calcium ammonium nitrate /ha/year; 375-750 kg ammonium sulfate/ha/year) in stocking ponds give good results. The fertilizer should be applied in equal monthly splits alternately with organic manure with a gap of about a fortnight.

Single Super Phosphate (SSP) is most commonly used as a phosphate fertilizer in fish ponds. Depending on the available phosphate content of pond soil, application of 25-50 kg phosphate (P2O5) /ha (i.e. 156-312 kg SSP/ha) and 40-75 kg P205/ha/year (i.e. 250-468 kg SSP/ha) in rearing and stocking ponds, respectively give good results. To get better utilization efficiency, phosphorus fertilizers should be applied in weekly intervals and the first installment should be given seven days after initial organic manuring.

Muriate of potash (potassium chloride, KCl) and sulfate of potash (potassium sulfate, K2S04) are commonly used as potassium fertilizers in fish ponds. Application of 10-20 kg K20/ha (i.e. 16-32 kg KCl/ha or 20-40 kg K2S04/ha) and 25-40 kg K20/ha/year (i.e. 41-66 kg KCl/ha or 52-83 kg K2S04/ha/year) in rearing and stocking ponds, respectively give good results. The fertilizer should be applied in equal monthly splits.

Application of manure and fertilizer should be suspended if thick green or blue green blooms of algae develop in the pond in order to avoid depletion of oxygen.

Careful use of organic manures and chemical fertilizers in combination is a sound strategy. Occasional development of un-hygenic conditions in the pond may be avoided by using pre-decomposed organic manure. Use of excessive amounts of raw organic manure can result in excessive blooms of microbes during aerobic breakdown of large amount of raw organic manure, and may also caused oxygen depletion.

An understanding of chemical and biological conditions of pond soil and water through regular monitoring systems and adoption of efficient and careful management practices will lead to enhanced production of fish food organisms and thereby increase the growth and survival of fish.

Growth enhancement of carp and prawn through dietary sodium chloride

...continued from page 4

intestine and hepatopancreas of the treated fish as well as prawn (Table 2). The type of diet is known to influence the activity of digestive enzymes[15]). Increased digestive enzyme activity coupled with higher nutrient digestibility might have been responsible for better utilization of nutrients from salt incorporated diets.

Our results suggest that dietary inclusion of salt can be beneficial.

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Exercising responsibilities to tackle aquatic animal diseases

CV Mohan, NACA

Recognize disease as our (common) problem. Facilitate flow of science (information). Exercise responsibilities. Disease impact will be minimized.

Asia is the hub of aquaculture. Around 80% of the world's aquaculture production comes from here. Diseases are the biggest deterrents to Asian aquaculture. Health management is the buzz-word in aquaculture and is still the most debated and discussed topic in meetings, seminars and workshops. The wealth of information (knowledge), expertise and resources that exist in the Asian region, on aquatic animal health management is remarkable. Significant progress has been made in disease management in Asian aquaculture and it is well documented. However, serious disease problems still continue to cripple the aquaculture industry in several countries of the region, affecting the livelihoods of many people directly and indirectly. Why this is happening? We may never be able to fully understand the underlying reasons and they will differ from country to country and opinions vary from person to person. Long lists of failures/constraints/limitations can be generated. But, three reasons (that can be called as failures) appear to be largely responsible:

- Failure to recognize aquatic animal disease as our problem by stakeholders.
- Failure to facilitate flow of science (information) among stakeholders
- Failure to exercise responsibilities by stakeholders

The term 'stakeholders' in this article is used very broadly to refer to all those linked to the industry directly and indirectly such as producers, service providers, development agencies, research organizations, policy makers and consumers. This article attempts to address these failures, hoping to stimulate some discussions. The generic analysis and comments presented are not specific to any country in the region. Shrimp viral diseases in Asia are used as examples to base some of the opinions. Before addressing the three identified issues, it is necessary to briefly look into the concept of aquatic animal diseases and health management in aquaculture.

Concept of disease and health management

Disease is the biggest threats to sustainable aquaculture. White spot disease (WSD) in cultured shrimp and epizootic ulcerative syndrome (EUS) in fish are the best examples. As aquaculture intensifies and expands, more and more new diseases will emerge and health management will become very challenging. Health management can be broadly defined as approaches taken to prevent, control and eradicate aquatic animal diseases.

For a disease to occur, the pathogen must be able to gain entry into the culture system. Possible pathogen carriers include infected hosts (seed, brood, vectors, intermediate hosts, reservoir hosts), non-host biological carriers (birds, dogs, insects, other predators, human beings) and fomites (water, vehicles, buckets, shoes, nets, clothing). The carriers can enter the culture system through waterborne, airborne and overland transport routes. Waterborne transport may include contaminated water (pond effluents and processing plant effluents) and natural hosts in water. Airborne transport (migratory birds, insects, wind) of pathogen carriers is a serious concern in open farming systems. Overland transport (infected seed, human beings, animals, vehicles, farm equipment) of pathogen carriers is often the common route of introducing the pathogen to the culture system.

Understanding the disease process involves understanding the pathogen, host and the environment. A pathogen can cause a clinical disease and mortality only when it can overcome the defense barriers of the host and establish in the target tissue, proliferate, cause cellular and tissue damage and impair the function of the target tissue. Understanding the pathogenicity mechanisms of the pathogen, disease resistance strategies of the host and the role of the environment will help to gain insight into disease process. The concept of disease in an animal, how it spreads between animals in a pond, and between ponds, farms, provinces and countries is vital for devising measures to minimize pathogen spread. Knowing pathogen transmission pathways helps to better understand pond outbreaks, epidemics and pandemics. Serious disease outbreaks (epidemics) and crop losses are normally caused under certain circumstances by pathogens referred to as Category-1 pathogens. These are highly virulent, spread rapidly, untreatable, have diverse host range, and threaten the very survival of the industry.

Principles of health management should be considered to keep serious pathogens not only out of the cultured host and environment but also out of the country and the region. Once these pathogens enter and become established (endemic) it becomes very expensive to keep them out. Health management involves understanding and managing the host, pathogen and the environment. Aquatic animal disease control strategies broadly include preventive and prophylactic strategies, chemotherapy, epidemiological approaches, risk management, rapid diagnostics and early warning surveillance, biosecurity protocols and specific pathogen free (SPF) and specific pathogen resistant (SPR) based aquaculture programs. There is considerable knowledge and expertise on these approaches. Principles of health management need to be applied at the hatchery, farm, local, provincial, national, regional and international levels in order to minimize the impact. The responsibility of health management therefore, lies with all the stakeholders.

Recognize disease as our problem

Aquatic animal disease impacts on livelihoods of aquaculture farmers and the people who make their living around aquaculture (suppliers, traders, processors and others), national economies, trade and human health. Disease epizootics have a cascading effect on all stakeholders. Responsible interventions by each of the stakeholders will have a direct or indirect positive outcome on minimizing the impact of disease. Lack of direct benefit should not be seen as a disincentive for exercising responsible intervention. This is where the concept of recognizing disease as “our” problem will help. Otherwise, disease will remain as his or their problem, but never our problem. This should change and it is a challenging task to bring about this change. The flow of science-based information to the stakeholders and demonstrating the benefits of a collective approach, will contribute towards achieving this change. Responsible interventions taken at any level can help the overall sector. The benefits of every positive reactive and proactive intervention will have a trickle down effect to the stakeholders. On the other hand, negative effects of not exercising a responsibility can have a dramatic devastating effect on the stakeholders. Several examples for both these scenarios can be found in the Asia-Pacific region. Examples and lessons learnt in the region should help stakeholders to recognize disease as our common problem.

Facilitating flow of science based information

Considerable knowledge is available on aquatic animal disease process, transmission pathways, diagnostics and management strategies. Information flows to the stakeholders through various channels under different circumstances for various purposes. This flow of information has significantly helped in the management of aquatic animal diseases in the region. The well documented, positive impacts, will not be discussed here. However, upon close examination of flow of health management information to the stakeholders, it becomes apparent that many times a message reaches the stakeholder but not the science behind it. It works more like promotion of information. Unless the science behind the message reaches the stakeholders, we will continue to hear statements as the following which I offer as food for thought:

- “We are using screened brood stock, our seed is disease free”
- “We are using screened seed, we can increase stocking densities”
- “We have PCR testing facilities in the country and that should solve the shrimp disease problem”
- “Why should I spend money to treat my pond water after losing the crop?”
- “Processors have no role in disease management”
- “We tried everything, but still we get disease”
- “We are using SPF animals, they are resistant, we should not have any health problem”
- “We are diversifying into an alternative exotic species which is resistant”
- “Our products help control shrimp viral diseases”
- “I would not mind trying treatments and health products to manage shrimp viral diseases”

There are many health management concepts that need to be correctly informed to the appropriate stakeholders. At the outset, it may appear that stakeholders are well informed about these concepts. If one goes down to the individual stakeholder level (farmer/policy maker), it will not take much time to realize that very little is known where it is most needed. If the science behind the information becomes available many of the responses of the stakeholders could be different. Devising approaches to channel the information and the science behind the information to the concerned stakeholder is going to be a challenging task. Responsibility to facilitate flow of information rests with many people. Each of the stakeholders can play a vital link to facilitate flow of information. Information should be provided with the objective of creating awareness, and not just promoting hidden agenda. Following are just a few examples of such health management concepts, where science based information should be made available to the stakeholders.

Disease risk is inherent with aquaculture. Aquaculture free of disease risk is an utopian dream. Application of right strategies will minimize the impact of disease significantly. There is no single risk factor for a disease outbreak and hence no single solution. Risk identification, prioritization and management will minimise the impact of the disease. Stakeholder perception of risk and solution should broaden and become more refined

Chemotherapy is not same as health management. Treating a clinical disease will be of little use in most circumstances, because damage to the target tissue of the animal has already been done. In addition, chemical use in food fish has potential to create food safety and market related concerns, an issue that is becoming increasingly significant in trade and food safety

PCR screened shrimp seed. There is no true PCR negative seed. Virus may be present at levels below the detection limit of the test employed or present in the population at prevalence levels below what could be detected by the sample size selected. PCR screening, correctly applied, significantly minimizes the risk of introducing the pathogen into the system with the seed. Screened seed is negative (only at specific probability level) for pathogens against which it is screened, but not for other pathogens and is not resistant to any pathogens. Their use does not ensure success if exposed to the same pathogen or other pathogens

Shrimp Broodstock screening before spawning is of little use. Spawning stress has been shown to stimulate viral replication. Broodstock which test negative prior to spawning might test positive following spawning. Screening to be effective, should therefore, be done after spawning. For screening to be beneficial, hatchery practice should not allow mixing of progeny from different brooders

SPF stock. Stocks domesticated and reared in systems where the specific pathogen has been excluded. Domestication and SPF are not necessarily same. They are not resistant to the specific pathogen. They are not free from other pathogens. SPF stock when exposed may become susceptible to the pathogen. Their use does not ensure success if exposed to the same pathogen or other pathogens

SPR stocks. Domesticated animals selected for their ability to survive specific pathogen infection.

Biosecurity. Providing secucity to the cultured organisms from exposure to pathogens of concern. Pathogen carriers (described earlier) can enter the culture system through waterborne, airborne and overland transport routes. Several recommended bio-security approaches are available to prevent the entry of pathogens and their carriers to the pond, farm and the country. Adoption and implementation of principles of a biosecurity can considerably minimise the probability of pathogen introduction. Several biosecurity principles can be very easily implemented at the farm/hatchery level. Disinfection programs at critical points, screening of hosts, not sharing labour and equipments between ponds, restricted access, safe disposal of sick and dead animals are some examples.

Epidemiology. Disease causation is multifactorial in nature. Disease will occur only when there is a sufficient cause. Mere presence of pathogen (necessary cause) will not always lead to disease outbreaks. WSD will not occur without the presence of WSSV. But, mere presence of WSSV (necessary cause) will not necessarily lead top WSD outbreaks. Necessary cause, along with component causes (risk factors) become a sufficient cause to produce the disease outbreak. Epidemiological studies identify these risk factors based on population evidence, quantifying their effect on outcome (disease), and assist to formulate intervention strategies. Epidemiological approaches hold great promise for management of aquatic animal pathogens, which have become endemic and established

Import risk analysis. Scientific process to assist decision making regarding importing an item (new species/feed/frozen shrimp). IRA involves hazard identification, risk assessment, risk management and risk communication. It should be done before making the decision and not done to support a decision already made. Any analysis done without the real perception of hazard and associated risks will of little value. IRA puts the onus on the importing countries. Responsibilities for preventing introduction and spread of pathogens lie also with the exporters. IRA (more appropriately, trade risk analysis) should take into account the liabilities and responsibilities of both importers and exporters.

Exercising Responsibilities

Not exercising responsibilities has cost the aquaculture industry dearly and will continue to hurt the sector, if changes are not brought about. Exercising responsibilities is bound to benefit the industry substantially. What is needed is to demonstrate the benefits, convince the stakeholders and facilitate them to exercise their responsibilities. This can't be policed and there is no need for it. Initiatives and approaches should come voluntarily from the stakeholders, then it is going to be sustainable. Orientation of stakeholders and raising awareness are vital to accomplish this mammoth task.

Responsibilities to manage diseases rests with all stakeholders concerned directly and indirectly with aquaculture. Principles of health management should be considered at the hatchery, pond, farm, local, national, regional and international levels. Adoption of better management practices (BMP) for example, can minimize the impact of diseases at the production level (hatchery/pond/farm). Existing knowledge in the region on BMPs should be communicated to the primary producers. Local approaches like adoption of voluntary codes of practice can assist to manage diseases at the local level. Self-help groups, farmer clubs/associations can take lead role in developing voluntary codes of practice and in implementing them. Such voluntary approaches are important because, despite the value of aquaculture, the support services (extension) are extremely weak in many countries of the region.

So much is known about exotic pathogen introductions associated with transboundary movement of live aquatic animals. Despite this awareness, introductions take place. In many countries, stakeholder lobbies make strong case for new species introductions largely based on perceived advantages of an exotic over a native species, often with a narrow personal interest. It would be proactive, if a free and fair consultative process is held at the national level involving all the stakeholders. The collective opinion emerging from such consultative processes will be very useful for right decision making. For example, because of the proposed advantages of Penaeus vannamei, it has been introduced to many countries in Asia. Reports of taura syndrome (viral disease) and other syndromes are already emerging from some of the countries in the region. Despite this, many countries are eager to introduce the species. Countries in the process of considering introductions, should seriously take into account the associated risks, conduct IRA, seek balanced advice (not just from a few lobbying groups) and learn from the regional experiences, before making decisions. Both exporters and importers have responsibilities for preventing the spread of pathogens across countries.

Effective implementation of National strategies for aquatic animal health can minimize the risk of entry of dangerous pathogens into the country and their subsequent spread. Effective and practical national strategies in countries like Australia (www.affa.gov.au) have been successful to keep many serious pathogens out of the country National strategies should assist to develop skills and facilities to undertake import risk analysis, quarantine and certification, surveillance and disease reporting and preparedness to deal with disease emergencies.

Regional aquatic animal health management program of NACA is developed and implemented in close cooperation and collaboration with member governments, regional organizations, donor agencies and stakeholders. It facilitates sharing of resources (information and expertise) between member governments in the region. Regional initiatives, aim to reduce risks of aquatic animal disease impacting on livelihoods of aquaculture farmers, national economies, trade and human health. (www.enaca.org/health) To support achievement of the goal, NACA regional initiatives aims to:

- Support development and implementation of National Aquatic Animal Health Strategies in Asia-Pacific.
- Promote widespread adoption of better aquatic animal health management practices
- Promote programs for improved surveillance, reporting and response to disease problems
- Facilitate harmonisation of diagnostic procedures and approaches to risk assessment.
- Improve regional and international cooperation in aquatic animal health.

There are several international initiatives, which address management of aquatic animal diseases. International standards and guidelines are prepared with the objective of promoting responsible trade and minimizing trans-boundary movement and spread of dangerous pathogens (www.oie.org, www.fao.org). Following are some of the important instruments and mechanisms to support it:

- OIE (world animal health organization) Aquatic animal health code and diagnostic manuals
- FAO code of Conduct for responsible fisheries
- FAO/WHO Codex Alimentarius
- List of OIE notifiable diseases and other diseases of significance
- Regional/International reporting of aquatic animal diseases
- OIE Referral laboratories
- Aquatic Animal Health Standards Committee (AAHSC of the OIE)
- Regional Advisory group on aquatic animal health (AG of NACA)

Adhering to international obligations and requirements will contribute to minimize the introduction and spread of serious pathogens

Conclusion

If some of the following examples are any indication, the future appears to be bright. Stakeholders in the region are gradually beginning to exercise their responsibilities to fight the common problem. This is encouraging and the right way forward Such initiatives can be good lessons for stakeholders in all the countries of the region. Voluntary proactive approaches coming from stakeholders are signs of a good beginning. Sustaining the proactive approaches requires commitment from all the stakeholders. Considerable effort and resources are required to stimulate and sustain proactive approaches

Hatcheries and Farms are increasingly adopting better management practices aimed at reducing disease risks. Hatcheries/ farms are willing to exercise damage control strategies (in the case of white spot outbreak) like isolation of affected unit, removal of hosts, effective disinfection programs and early warning systems

Collective approaches in various forms are beginning to make an impact on disease management. Farmer self help groups (clubs/associations/ societies) formulating strategies and guidelines to suit local needs and developing voluntary codes of practice are on the increase. Industry is becoming open to application of certification programs and quality assurance schemes (HACCP)

Extension approaches are being better understood and new methods are being developed to facilitate flow of science (information) to the stakeholders. Private sector is beginning to play a lead role in enabling information flow.

Research in the area of aquatic animal health is active in the region. Population based studies (epidemiological approaches) to identify risks and devise disease management intervention strategies are on the increase. Rapid diagnostics are available to diseases of concern to the region and dedicated efforts are being made to develop rapid diagnostics for emerging infectious diseases.

National strategies on aquatic animal health management are being gradually developed and implemented. There is evidence of countries adhering to regional and international obligations and requirements. Capacity for IRA and emergency preparedness are being slowly upgraded in the region.

Regional/international initiatives are increasingly facilitating capacity building and sharing of resources. Donor and developmental agencies supporting aquatic animal health management programs in the region is on the increase.

The above examples of stakeholders proactively exercising responsibilities is hoped to serve as useful models. Only through strong resolve and commitment, stakeholders can ensure responsible health management. "Exercising responsibilities" should become the new buzz-word in aquatic animal health management

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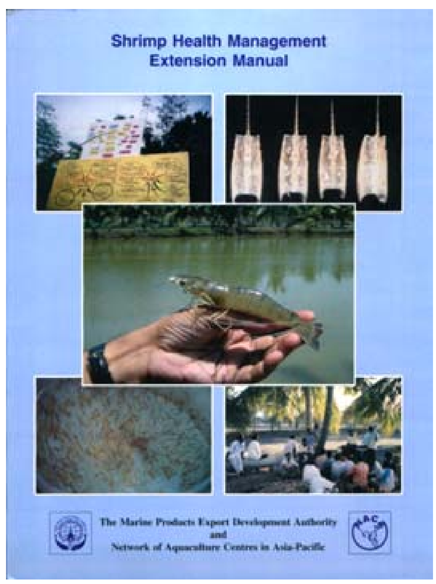
Shrimp Health Management Extension Manual now available

This new extension manual summarises the farm level risk factors identified during a NACA/MPEDA technical assistance project on shrimp disease and coastal management. The manual summaises farm level risk factors and practical management practices that can be used to reduce risks of shrimp disease outbreaks and improve farm production. The recommendations are based on the Andhra Pradesh area, India, and are of particular relevance there. However they can also be taken into consideration by farmers elsewhere.

The manual was prepared by NACA and MPEDA, in association with the Aquatic Animal Health Research Institute, Siam Natural Resources Ltd, and AusVet Animal Health Services (Australia) and technical support from the Australian Centre for INternational Agricultural Research. Download it now, for free from:

http://www.enaca.org



Freshwater prawn, *Macrobrachium nobilii* a promising candidate for rural nutrition

Pitchimuthu Mariappan, P. Balamurugan, and Chellam Balasundaram

Department of Animal Science, Bharathidasan University, Tiruchirapalli 620024, India.
e-mail: mnobilii@rediffmail.com

India's abundant freshwater resources include 2.25 million hectares of ponds and tanks, 1.3 million hectares of beels, jheels and derelict waters and 1.2 million km of irrigation canals and 3 million hectares of lakes and reservoirs[1] that strongly support inland aquaculture activities. At the moment, freshwater prawn production in India is mainly based on capture fisheries rather than on aquaculture. Freshwater prawn culture has undergone a phenomenal growth in the past two decades. Of the 100 species of freshwater prawns belonging to the genus *Macrobrachium* recorded worldwide, 40 species are found in India. Species growing to more than 15g are regarded as commercially important. Reports on the prawn fishery of the longest rivers such as Godavari, Krishna, Ganges, Mahanadi, Hooghly and Cauvery in India indicate that the major commercial species are *M. rosenbergii* and *M. malcolmsonii*. However, other Palemonid prawns like *M. nobilii*, *M. lamarrei*, *M. scabriculum*, *M. birmanicum choprai*, *M. mirable*, *M. rude*, *M. hendersonii*, *M. villosimanus* and *M. hendersonii* support local fisheries[2,3].

The Cauvery River, the fourth largest river in India, contributes a considerable amount of both fin and shellfish in the states of Tamilnadu and Karnataka. Regarding *Macrobrachium* diversity in river Cauvery seven species have been recorded recently, namely: *M. malcolmsonii*, *M. nobilii*, *M. scabriculum*, *M. lamarrei*, *M. rude*, *M. australe* and *M. emulum*[3]. Among these prawns, *M. malcolmsonii* is the most widely distributed and holds first place in the capture fisheries and commercial culture in and around the delta region. Juveniles are collected en masse during the monsoon season in Lower Anicut, a seed collection center from which juveniles are used to stock farms in and around Tamilnadu[5].

M. nobilii makes a significant contribution to prawn fisheries since it is abundant in the entire stretch of the Cauvery River. It is a diecdysic crustacean that molts and breeds around every 19 days. Female *M. nobilii* attains first sexual maturity at around 34 mm in total length and 0.45g in weight and reach a maximum size of 71mm (7.2g). The maximum size of male is 77mm and around 13g total weight[3].

An average female incubates about 2,200 eggs/clutch for a fortnight[6]. After the embryonic development hatching takes place in 3 to 4 batches. To avoid batch hatching a hatcher device was designed[7], which enables 70% successful, hatching simultaneously in a given time. Application of eyestalk ablation increases molting and spawning frequency and produces an average of around 5,900 eggs per prawn[8]. The culture of *M. nobilii* has been encouraged due to early maturation and reproduction in captivity and year-round breeding which facilitates the collection of egg-bearing females at any time. Even though it is smaller in size, this species of freshwater prawn is accepted by consumers and has a higher survival rate. Differential growth between sexes encourages monosex culture since males grow faster than females. Hybridization with other desirable species may be a promising endeavor and provide a valuable contribution to rural nutrition[8]. Egg bearing females have a higher calorific value as compared to *M. malcolmsonii*[8], and are an excellent source of PUFA, which are fatty acids essential for human health along with a balanced level of amino acids essential to the growth and nutrition of human beings. The sun-dried juveniles of *M. nobilii* are used for preparation of fishmeal and prawn feed. *M. nobilii* hand collected by the

Macrobrachium nobilii: The female (above) has a stouter body than the male (below) which sports larger chelae

women fish-folk are generally sold in the local markets at the rate of Rs.100/kg for adults and Rs. 60/kg (1 US$= Rs. 45) for juveniles in the local market. *Macrobrachium nobilii* is an affordable food accessible to the poor rural people, for whom the major commercial species are a daydream.

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Farming freshwater prawns: A manual for the culture of the giant river prawn

FAO has released a new publication - the definitive and practical guide to the farming of giant freshwater prawn *Macrobrachium rosenbergii*.

After a preliminary section on the biology of freshwater prawns, the manual covers site selection for hatcheries, nurseries and grow-out facilities, and the management of the broodstock, hatchery, nursery and grow-out phases of rearing. Harvesting and post-harvest handling are also covered. The management principles described are illustrated by photographs and drawings. The manual contains annexes on specific topics such as the production of larval feeds, size variation, and stock estimation. The final annex is a glossary that lists not only the terms used in the manual itself but also those which may be found in other documents.

Editors note: This is simply the best technical manual I've seen. You can download it for free from our website http://www.enaca.org/modules/mydownloads/visit.php?cid=74&lid=350.

Snapshots of a clean, innovative, socially responsible fishfarm in Sri Lanka

Pedro Bueno, NACA

If there is something worthy to mention about the Jaysons Farm – an 80-acre spread in Chilaw that contains a fish and shrimp hatchery, a commercial fishfeed mill, and a complex of earthen shrimp and fish ponds with over 60 acres of water surface – it is that it does not add to the pollution load of the Dutch Canal, a marvelous piece of work done by the Dutch hundreds of years ago for water transport. The collapse – from diseases - of the shrimp farms located along this canal has been largely attributed to the pollution of the water by discharges into it from hundreds of these farms and the intake of the dirty water by the same farms. The Jayson's Farm draws water not from the canal but from the coast, through a 4 km pipeline, thus avoiding intake of the polluted canal water. It recirculates the water and therefore does not discharge its own used water into the canal.

The used water recirculation system is simple and effective. The water channels leading from the ponds to the used water purification pond are lined with seagrass to absorb ammonia. The 3–acre, 4-feet deep purification pond likewise contains the grass but also tilapia and milkfish. In fact tilapia is now a major part of the farm's output. Its other important function is to help clean up the shrimp pond water and, as with the trials being done elsewhere, for its "probiotic" effects on the shrimp. Milkfish is being tried for the same purpose. Plans are also to raise more of it for food. Water stays for 3 days in the purification pond before it is re-used.

They employ the people in the community where the farm is located, as regular and contract workers. They have not had social conflicts, no poaching, no sabotage, no labor complaints. Daily workers for seasonal activities are paid more than the minimum wage and meals. The farm contributes to community activities.

I was walked around the farm by Mr. Vasantha Jayasuriya, the young managing director and chairman of the Jaysons Group of Companies, which owns Jaysons Farm. Here are the highlights, in pictures:

Mr. Athula, the farm manager (left) and Vasantha flank me in front of a strip of mangrove bordering the Jaysons Farm (1), which they have left untouched. Addendum: Mr. Athula was invited by the World Bank to the Washington consultation of stakeholders to discuss the result of the work of the Consortium Program of WB. FAO, WWF and NACA in Shrimp Aquaculture and the Environment in order that he could describe the Jayson's Farm experiences and take part in the discussions to determine the next steps for the consortium but, as Vasantha clarified, when I insinuated they might not have wished to reveal their farm innovations, it was because Athula was unable to obtain a US visa, despite several letters from the Bank addressed to Jaysons Farm, to Athula, and to the US embassy in Colombo,

(2) The pond is a water purification pond using seagrass, tilapia and milkfish as filters; (3) the waste-water channels are also planted with the seagrass, this one leads to the purification ponds. Such is the clarity of the purified wastewater, I could see the bottom of the 4-foot pond

(4) These very healthy and unblemished shrimps were taken out of a grow-out pond that is stocked purely with shrimp but beside a similarly sized pond stocked with tilapia. The shrimp pond water is pumped into the tilapia pond, to enable the fish to clean up the detritus including uneaten feed, and then gravity-flowed back (at the other end of the tilapia pond) into the shrimp pond. Addendum: Vasantha and Athula harvested a few more of the shrimp for dinner that night at the company's excellent Golden Mile Restaurant located on a fine strip of beach in Colombo. There we were joined by the third member of the Jaysons Farm Team, Mr. Chanaka Perera, Technical Director and superintendent of the feed mill.

The farm can be contacted at: Jaysons@dynanet.lk; Fax: 94-1-716424.

(1) Mr Athula, the farm manager (left) the author (centre) and Mr Vasantha (right)

(2) Water quality in the settlement pond is very good, assisted with more seagrass and also filter-feeding tilapia and milkfish which contribute to the sustainability (and profitability) of the farm

(3) Waste water channels are planted with seagrass for bioremediation of nutrients

The feedmill product, a shrimp starter feed. They also produce grow-out feed

(4) Water from the shrimp pond is cycled back and forth through another pond stocked with tilapia which consume wastes and uneaten feed. Polyculture of shrimp and red tilapia, pictured here, is also conducted.

This farm worker holds up a medium for the production of periphyton in a tilapia-shrimp polyculture pond

Introduction of rainbow trout *Onchorynchus mykiss* in Nepal: Constraints and prospects

Tek Bahadur Gurung*, Sadhu Ram Basnet**

*Corresponding author: Agriculture Research Station (Fisheries), Pokhara, PO Box 274, e-mail: fishres@fewanet.com.np
** Fisheries Research Station, Nuwakot, Trishuli, Nepal

The introduction of trout to Nepal

The first origins of salmonid fish in Nepal is not known. On the Indian sub-continent, Francis Day was the first to introduce salmonids in 1983[1]. India, Pakistan and Bhutan had successful introduction of trout[2]. In Nepal, two earlier attempts were made to introduce trout for sports and aquaculture development before 1988, however on both occasions the trout could not survive[2]. We are currently making a third attempt and there are indications that this time trout can be promoted successfully.

Nepal is a narrow country with a tremendous variation in both elevation and climate across its 200km width, ranging from tropical southern plains (terai) to the alpine northern Himalayas[3].

Inland water resources are abundant in Nepal[4]. There are approximately 6,000 rivers which flow from north to south[5]. Most of these rivers are turbid during the monsoon due to silt loads from glaciers. This has been suggested as the reason that the earlier introductions of trout failed. However, there are many rivulets where such high turbidity does not exist. The current success of trout cultivation in the Trishuli and Godwary areas suggests that turbidity is not the major issue and instead technological knowledge of trout farming is more important.

At present annual fish production in Nepal is estimated to be around 35, 000 tonnes (2002)[6], mainly from rivers, lakes, ponds, and rice field in Nepal. Anecdotally the aquaculture of carps seems to contribute more than 95% of total fish production in Nepal, although there are no authoritative estimates. Most production comes from the warm southern Terai region.

Trout raceways at Godawari

Trout prefer clean, cold and high oxygen water for their growth and survival, which are abundant in Nepal, particularly in the hill and mountain areas.

At present the technology for farming Nepal's native coldwater fish is not well developed and few species are economically viable to farm. The introduction of an economically viable coldwater species could allow the coldwater resources of Nepal to be used more effectively. Salmonids are well suited to commercial cultivation in cold waters and the technology is well developed[7,8,9]. There are many examples where introduction and aquaculture of trout is important source of income[9,10,11].

The first attempt to introduce salmonids in Nepal was made in 1969 by importing Atlantic salmon (*Salmo salar*) and brown trout (*S. trutta*) from Kashmir, India, and rainbow trout (*Onchorynchus mykiss*) from the United Kingdom, and sockeye salmon (*O. nerka*) from Japan in 1979-80 without success. In the third attempt to introduce rainbow trout into Nepal, 50,000-eyed eggs were brought in from Japan[12,13]. Since then rainbow trout has been bred and reared for more than a last decade[14,15].

Trout was introduced in Nepal to meet many needs including substitution of fish imported in hotels catering for tourists, use of cold-water resources for aquaculture and promotion of fishing tourism in hill streams. We have evaluated the performance of technological management of trout under Nepal's prevailing socioeconomic conditions. Here we review and briefly analyze the introduction, and possible constraints to farming rainbow trout in Nepal.

The third introduction of rainbow trout to Nepal

Approximately 50,000-eyed eggs were received at the Godawary Fish Farm in Lalitpur, Kathmandu Valley on 28 December 1988 from the Kobayashi Fisheries Experimental Station, Miyazaki Prefecture, Japan. More than 99% of the eggs survived transport and were successfully hatched and reared at Godawary, when water temperature ranged 8.0 to 10.5C. Hatching was completed after 18 days. Some of the fingerlings were sent to the Fisheries Research Centre, Trishuli. The first fish spawned after two years[7,8]. Fry were initially fed with powdered feeds obtained from Japan but later with locally available chicken yolk powder, buff liver and pellet crumble. The fish were subject to intensive health examinations.

The farms

The Godawary Fisheries Research Centre was established in 1962. This station is situated in central Nepal in the Kathmandu Valley, some 1,700 metres above the sea level and about 16 Km southeast of Kathmandu. The climate is sub-tropical and cool with water temperature falling to 8C in winter. Pond waters reach about 26-27C in summer but not more than 20C in streams. The farm is fed by small streams from surrounding hills. The discharge rate of the stream is approximately 30 litres/second.

The Trishuli Fisheries Research Centre is some 70km north-east of Kathmandu, supplied by the Trishuli River. Water temperature never exceeds above 19-20C making Trishuli suitable for trout cultivation. The elevation of the farm is approximately 600 metres from sea level.

Rearing Systems

Trout are reared in raceways at Trishuli and Godawary Farms and fed with dry pellet feed (32-40% of crude protein) and sometimes with fresh minced water buffalo meat. The rate of feeding is 2-3% of total fish biomass for production purpose.

Disease

The main diseases observed are as follows:

Fin Rot: One of most predominant diseases. This occurred among fish of greater than 1kg body weight. Fish less than 1kg were less vulnerable but not free of this disease. Fin rot was most predominant in caudal fin though occasionally pectoral and pelvic fins were also affected although fish seldom died. In newly infected parts a white streak appears near the caudal fin[16] broadening later on as the muscle and rays start to degenerate slowly. Usually, such affected fins can heal and regenerate.

Hepatoma: This was generally seen in fish bigger than 1kg body weight. This is a cancerous disease found in the liver. About 30% of fish examined had the hepatoma disease. This has also been reported from Trishuli Fisheries Research Station. The infected liver becomes enlarged and pale to white[17]. Seriously infected fish lose balance. This disease is caused by feed contamination with aflotoxin produced from mold, *Aspergillus* flavus[8,17]. Hepatoma arises after 4-6 months of exposure18. A dose of 0.1 to 0.5 ppb of aflatoxin-B1 in feed can cause the liver cancer[17,18].

Fungal diseases

Fungus is mostly a problem in fertilized eggs during incubation, and in post-spawning fish. This might be due to bruises caused by handling. In grown out fingerlings fungal diseases were hardly seen as they are not subjected to stressful handling. The most prominent fungus is *Saprolegnia* sp. This appears as 'cotton' and rapidly spreads to cover the whole body, initially attacking open wounds in adult fish[16]. Severe cases can kill the infested fish.

Intestinal disorders

Some intestinal disorders were seen during the study period. The most common occurrence was carcasses with a swollen stomach. Often in such specimens a hemorrhage and presence of watery fluid in the stomach were observed. In such cases the stomach was totally empty indicating that the fish had not consumed any feed for several days before death. The swollen stomach was also associated with redness of anal opening. Such specimens often discharged dark yellow fluid if pressed gently at proximate end of the opening.

Physical disorders

- *Blunt snout:* Some individuals had blunt or asymmetrical snout. It seemed that the lower jaw grew normally but upper jaw remained undeveloped during the course of growth and development.
- *Twisted alevins:* In 1992 some abnormal twisting occurred in under-developed alevins. These were segregated from the healthy ones but did not survive long.
- *Abnormal gills:* Abnormal gills were fringed and not properly developed. Such gills lacked compactness and redness in appearance.
- *Degenerated operculum:* In some fry the rear part of operculum was missing and gills were not completely covered with the operculum. The reasons of the degenerated operculum were not known.
- *Blindness:* Sometimes one of the eyes was absent due to unknown reasons. In the beginning the lost eyes were opaque but ultimately led to complete degeneration. Such fish were found to lose their balance. Trout are delicate and demand highly oxygenated waters[7,8].

Past failures

The reasons for the past failures of salmonids in Nepalese waters are not clearly known. Management of trout farms is labor intensive and requires considerable skill, therefore a lack of experience (management failure) might have led to failure of trout rearing in past. Fish are also susceptible to disease when reared under intensive conditions. Commercial trout farming requires good hygienic to prevent epidemics[8].

Rainbow trout can also be reared extensively, but its farming is mostly characterized by intensive feeding with high protein content feed for higher production[7]. The fish in such systems become more susceptible to many diseases. Among many diseases we encountered the most difficult seems to be hepatoma. This disease is well studied and illustrated by Wales[17]. Most of the diseases can be controlled, if proper management and hygienic measures could be taken. To prevent hepatoma, artificial feeds must be protected from contamination by aflatoxin which is often related to poor storage and handling of feed.

Fin rot was seen in large fish. This might have resulted due to overcrowding or associated with vitamin deficiency. Most diseases might be associated with the quality of feed stuffs and quality and quantity of water input in raceways.

The introduction of exotic fish may cause both positive and negative effects in a particular ecosystem[1,19,20] but trout introduction in Nepal was not as controversial as for other fish. This might be due to lack of indigenous cold water fishes for commercial farming in Nepal. Before the introduction of trout in Nepalese waters, populations of a cold water native fish Asala (*Schizothorax* sp.) was considered to be severely impacted due to trout predation. However, in Indian cold water Asala was not affected much by the presence of trout in natural waters[9]. In Japan, trout are commercially cultivated from north to south throughout the country, but trout could breed naturally only in Northern Province, Hokkaido[10]. This implies that trout are not prolific breeder but need a specific habitat to spawn in the natural environment. If this would be true in Nepalese conditions it is probable that trout populations can be regulating by stocking manipulation. These experiences also showed that trout and Asala can co-exist in same environment even if trout are stocked and succeeded to reproduce naturally in cold waters.

Conclusion

Considering vast water resources flowing through glaciers, pristine mountainous rivers; and market potential to substitute imported fish to meet tourists demands rainbow trout has been introduced in Nepal. The success of trout breeding, rearing and production, over more than one decade shows gradual development of technological packages of practices, technological feasibility and perspective in Nepal. Although some diseases and management problems related to hygienic feed storage were seen this easily remedied. For wider adoption of trout farming further investment and extension activities are desirable.

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Application of immunostimulants in larviculture: Feasibility and challenges

ZhouJin

Shanghai Fisheries University, E-mail: Zhoujin9346@sina.com)

Immunostimulants are valuable for the control of fish diseases and may be useful in fish culture. Microbial pathogens are one of the main problems in the rearing of larvae. It is therefore important to develop methods for establishing microbial control at all stages of the cultivation progress. One possibility is immunostimulation, which includes methods of enhancing the capacities of the specific and non-specific immune systems. There are many experiments on nonspecific immunostimulation of fish that suggest that the method has considerable potential for reducing losses in aquaculture, both during larval and on-growing stages. So, on one hand, we can say that use of immunostimulation in larviculture is possible. On the other hand, due to the small size and fragility of larvae the development of methods to administer the stimulant, and the adaptation of methods for detecting the response of the immune system is full of challenges. The aim of the paper is to evaluate the status and the potential for immunostimulation as an element in the strategy for solving microbial problems in larviculture. The focus will be on fish, but the ideas are also applicable to other groups of organisms relevant to aquaculture.

The characteristics of the larval immune system

The main function of the immune system is to protect the animal against disease causing microbes. The immune system comprises both nonspecific and specific components, and involves both cellular and humoral factors. It is well known that larvae do not have the ability to develop specific immunity during the early stages of development. In this respect, fish are reliant on passive immunostimulation from maternal antibodies, and this mechanism has been shown in tilapias (Mor et al, 1990; Sin et al 1994). In any given species, size rather than age seems to be the most critical determinant of the development of immunity. For example, in salmonids, memory-dependent immunity has been achieved for sizes > 0.26g (8 weeks of age), whereas in carp it was acquired at

9-10 weeks (Ellis 1988).

The nonspecific immune system is probably the main defence against microorganisms in larvae. Although we understanding of the components of the innate defence system of fish is growing, relatively little is known about the functioning and the ontogeny of the general immune system in larvae (Olafsen et al 1993). In the few fish species that have been studied, the major lymphoid organs are not fully developed at the time of hatching, and the phagocytic activity is mainly associated with gills, skin and gut (Eills,1988). It is therefore possible that during the stages when the lymphoid organs are developing, the main cellular defence is by the phagocyte populations within the integument (Ellis 1988).

The nonspecific or innate immune system is regarded as the first line of defence in animals. Furthermore, it seem that the microbial problems in larviculture are most likely due to opportunistic bacteria rather than specific pathogens (Munro et al,1995).This emphasizes the importance of nonspecific defence system for larvae under intensive hatchery conditions, and the need for more knowledge of the ontogeny and functionality of the nonspecific immune system of larvae.

Immunostimulation of larvae: Possibilities and constraints

Immunotherapy comprises all methods that utilize immunological principles to prevent or treat disease. In human and veterinary medicine, immunotherapy has already been applied but it is still regarded as an area for growth. Methods of transplanting immunologically active cells or transferring immunoglobulins are not relevant to larviculture, and therefore not treated further in this study. Immunomodulation, and in particular immunostimulation, seems to be the most suitable immunotherapeutic method for larviculture in the foreseeable future.

Immunomodulation may be direct at both specific and nonspecific immunity. Vaccination is probably the best-known method of specific immunostimulation, and it entails increased resistance against a specific antigen (pathogen).

Fingerlings of round herring

Nonspecific immunostimulation refers to a condition in which the immune response is changed to a condition with higher response towards a variety of antigens. An example of nonspecific immunostimulation is macrophage activation. An immunostimulant may be defined as an agent that stimulates the nonspecific immune mechanisms when given alone or the specific mechanisms when given with an antigen. It is believed that in eggs and larvae the effects of immunostimulation may be to enhance the "inheritance" of an immune defence, but they last for only a short period. A special case of immunostimulation may be to enhance the immune defence of larvae through immunostimulation of the mother (maternal immunity).

Many different types or groups of substance are known to act as immunostimulants, such as lipopolysaccharride (LPS),b-1,3-glucan, peptidoglycan and so on. It is important to consider the specificity of immunostimulants for two reasons. First, a stimulation of an immune system may be too intense, and may harm or even kill the host. This is well-known in humans, where the activation caused by LPS in connection with infections may cause septic shock and death (Morrison et al,1994). Secondly knowledge of the functions of different immunostimulants may be used to stimulate those parts of the immune system that may be more relevant in certain situations.

Three factors are essential to consider in the design of an immunostimulation strategy. First, it is important to remember that in most cases we do not have a specific microbial problem, but rather a general one involving large numbers of bacteria and a high proportion of opportunistic species. Secondly, the immune system of larvae is poorly developed, consisting mainly of nonspecific defences. Thirdly, the immune defences of maternal origin will be significant only during the earliest developmental stages. Although this period and hence the maternal immune defence may be critical, aquaculturists cannot rely on this part of the immune defence of the larvae alone. These three factors mean that research aimed to develop methods for immunostimulation of larvae should place the highest priority on stimulation of the nonspecific defence system. This work should principally involve stimulation of the nonspecific defence of the larvae itself, and should also include stimulation of nonspecific maternal defences if possible. In cases where specific pathogens are known to cause problems, stimulation of the specific defence may be considered through immunization of the broodstock.

Immunostimulation of larval fish: Nonspecific defences

Newly hatched fish larvae have not acquired specific imune defence, but maternally transferred specific immunity may also be of significance (Mor and Avtalion, 1990). Contrary to earlier conceptions, there are recent observations indicating that larvae start to develop immunocompetence relatively early. Bergh et al (1995) observed presence of lymphoid cells early in the first feeding period of Atlantic halibut. Padros and Crespo (1996) have described development of lymphocytes in lympoid organs of turbot at the time around

Applying oral peptidoglycan, a very important immunostimulant metamorphosis. These findings clearly indicate the importance of nonspecific immune defence in the larvae stages.

A number of studies have been performed on stimulation of the nonspecific immune defence of both fresh and seawater fish, describing a wide range of attractive methods for prophylaxis in aquaculture (Vadstein 1997). Most investigations have so far involved juvenile or adult stages, but development of strategies for nonspecific immunostimulation in culture of the earliest stages of fish may have considerable potential (Vadstein 1997).

During their 4-5 week yolk sac period larvae of Atlantic halibut are exposed to stress from high numbers of opportunistic pathogenic bacteria compared to what they experience in their natural conditions (Hansen 1993). Use of nonspecific immunostimulants has been shown to enhance viability of halibut yolk sac larvae during 4 weeks incubation, from on average 10% survival in control groups to 52% survival in treated groups (Vadstein et al 1993a). The immunostimulant used in the halibut larvae experiment was an alginate rich in mannuronic acid polymers, which is stimulatory towards human monocytes (Espevik et al 1993) and fish. The immunostimulant (termed FMI) was administered to the incubation water of small, stagnant units, and the larvae were thus long term exposed during the whole yolk sac period. The route for uptake was not studied, but stimulation of the nonspecific defence of both the skin and gut surfaces can be suggested. Immersion of marine larvae in immunostimulants at an early pre-feeding stage is therefore believed to be a suitable technique for immunostimulation, preferably in periods with stagnant or low water exchange conditions. The technique must be carefully prepared for the actual organism, regarding immunostimulant, concentration, duration of immersion, developmental stage of larvae and frequency for administration of the stimulant. Immersion has been documented as efficient also for carp (Siwicki et al 1988),even though oral administration or injection seem to be more efficient (Vadstein,1993a).

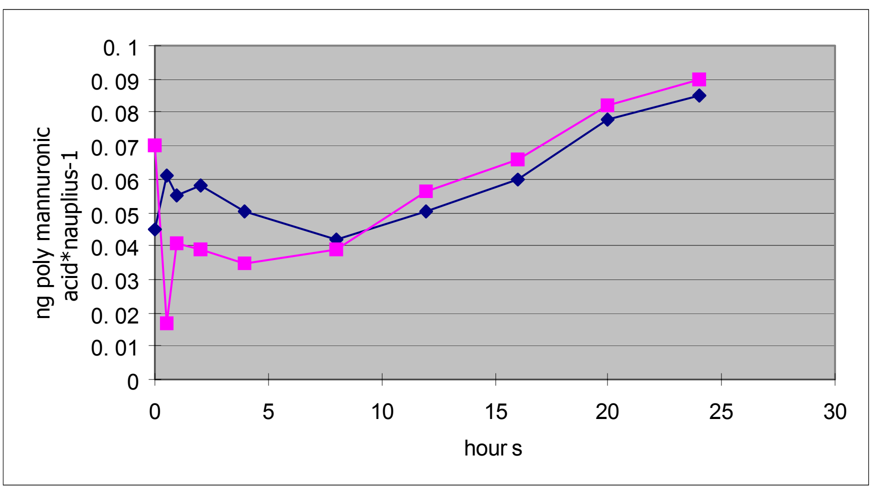
A technique for administration of immunostimulants via live food organisms has been developed. The immunostimulant is immobilized in alginate microcapsules (2-30um) and ingested by live food organisms, such as rotifers or Artemia nauplii. Fig 1 shows the content of polymannuronic acid in Artemia nauplii after grazing on alginate beads, and illustrates the relatively rapid decrease in content after transfer of the nauplii to the larval tanks. The regime for feeding the fish larvae is therefore important for successful use of live food organisms for administration of immunostimulants to larvae. The method is non-stressing and very suitable for prophylactic treatment in the earliest stages in larval first feeding. The efficiency of the method was demonstrated in two experiments where FMI was administered to turbot fry via alginate beds and Artemia two days prior to a challenge with a fish pathogenic *Vibrio anguillarum*. Mortality reductions of 39 and 48% were obtained in stimulated vs non-stimulated groups (Skiermo et al, 1995). Progress in the development of formulated first food for marine larvae, and entrapping immunostimulant in food particles suitable for larvae is therefore a challenge.

Challenges in future

As the review above demonstrates, more knowledge is needed before a strategy for specific and nonspecific immunostimulation can be developed for larviculture. The few studies on stimulation of specific maternal immunity and the more numerous studies of stimulation of nonspecific defence of fish suggest that there is a good possibility of developing efficient methods for immunostimulation in

An export-oriented farm - mainly turbot and flounder

Stability of the non-specific immunostimulant poly mannuronic acid in Artemia nauplii that had been grazing on alginate microcapsules containing the 14C-labelled stimulant, after tranefer to larval tank condition. The experiment was run with two replicate cultures (Skjermo and Vadstein, unpublished results)



to funds comparable to those available to human medicine; therefore research should focus on the immunostimulants that have already been intensively studied in other areas. The knowledge and the spin off from these other areas represent a considerable resource for aquaculture research.

For stimulation of maternal immunity, it is important to clarify whether it is possible to stimulate nonspecific immunity in a way that is relevant to larviculture. Due to the shorter duration of such stimulation, nonspecific stimulation through the maternal pathway may not be feasible, but a clarification of this point is necessary before and final conclusion can be drawn. Stimulation of specific immunity is the most promising method for applying maternal stimulation. As a general method, it is not suitable, but in the cases where specific problem

organisms have been identified, it should be possible to evaluate the potential of the method. Such an evaluation should include optimization of immunization procedures, and evaluations in both challenge experiments and under production conditions. It is important that evaluations are done under both sets of conditions, because even if stimulation of maternal immunity does not have significant positive effects in a challenge test, in which the problem organism occurs at high densities, it may do so under production conditions. The method is not restricted to bacteria (Sin et al 1994).

The challenges related to nonspecific immunostimulation of the larva itself are more diverse than those related to maternal immunity. Reliable larval experiments are expensive, due to the complexity and the poor reproducibility of such experiments. More information is required on the developmental stage in which immunostimulation is possible, and for these additional evaluation criteria other than challenge tests will be needed. The research on the ontogeny of the nonspecific immune system should focus not only on the development and the functioning of relevant organs, but should also include studies of the immune system in the integument. The development of methods of assessing stimulation is a special challenge; due to the small size of larvae. Priority should be given to the establishment of methods for determining parameters that occur early in the cascade of reactions triggered by immunostimulants. The research directly related to the establishment of an immunostimulation strategy should include evaluation of administration procedures, dose-response relationships, and the evaluation of the duration of stimulation.

Prospects

Immunostimulation is one element in a strategy to achieve microbial control. Direct stimulation of nonspecific immunity and stimulation of specific defence mechanism of maternal origin seem to be the most promising methods for larvae. Based on available knowledge, it is concluded that although this technique is still in its infancy, immunostimulation of fish has a considerable potential for reducing losses in aquaculture, during both larval and on-growing stages. The experience with larvae, however, is very limited. More research and developmental work on immunostimulation of relevance for larviculture is needed if immunostimulation would contribute to the development of the aquaculture industry.

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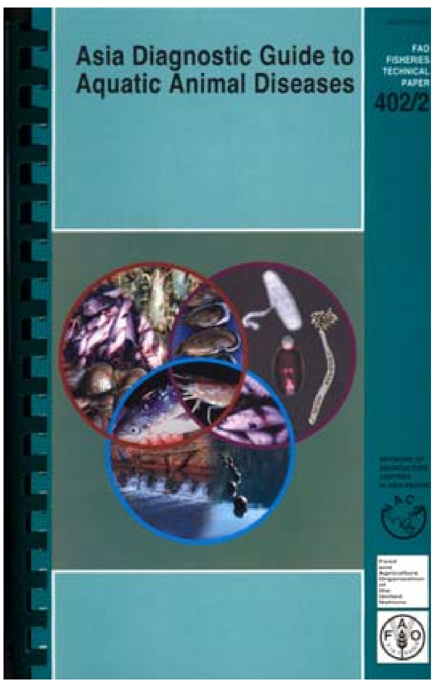


Tilapia seed production in Ho Chi Minh City, Southern Vietnam

H. P. V. Huy, A. MacNiven, N. V. Tu, Ram C. Bhujel and David C. Little

Climatic conditions in Vietnam vary greatly as the country stretches from the South of China in the North to the Gulf of Thailand in the South. In the north, temperatures sometimes drop below 10ºC during winter, and tilapias need careful over-wintering to survive. In the south of the country temperatures are suitable year-round. In Southern Vietnam especially around Ho Chi Minh (HCM) city, tilapia seed is produced in sewage-fed ponds using methods that have been developed by farmers themselves. The majority of tilapia seed used in the provinces around HCM and on the Mekong Delta are produced in these systems. Tilapia seed production has become a part of diversified suburban agriculture system and appears to have evolved as a byproduct of food-fish production.

Culture of fish in ponds fed with wastes from latrines has been a tradition in Southern Vietnam, especially stocking of Pangasius seed collected from wild. Stocking of hatchery-produced seed is more recent phenomenon that has been driven by the market demand in and around the HCM city where aquaculture is increasingly commercial in nature; 40% of the fish farmers say that aquaculture is their main source of income1. Although Chinese and Indian carps, silver barb, gouramies and hybrid catfish are cultured in Southern Vietnam, the most preferred species are tilapia and the common carp. Hatchery techniques and infrastructures for all of these species are now well developed. Specialized nursing and trading activities have become well established. Both wholesalers and retailers are important players in the trading of fish seed in Southern Vietnam. While this has improved the supply of fish seed to farmers, it has led to a lack of contact and reduced information flow between hatchery operators and food fish farmers. For example food fish farmers understand little about the source of broodfish or method of seed production. Perceptions of seed quality vary with grow-out farmers, traders and nursers. Inconsistent tilapia seed quality was perceived to be a problem by the traders in Southern Vietnam, especially those distributing seed to the Mekong Delta that involves longer transportation times. Farmers were also of the opinion that the poor seed quality is a main factor causing poor fish productivity. The causes of the perceived poor quality could be due to poor pond management, lack of technical know-how, long distance transportation, poor handling and/or poor broodstock quality. Therefore, tilapia fry were collected for an on-station research at the University of Agriculture and Forestry to compare the quality and to identify the associated factors. A survey was also conducted to provide supplementary information to the research trial. It was felt that this information on it's own would be useful for those who are involved in planning, research and education in Vietnam and other parts of the world.

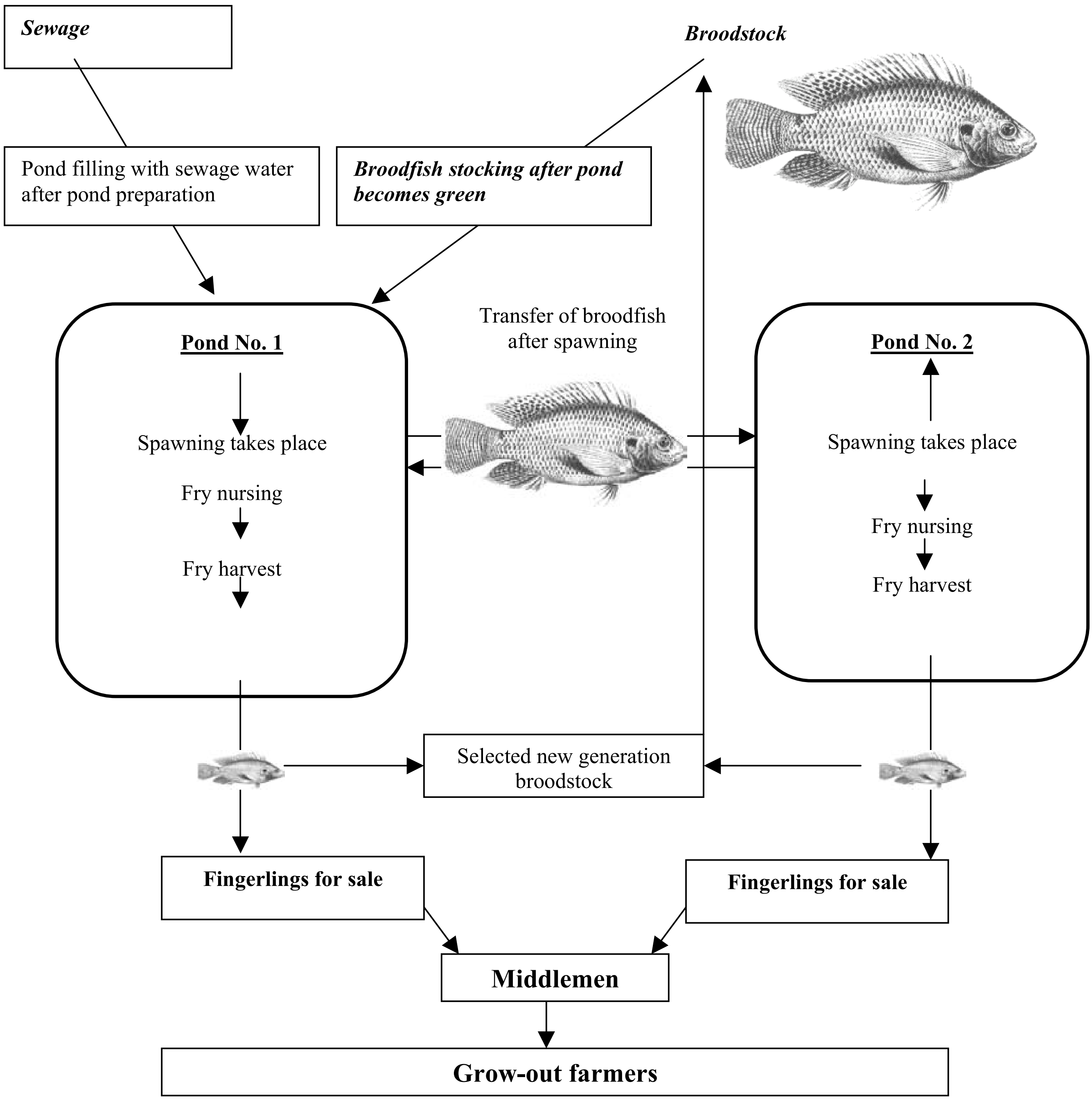
Survey method

A questionnaire survey was conducted with 20 fry producers who provided seed that were used in an on-station nursery trial. These farmers represented a sample of about 10% of the hatchery operators in District no. 8 of Ho Chi Minh City A brief face-to-face interview was carried out with each hatchery operator to gather information on the source of seed, broodstock and nursery management. The survey covered both socio-economic and technical issues relating to the quality of fish seed.

Production system and the practices

Observation during the survey revealed that most farmers use at least two ponds that are filled with water from the municipal sewage canals, which pass through the district. Before filling the ponds, farmers drain and dry them, and use pesticides to kill predators. Some farmers also use quick lime (@7-10 kg/100m2). The average pond size ranges from 1,000 to 2,000 m2. As sewage water is rich in nutrients, growth of natural food or plankton occurs within a week or so. Sewage varies in strength seasonally. As it is stronger in the dry season, it needs settlement before use. After the appearance of sufficient natural food, tilapia brooders are stocked into the pond i.e. Pond 1 (Figure 1). Normally fry are observed after about three weeks of broodfish stocking. After spawning the broodstock are transferred to the other pond i.e. Pond 2 leaving the fry behind in the Pond 1. Some farmers claim that if broodfish are seined by 4-5 persons early in the morning when the fish are surfacing because of low dissolved oxygen, 90% of the broodfish can be removed. All the fingerlings are harvested after about 10-30 days by seining and draining of the pond. The seed are graded at harvest into 5 sizes (mean individual weights 6, 8, 10, 12 and 14 g) and the ratio of seed size harvested depends on the nursing period. The duration of cycles varies with demand. If the demand is low the operator tends to lengthen the nursing period resulting in larger seed. The first pond is again prepared over a 10-day period for the next breeding cycle to stock the same broodfish kept in the second pond or the new breeders. The new breeders are the fingerlings produced in these ponds and nursed separately in other ponds. In this way the cycle of tilapia seed production continues. The majority of seed producers use 3-4

Figure 1. Steps involved in tilapia seed production in HCM City, Southern Vietnam



cycles per year; however, some of them can produce up to 8 cycles a year. The majority of farmers change the water either continuously or at least 2-3 times per culture cycle.

Socio-technical information

The survey results showed that the majority (60%) of the tilapia fry producers have considerable experience (mean of 12 years (range 5-24 yrs). Almost all (95%) of the hatchery operators produce tilapia seed as their main occupation, utilizing mostly family labor. However, at least one-third of the total producers have some alternative source of income such as sale of fruits from the trees grown on the dikes or from family members who are employed off-farm. Most of the fry producers (85%) feel they lack technical information. The majority (75%) of the seed producers learned the techniques from their neighbors and none has had any training even on general fish culture. A small percentage (15%) of the seed producers interviewed learnt by themselves suggesting that the techniques employed are relatively easy to adopt. Most of the seed producers (90%) recognise Nile tilapia, and 60% use a pure strain initially imported and distributed by AIT Aquaculture Outreach in 1993. About 40% produce hybrids, but 75% wanted to try to produce pure Nile tilapia. A minority of producers (20%) were aware of all-male tilapia production techniques. Only a few seed producers (15%) are planning to expand their operations while the majority (70%) were satisfied with their current level of business and said that they would continue rather than selling off their land, which is a common practice in such suburban farming areas.

Table 1: Characteristics of tilapia seed production system in Ho Chi Minh City, Vietnam

Parameters	Special features
1. Stocking density	ranged from 0.7 to 1.1 kg (average = 0.9 fish/m^2)
2. Sex ratio male:female (at stocking)	1:2 - 8 with an average of 1:5
3. Broodfish weight	male = 99.5 g and female = 101.5 g
4. Broodstock feeding	rice-bran (80%) only @1.5 mt/ha/cycle or with duckweed (20%)
5. Fry feeding	rice bran only
6. Fingerling holding system	hapas in tank to hold the over-produced seed but they don't feed them anything during this holding period
7. Annual fingerling production	400 – 5,500 kg (i.e. 0.2 – 3.3 million fingerlings)/per family)
8. Fingerling sale	Most of the hatchery operators (90%) sell their fry to middlemen in the local district market i.e. Trong Vuaong
9. Fingerling price	1 US$/kg (~ 0.17 cent/fingerling)

Most of the respondents hadn't received any complaints against the quality of fry they sell. Their customers are mainly fingerling traders. Out of 20 fry producers interviewed 19 have maintained or increased their level of fry production over the last five years. Only one producer has decreased the production. The main constraints to further increasing production are time availability, and the cost of feed and broodstock. Feed (90% of the respondents) and broodstock quality (65% of the respondents) were considered the most important factors in improving productivity. Various technical features of the system practiced by the farmers are presented in Table 1 and Figure 1.

Implications

As the system used by these peri-urban Vietnamese farmers is, largely, self-sustaining, almost all of the seed producers have adopted it as their main business. Seed quality was not an issue for these hatchery operators; any feedback they received gave them no cause to change their practices. On the other hand, there might be some problems but complaints come up to the middle-men level only since they have no direct contact with the end-users or the small farmers, and they only deal with middlemen who transport the seed throughout the region. These farmers had not been trained or supported with appropriate knowledge and skills. We can see, however, that a successful farmer can have an important impact on neighboring farmers through the existing diffusion mechanism, or network for innovation. However, the perception of the hatchery customers on the Mekong Delta is different from those in the provinces around HCM city. On the Mekong Delta, farmers perceived the quality of tilapia seed to be poor whereas this was not so strong closer to their site of production. An earlier report1 concluded that the poor quality of the seed produced in the same system was related to poor transportation and handling conditions of seed rather than genetics per se. Nevertheless, inconsistent supply of quality seed has led commercial cage operators on the Delta to regularly import high quality mono-sex fry from Thailand. The continuance of this sewage-based hatchery system is likely given current prices and input costs but a market for seed of higher quality has emerged for which alternatives are required. Use of sewage requires frequent sediment removal from ponds if productivity is to be maintained which is labor intensive but is currently a cost effective method to both produce a value-added crop and, in the process, treat human waste. Open pond-based systems make production of pure, improved stocks difficult because of contamination with feral fish. Moreover hormone treatment of fish removed from such systems produces very inconsistent results. Poorer access to sewage as municipal sanitation projects come on stream is also likely to impact on the system.

Realizing the benefits of tilapia as a source of protein and income for the rural poor, and as a potentially lucrative export commodity, the Vietnamese government is now actively promoting tilapia production through activities under their Fisheries Master Plan. The sewage based system produces an estimated 200 million of fry annually in a single district (no. 8) in Ho Chi Minh city and provide employment to about 200 families; the practice also occurs in other areas of the peri-urban zone. However, to fulfill the potential demand for high quality tilapia fry, a larger scaling up in the capacity of hatcheries will be needed to produce and supply seed to meet such ambitious government targets. The existing system will require improvement to remain competitive with other hatchery systems in the future and to contribute to the increase in production planned. This will require active support for current and new sewage hatcheries from government agencies responsible for both aquaculture development and urban sanitation.

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Seaweed Mariculture: Scope And Potential In India

Sajid I. Khan and S. B. Satam

College of Fisheries, Dr. B. S. Konkan Agricultural University, Ratnagiri

Seaweeds are macrophytic algae, a primitive type of plants lacking true roots, stems and leaves. Most seaweeds belong to one of three divisions - the Chlorophyta (green algae), the Phaeophyta (brown algae) and the Rhodophyta (red algae). There are about 900 species of green seaweed, 4000 red species and 1500 brown species found in nature[1]. The greatest variety of red seaweeds is found in subtropical and tropical waters, while brown seaweeds are more common in cooler, temperate waters.

Economic importance

Some 221 species of seaweed are utilized commercially. Of these, about 145 species are used for food and 110 species for phycocolloid production (eg. agar). Seaweed has been a staple food in Japan and China for a very long time. The green seaweeds *Enteromorpha*, *Ulva*, *Caulerpa* and *Codium* are utilized exclusively as source of food. These are often eaten as fresh salads or cooked as vegetables along with rice. *Porphyra* (Nori), *Laminaria* (Kombu) and *Undaria* (Wakame) are used for making fish and meat dishes as well as soups and accompaniments.

Agar-agar, agarose and carrageenan are commercially valuable substances extracted from red seaweeds and find extensive use in many industries. The greatest use of agar is in association with food preparation and in the pharmaceutical industry as a laxative or as an outer cover of capsules. With the advent of modern molecular biology and genetic engineering, agar gums producing an 'agarose' factor are used extensively in electrophoresis in most laboratories around the world. Carrageenans are generally employed for their physical functions in gelation (include for example, foods such as ice cream), viscous behavior, stabilization of emulsions, suspensions and foams, and control of crystal growth[2].

Chemicals from brown seaweeds such as alginic acid, mannitol, laminarin, fucoidin and iodine have been extracted successfully on a commercial basis. As the alginates can absorb many times their own weight of water, have a wide range of viscocity, can readily form gels and are non-toxic, they have countless uses in the manufacture of pharmaceuticals, cosmetic creams, paper and cardboard, and processed foods.

Being rich in minerals, vitamins, trace elements and bioactive substances, seaweeds are called medical food of the 21st century. *Digenea* (Rhodophyta) produces an effective vermifuge (kainic acid). *Laminaria* and *Sargassum* species have been used in China for the treatment of cancer. Anti-viral compounds from Undaria have been found to inhibit the Herpes simplex virus, which are now sold in capsule form. Research is now being carried out into using *Undaria* extract to treat breast cancer and HIV. Another red alga *Ptilota* sp. produces a protein (a lectin) that preferentially agglutinates human B-type erythrocytes in vitro. Some calcareous species of *Corallina* have been used in bone-replacement therapy[3]. *Asparagopsis taxiformes* and *Sarconema* sp. are used to control and cure goiter while heparin, a seaweed extract, is used in cardiovascular surgery.

Global seaweed production and trade

Currently there are 42 countries in the world with reports of commercial seaweed activity. China holds first rank in seaweed production, with *Laminaria* sp. accounting for most of its production, followed by North Korea, South Korea, Japan, Philippines, Chile, Norway, Indonesia, USA and India. These top ten countries contribute about 95 % of the world's commercial seaweed volume. About 90 % seaweed production comes from culture based practices. The most cultivated seaweed is the kelp *Laminaria japonica*, which alone accounts for over 60 % of the total cultured seaweed production while *Porphyra*, *Kappaphycus*, *Undaria*, *Eucheuma* and *Gracilaria* make up most of the rest to a total of 99 %. The most valuable crop is the red alga Nori (*Porphyra* species, mainly *Porphyra yezzoensis*), used as food in Japan, China and Pacific.

According to FAO[4], between 1981 and 2000, world production of aquatic plants increased from 3.2 million tons to nearly 10.1 million tons (wet weight), upholding US $ 6 billion world trade in 2000, compared to US $ 250 million trade in 1990. The contribution of cultured seaweeds is 15 % of total global aquaculture volume (45,715,559 tons) or nearly 5 % of total volume of world fisheries production (141,798,778 tons) for 2000. The seaweeds that are most exploited for culture are the brown algae with 4,906,280 tons (71 % of total production) followed by the red algae (1,927,917 tons) and a small amount of green algae (33,700 tons).

East and South-East Asian countries contribute almost 99 % cultured production, with half of the production (3 million tons) supplied by China. Most output is used domestically for food, but there is a growing international trade. The *Porphyra* cultivation in Japan is the biggest seaweed industry, with a turnover of more than US $1.8 billion per annum. Total EU imports of seaweed in 2001 amounted to 61,000 metric tons with the Philippines, Chile and Indonesia as the biggest suppliers. Significant quantities of Eucheuma are exported by the Philippines, Tanzania and Indonesia to USA, Denmark and Japan. The

Table 1: Different edible seaweeds with their local names

Species	Type	Country	Local name/product
Laminaria	Brown	Japan	Kombu
		China	Hai Dai
Porphyra	Red	Japan	Nori / Amanori / Hoshinori
		China	Zicai
		Korea	Kim
		UK (Wales)	Purple laver / Laver bread
Undaria stipes *Undaria pinnatifida*	Brown	Japan	Wakame
		China	Quindai cai
Rhodymenia palmata *Palmaria palmata*	Red	Scotland	Dulse
		Ireland	Dillisk
		Iceland	Sol
Chondrus crispus	Red	Europe	Irish Moss / Carraghean
Asparogopsis taxiformis	Red	Hawaii	Limu kohu
Misc. sp.	-	Hawaii	Limu

Philippines accounts for nearly 80 % of the world's total *Eucheuma cottonii* production of 1,30,000 tons, roughly 35 % of which is traded in dried form. It supply 14 % of the world's total raw seaweed production and holds first rank as producers of semi-refined carrageenan, contributing close to 60 % of the world market.

Seaweed resources of India

Seaweeds grow abundantly along the Tamil Nadu and Gujarat coasts and around Lakshadweep and Andaman and Nicobar islands. There are also rich seaweed beds around Mumbai, Ratnagiri, Goa, Karwar, Varkala, Vizhinjam and Pulicat in Tamil Nadu and Chilka in Orissa[5]. Out of approximately 700 species of marine algae found in both inter-tidal and deep water regions of the Indian coast, nearly 60 species are commercially important. Agar yielding red seaweeds such as Gelidiella acerosa and Gracilaria sp. are collected throughout the year while algin yielding brown algae such as *Sargassum* and *Turbinaria* are collected seasonally from August to January on Southern coast. A standing crop of 16,000 tons of *Sargassum* and *Turbinaria* has been reported from Indian waters[6].

The surveys carried out by Central Salt and Marine and Chemical Research Institute (CSMCRI), Central Marine Fisheries Research Institute (CMFRI) and other research organizations have revealed vast seaweed resources along the coastal belts of South India. On the West Coast, especially in the state of Gujarat, abundant seaweed resources are present on the intertidal and subtidal regions7. These resources have great potential for the development of seaweed-based industries in India.

Seaweed industry in India

The seaweed industry in India is mainly a cottage industry and is based only on the natural stock of agar-yielding red seaweeds, such as *Gelidiella acerosa* and *Gracilaria edulis*, and algin yielding brown seaweeds species such as *Sargassum* and *Tubineria*[6]. The production of total seaweeds in India in 2000 was approximately 600,000 tons (wet weight). India produces 110-132 tons of dry agar annually utilizing about 880-1100 tons of dry agarophytes. Annual algin production is 360 to 540 tons from 3,600 to 5,400 tons dry alginophytes.

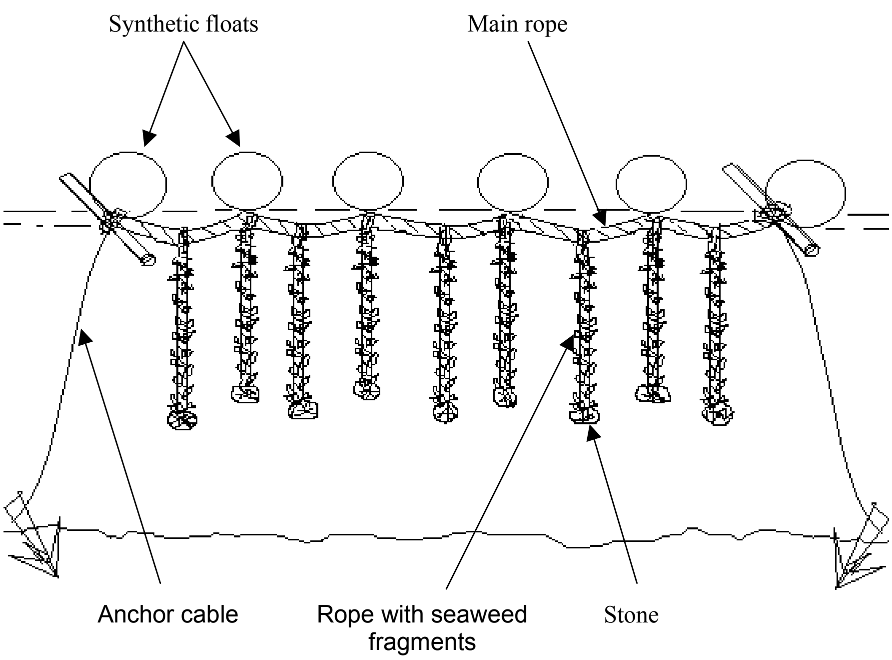
Perhaps, the first large scale commercial cultivation of seaweeds in India has been embarked upon by Pepsi Foods Ltd. (PFL) along a 10 km stretch of the Palk Bay side towards Mandapam (Ramanathapuram Dist.) in Tamil Nadu, with technical support from Marine Algal Research Center, CSMCRI, Mandapam. They have started cultivating *Eucheuma cottoni* and *Hypnea musciformis* in an area of 100 hectares through a contract farming system in which seaweeds are grown in individual plots of 0.25 ha (40 m x 60 m). Each harvest cycle from planting to harvesting takes 45 days with an annual yield of 100 tons (wet weight) per hectare, which translates into 10 tons of dry seaweed or 2.5-3 tons of carrageenan. The company has plans to expand culture operations to over 5,000 to 10,000 ha in the near future. Furthermore, many agar and algin extracting industries have been established in different places in maritime states of Tamil Nadu, Andhra Pradesh, Kerala, Karnataka and Gujarat the seaweed industry is certainly on its way towards establishing itself well in India.

Seaweed mariculture

Large-scale seaweed mariculture is carried out only in Asia, where there is a high demand for seaweed products and burgeoning populations to create market growth. Cultivation of seaweeds in Asia is a relatively low-technology business in that the whole, attached plants are placed in the sea and there is a high labor content in the operation. Except for the large kelp harvesters of Southern California and Baja California or in Philippines and Taiwan Province of China, most seaweed are grown or harvested from wild stocks using manual techniques.

The demand from the phycocolloid industry of India is great but the present production from natural habitats is very low and insufficient to cater to the needs of the local industry. This gap between the demand and supply can be bridged through mariculture practices for seaweeds by cultivating the useful species on commercial scale. Continuous supply, improved yield and quality as well as conservation of natural seaweeds beds are some of the important advantages of seaweed mariculture.

Figure 1: Single Rope Floating Raft culture technique



The main culture methods involve either vegetative propagation using fragments from mother plants or by different kinds of spores such as zoospores, monospores, tetraspores and carpospores. Kelps (brown algae) cannot be grown from fragments as there is a high level of specialization and fragments of sporophytes do not regenerate whereas the agarophyte cultivation can be done by vegetable propagation starting from fragments. Fragments of adult plants, juvenile plants, sporelings or spores are seeded onto ropes or other substrata and the plants grown to maturity in the sea.

Amongst the many culture techniques, the Single Rope Floating Raft (SRFR) technique developed by CSMCRI is suitable for culturing seaweeds in wide area and greater depth (fig. 1). A long polypropylene rope of 10 mm diameter is attached to 2 wooden stakes with 2 synthetic fiber anchor cables and kept afloat with synthetic floats. The length of the cable is twice the depth of the sea (3 to 4 m). Each raft is kept afloat by means of 25-30 floats. The cultivation rope (1 m long x 6 m diameter polypropylene) is hung with the floating rope. A stone is attached to the lower end of the cultivation rope to keep it in a vertical position. Generally 10 fragments of Gracilaria edulis are inserted on each rope. The distance between two rafts is kept at 2 m. Floating raft technology has been recommended to be used on the Kerala coast for agarophyte cultivation[8]. Certain areas in the Gulf of Kutch have been suggested as suitable for deep-water seaweed cultivation[7]. In addition, CMFRI has developed and perfected techniques for culturing *Gelidiella acerosa*, *Gracilaria edulis*, *Hypnea musciformis* and *Acanthophora spicifera*, and now attempts are being made to find improved techniques for propagation and large scale culture of other economically important seaweeds.

Problems and Prospects

The major problems in the seaweed industry include overexploitation leading to a scarcity of raw material, poor quality raw material, labor shortages during the paddy harvesting and transplanting season, lack of technology to improve processed product quality, and a lack of information on new and alternative sources of raw materials.

Despite the great number of sheltered bays and lagoons suitable for mariculture, no large-scale attempts to grow seaweed have been made in India so far. Efforts are needed to increase production through improving harvesting techniques, removal of competing species, creation of artificial habitats and seeding of cleared areas. As the technology for reliable methods for the cultivation of different commercially important seedstocks and their improvement has either already been developed or presently being in research, it needs to be disseminated effectively to the target community. Extensive surveys need to be conducted to identify suitable sites for large-scale seaweed culture.

There is great potential for the agarophyte cultivation because of its low availability from the wild stock due to over-exploitation. Many edible seaweed species are available on the Indian coast; attempts should be made to develop products suitable for the Indian palate and to popularize the same amongst the public. With regard to pharmaceutical substances, heparin analogues (heparinoids) that are inhibitory to thrombin activities have been reported from Chlorophyta of Indian coasts[9]; this and many other important types of seaweed are available on Indian coast that can be utilized for production of many important pharmaceutical products through extraction of bioactive compounds.

Attention should also be given towards developing hybrid species with superior growth and nutritional characteristics, as the same has been proved successful in countries like Japan. Rather opting for high-volume-low-value seaweeds, culture of high-value seaweeds should be aimed for, as part of integrated coastal and national development programmes[10].

Seaweed polyculture in association with molluscs and fishes seems to have good prospects to increase harvest and profits. Pond and canal culture of seaweeds (e.g. *Gracilaria*) in shrimp farming areas can help to treat the effluent water. The problem of eutrophication of culture ponds due to overfeeding and excreta released by fish/shrimp can be tackled by culturing seaweeds in such ponds.

Out of estimated around US $ 3 billion global phycocolloid and biochemical business, India's share is meager. We can surely grab a bigger part in this lucrative business with sincere efforts towards large-scale cultivation of commercially important species and processing. To facilitate this, more technologically sophisticated extraction plants with easy access to markets and marketing organizations need to be established nearby cultivation areas to utilize the resources efficiently with greater profits.

Since it requires low inputs, and provides good returns and can employ many people seaweed culture is a good industry for coastal communities. The efforts in seaweed cultivation and its utilization through product and process development could help in meeting the food and nutritional security of Indian population as well as augmenting value of total fisheries export. Seaweed has a very important role to play towards betterment of coastal fishing communities and as a valuable foreign exchange earner. The need of the present hour is to train, encourage and promote coastal fishermen population at suitable sites, through combined efforts of respective State Governments, research institutes, seaweed industry, Marine Products Export Development Authority and local NGOs, to adopt commercially viable large-scale culture technologies, and to provide them with good marketing facilities through proper channels.

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Shrimp harvesting technology on the south west coast of Bangladesh

S. M. Nazmul Alam, Michael J. Phillips and C. K. Lin

Shrimp farming is an ancient traditional practice along the southwest coast of Bangladesh. This kind of farming is a natural rearing process in its simplest form. The main species grown are the black tiger shrimp *Penaeus monodon* along with other finfish as by-catch.

The ownership patterns of extensive shrimp farming systems are complex and vary from area to area in Bangladesh. The major categories of shrimp farm ownership are:

- *Individual owner:* The land in the farm is owned and operated by one person. The landowner invests cash according to his capability and enjoys total returns from the farms.
- *Farmers group:* The land in the farm is owned by a number of persons who all pay an active role in operating the farm. They contribute land and money and do the farming jointly. They also share the returns on shrimp from the farm proportionate to their contribution of land, cash and physical labor. However during paddy cultivation each farmer in the group cultivate paddy singularly.
- *Outsider lease:* The land in the farm is leased out by owners to a person or persons living outside the Polder area. The outsiders provide capital, and usually set up shrimp farms taking most of the land from small and medium landowners. They usually ally themselves with neighboring medium landowners by taking their land and give them a share in the farm operations and income. This is done to gain influence over the land and control over the local people.

Shrimp farms are located in the inter-tidal range. Farm design is highly dependent on the characteristics of the site selected and there is no consistent design. However, most farms follow an open system with no treatment ponds. The bottom of the ponds is generally irregular.

The farming period starts from February to the end of November with multiple stocking and harvesting methods. The different categories of shrimp farmers described above use almost the same type of management activities for pond preparation and grow out. However, the application rate of fertilizer, stocking density of post larvae, and water exchange rates vary from farmer to farmer.

The average water depth in the pond is 0.6 meters. Generally the depth is reduced around 10-15 cm at two-week intervals. 10-30% of the pond volume is exchanged during tidal regimes and farm outflows are discharged directly to the common flushing cum drainage canal.

The farms are usually rectangular or irregular with a large surface area. The actual farm size is highly variable. Shrimp farms under individual ownership are generally smaller in size (average 2.3 ha) than that of the farm owned by the farmers group (average 4.6 ha). The largest farms are occupied under outside lessee (19.6 ha) ranging from 10.8 ha. - 36.4 ha. Yields of *Penaeus monodon* are variable ranging from 109 kg/ha to 146 kg/ha.

Harvesting is generally carried out after 90-120 days of extensive shrimp farming. Harvest is usually done early in the morning and a number of different methods are used. The harvesting techniques also vary among farm owners. The harvesting usually takes place during full and new moon of a lunar cycle. A cycle consists of 5-7 days. The used water from the farm is partially drained out through the canal and fresh tidal water introduced into the farm. The shrimp become excited and start moving towards the entry point of the tidal water as shrimp by habit like to swim against the current.

The following methods are in practice for harvesting of farmed shrimp in the area.

Gai method

A very small portion of the farm is converted into a rectangular shaped harvesting area. This area is prepared adjacent to the canal. The individual and farmer groups build the area with soil dikes all around. One wooden gate locally called tepata of varied size is placed in the inner dike of the area to control of the flow of water from both sides. The outside lessees build the dikes and bottom with concrete materials to ease the harvesting process. Individual farmers place a bamboo fence laterally a short distance from the canal to prevent the escape of shrimp and fishes. Better off farmers operating either as individuals or in groups now use plastic pipes to make the fence as it is more durable and long-lasting. This fence is called main pata. Another 'V-shaped' bamboo made fence is set up to a little distance from the main pata. This fence is called pusti pata. The tail end of this fence is faced against the incoming water. This end has small vertical opening to allow shrimp to enter into the vacant area from the farm. The area in between these two fences is the catchment area and the total harvesting area is locally called Gai.

Shrimp enter the catchment area through a narrow passage of the fence, and cannot go back to the rearing area of the farm. When the inflow of the water has become stationary shrimp are caught with cast net. The outside lessee sometimes drags the cast net, as the bottom is smooth concrete. Lastly, the water of the catchment area is totally drained out and the last few pieces of shrimp are caught manually. The system is repeated during a lunar cycle.

Trap method

Trapping is another way of harvesting shrimp. Some bamboo traps, locally called Aatol and measuring of various sizes (standard 60cm x 75cm x 60cm) are placed at 2.5-3metre intervals from the periphery to inside the farm. Fine meshed net is attached to each of the traps. These are set up in the deeper area of the farm. During the flow of the tide the shrimp usually move towards the edge of the dike and happen to entry into the traps. The are checked at intervals, the shrimp removed and the traps reset. This system continues until the end of each lunar period. The Aatol is also placed at the attachment of the main pata of the Gai. The large shrimp farms, especially outside lessee usually set up the Aatol where shrimp are unable to move to the Gai because of the tide. All categories of shrimp farmer believe that the hatchery bred shrimp fry are not capable of moving to the Gai against a strong current. So the farm owners put traps out at intervals to harvest the shrimp.

Net method

Cast nets are used for harvesting the shrimp when the farmer finds fewer amounts of shrimp is caught in the Gai or in the trap. The farm owner engages some cast net owners. The netters stand close to each other and cast together. Thus they move forward casting nets all over the farm and shrimp are harvested. This technique is particularly used by large farm owners (outside lessees) at the end of season.

Market

A small size floor is constructed near the Gai and is called Chatan. This place is used for washing, sorting and selling of shrimp. A guardhouse made by nypa leaf is also constructed close to the Gai. The harvested shrimp are kept in different kinds of bamboo crates/ coops. The shrimp are washed with saline water and placed in a heap at Chatan to make ready for sale at the farm gate. The Chatan is made of concrete by the outside lessees, but small individual and group farmers prepare the area with earth instead and place a piece of polyethylene sheet on it during selling time. The buyer comes to the farm gate, bargains and settles on the price. Sometimes selling through auction is takes place due to presence of a number of buyers. The bid winner occasionally shares the lot with other fellow buyers who came to bid to keep social harmony. The head-on shrimp are then taken into the local depot for icing and are forwarded to the processing plant within shortest possible time for beheading and onward dressing.

Earth made Gai *mostly operated by individual or group farm owners*

Concrete made Gai *by outside lessee*

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About the authors

S. M. Nazmul Alam has recently completed M. S. degree on Integrated Tropical Coastal Zone Management from Asian Institute of Technology (AIT), Thailand. E-mail: smnazmul@bdonline.com.Postal: 169-West Agargaon, Shere Bangla Nagar, Dhaka-1207, Bangladesh. Tel: 880 2 8117258.

Michael J. Phillips is an Environmental Specialist with Network of Aquaculture Centres in Asia-Pacific (NACA), Bangkok, Thailand.

C. K. Lin is an adjunct Professor in Asian Institute of Technology, Thailand.

Farmers as Scientists
This is a series anchored by M.C. Nandeesha. It describes farmer-driven innovations and experiences.

The "Gher Revolution"

Innovations in freshwater prawn farming by Bangladesh farmers

Dr M.C. Nandeesha is Head of the Department of Aquaculture, College of Fisheries, Central Agricultural University Tripura, India. Email mcnraju@yahoo.com

Happy fish farmers display the harvest of giant prawn from Ghers. Periodic harvesting helps farmers to access income regularly throughout the culture period

Giant Freshwater prawn production

Globally , the freshwater prawn industry is growing at a rapid speed surpassing all estimations and assumptions. Mr. Michael New organized the first dedicated symposium on Freshwater prawn more than two decades ago in Bangkok in collaboration with the Department of Fisheries and brought out a special publication with selected papers entitled Giant Prawn Farming through Elsevier . That global event consolidated research and development directions for giant freshwater prawn (GFP) farming. The latest revised publication of the manual "Farming Freshwater Prawns (FAO Technical paper 428) further indicates the growing importance received by this group from farmers, researchers and development personnel. In August, 2003, in Kochi , in the southern part of India , an international symposium on Freshwater prawns was held with representatives from 15 countries and more than 400 delegates attended the event. Mr. Michael New took part in this symposium and delivered the key note address. Historically , a lot of significance was attached to the participation and presence of Michael New and in particular for the constant efforts made by him in stimulating timely debate on GFP and driving healthy growth of the industry.

India produced a very small amount of fresh water prawns from the cultured environment about two decades ago. Ten years ago the College of Fisheries at Kerala Agriculture University organized the first symposium on freshwater prawn farming in India. I had the opportunity of attending that symposium. Most people were not sure how the industry would expand further as many technical and social questions remained unanswered. However, the latest symposium organized by the same College in August 2003 a decade later clearly demonstrated that their vision on the potential of this species has been right and the industry is likely to further expand greatly. Today , with the research and developmental efforts of many organizations and farmers in particular, giant freshwater prawn farming has grown into a major industry in the country contributing to more than 30,000 tons of production. Over 34,000 ha of water bodies are under the culture of this species. Land locked states are perfecting the technique pf producing prawn seed using artificially constituted sea water. As per the information presented in the symposium, based on 2001 statistics, China is leading with a production of 128,000 tonnes followed by Vietnam (28,000 t) , India (24,230 t) , Thailand (12,067) , Bangladesh (7000t) , Taiwan (6859 t) , Brazil, (5380 t) , etc. These production figures need to be viewed with caution as the data collection systems for aquaculture production is yet in developing stage in many countries. However, most importantly , much of the production of GFP comes from small farmers . The species is contributing immensely in poverty alleviation and ensuring most essential livelihood necessities of these small farmers. As it is time to learn from the repeated success of this species culture by small farmers, in this article an effort is made to document the "Gher Revolution" accomplished by the farmers of Bangladesh.

Cultivation of GFP in Ghers: Bangladesh farmers innovation

Gher is a Bangla word used for the physical construction made for growing freshwater prawns in an impounded environment. These constructions, generally built in paddy fields, are used for growing both paddy and prawns / fish. The Ghers usually have a large dike with canals and an area dedicated for paddy cultivation

A Gher with paddy crop

within the Gher. Generally , less than 50% of the area is allocated for canal and rest of the area is used for paddy cultivation. The latest production figures reported by various authors from Bangladesh indicate that the country is already producing about 12,000 tones of giant fresh water prawn from Ghers. This huge quantity is produced by a large number of families (100,000) in an area of 30,000 ha using the types of Ghers described above. The farmers involved in the activity are generally very small farmers with land area being less than 0.3 ha.

Necessity is the mother of invention

With high population density, farmers in Bangladesh have always had a need to innovate to increase productivity and income from the small area of land owned by them. Paddy is the widely cultivated cereal crop in the country. With large amounts of water logged area rice and fish became the staple diet of the people. With the modernization in agriculture resulting in heavy usage of fertilizers , pesticides and high intensity cropping patterns, many fish species have been disappearing from the environment . In the Southwestern part of Bangladesh, paddy cultivation was compounded with the problems of productivity and profitability. To meet their livelihood necessities, farmers have been looking for alternative profitable crops. The availability of freshwater prawn post larvae in the costal environment encouraged some of the progressive farmers to explore ways of culturing prawns in paddy fields. Their initial success encouraged farmers to innovate improved ways to grow both paddy and prawn together. Small ditches were converted in to canals with more than a meter depth to hold water during the dry season and these canals sometimes either covered all the four sides of the paddy field or, based on convenience, covered only some portion of the paddy field. As a general principle less than 50 % of the area was used for canals and rest of the area for growing paddy. This activity, which started as a small venture in Bagherhat district, has spread to almost all parts of Bangladesh although still most of the activity is concentrated in the Southwestern part of the country. The farming area is reported to be growing at about 10% / year. Recognizing the vulnerability of small farmers in undertaking giant prawn farming, and with a view to reduce risks and increase profitability , DFID undertook a massive programme of assisting 15,000 families involved in Gher farming through CARE Bangladesh . The project used the innovative potentials of farmers and helped them to recognize the capacity available within themselves and in the community to solve various problems encountered in Gher farming. Using knowledge as the basis, strategic interventions were made in the key problem areas.

Practices followed

Although farmers began experimenting on culture of prawns in paddy fields , high price for prawns influenced farmers to resort to stocking of only prawns and grow only one crop of paddy during the boro season. They adopted high stocking with more than 20,000- 30,000 PL / ha. Ghers were generally stocked with post larvae by April-May and fed heavily with snail meat as feed. Fish were either stocked at very low density or not used at all. Dikes were either underused or unused. Usage of pesticides to both paddy and even the vegetables cultivated added additional costs. Harvesting was done

Another model of Gher with canal surrounding the paddy field

Women generally take care of vegetable cultivation on dikes.

Men attending a learning session in the project area

Women attending a learning session in the project area

intermittently with most harvest being completed by December. Small size prawns were left and allowed to grow up to March- April and harvested before stocking with fresh post larvae. These culture practices were not very profitable due to the heavy cost of feed. Small farmers with no experience entered prawn farming often with capital borrowed with an interest rate exceeding more than 100% / year. As the average productivity of prawns is less than 250 kg/ha, with high input cost on snail meat as feed some farmers were pushed into a debt trap. This created a social crisis in several areas and created an impression that aquaculture was adversely affecting the livelihoods of people. Hence , the DFID project implemented by CARE mainly targeted farmers with less than two acre of land and socially vulnerable groups with an objective of assisting them to adopt sustainable farming practices and help them derive benefits from the system.

Reaching the unreached

Most developmental projects aim at targeting one member in the family for imparting knowledge under the assumption that the imparted knowledge is shared with other members in the family and also to save cost on training two people. However, such exchange of information between the sexes often does not take place because of the existing social practices . Several important parts of aquaculture activities are often carried out by women such as feeding fish and growing vegetables. Hence, the project targeted at least one male and one female member from each family. The training used a group training approach with 20-30 farmers in an area being formed into a group. Because of social constraints, male and female groups were formed separately.

The groups met at a fixed time at least twice a month for a limited period of time that would allow them to focus completely on the learning session. Usually , these meetings did not last more than 2-3 hours at a time. The groups identified common problems that are confronted by most farmers and prioritized the issues that can be tackled using the resources that are easily available to them. The project assumed no responsibility to provide credit support or organize credit , except that the knowledge and technical support needed to address the agricultural problems encountered are provided from the project. Each field trainer was responsible for managing at least 5-6 groups and was encouraged to provide follow up support to farmers through individual visits to the farm.

Learning sessions

Farmers identified several problems related to technical aspects of prawn farming , vegetable and paddy cultivations, social aspects arising due to expanding ghers and income and a declining natural resource base particularly in regard to snail populations. As most farmers have been focusing heavily on the prawn component of the system , neglecting the opportunity that is available to raise income from mixed farming of prawn and fish , efficient utilization of pond dikes for vegetable cultivation, use of the central portion of the gher for growing at least two crops of paddy and reducing feed input cost by efficient management of feed resources were identified as the strategic areas wherein intervention could bring perceptible changes in the cultivation practices. Hence, learning sessions were planned to address these problems by enriching farmers knowledge and helping them to set up observation plots either in their own farm at little or no risk or making a collective observation with one or more of the farmers in the group. Each learning session was centered around the most felt necessity of the group and on several occasions , farmers themselves were asked to develop the session contents with only support from the project to provide them with the technical information. Hence, the use of group approach with creation of atmosphere of trusting and respecting the knowledge of each other helped in getting the best from each farmer in finding solutions to the problems encountered.

A tin shed based house is an indicator of the wealth status of family. A Gher farmer is finishing the house built with income earned from Gher farming

Thatched houses indicate the poverty level, note the roof being replaced with tin sheets

Impact of learning sessions on innovations

The Learning sessions began to make changes in the culture practices of farmers with the increasing confidence of farmers on the trainers and understanding project’s sincere efforts to resolve problems using local resources. Farmers began nursing post larvae to juvenile stage in hapa or impounded canal sites and reduced stocking density; they stocked fish species along with prawn and used it as one of the prime approaches to increase income; the dikes of ponds were used for growing vegetables of diverse varieties with growing season extending to almost all the years. Instead of taking one crop of paddy during the boro season , farmers began taking two crops in wet and dry seasons. Pesticide usage was reduced in both paddy and vegetables and several farmers stopped using pesticides based on the lessons learnt from the observations they set up. Most importantly , farmers began learning strategies on feed management to avoid wastage of feed and reduce their dependence on snail meat. Locally available feed ingredients

Pata Mallick, a widow with two children has been able to improve her family economy by resorting to Gher farming. Her children dream to acquire a good education with the income derived

Women display locally designed feed making machines. These are constructed from bamboo. The one on the right side is more commonly used

like various oil cakes , rice bran , wheat bran and dry fish powder were processed and used for preparing feeds and the processed feed ingredients were compressed in to pellets using different types pellet making devices that were locally manufactured . A survey revealed almost eighteen different types of pellet making instruments were invented locally by farmers. As can be seen in the pictures, bamboo available locally was used to manufacture simple pellet making machines following the principle of pressure pump.

Reaching beyond the targeted groups

Spreading the message across large section of the community practicing Gher farming called for new innovative approaches to be tried based on the local customs. The Bengal region being rich in culture , folk songs and dramas have tremendous mass impact. Special folk songs and dramas appropriate to local traditions were explored covering various aspects of Gher farming , including poaching with an objective of bringing visible changes in the culture practices beyond the targeted group of 15,000 families. Evaluation studies conducted following such public demonstrations revealed that large percentage of farmers changed some of the practices following the knowledge gained from such public demonstrations.

Use of cooperative spirit and local knowledge

Gher farming has been reported to cause enormous damage to water drainage systems through improper planning of ghers in the area. However, when the village level competitions were organized with elders on how their village was about 50 years ago and what they would like to see in the coming years, many new ideas emerged from the elderly persons who are considered as knowledge banks by the villagers. Those ideas were used to make community level planning appropriate to each village. An eco-village concept was adopted with an objective of making villages free from pesticide usage, provision of good sanitary measures to avoid health problems and plantation of adequate numbers of trees to build up the vegetation helped in building community based movements based on local knowledge and resources.

Gender and social issues

With Gher farming expanding the impact on women in particular became more conspicuous. As the learning sessions were organized separately for the women and men , there were no easy opportunities to discuss gender issues together . Hence , plans were made to bring both men and women groups together , identify key gender related issues confronted in the family and set pathways to resolve such issues. For example increasing workload on women due to gher farming is an issue that needs coordinated efforts in the family . Education and other equal opportunities for girls are issues that also need the coordinated efforts and understandings of parents. Apart from discussing some of the general issues of gender at the end of learning sessions , special gender days were celebrated wherein both men and women groups met together discussed the common gender issues and made plans. Project assessment results demonstrate that the position of women in the family and status in the society improved enormously with the introduction of Gher farming in the area.

Exploring new method of credit system

As the existing credit systems did not suit the needs of prawn farmers, new methods of credit that suit the prawn farming cycle with long repayment period were encouraged to be experimented by the partner NGOs.

These payment systems proved useful both to farmers as well as lending agencies. As the borrowed capital constituted major cost factor in the production cycle, farmers were encouraged to make group savings and lend money to the needy farmers within the group. This approach developed based on the principle of self help groups gave raise to considerable savings and lending opportunities within group members.

Knowledge based approach

The project used the approach of imparting knowledge to farmers and help them in solving the problems by themselves by group learning and sharing approaches using the resources available or that can be accessed easily based on their capacity. Evaluation results indicate that most of the farmers were able to achieve improvements in production and were pleased with the knowledge based approach used. In fact , with building of confidence of farmers on the project strategy and approach, even there was no easy way to distribute even research materials freely to members of the group. In such cases, farmers made an agreement on the strategy to adopted. Five years of working experience with 15,000 families within the project area and several more families beyond the project area indicate that poor farmers will derive better benefits through knowledge based approaches that help them to optimize the resource utility in the farm and derive best benefits from aquaculture on a sustainable basis.

Conclusion

Pata Mallick is one of the farmers who worked closely with the project and derived benefit of knowledge based intervention. With a small Gher , she has been able to improve her family situation. She lost her husband due to a poisonous snake bite few years ago. With two children , she had to struggle to cover the family expenses. Today , gher farming has given her the required income and brought stability. Her daughter who was born handicapped with the loss of one fore hand desires to be a teacher and help people like her mother in the area with no education to become literates. Her son, having seen the death of father with snake bite and no doctor and medicine available in the area, desires to become a doctor. Time and social circumstances will decide whether they will accomplish their dreams. However, several indicators suggest that diversified Gher farming has been most beneficial to farmers in reducing risk and increasing income.

The Project has increased productivity of prawns from Ghers and currently it ranges up to 500 kg/ha depending on the strategies adopted with most farmers deriving around 350 kg/ha in 8-10 month culture period. With the improved prawn productivity , increased income from fish , vegetable and paddy , the system is reported to be growing and in the majority of cases giving returns that brings smiles and little comforts these families. As per the information presented in the Kochi meeting , there is an additional support set up under the banner of Shrimp seal of Quality Organisation that helps farmers with certification when they meet the standards. This is likely to help farmers in deriving a better price and also create positive outlook for the product.

The lessons from Bangladesh DFID CARE project , wherein I had an opportunity to work and see the changes clearly demonstrate that GFP farming can be an effective tool for poverty alleviation and improvements in livelihoods of the family. Hearing again from several of the participants from Bangladesh in Kochi International Symposium on Freshwater Prawns influenced me to write again on GFP for the second time during this year through this column. However, to ensure such a positive change, it should be noted that project invested heavily in capacity and confidence building of staff involved with the project work . Over 150 field level trainers interacted with more than 15,000 families over a period of five years to bring such a change. These ground level staff were supported with various technical and managerial staff that helped in the effective implementation of the program. If some of these successful approaches are adopted in our extension / development programs, we should be able to see more benefits of aquaculture in poverty alleviation.

Lastly, Bangladesh farmers continue to depend heavily on wild caught seed for culture and there is a need to initiate programs to increase quality seed production from hatcheries . With large number of families engaged in collecting wild seed, as a by-catch several other species are being destroyed. This is likely to have negative impact on the environment. Government has already banned the collection of seed from nature . With the establishment of hatcheries in the private sector , the scenario should change soon in the best interest of the industry.

Prawn farming is spreading to various regions in Bangladesh wherein it is grown with paddy commonly

Marine Finfish Section

The Grouper Section has taken on a new and broader name: It has become the Marine Finfish Section to take account of other species. This section is almost wholly based on the Marine Finfish Aquaculture Newsletter which is prepared by Sih Yang Sim (Editor), Michael Phillips (NACA Environment Specialist) and Mike Rimmer (Principal Fisheries Biologist of the Queensland Department of Primary Industries). Visit www.enaca.org/grouper for more information on the network or email sim@enaca.org.

Regional study of seafarming technologies, production trends and market opportunities

NACA has started a cooperation with the Terre des Hommes Foundation-Italy (THF) project in Phanga Nga Bay, Southern Thailand entitled "Children of the Sea – Requalification of Small-scale Fisheries Micro-enterprises and Ecosystem-based Innovation of Aquatic Production Systems for the Sustainable Development of Thai Coastal Communities". The cooperation involves simultaneous studies of seafarming technology and markets in southern Thailand, Bangkok live fish markets and trading networks, regional markets for seafarming products and a status review of regional seafarming production technologies. The emphasis will be on seafarming technologies and commodities that may be important to small-scale fishing communities in Southern Thailand, including an analysis of options for integrated seafarming. The outcome from the studies is expected to be of wider interest to the network, particularly for people working with small-scale fishing communities where there is potential for seafarming. Further information on the project will be made available through a new web site and a report expected to be available in July 2004. In the meantime, further information can be obtained from Paolo Montaldi or Sandro Montaldi at a_montaldi@hotmail.com.

Fish Feed and Feeding

With marine fish farming growing in Asia, there is increasing need to look for better options to reduce the use of wild fish resources to feed groupers and other carnivorous species, and at the least make more efficient use of existing resources. Two reviews have been initiated in 2003, which when completed should provide useful direction for future development of feeds and feeding practices for marine fish in Asia. The first is a study commissioned by ACIAR in Vietnam on so-called feed fish use (definition: feed fish includes all fish used in an unprocessed form as a feed ingredient, either solely or in combination with other ingredients such as rice bran, to feed other animals). The study is showing the importance of feed fish to Vietnam, as the largest fishery in terms of both volume and value. Catches are reported to be increasing, and as in other countries, there is rapidly increasing use of feed fish for aquaculture, although marine fish farming makes up so far only a small proportion of that used. The future planned increases in aquaculture, including a 200,000 tonne target for marine fish, will certainly be constrained by finite sources of feed fish, suggesting an urgent need to stimulate more effective use of these fish feed resources. The second study is an FAO initiative for 5 country reviews of trash fish use in aquaculture, with results expected in 2004. For further information on the ACIAR review, contact Geoff Allan at Geoffrey.Allan@fisheries.nsw.gov.au. Simon Funge-Smith can be contacted at Simon.FungeSmith@fao.org for information on the FAO review. The experiences of the ACIAR project "FIS/97/73 Improved hatchery and grow-out technology for grouper aquaculture in the Asia-Pacific region" in replacement of feed fish in grouper diets are also being summarized into a guidance document, that will be available in early 2004.

Request for information on *Plectropomus*

As reported in a previous issue, some researchers and commercial operators are reporting success with breeding of Plectropomus species. A commercial research and development project in Myanmar is working on red coral grouper (*Plectropomus pessuliferus*). If anyone has any information on this species, the contact email is anawadevi@mptmail.net.mm. The editors would also be interested to hear of other R&D experiences with *Plectropomus* species, please send to grouper@enaca,org and we will include the your experiences in a future newsletter.

Aquaculture Compendium

The response from marine fish network members to assist with the Aquaculture Compendium was very good, and work has now started on several marine fish reviews and species profiles. The web site www.cabicompendium.org/ac/ gives further information on the project.

Live Reef Food Fish Trade Best Practice Standards Review Workshop: WAS Asia Pacific, 26 September 2003

The Live reef Live Reef Food Fish Trade Best Practice Standards being developed by the Marine Aquarium Council (MAC), with various partners, is progressing, and a review workshop of the latest draft of the aquaculture standards was organised by NACA in association with the WAS Asia Pacific Conference on 26 September. The meeting involved aquaculture specialists from Australia, Thailand, Vietnam, Malaysia and Indonesia, with good attendance from Thai Department of Fisheries staff from all coastal research stations. The workshop participants discussed the draft aquaculture standards, and made suggestions for the different levels of documentation required to support implementation of the standards, as well as raising issues of more general concerning practical implementation of the standards. Particular attention was given to so-called "Level 2 documentation" - Best practice guidance and "Level 3 documentation" - Implementation manuals (or tool kits), and other guidance required to provide practical support to implement the standards/best practice. A further workshop was held in Hong Kong/ Southern China in late 2003. For further information, please contact Peter Scott (P1G1Scott@aol.com)

Pacific Islands: SMART Project to Bring MAC Certification to 10 Countries

The Sustainable Management of the Aquarium Reef Trade (SMART) Project is a two-year MAC initiative to ensure Pacific communities involved in collecting marine ornamentals are part of a responsible trade that contributes to sustainable livelihoods and MAC Certification. The SMART Project will assist communities in ecosystem management plans, responsible collection of aquarium products and market linkages within the added-value context of MAC Certification. The project will also seek to increase the number of MAC Accredited certifiers in the region. The SMART Project will focus on economically disadvantaged coastal fishing communities in the Cook Islands, Federated States of Micronesia, Fiji, Kiribati, Marshall Islands, Palau, Samoa, Solomon Islands, Tonga and Vanuatu. The SMART Project is supported by the European Union. Project partners include the Foundation of the Peoples of the South Pacific (FSPI) and Just World Partners (a United Kingdombased group and FSPI member). FSPI is a network of non-government organizations throughout the Pacific with metropolitan members in the United States, United Kingdom, Australia and elsewhere. For more marine aquarium council news, please visit the MAC web site at www.aquariumcouncil.org.

A Novel Zero Discharge Intensive Seawater Recirculating System for the Culture of Marine Fish, by Ilya Gelfand, Yoram Barak, Ziv Even-Chen, Eddie Cytryn, Jaap Van Rijn, Michael D. Krom, and Amir Neori

Results are presented of a zero-discharge marine recirculating system used for the culture of gilthead seabream Sparus aurata. Operation of the system without any discharge of water and sludge was enabled by recirculation of effluent water through two separate treatment loops, an aerobic trickling filter and a predominantly anoxic sedimentation basin, followed by a fluidized bed reactor. The fish basin was stocked for the first 6 months with red tilapia *Oreochromis niloticus* x *O. aureus* at an initial density of 16 kg/m3. During this period salinity was raised from 0 to 20 ppt. Then, gilthead seabream, stocked at an initial density of 21 kg/ m3, replaced tilapia at day 167 and were cultured for an additional 225 d. Non steady-state inorganic nitrogen transformations occurred as a result of these salinity changes. After day 210, the system operated at all times with those water quality parameters considered critical for successful operation of mariculture systems, within acceptable limits. Thus ammonia, nitrite, and nitrate concentrations did not exceed 1.0-mg total ammonia-N/L, 0.5-mg NO2-N/L and 50-mg NO3-N/L, respectively. Sulfide levels in the fish basin were below detection limits and oxygen > 6 mg/L after the oxygen generator was added at day 315. Ammonia, produced in the fish basin and to a lesser extent in the sedimentation basin, was converted to nitrate in the aerobic trickling filter. Nitrate removal took place in the sedimentation basin and to a lesser extent in the fluidized bed reactor. Sludge, remaining in the sedimentation basin at the end of the experimental period, accounted for 9.2% of the total feed dry matter addition to the system. The system was disease-free for the entire year and fish at harvest were of good quality. Water consumption for production of 1 kg of tilapia was 93 L and 214 L for production of 1 kg of gilthead seabream. Additional growth performance data of gilthead seabream cultured in a similar but larger system are presented. During 164 d of operation of the latter system, maximum stocking densities reached 50 kg/m3 and fish biomass production was 27.7 kg/m3. Relatively poor fish survival and growth resulted from occasional technical failures of this pilot system. The full article is available from Journal of the World Aquaculture Society, Vol. 34, No. 3, September 2003. For further information contact Department of Animal Science, Faculty of Agricultural, Food and Environmental Quality Sciences, The Hebrew University of Jerusalem, Rehovot 76100, Israel.

News from Vietnam

Results released by World Resources Institute in 2002 indicated that Vietnam's coral reefs are among the most threatened in the region. Destructive fishing practices, such as poison and blast fishing threaten as much as 85 percent of Vietnam's reefs while overfishing threatens more than 60 percent of Vietnam's reefs (Reefs at Risk Southeast Asia, 2002). In response to such problems, the Danish International Development Agency (DANIDA) will assist $ 2.7 million to help Vietnam implement the project to support marine reserve area network across the country, according to an agreement signed in Hanoi on December 19, 2003. Fifteen marine reserve areas nationwide are selected for the 2003-06 network support project, which comprises two sub-projects. The first will be implemented in Hanoi with the aim of establishing a consistent system of marine reserve areas and creating a legal framework for the management of those areas. The second, which will be carried out in central Quang Nam province, will support the management of the Cu Lao Cham reserve. The network will help balance marine ecosystems, protect sea biodiversity, regulate environment and develop sustainable economy, as well as eco-tourism. Vietnam is considered one of the world's most diversified marine-biological centers. Some further background on reefs in Vietnam can be found at www.reefcheck.org/newsletter8/newsletter8.htm

Weekly Average Wholesales Live Marine Fish Prices in Hong Kong

The weekly average wholesales live marine fish prices in Hong Kong's Aberdeen Wholesales Fish Market is available on www.enaca.org/Grouper/FishPrices/FishPricesIndex.htm. The prices are in US$, converted from HK$ to US$ is at 1 HK$ = US$ 0.1282 obtained from the Fish Marketing Organisation (FMO). Further information can be found on the FMO website.

Live Marine Fish Prices at the Huangsha Seafood Wholesales Market, Guangzhou, China – 29-12-2003

NACA staff made a visit to the largest live marine food fish market in China – the Huangsha Live Seafood Wholesales Market – at the end of December 2003. The market sells a wide range of groupers and other coral reef fish from all over the Asia-Pacific region. Information on wholesale prices during December are available (Chinese currency-Yuan, converted to US Dollar with conversion rate of US$1 to Yen is 8.2) at www.enaca.org/Grouper/FishPrices/FishPrices-China-29- Dec-03.htm.

Study Program on Marine Finfish Aquaculture and Markets in Southern China and Hong Kong, July 2004

To provide further insight into marine fish farming and markets in southern China and Hong Kong, NACA will organized a study program to Guangzhou and Hong Kong, China in July 2004. The study program is organized by NACA in cooperation with the Guangdong Dayawan Fishery Development Center (Department of Marine & Aquatic Products, China), Guangdong Provincial Bureau of Ocean and Fisheries, Guangdong Fisheries Society, and the Agriculture, Fisheries and Conservation Department (AFCD) of Hong Kong. More information on this study program will be provided on the marine fish network website in late January 2004 and interested parties please can contact Mr. Sih- Yang Sim (grouper@enaca.org) for further information.

Improving Access to Market Information

In 2004, NACA intends to increase coverage of market prices for marine fish in Asia, for both cultured and capture fish, through a regular e-news. Key informants and information sources are being identified in different export countries and key markets in the Asia-Pacific region. If you are interested to get involved in this initiative, and to share information on marine fish markets and prices, please contact grouper@enaca.org for further information.

The International Seafood Trade: Supporting Sustainable Livelihoods Among Poor Aquatic Resource Users in Asia

The international seafood trade has significant implications for many millions of poor fishers and farmers in developing countries, most recently highlighted by the World Fish Center report (Outlook for Fish to 2020: Meeting Global Demand). Global trade in fisheries products is a multi-billion dollar trade with developing countries in Asia as major stakeholders. Projections are that developing countries will become even more significant suppliers to global seafood trade in the future. Yet, the links between such trade, poverty alleviation and livelihoods of poor aquatic resource users are poorly documented, and ways in which the seafood trade can be oriented towards supporting poverty reduction goals are poorly understood. The implications of moves towards certification, stricter imposition of sanitary and phytosanitary standards and other trade measures are potentially significant for producing countries in Asia, probably impacting on the poorest producers. A new project entitled "The International Seafood Trade: supporting sustainable livelihoods among poor aquatic resource users in Asia" is being implemented with support from the European Community's Poverty Reduction Effectiveness Programme (EC-PREP) (a programme of research supported by the UK Department for International Development (DFID) to enhance the poverty impact of the European Community's development assistance and contribute to achieving the International Development Target of halving the number of people living in extreme poverty by 2015). The project focuses specifically on exports from Asia to the EU of shrimp and coral reef associated fish, principally marine ornamentals, with case studies being conducted in Vietnam, the Philippines and Indonesia. Poseidon Aquatic Resource Management Ltd, the Network of Aquaculture Centres in Asia-Pacific (NACA), and the Support to Regional Aquatic Resources Management (STREAM) Initiative are collaborating to implement the project. The project started with an initial review in October 2003, and will run until to March 2005. Case study field work will be conducted in Vietnam, Indonesia and the Philippines during 2004, and then early in 2005 a final report with recommendations about pro-poor trade mechanisms will be prepared. Case studies on the marine ornamentals trade should generate further understanding of the social implications of the trade, and possible mechanisms to improve social benefits. A web site (linked to www.enaca.org) will be available to provide background information on the project, and reports, from January 2004. The project builds on some of the experiences of the consortium program on shrimp farming and the environment (www.enaca.org/shrimp/) and APEC supported studies of coastal livelihoods and coral reef fish aquaculture (www.streaminitiative.org).

Fish health news

As grouper and marine fish farming starts to expand in the region, there is increasing concern about the spread of serious aquatic animal pathogens. Already, there are reports of VNN and iridovirus being spread around the region due to infected juveniles, causing significant losses on grow out farms, and unknown effects on wild stocks. Clearly, better management of hatcheries and nurseries will be essential to reduce risks. In response to such problems, the health management components of upcoming NACA courses are being strengthened to emphasise better health management in hatcheries and nurseries. A special workshop "Management of environmental and health risks in marine fish farming" is being planned by NACA in late 2004 to develop some practical guidance on managing of such risks in hatcheries, nurseries and grow-out farms.

Regional Training Course on Grouper Hatchery Production 2004, Bali, Indonesia

The Asia-Pacific Marine Finfish Aquaculture Network and its cooperating partners are planning for the 3rd training course in 2004, the tentative schedule will be from March 24-April 13. As the training course is only taking limited number of participants therefore it is important for those who are interested to contact Mr. Sih-Yang Sim (grouper@enaca.org) to register their interest and secure a place in the training course. The training course reports for 2002 and 2003 are available from the NACA website http://www.enaca.org.

Update on 2003 Training Course Participants

Dr. Trevor Anderson from GFB Fisheries Ltd, Australia successfully produced some 20,000 *Cromileptes altivelis* fingerlings in November 2003, with success also extended to *E. coioides* in his hatchery. Mr. Sufian B. Mustafa from the Marine Finfish Production and Research Centre, Malaysia reported some success in spawning (*Epinephelus* species) after implementing pellet LHRH hormone implantation for broodstock. However, he reports larviculture problems, constrained by lack of S and SS-rotifer. Dr. K. Kailasam from the Central Institute of Brackishwater Aquaculture, India has seen improvement in grouper (*Epinephelus coioides*) breeding with successful female fish spawned and fertilized by stripping method. But larvae did not survive beyond day 7.

Notes from the Publisher

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national R and D institutions and invites experts from other countries to provide technical advice on a range of issues including taxonomy and processing. Sri Lanka's Ornamental Fish Producers Association works with national technical and economic agencies and also engages professionals and scientists, and fosters relationships with similar associations in other countries. The Vietnamese fishery society – a vast well-organized and powerful multi-stakeholder entity - includes in its agenda building links and collaborating with national, regional and international organizations and other NGOs to share experiences and information. Its biennial fishery exhibition and technical conference brings in the participation of policy makers, scientists, technicians, farmers, input supply companies and technical advisers.

Included in the survey are the village farmers associations in Eastern India (where STREAM and other international agencies have been operating). The village associations have realized that maintaining relationships with the NGOs and state and federal government agencies, and continuing their participation in community development activities can sustain the build up of their capacities. A recent move is to provide support for networking the various village associations to facilitate exchange of information among them. Networking builds up numbers. More importantly it broadens the scope of the associations' influence through their alliance fostered by networking.

Holding on to members and staying financially stable are, for obvious reasons, the foremost organizational concerns of farmers associations in developing countries. Other than being able to serve members' needs, being able to sell their produce at a profit is still their best bet to staying viable, relevant and cohesive. The national associations based on a single export commodity (almost all producers associations are organized around a single commodity) are dependent on the market and, on top of coping with risks posed by vagaries of nature and markets, must comply with an increasing number and stringency of "market requirements." They have shown that they are willing to comply with requirements - including those that ask them to be environmentally responsible, to assure that food safety and quality are of a certain standard – as well as to work with government and other sectors on legislation, policies, and standards, and to promote and apply codes of practices and conduct among their members.

Pragmatically, they know that environmentally sensitive and socially responsible farming makes good business sense. However, to the small farmers, or even large but unorganized farmers, some elements of the "market requirements" can be a threat to their staying in business. This is a strong reason to organize to attain economy of scale, and more importantly, to attain a degree of authority to be able to negotiate from a position of strength. Being able to negotiate effectively - for favorable prices and terms for their product and for input supplies and equipment, for better allocation of or access to land, water and credit resources to the industry, for favorable tax structures and other incentives, for access to technology, for improvement of the marketing infrastructure and system, for fairer trade regimes, etc – is probably the best way farmers' organizations can serve their members.

While maintaining viability is a primordial concern, the association should have the ability to work with government and other sectors of society to shape policies and research and development agenda, precisely define its needs and work with others to meet those needs, bring professional and scientific advice into the discussions and decision processes (as the Federation of European Aquaculturists or FEAP does with great effectiveness), and engage in mutually beneficial alliances.

It is clear that to develop the potentials of farmers organizations for sustainable development, it would be best to provide them the environment and motivations to attain a status of authoritativeness.

What's New in Aquaculture

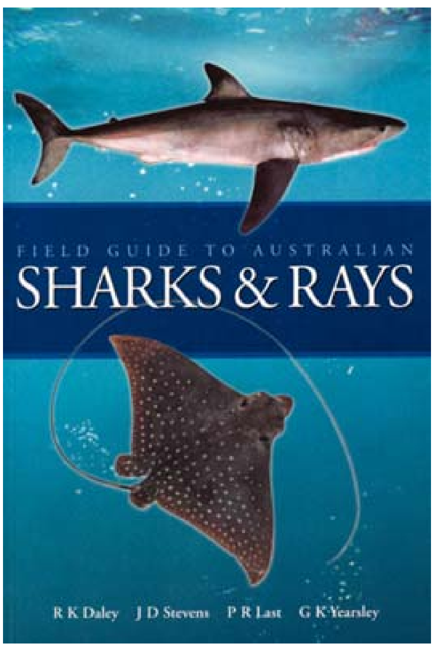
CD: APAARI Success Stories

The Asia-Pacific Association of Agricultural Research Institutions (APAARI) have published a collection of 17 success stories on the development of new agricultural products, three of which are aquaculture related: Tilapia farming in the Philippines, Bivalve Mariculture in India, and Farming of Red Seaweeds in the Philippines.

System requirements: Acrobat Reader. Available from the APAARI Secretariat, FAO Regional Office for Asia & the Pacific, Maliwan Mansion, Phra Atit Road, Bangkok 10200, THAILAND, Tel.: (662) 281-7844, Fax: (662) 280-0445.

Field Guide to Australian Sharks and Rays

A small user-friendly guidebook to about 100 species of shark, ray and chimerids. It has a user-friendly format with pictorial keys to families and full colour photographs annotated with key features for identification. Species are arranged according to their broad distribution – pelagic, northern demersal, southern demersal and there is also an interesting section on 'rarely caught' species.



Each species has a short description outlining key features that can be used to distinguish it from its near relatives. The main text also provides fishery and conservation information and remarks of general interest such as size. A distribution map is provided along with an indication of the main fishing gear/ method of capture. The guide was written by some of Australia's leading taxonomic experts including R.K. Daley, J.D. Stevens, P.R. Last and G.K. Yearsley. Published by the CSIRO Division of Marine Research, the Fisheries Research and Development Corporation and the Australian Fisheries Management Authority. 84 pages.

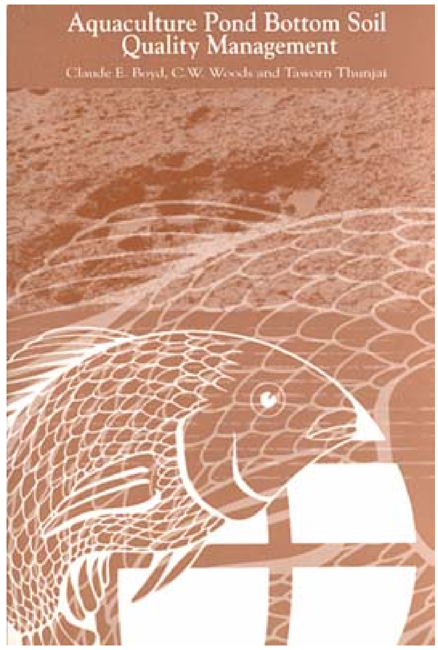
Price: AUD$ 24.95 plus international freight. Available from CSIRO Publishing, PO Box 1139, collingwood, VIC 3066, Australia. Fax +61 (3) 9662 7555, email publishing.sales@csiro.au, www.publish.csiro.au.

Conclusion: Recommended as a portable general field guide. However, those seeking a comprehensive reference should try to get a copy of the 1994 publication Sharks and Rays of Australia (also by P.R. Last and J.D. Stevens) which unfortunately is now out of print.

Aquaculture Pond Bottom Soil Quality Management

Written by Claude E. Boyd, C.W. Woods and Taworn Thunjai, 2002, 41pp.

This is a small and practical manual that will be popular with anyone working on pond maintenance and repair. It has three sections. The first section, pond soils, provides a short review of soil properties and their interaction with pond water. The second, pond soil treatments, provides general guidelines for carrying out various remedial measures including liming, drying, tilling, sediment removal, fertilization, bottom raking, disinfection and probiotics. , and iii) soil analyses provides simple techniques for assessing soil condition.



The nice thing about this book is that it is written with practical applications in mind – the subjects and techniques described – including the soil analyses – are things you can do on the farm. This is the book that you will be flicking through while standing in the bottom of your dried-out pond !

Available from: Pond Dynamics/ Aquacutlure Collaborative Research Support Program, Oregon State University, Corvallis, Oregon 97331-1641, Tel +1 541 737 6416, Fax +1 541 3447, www.pdacrsp.orst.edu

Conclusion: Recommended as a good pocket guide/ready reference to pond soil management for technicians and farm managers. For a comprehensive reference book nothing beats Boyd's earlier book Water Quality in Ponds for Aquaculture (1990) but you won't be carrying that one around in your pocket.

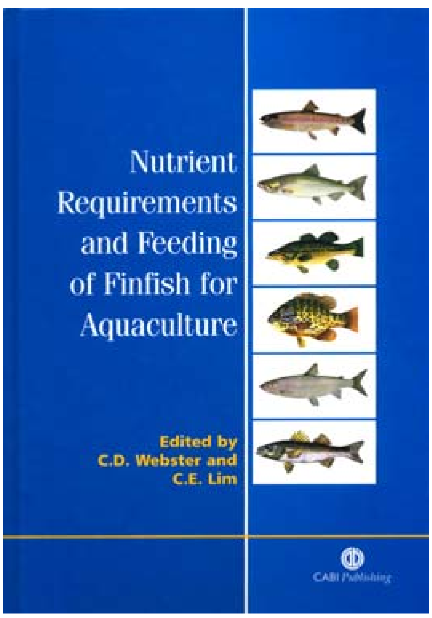
Nutrient Requirements and Feeding of Finfish for Aquaculture

C.D. Webster and C.E. Lim (eds.) 418pp.

This is a 'milestone' publication, a book that takes a detailed snapshot of the current state of knowledge in a field. It summarises the current state of knowledge in the nutritional requirements of about 30 groups of important aquaculture species from all over the world.

Each species is dealt with in an individual chapter written by a nutritionist who is an acknowledged expert. Sections include i) introduction to basic biology and commercial importance, ii) nutrient requirements (protein and amino acids; energy; lipid and fatty acids; carbohydrates; vitamins and minerals), iii) formulation of practical diets iv) feeding practices and v) a detailed reference list. Additional information is provided for some species – for example the gilt-head sea bream Sparus aurata includes some nice sub-sections on the nutrient requirements of different life stages (ie. larval fish, juveniles and broodstock), and the Atlantic salmon section also covers caratenoid pigments. Overall, the quality and presentation of the information is very high. The authors have gone to considerable lengths to review and summarise the literature.

It's nice to see good coverage of the Asian region in such a volume. Asian species include the Asian sea bass (*Lates calcarifer*), Red sea bream (*Pagrus major*), Japanese flounder (*Paralichthys olivaceus*), yellowtail (*Seriola quinqueradiata*), milkfish (*Chanos chanos*), common carp (*Cyprinus carpio*), Indian major carps, tilapia, freshwater eels (*Anguilla* spp.), silver perch (*Bidyanus bidyanus*), snakehead (*Chanos* spp.) and Pangasius catfish. The book also covers major European and American species.

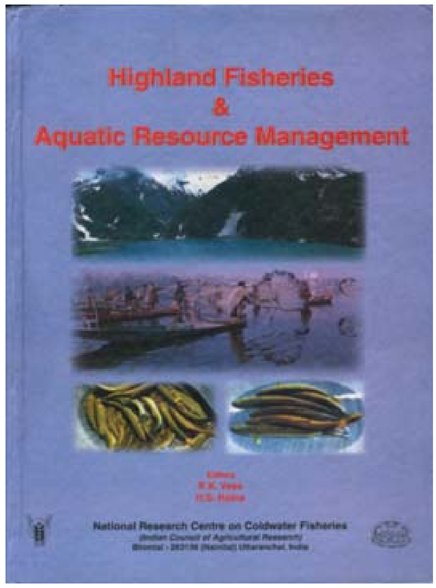


Cost: US$140 + freight. Available from: CABI publishing, CAB International, Nosworthy Way, Wallingford, Oxon OX10 8DE, UK. Tel +44(0)1491 832111, Fax +44(0)1491 829292, email orders@cabi.org, www.cabi-publishing.org.

Conclusion: Highly recommended, a very detailed resource. However, you may wish to check that it covers your species of interest before you purchase since most of the information is species-specific.

Highland Fisheries & Aquatic Resource Management

K.K. Vass, H.S. Raina (Eds.) 2002. 363pp.



Highland development is becoming a priority in many countries as these areas are not keeping pace with development in lowlands, due to more difficult climatic, topographical and resource constraints. In particular, highland fisheries essential to the livelihoods of many communities have not received the attention they deserve. This book attempts to address some of these issues with a collection of 31 scientific reviews. The first section provides an overview of the status of highland fisheries in India's highland/coldwater fisheries. The book moves on to address human resource development in capture fisheries, with additional sections on aquaculture and biology (mostly concerning mahseer and trout), and conservation and management in coldwater fisheries. There is an interesting paper summarizing internet application in fisheries, which summarizes many of the websites and resources available on the internet.

Available from the Director, NRC on Coldwater Fisheries, Bhimtal 263136 (Nainital), Uttaranchal, India.

Conclusion: A useful reference book for hill fishery scientists, planners, policy makers, farmers and entrepreneurs alike.

Textbook of Fish Processing Technology

K. Gopakumar (Ed.), 491pp.

Internationally fish is traded mostly in frozen form. New species and value-added fishery products are finding niches as the international trade expands. Fish processing technology has become one of the most developed brnaches of food processing science.

In India a number of agricultural and conventional universities have started programmes at the graduate and post-graduate levels. However, until now there has been no textbook or comprehensive reference available on the subject. This book provides a detailed overview of fish processing technology. Coverage includes: Biochemical composition of fish; post mortem changes and quality assessment; chilling (both direct and indirect); fish freezing technology; bacteriology of fish and shellfish; proteins and lipids of marine products and their changes during processing; irradiation; fundamentals of drying

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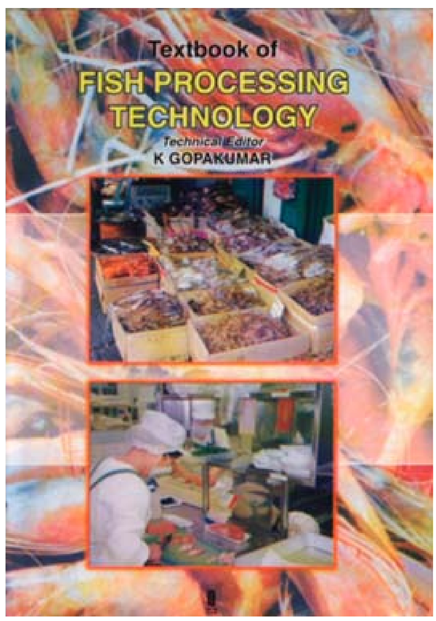
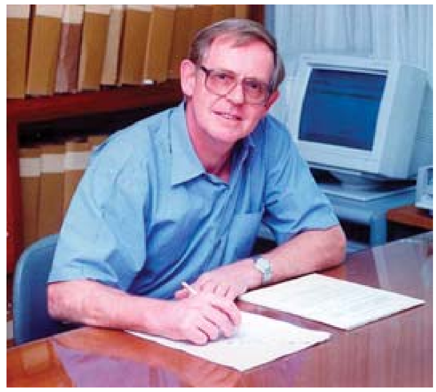


Peter Edwards writes on

Rural Aquaculture



Peter Edwards is a consultant and part time Asian Regional Coordinator for CABI Publishing. Previously he was Professor of Aquaculture at the Asian Institute of Technology where he founded the aquaculture program. He has nearly 30 years of experience in education and research relating to small-scale inland aquaculture based also on extensive travel throughout the region.

Aquaculture Compendium – Case Study Component

An important event to facilitate the development of aquaculture in general, but especially rural aquaculture, will be the publication of a new Aquaculture Compendium. The Compendium will be an electronic multimedia encyclopaedia knowledge base which will serve as a versatile reference and problem–solving/opportunity-seeking resource. It is currently being developed by CABI Publishing, a division of CAB International, one of the world's leading applied life science publishers in association with the Asian Institute of Technology (AIT), the Institute of Aquaculture, University of Stirling (IoA), the Network of Aquaculture Centres in Asia-Pacific (NACA) and the World Aquaculture Society (WAS). The Aquaculture Compendium is taking 2 years to develop, involving contributions from experts around the world, and will be published in 2005.

The Aquaculture Compendium will be the fourth one that CABI has produced, the others being Crop Protection (1999), Forestry (2000) and Animal Health and Production (2002). There will be another on Coffee, and the feasibility of others on Invasive Species, Plant Genetic Resources, and Tropical Fruits in future is being explored.

A new feature for the Compendium Programme will be case studies i.e., specific examples from real world practice. Case studies will thus link theory and practice. They will be a potential learning tool as they will cover farmer practice, successes as well as failures in research and development, and issues in aquaculture. The Aquaculture Compendium is pioneering the creation of knowledge and its dissemination. Knowledge will be less for academics and researchers in their "ivory tower" and more for development workers and farmers at "grass root" level.

Although case study coverage will be broad, emphasis is to be given to poverty-focussed, field based rural aquaculture. Two countries are being used as pilots to devise and test an approach for a practially oriented knowledge base for aquaculture : Bangladesh and Vietnam. These countries have been chosen because fish plays an important role in their national economies yet there is still a huge unfulfilled need for aquaculture knowledge by practitioners as well as potential new entrant farmers. It is recognized that the need for knowledge is demand driven and case studies are being developed through a participatory approach to synthesize and integrate existing knowledge relating to aquaculture into the Aquaculture Compendium.

Case studies are being identified and draft material produced in-country in Bangladesh (facilitated by IoA / SUFER) and in Vietnam (facilitated by AIT) by individuals from those countries. The draft material will be edited by myself as Editor and Asia Regional Specialist for CABI before verification of content by specialists. It will then be passed to CABI for incorporation into the Compendium but, before publishing in the Compendium, it will be field tested to see if it meets the needs of intended beneficiaries. Feed-back from likely end users will be used to modify case study materials before release of the first version of the Aquaculture Compendium. The farmer or producer is the major ultimate target but in most cases will be reached through local institutions. Examples are government, NGO and private sector extension and information providers, universities and vocational schools, and research and development projects.

Case studies will cover a range of systems in the two pilot countries : production systems, both seed and growout in inland and coastal aquaculture; integrated systems; input supply, marketing, trade and consumption; and institutional systems and governance. They will also cover a spectrum of issues or key topics such as poverty alleviation, trash fish and fish and fish meal, and international trade. An example of the latter are the problems experienced by Vietnam in marketing catfish in the United States.

There are potentially 100s if not 1000s of case studies globally. About 100 were identified in a Bangladesh Country Focus workshop held in Dhaka on 12 and 13 November 2003. A similar number is expected from the Vietnam Country Focus workshop scheduled for 13 and 14 January 2004 at the University of Fisheries, Nha Trang. As there is a vast amount of existing material, the intention is to use published / printed material as much as possible to minimize rewriting and editing and to increase coverage. Besides the Bangladesh and Vietnam pilot countries, case studies will be

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Rice-Fish Culture in China

Fang Xiuzhen

Freshwater Fisheries Research Centre, Wuxi, Jiangsu 214081, China

Sumps provide a refuge for fish and a reservoir during the dry season

Fish culture in paddy field was an ancient farming practice found in several rice-growing areas, such as Sichuan and Guizhou Provinces, in South and Southwest China. It can be dated back to nearly twenty centuries ago. In traditional rice-fish culture practice, rice cultivation was the main activity of farmers, while some fish seeds were stocked in paddy fields and looked after extensively, merely for the purpose of having additional animal protein food for household consumption by farmers. From the 1950's to late 1970's, this once common practice faded out considerably as a result of introduction of planned economy run under rural communes and later the increase in use of chemical fertilizers and pesticides. When economic reform was started in 1978 and farmers began again to decide again what they could do the best with their land for their families, some farmers chose to resume fish culture in their paddy fields just as their ancestors had done.

Development in the past two decades

In 1983, a national field seminar on rice-fish culture was conducted for the first time. As a result, the socio-economic and ecological benefit of rice-fish culture started to draw the increasing attention of farmers and various public sectors. A series of follow-up actions recommended during the seminar lead to the gradual spread of rice-fish culture from its traditional homes to areas where it was not practiced in the past. Eventually, rice-fish culture emerged as an important rural farming system by the early 1990's. Its role in alleviating rural poverty and improving the rural economy, especially in remote provinces and regions, was widely recognized.

In the 1990's, rice-fish farming enjoyed a rapid expansion in the number of new entries and total area of rice-fish production area in the country. The farming system has extended from pluvial and warm provinces in South, Southeast, Central and East China to the Northeast and Northwest China, including several economically less developed regions, such as Xinjiang Urgur Autonomous Region, Inner Mongolia and Gansu Province. During the course, it evolved from traditional family-scale extensive operations towards medium-to-large scale or even commercial scale operations in selected provinces. The rapid expansion of rice-fish farming was the immediate result of the growing interest and enthusiasm among farmers in the rice-growing areas, coupled with the continuous collective supporting efforts from the public sector such as provision of relevant extension and advisory services to farmers, application of policy incentives and better accessibility to loans for renovation of conventional paddy field to suit fish culture and four nation-wide rice-fish culture field seminars.

By 1999, the area of rice-fish farming in China reached 1,464,094 ha, an increase by 71.6% from 853,000 ha in 1994. The rice-fish farming area further expanded to 1,528,027 ha 2001. Food fish production from paddy field increased from 206,900 tons in 1994 by 214% to 649,996 tons in 1999. The food fish production from rice field increased to 849,055 tons in 2001. The increase in food fish production from paddy was not at the cost of rice yield reduction. Instead, rice yield from the rice-fish farming attained an average increase of 225 kg per ha over the period 1994-1999.

Farming systems

The technological advances borrowed from pond aquaculture and the changes in market demand have lead to the changes in the rice-fish farming practices including the species used and the scale of operation. To maximize the use of natural productivity in the paddy field space for the optimal economic returns, various rice-fish culture models with variations of integration with crop and animal species were developed through field trials by farmers in different parts of the country according to the local conditions and available resources.

Several newly developed rice-fish culture models with desirable economic return became popular among farmers, and the examples include the culture of high-value fish species with rice in Chongqing suburb, giant freshwater prawn culture with rice in Jiangsu Province, native freshwater shrimp culture with rice in Shanghai suburb and Chinese mitten-handed crab in Liaoning Province. With intensified management and increased input, including artificial feeding, rice farmers could gain an average annual net profit of USD 1,813 per ha from the animals they raise in their paddy with these new models.

Paddy field renovation

At present, most paddy fields used for rice-fish culture have been renovated to varying degrees in favor of fish growth. The renovation usually includes the excavation of ditches and sumps as shelter for fish and building of higher and wider dikes. About 10-20% of the total area is converted for these purposes. Paddy fields with such renovations on average could produce at least 7,500 kg of rice and 750 kg of fish per ha without artificial feeding. The fish yield can be significantly increased as farmers develop better skills in handling their fish and increase their inputs, such as fish seeds and feed, into the system.

Fish species used in rice-fish culture

In the past two decades, the fish species employed in rice-fish culture as a whole have changed from simple species combination, such as Chinese carps and common carp, into a multi-species combination. Both monoculture and polyculture are adopted. Nowadays, a great diversity of aquatic animal species is found in the rice-fish culture systems, adapting to the wide range of farming systems and market environment in different parts of the country. Apart from the traditional finfish species, crustaceans, amphibians, mollusk and reptiles became common in rice-fish culture. The general trend is shifting from low value carp dominated species towards species that could fetch higher market price. Currently, the popular species for rice-fish culture in China are Chinese carps, tilapia, swamp eel (Monopterus albus), eel (Anguilla japonica), giant freshwater prawn (Macrobrachium rosenbergii), native freshwater shrimp (M. nipponensis), Chinese mitten-handed crab (Eriocheir sinensis), Letiobus cyprinelus, American frog (Rana nigromaculata), Crucian carp (Carassisu auratus,), snakehead (Oxyeleotris marmorata), loach, catfish (Misgurnus anguillicaudatus, Clarias leatheri, Silurus meridionalis), soft-shell turtle (Trionyx sinensis) and edible snail.

Development of large-scale rice-fish culture

Although China is a vast country, it has the world's largest population and its land resources for crop farming and aquaculture development are limited for further expansion by area. Rice-fish culture is an effective way of land utilization for food fish production with nominal competition with other agriculture activities for land and water resources. Taking 1999 as example, the fish production from paddy field in that year was 650,000 tons. It was equivalent to the fish production from 86,667 ha of fish ponds with the yield of 7,500 kg/ha. It is estimated that about 6.7 million ha of paddy field in China has the potential for conversion into rice-fish culture. If half of these paddy fields are used for rice-fish culture, it is equivalent to the fish production from 200,000 ha of fish ponds based on the present-day fish yield level.

Rice-fish culture is a relatively easy, low-cost and low-risk entry point for rural farming communities to improve their livelihood and household income without jeopardizing the sustainability of rice production. Compared with pond-based aquaculture, rice-fish culture is less restricted by initial capital investment and labor requirement. Rice-fish culture is now used widely as an alternative livelihood improvement and poverty alleviation.

In the 1990's, China has undertaken a series of mass campaign of rice-fish culture extension. Several standardized paddy field renovation models were recommended and widely adopted. It turned out that farmers with their paddies renovated became less vulnerable to flood and drought. For instance, in rice-fish-duckweed-lotus-water cane-chufa-vegetables integration, the recommended renovation includes an increase in dike height to 80-100 cm, the excavation of a 120-150cm deep sump and 50-70cm deep ditches. The sump, sometimes brick and cement walled for durability, accounts for 7-10% of the paddy field area while the ditch occupies 3-5% of the total area. Each hectare of paddy filed with such renovation could store up to 7,500m3 of water during rainy season. The sump could be used as reservoir for watering vegetables in dry season.

Effective extension service at various levels, financial support and incentive policy by government have played important roles in the wide spread of rice-fish culture in China in the past two decades. At present, the government has formed a national fisheries extension network and extension activities are carried out at four different levels under the National Fisheries Extension Centre, namely provincial, prefecture, county and township levels. In some places, extensions officers also help to secure fish seed supply and marketing information for farmers. Rice-fish culture has been incorporated into the overall rural development plan and agriculture development plan by many local governments. In less developed and remote regions, financial support in the initial stage is a key factor to help the resource-poor farmers in paddy field renovation and first run operations. Financial support from the government is usually delivered in the forms of construction materials and seeds, etc. Tax exemption is applied to rice-fish culture in places where it is promoted poverty reduction purpose. Such incentive policy should be continued.

It is apparent that small-scale rice-fish culture can bring improved economic benefits to individual farmer families. With more than 60% of China's population occupied in agriculture, there is a need for further extension on rice-fish culture among rural communities on a mass scale, where it is possible, in order that its development can benefit the economy and well being of the whole society. Only when rice-fish culture is practiced on a mass scale will its socio-economic and environmental benefit be realized. Therefore, the need in the immediate future for aquaculture development should include rice-fish culture as one of the top agenda items.

What's New in Aquaculture

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fish; smoked and marinated fishery products; canning; silage; packing; quality assurance, HACCP and sensory evaluation.

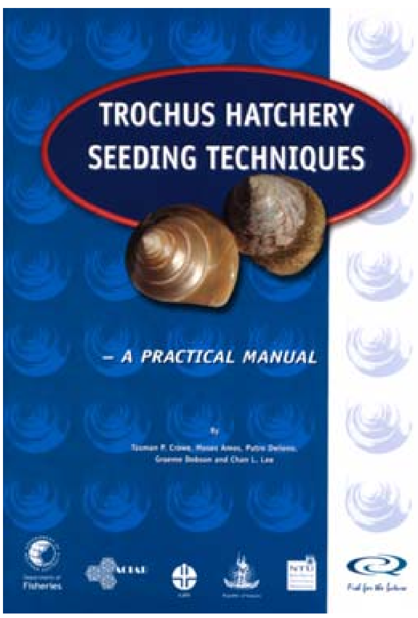
Available from: Directorate of Information and Publications of Agriculture (DIPA), Krishi Anusandhan Bhavan, Pusa, New Delhi-110012, Phone: 91-11-25731350, Fax : 91-11-25731282, http://www.icar.org.in/icar6.htm

Conclusion: Recommended. This book provides a useful insight into manufacturing processes and their impact on product life, quality and nutritional value.

Trochus hatchery seeding techniques – a practical manual

T.P. Crowe, M. Amos, P. Dwiono, G. Dobson and C. Lee.32pp.

This manual is written for the general public, fisheries extension officers and artisinal fishermen. It aims ot provide a basoc overview of the biology of trachus and its production in aquaculture facilities. It also summarises the findings nd protocols of the ACIAR Truchus Reseeding Research Project in practical terms. The manual contains sections on i) the biology and life cycle of trochus, ii) hatchery production of trochus and iii) reseeding of trochus. The manual addresses practical issues such as how to spawn and raise the shellfish, selection of suitable sites, size of trochus at release, how to improve survival and packing and handling. It includes a reference section for readers who wish to explore topics in more depth.



Available from the Australian Centre for International Agricultural Research, GPO Box 1571, Canberra ACT 2601, Australia, Tel: +61 (02) 6217 0500, Fax: +61 (02) 6217 0501, email comms@aciar.gov.au http://www.aciar.gov.au/web.nsf/publicationcategory?openform

Conclusion: A useful introductory manual and a good starting point for people wishing to become involved in trochus culture.

Aquaculture Compendium - case study component

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developed from published materials from our Compendium partners (AIT, IoA, NACA and WAS), and collaborators (MRC, STREAM), with discussions on-going with other potential collaborators (Deacon University, FAO, SEAFDEC, WorldFish Center). Although it is CABI's intention to cover case studies in other selected countries more fully in subsequent editions of the Aquaculture Compendium, it would benefit the first release of the Compendium if it were to have wider case study coverage. I intend to "cherry pick" systems and issues of particular relevance and interest from around the world so do contact me if you wish to contribute.

Formats and examples of case studies are in preparation. Each case study is to be brief, about 10 pages, with summarized text and bullet points. There will be a standardised table of contents for growout production systems although for other topics it will be flexible because of diverse content. Case studies will be richly illustrated with photographs, tables and graphs.

For more information contact Martin Parr at m.parr@cabi.org. Specifically for case studies, contact Peter Edwards pedwards@inet.co.th. Contributors will receive a small honorarium to express appreciation for their input to the Compendium.

Aquaculture Calendar

Symposium on Disease Problems in Aquaculture: Challenges and Management, 6-7 February, Mumbai, India

The Symposium is organized by the Central Institute of Fisheries Education. Themes covered in the Symposium will include: Emerging diseases of finfish and shellfish; Finfish and shellfish immunology; Aquatic environment and management; Genetic selection and disease resistance; SPF stocks; Probiotics and therapeutics; Epidemiology; Herbal products in aquaculture; Exotic and emerging diseases; Quarantine; Drugs and chemicals; Antibiotic resistance; Tissue culture in disease diagnosis; Finfish and shellfish vaccines. For more information contact Dr S.C. Mukherjee, Director, Central Institute of Fisheries Education, Versova, Fisheries University Road, Mumbai - 400 061, India. Phone 0091 22 26363404, email subhasmukherjee@hotmail.com

WAS 2004 Special Session Announcements, 1-5 March, Hawaii USA

A number of special sessions will be convened at the World Aquaculture Society Meeting in Hawaii, 1-5 March 2004. People wishing to participate in these sessions are encouraged to submit an abstract. Please note that neither WAS nor session organisers will be offering any support for expenses to participate in special session sessions, ie. Participants must meet their own expenses and registration fee. The special sessions are as follow:

Economics & markets of marine finfish culture

The International Association of Aquaculture Economics and Management (IAAEM) and the Network for Aquaculture Centres in Asia-Pacific (NACA) will be co-sponsoring a special session entitled "Economics, Socio-Economics and Markets of Marine Finfish Culture" for the World Aquaculture Society (WAS) 2004 Conference in Honolulu, March 1-5, 2004. This session will cover all aspects relating to the economics, socio-economics, policy, markets, and trade of marine finfish aquaculture around the world. Selected papers from this session will be published as a special issue of the journal Aquaculture Economics and Management.

Computers in aquaculture

This special session is intended to be a forum for exchange of information on the latest innovations and developments for the practical application of computers and the Internet in aquaculture and fisheries. Another purpose for convening this special session is to bring together as many individuals as possible who are involved in the development and use of computer based information technologies so that we may meet one another and discuss how best to move towards integrating an international distribution network for the ever expanding array of Web sites, equipment, software, distance education opportunities and other products and services being developed for aquaculture.

Advances in aquafeed

This special session, organized by Aquafeed.com is intended to be a forum for exchange of information on new feeds and the latest technology and nutritional innovations of practical application to the aquafeed manufacturing industries. Abstracts for the Aquaculture 2004 meeting are due by August 1, 2003. There is a section on the abstract submittal form to indicate that the abstract has been invited for a special session – please enter: "Advances in Aquafeed (Aquafeed.com)"

Economics of shellfish culture

A session will focus on the economics of shellfish (i.e., culture, management, etc). If interested, please go to the Conference website for online abstract This session is being developed under the auspices of the National Shellfisheries Assocation, which will be a one of the three major associations joining in the Aquaculture 2004 meetings.

Aquaculture Without Frontiers - the Aquaculture Work of NGOs in Developing Countries

An idea to form a new NGO, tentatively called 'Aquaculture without Frontiers' (see www.was.org for further details), aimed specifically at assisting in the alleviation of poverty in developing and transition countries through aquaculture, was put forward in a keynote paper presented at the 2003 conference of the World Aquaculture Society (WAS) in Brazil in May 2003.

Recognizing the role of and need for NGOs to use aquaculture to assist in mitigating the projected shortage of fish, a workshop on the aquaculture work of existing NGOs in developing countries is being organized in conjunction with next year's annual WAS meeting ('Aquaculture 2004', 1-5 March 2004, Honolulu, Hawaii) with the following objectives: i) to review the experiences of NGOs in aquaculture and to identify potential future opportunities; ii) to document the institutional experiences on aquaculture development through NGOs; and iii) to understand the perspectives of governments and donors assisting NGOs in this type of work. Attendees will include Caritas Bangladesh, NACA, the World Bank, and the WorldFish Center. It is hoped that this initiative will help to publicize the significantly positive contributions of existing NGOs and their donors to aquaculture in developing countries, as well as assist in promoting the formation of 'Aquaculture without Frontiers'. The abstract deadline for this session has been extended to 1 September 2003. Abstracts need to be submitted to WAS www.was.org/SubmitAbstract.asp?Code=WA2004, with copies to the moderators mcnraju@yahoo.com and Michael_New@compuserve.com.

New Zealand Aquaculture for the 21st Century, 12 March, Auckland

Organized by the Asia-Pacific Chapter of WAS. The aim of the conference is two fold. One to help New Zealand aquaculture with a conference that focus on all aquaculture industry in NZ. The second is to help network people in NZ aquaculture and overseas industry with the view of helping NZ achieve its full aquaculture potential. The cost for the day is NZD $75 and affordable room rates are available if you want to stay over night or the weekend. The registration forms will be out by 12 December 2003. For more information or registration forms contact Robert Bishop at robert@westernaquatec.com. The programme is available for download.

Third Regional Grouper Hatchery Production Training Course, 17 March-6 April, Bali, Indonesia

The Third training course is tentatively scheduled to be from March 17 - April 6, 2004. Any interested parties should contact Mr Sih-Yang Sim at grouper@enaca.org to register their interest. The training reports for the last two years are available from network website at http://www.enaca.org/Grouper/.

The Eleventh International Symposium on Nutrition and Feeding in Fish, 3-7 May, Thailand

International Symposium on Nutrition and Feeding in Fish (XI ISNFF) will be held on Phuket Island in Thailand. This symposium will be the forum to continue scientific discussion on all aspects of fish nutrition including current knowledge and future perspectives in plenary sessions , workshops , oral presentations and pesters. In addition, emerging issues that relate to food quality and safety will be addressed. There will be an opportunity to organize meetings to discuss special topics that may lead to the formation of networking groups to promote the advancement of aquaculture nutrition science , technological development and discussions on potential regulatory issues where nutritionists could provide appropriate advice on policy .

Study Program on Marine Finfish Aquaculture and Markets 2004, Guangzhou and Hong Kong, China, 1-7 July

The study program is intended to provide participants with an insight into the live marine fish markets and aquaculture in southern China and Hong Kong. The study program will be organized by NACA in cooperation with the Guangdong Dayawan Fishery Development Center (Department of Marine & Aquatic Products, China), Guangdong Provincial Bureau of Ocean and Fisheries, Guangdong Fisheries Society, and the Agriculture, Fisheries and Conservation Department (AFCD) – Hong Kong SAR. Tentative schedule will be around July 2004 period. More information on this study program will be provided on the marine fish network website when available. Interested parties can contact Mr. Sih-Yang Sim (grouper@enaca.org) to register their interest.

4th Conference of the Asian Federation of Information Technology for Agriculture and 2nd World Congress on Computers in Agriculture and Natural Resources, 9-12 August, Bangkok, Thailand

Call for Papers and Workshop Proposals The Organizing Committee of the Joint AFITA/WCCA Congress is pleased to extend this invitation to all professionals involved in agricultural information technology to attend the Joint Congress between AFITA and WCCA, August 9-12, 2004, in Bangkok, Thailand. Also, to participate as authors of a paper to be included in the proceedings and to be presented orally or at a poster session in keeping with the theme of the Congress. Submissions for pre-congress workshops are welcome.

Areas of interest include but are not limited to: Information Technology in Agriculture, Rural Development and Poverty Reduction / Knowledge Based Society and Its Strategies/Policy; Adoption and Extension; Agricultural Risk Management and Farm Management; Decision Support System and Modeling; E-AgBusiness and Production Chain Management; Information Resource and Databases; Grid and Web Services; Field Data Acquisition and Recording; GIS, Remote Sensing and Precision Agriculture; Food Safety, Food Security, Trace ability and Quality Management; Education and Distance Learning; Digital Library / Knowledge Representation and Library Science; Water Management; Multilingual Services; Aquatic Resource Management; Bioinformatics; Birth of Feathers. Abstracts can be submitted online and more information is available from http://www.afitaandwcca2004.net/att.php. Full papers that are accepted must be submitted in the appropriate format before April 30, 2004.

AustralAsian Aquaculture 2004, Sydney, Australia, 26-29 September

Australasian Aquaculture 2004 will be the first in a series of national aquaculture conferences to be held biennially near the major aquaculture producing areas of Australia. Australasian Aquaculture 2004 will be the biggest aquaculture conference and trade show in Australia since World Aquaculture '99. This international conference and trade show will examine the Australian National Aquaculture Action Agenda and also provide a wider forum for general exchange of technical information among producers, suppliers of equipment and services, researchers and policy makers. Australia is an ideal location for the event because of its close links with New Zealand, the Pacific Islands and Asia. Call for papers: Abstracts are due by 27 February. For further information or download the brochure from the NACA website http://www.enaca.org/AusAq.pdf (PDF 260 KB).