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

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NACA
An intergovernmental 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.

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From the Editor's desk

Online networking is now a reality. Try it.

For some time now we have been talking about the potential of 'online networking' via the internet. In a highly decentralized organization such as NACA – with participants scattered across many different countries - this has enormous potential as a tool for information exchange and collaboration. I am happy to say that for NACA online networking is now a reality.

Regular visitors to the NACA website will have noticed that it has been completely overhauled and the discussion forums I foreshadowed in the last issue are now active. For practical purposes, the main difference is that the website is now interactive. You can now contribute your own news stories, events and publications to be published on the site ! Our goal is to establish an 'online community' where participants from all over Asia can share their local news and discuss issues with their colleagues, no matter where they may be physically located. Central to this are the new discussion forums where you can ask (or answer) questions about aquaculture in real time. Each question is automatically posted on the home page where other visitors to the site (some 10,000 per month) can see it and respond. You can also post comments about news stories or publications on the site.

The new website also offers a lot of new services that can help you to find information, automatically track issues and publish your own news. In the back of this issue of the magazine you will find a "Guide to Member Services", which explains in detail how to make full use of the site and how to customize your personal website account. Investing a few minutes in this now will pay off quickly, and will help to bring you the latest news and publications on topics of your interest as they are released.

To participate in the online community you must register as a member of the website, which is (and will remain) free. Click on the 'register now' link in the login box, or visit www.enaca.org/register.php. Please note that you must provide a valid email address (as we will email you a link that you need to click on to activate your account).

In other news, our regular "Genes and Fish" correspondent Dr Graham Mair has moved to Australia to take up a new position. He is taking a well deserved break from Aquaculture Asia while he settles in. We have recently gained a new Research Associate at NACA, Dr Thuy Nguyen, who is working on the application of genetics in biodiversity issues related to inland fisheries management and aquaculture in the region, so you can look forward to greater coverage of genetics in future issues.

Lastly, production of Aquaculture Asia has been running behind schedule for some time now and for this I apologise. We are currently working to bring it back up to speed and it should be back on track shortly. We are also gauging the level of interest in starting a new section on ornamental fish for both the magazine and website. If you would like to express your views on this please email me at simon.wilkinson@enaca.org or send in an article.

That's all for now. Please join our online community, and I look forward to seeing you online !

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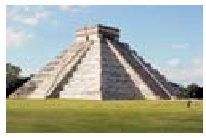

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Notes from the Publisher

The revolutions Blue and Green: Parallels and contrasts

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

Comparing the promise of modern high-tech aquaculture to the achievements of the green revolution of the 60s and 70s is off-track. Such comparisons neglect the contribution of traditional aquaculture to food and income in developing countries. Traditional aquaculture has long been, rather than it may yet be, a big contributor to food supplies in developing countries. A lead story of the "Economist" (August 9, 2003) had described traditional fish farming as a "low-tech affair invented by the Chinese." This characterization ignores the fact that a great deal of traditional and scientific knowledge is needed about the habits and life cycle of the species and the biological, technical and economic intricacies of the farming system. The Chinese-originated integrated fish farming system, which has evolved into many versions in China and elsewhere, requires a farmer to be familiar not only with what is needed to breed, nurse, rear and harvest each of the fish, land animal and plant species in the mix, but also how to manage this complex combination to give the best possible yield and economic returns.

From the 1980s, Chinese scientists and their counterparts in other countries have gradually placed the art of integrated fish farming under the light of science, making it better understood by researchers, extension workers and farmers. Since 1981, the practice has been shared with much of the developing world through a yearly training program the Chinese government conducts for free – at the NACA regional lead center in China, the Freshwater Fisheries Research Centre in Wuxi - to trainees from Asia, the Pacific region, Africa, the Middle East, Latin America and Eastern Europe.

The system produces a lot of low-cost fish, and meat and vegetables (10-15 tons of fish from a hectare of pond per crop cycle is the norm in China, only a bit less in Indian and Bangladeshi farms with their own composite culture of 3-4 species of the Indian major carps in a pond). Just as significant to resource-poor areas, the system converts farm wastes and by-products to fish flesh, uses the spent pond water to irrigate crops, and the sludge to fertilize the soil (rather than being thrown out to pollute estuaries). Pig and chicken wastes in bigger farms in China and in trial sites in India are fed into a biogas generator to power the farm. None or very little input is brought in from outside the farm, certainly no fishmeal, as almost all of the carp species (as well as the others grown – in integrated systems not monoculture - in other countries such as milkfish and even tilapia) feed on farm wastes and planktons, the latter grown in the pond by fertilization, usually with farm yard manure. One species, the grass carp, feeds on grass and vegetables and fertilizes with its feces the pond. As carps are a hardy fish, drugs and therapeutants are rarely used. To be economically efficient the system does not need a large area either. A lot of Vietnamese farm families produce and earn much of their food needs and income by applying the same system on space as tiny as half an acre. Thailand, the world's biggest producer of farmed shrimp, produces yearly a quarter of a million tons of freshwater fish, much of it from integrated and traditional farm systems.

For coastal areas, another Chinese system raises four species in one column of water – seaweed on long lines, high value shellfish such as scallop and abalone, in cages, the latter fed with young seaweed leaves, and sand fish (sea cucumber) on the seabed. In poor coastal communities, this type of integrated aquaculture, with modifications like raising high-value fish and crustaceans in low-cost cages, offers an alternative livelihood to fishers displaced by too much fishing effort or destructive fishing. As with its land-based cousin, the system depends largely on natural productivity of the water. Clearly, it does no harm to the environment; seaweed and molluscs in fact clean up the water.

"Blue revolution" is a catchy phrase, much as "green revolution" was in reference to producing high grain yields. They are powered by technology wrapped around a high yielding material raised in highly intensive monoculture two or three times a year. The green revolution led to bigger harvests, staple grain sufficiency and even surpluses in previously chronically grain-deficit nations. But it also gave rise to a host of problems such as more pesky pests and resilient microbes that became more difficult, expensive, and harmful (to the environment and farmer's health) to be rid of. Higher dosages of inorganic fertilizer weighed heavily on small farmers' budgets and turned soils acidic, requiring yet more soil amelioration costs. Runoffs from farmlands polluted streams or made them extremely fertile that the resulting algal bloom choked them.

The beneficial results and harmful side effects of the green revolution now have parallels in the modern high-

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Pancham's Tryst with *P. japonicus*

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A wild male Kuruma shrimp P. japonicus.

Pancham Aquaculture Farms Ltd. (Pancham) was established in 1987 with an objective to culture the Kuruma shrimp *P. japonicus* for live export to Japan. The project was abandoned due to the anticipated quarantine problems at Osaka and Tokyo. Finally, culture began in 1991 with *P. indicus* as the culture species. Due to the meager margins for *P. indicus*, it was replaced by *P. monodon* in 1995. Culture of *P. monodon* continues to date along with our obsession for *P. japonicus*, the most beautiful of shrimps.

The regular landings of gravid *P. japonicus* females at a nearby fishing harbor between August and October every year, as well as the availability of wild juveniles in our vicinity between September and December, had kept us hoping. Unfortunately our efforts to persuade the fishermen to collect gravid females for us were not bearing any fruit. *P. japonicus* are only a by catch during trawling trips extending up to ten days. Special fishing trips exclusively for *P. japonicus* are too expensive. It is much easier to get juveniles from one-day trips. However, our halfhearted efforts to grow wild juveniles to maturity were abandoned four times since 1995 due to the fear of whitspot disease.

The northern part of Maharashtra State where Pancham farms are located and the adjoining parts of Gujarat State suffer a cold winter. Water temperatures are lowest in the month of January and regularly touch 17 / 18 C. Due to the low temperatures, growth of *P. monodon* is very poor and in winter culture becomes unviable. As a result most farmers only grow one crop of *P. monodon*, which starts from June / July and extends up to November. The possibility of culturing cold tolerant *P. japonicus* was often considered but ultimately rejected due the fear of contracting whitespot disease through the wild brooders. Fed up with the repeated failures of our winter crops and after a lot of deliberations, we decided to accept the risk. And thus we decided to produce and stock *P. japonicus* fry.

The next step was to persuade the fishermen to collect brooders for us. After a lot of attempts the fishermen were successful in getting brooders to the harbor. The brooders were collected in three batches during September and October of 2003. They were transported from the fishing harbor to our hatchery, which is around 100 km away. Individual shrimps were packed in 60 mm perforated PVC pipes. Two shrimps were packed per 15-liter plastic bags with five liters of water and ten liters of oxygen. The transportation time from the harbor was around five hours.

The size of brooders we obtained was good with females ranging from 52g to 115g with an average of 82g and males with 25g to 53g with an average of 40g The size of brooders that died during fishing operations was not taken into consideration. The majority of the dead females were over 100g.

All the female brooders collected live were at different stages of maturity. A total of six females (two from 1st batch, four from 2nd batch and none from third batch) at third stage of maturity were kept for spawning. 300 liter black circular plastic tanks were used for spawning. Two gravid were stocked per tank. The remaining brooders were transferred to five-meter diameter round concrete maturation tanks. The shrimps could be fed only fresh clam meat.

All the female brooders except the two gravid ones from the first batch died within two days of stocking. We also lost 17 males out of the 28 within a week. The main reason may be the physical stress and damage suffered during collection and transportation.

There were three partial spawning from the two surviving spawners (58g and 62g). The spawning invariably occurred during night. The eggs were comparatively smaller in size than those of *P. monodon*, and were greenish black in color. The eggs were collected after passing through 300-micrometer mesh to separate debris, washed with clean seawater, counted, checked for fertilization and kept for hatching. The eggs seemed to be much heavier than *P. monodon* eggs, so to keep them in suspension a narrow fiberglass cylinder of 30cm diameter and 1.2 meters height with vigorous aeration was used as hatching tank.

The eggs hatched around 12 to 14 hours after spawning. The nauplii were collected by siphoning after congregating them using their phototactic behavior, washed with clean sea water and stocked in 300 liter round plastic tanks. The stocking density was 50 to 70 nauplii per liter. Nauplii stage lasted for 24 to 36 hours. When 1st zoea was observed mixed diatom culture dominated by *Cheatoceros* was added to the larval tanks. Water exchange was done at 30% per day with clean seawater. Since diatoms were blooming in larval rearing tanks. only one more diatom culture addition was required during the entire larval culture period. The mysis appeared 78 to 89 hours after the zoea stage. During mysis stage marine rotifers were added to the already existing diatoms. Rotifer densities were maintained at one individual per ml on 1st day of mysis stage and gradually increased to three individuals per ml. on fourth day. The water exchange during mysis stage was 50% per day. On fourth day of mysis stage post larvae appeared. The post larvae were fed with freshly hatched *Artemia* nauplii, addition of rotifers continued at lesser density until P.L. 5. At P. L. 5 to P. L. 7 stage the larvae started settling at the bottom of the tank. To facilitate cleaning of the tanks PLs were harvested and stocked in new tanks at the density of 25 to 33 PLs per liter. The settling behavior became more pronounced as the PL age increased. While changing the tanks 10,000 PLs of second batch were stocked in black opaque tanks of 300 liters and all others in four white translucent tanks of 500 liters capacity. There was a marked difference in pigmentation between these two types of tanks. The larvae from the black tank had uniformly dark reddish black pigmentation. The larvae from white tanks were translucent pale yellow. The PLs were fed adlibitum with *Artemia* nauplii till the end of culture and water exchanged unto 80% per day.

The post larvae were harvested at PL23 to PL28 stage and stocked in earthen ponds at 2/m^2 density. The size of larvae was 1.5 centimeters to 2.5 centimeters while harvesting in different batches. The survival from nauplii stage to harvested PLs was 47.6%, 75.7% and 68.8% respectively for the 1st, 2nd and 3rd batch. The average survival was 65.43%.

The success of the hatchery trial even though on a minuscule scale has given us enough fry to stock two ponds at a low density. Formulated feed for *P. japonicus* is not available and feed meant for *P. monodon* is being used. Growth during the first month is good (4.1g at 34 days of culture). The growth during the second month appears lower (5.8g at 51 days of culture). Whether the slower growth is due to lower temperature (18 C) or the lower protein feed has to be studied. This culture trial has the dual objectives of studying the suitability of *P. japonicus* as the culture species for winter crop in the neighboring area and to produce captive broodstock.

A juvenile P. japonicus from our hatchery.

Enzymes for sustainable aquaculture

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The expansion of global aquaculture production is increasing the demand for aquaculture feeds. Fishmeal is the main and most critical ingredient in aquafeed production. The increasing cost of fishmeal has encouraged feed manufacturers search for cheaper alternative protein sources such as plant proteins. Though the palatability of many plant materials has demerits, anti-nutritional factors are the most serious concern in replacing the fishmeal completely in feed formulations. Anti-nutritional factors have an adverse impact on the digestion of feed and its efficiency. There are many kinds of anti-nutritional factors. Three that are associated with the most widely used plant materials are trypsin inhibitor proteins, glucosinolates and phytate. Heat inactivation and water soaking are the two common detoxification methods used to overcome most of the anti-nutritional factors.

Enzymes provide additional powerful tools that can inactivate anti-nutritional factors and enhance the nutritional value of plant-based protein in feeds. They provide a natural way to transform complex feed components into absorbable nutrients. Endogenous enzymes found in the fishes digestive system help to break down large organic molecules like starch, cellulose and protein into simpler substances. The addition of enzymes in feed can improve nutrient utilization reducing feed cost and the excretion of nutrients into the environment.

Phytic acid is one of the most powerful anti-nutritional factors in plant ingredients. The anti-nutritional activity of phytic acid can be eliminated by the addition of relevant enzymes, for example phytase. The phytic acid or phytate found in cereals, legume grains and oil seeds is bound with phosphorus and also with calcium and magnesium, trace elements like iron and zinc, protein and amino acids. Most fishes do not possess their own enzymes to break down the phytate and release the nutrients so they pass through the fish undigested. This is why higher proportions of valuable nutrients from vegetable sources are not utilized by the animals and are wasted as excreta. The feed enzyme phytase not only releases phosphorus from the phytate but also releases minerals and amino acids that are also bound, paving the way for maximum utilization of nutrients.

Advantages of phytase

1. Since the phosphorus bound in phytate becomes available as nutrient due to the addition of phytase, the inclusion of inorganic phosphorus such as fishmeal can be drastically reduced.
2. The environmental performance of aquaculture operations is under scrutiny due to the discharge of nutrients into the surrounding ecosystems. Excessive phosphorus in particular is an important factor in the eutrophication of waterways. Phosporus bound in phytate may be unavailable to the fish but it will still ultimately be released into the environment as microbial action breaks down the fishes waste. The addition of phytase reduces the release of nutrients into the environment by making the bound phosphorus available to the fish for growth – so it is incorporated into the fishes body instead.
3. Phytase added to the diets improves protein and amino acid digestion in fishes.
4. Phytase can improve the metabolisable energy of feeds by breaking down the phytate-lipid complex.
5. Cheaper plant based protein sources can be substituted for fishmeal lowering feed costs.

Non – starch polysaccharides (NSP)

Another important anti-nutritional factor that can be addressed with feed enzymes is non-starch polysaccharides (NSP), present in the plant materials and found to reduce the performance of animals. Their anti-nutritive effects are mainly due to the increased viscosity of the digest in the intestine and the enclosure of nutrients making them unavailable to digestion. Since the animals lack the intestinal enzymes for the degradation of non-starch polysaccharides, the supplementation of degrading enzymes in the diet will break down these anti-nutritive factors and result in better feed utilization. Such an approach has been successfully used in poultry diets.

Experimental results using feed enzymes

A number of studies have reported successful use of enzymes to combat anti-nutritional factors in plant proteins for fish feeds. Phytase added diets have been shown to have a higher feed intake, growth and better food conversion efficiency than control diets in Channel catfish, as well as reduced phosphorus load in their faecal matter[1]. Trout fed with phytase-incorporated soybean based diets have been reported to show a 22% improvement over control fish as phosphorus availability increased from 46% to over 70%[2]. Microbial phytase added diets containing a higher proportion of plant protein have been shown to improve phosphorus and protein digestibility in Atlantic salmon[3].

A feeding trial conducted with tilapia (*Oreochromis niloticus*) fingerlings in Brazil showed the significance of phytase in plant protein based diets. The feed was supplemented with commercial phytase enzyme “Natuphas” at 0, 500, 1500 and 3000 units per kilogram of feed. Fishes fed with 500 units of Natuphas showed higher weight gain and a better food conversion ratio of 1.80. Supplementation of protease-based additive equaled the performance of low protein milk fish diet (24% protein) up to the level of higher protein diets (28% protein)[5].

The addition of commercial enzyme Pescazyme TM 5602 in soybean based diets free of fish meal showed equal performance of diets containing 10 or 12% fish meal in carp and tilapia[4,5,6].

Conclusion

Aquaculture is fast growing Industry. Successful and sustainable aquaculture depends on economically viable and environmental friendly feeds. Feed is the major operational cost involving 50 to 60% of the total cost in intensive farming. The major feed ingredient, fishmeal, is expensive and there is increasing competition with other livestock industries for the available supply. Hence, research work has been focussed to find alternatives to fishmeal. One alternative is to substitute fishmeal with plant proteins supplemented with feed enzymes. Phytase enzyme is able to release the phosphorus bound in phytate and this permits feed manufacturers to reduce the fishmeal and lower the cost of feed production. Improved phosphorus utilization can also help reduce the discharge of nutrients into the environment. Enzymes can therefore play an important role in formulating eco-friendly aquafeeds. Currently, the use of enzymes is able to reduce fishmeal inclusion by around 5% in most aquafeeds with potential for more as techniques are refined. This may help to reduce the demand for fishmeal from the aquaculture sector in coming years.

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A review of global tilapia farming practices

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Tilapia, that is native to Africa and Middle East, has emerged from mere obscurity to one of the most productive and internationally traded food fish in the world. The farming of tilapias in its crudest form is believed to have originated more than 4,000 years ago from Egypt. The first recorded scientifically oriented culture of tilapia was conducted in Kenya in 1924 and soon spread throughout Africa. Tilapia was later transplanted and became established as a potential farmed species by the late 1940s in the Far East and a decade later spread in the Americas.

The last three decades have seen significant developments in farming of tilapias worldwide. In view of the increasing commercialization and continuing growth of tilapia industry, the commodity is not only the second most important farmed fish globally, next to carps but is also described as the most important aquaculture species of the 21st century (Shelton 2002). The fish is being farmed in about 85 countries worldwide (FAO 2002) and about 98% of tilapia produced in these countries is grown outside their original habitats (Shelton 2002). The main culture industries are in the Far East but they are increasingly being farmed in Caribbean, Latin America and recently, in temperate countries where warm water through artificial means (thermal effluents or geothermal springs) are also available.

Development of technologies that are significant to tilapia farming

Tilapias are known to have been an important component of subsistence fisheries for thousand of years within their native range but this commodity has gained prominence in farming and food status not within their endemic areas but elsewhere as an exotic species. The farming of tilapia outside Africa began in Asia with the introduction of Mozambique tilapia (*Oreochromis mossambicus*) but early experience in culture of the species was met with failure due to its undesirable characteristics and production of small, low value fish at harvest. Success in tilapia farming began in the latter half of 20th century after introductions of better performing tilapia species from Africa and development of techniques to manage unwanted reproduction.

In populations of tilapia, males grow faster and are more uniform in size than females. For this reason, the farming of monosex populations of tilapias, which is achieved either by manual sexing, direct hormonal sex reversal, hybridization or genetic manipulation, has been reported as a solution to the problem of early sexual maturation and unwanted reproduction.

Manual sexing, which entails elimination of females based on sexual dimorphism observed in the urogenital papilla, is simple but is time consuming, requires qualified personnel and usually results in 3-10% errors.

Hybridization has been studied extensively mainly to improve commercial traits and to control unwanted reproduction in ponds. Early research work of Hicking (1960) on hybridization between various species of *Oreochromis* (*O. urolepis*, *O. hornorum* and *O. mossambicus*) resulting in all male hybrids was pivotal in subsequent investigations that led to important milestones in tilapia farming (Lazard 1996; Shelton 2002). Subsequent interspecific crossing and various culture methods for commercial application were tried and it was found that crossing male *O. hornorum* or *O. aureus* with *O. mossambicus* or *O. niloticus* also produced all male or nearly all-male progeny (Shelton 2002). Despite these developments, hybridization did not effectively solve the problem of unwanted reproduction mainly due to difficulty in sustaining production of all-male hybrids. This is most likely caused by insufficient care in keeping the broodstock segregated by sex and species and in preventing introduction of hybrids into the broodstock ponds.

In view of limitations described above in hybridization, masculinization of the entire tilapia populations through hormonal sex reversal was sought. The technique, which involves the addition of steroids in feeds for a short period during the fry stage, proved to be easily applied, relatively consistent in producing nearly all male populations and could be repeated in various country situations by farmers. The use of this technique however has not been fully accepted in some countries due to environmental and social constraints; for example, the metabolism and the effects on the environment of the degradation products of synthetic androgen are not yet fully understood in fish (Baroiller 1996). In the United States, the use of hormones in sex reversal is currently under evaluation by the Food and Drug Administration (Chapman 2003).

The recently developed technique for obtaining monosex population is by producing 'supermales' through genetic manipulation. Based on the theory of predominantly monofactorial sex determination, it has proved possible to manipulate sex ratio using a combination of sex reversal and progeny testing to identify sex genotypes. In a breeding program in *O. niloticus*, Mair et al (1997) developed a technology that produces genetically male tilapia (GMT) with an average sex ratio of >95% male and 40% increase in yield.

The development of Genetically Improved Tilapia (GIFT) technology that is based on traditional selective breeding and is meant to improve commercially important traits of tropical farmed fish is a major milestone in the history of tilapia aquaculture. Through combined selection technology, the GIFT program achieved 12-17% average genetic gain per generation over five generations and cumulative increase in growth rate of 85%. in *O. niloticus* (Eknath and Acosta 1998).

Species and strains for culture

There are about 70 species of tilapias, most of them native to Western rivers of Africa (Anon 1984). Of these, nine species are used in aquaculture worldwide (FAO 2002) (Table 1). However, tilapia production is concentrated mainly on Nile tilapia (*O. niloticus*), Mozambique tilapia (*O. mossambicus*) and Blue tilapia (*O. aureus*). Of these three species *O. niloticus* has for many decades been responsible for the significant increase in global tilapia production from freshwater aquaculture and accounted for about 83% of total tilapias produced worldwide (FAO 2002) (Fig. 1). Mair (2002) however argued that production data on *O. niloticus* may not accurately represent the correct figure. In China, for example, it is estimated that as much as 60% of the species produced is in fact production of an *O. niloticus* x *O. aureus* F1 hybrid. Although most of its reported productions are from feral populations, *O. mossambicus* is the next predominant tilapia species, contributing about 4% of the world's total tilapia aquaculture production.

Pullin (1983) compared various tilapia species with culture potential and suggested that research efforts be concentrated on *O. niloticus* and *O. aureus*. Shelton (2002) claimed that while the latter is still used to produce the hybrids, it has been effectively left behind as *O. niloticus* has taken the lead as the principal species for culture in many parts of the world. This species is the most favored by farmers due to its suitability for farming in a wide array of culture environments/ systems, ranging from extensive, low-input pond culture to intensive recirculating systems. The other species that are gaining recognition because of their adaptability to certain conditions are *O. aureus* for colder waters and *O. spilurus* for saline waters.

The Red tilapia hybrids, produced first time in Taiwan through the interspecific cross of *O. mossambicus* albino and *O. niloticus*, are providing the '3rd generation of tilapias' combining favored colors with other desirable features of tilapias (Anon. 1984). This fish has gained increasing preference of commercial farmers in some countries because of their reddish color liked by consumers and their resemblance to premium marine species such as sea bream (*Chrysophrys major*) and red snapper (*Lutjanus campechanus*). In terms of performance, Alceste (2000) claimed that Red tilapias are suitable for brackishwater and seawater culture because of salinity tolerance of the parental species, known to be moderately (*O. niloticus* and *O.*

Table 1. Commercially important tilapias and their characteristics (modified from Mair 2001)

Species	Common name	Characteristics
Oreochromis niloticus	Nile tilapia	Performs well in tropical/subtropical areas; sexual maturity in ponds reach only at age of 5-6 months; suitable for culture in wide range of farming system (extensive to highly intensive system; monoculture and polyculture); high consumer and producer acceptance; least tolerant to cold water
O. aureus	Blue tilapia	Most cold resistant species (can tolerate low temperature of 8-9 ^{o}C); suitable for culture in countries with seasonal changes in temperature; sexual maturity in ponds reach at age of 5-6 months; commonly used in hybridization for production of monosex tilapias
O. mossambicus	Mozambique tilapia	High saline tolerance (grows well up to 20ppt); early reproduction (attains sexual maturity at 8-9 cm) and high fecundity; poor aquaculture potential except when used for hybridization
O. spilurus	None	Saline tolerant; used in seawater cage culture
O. hornorum (Tilapia urolepis)	Zanzibar tilapia	Can tolerate brackishwater
Sarotherodon galilaeus	Gallilee tilapia	Saline tolerant; slow growth
S.melanotheron	Black-chinned tilapia	Wide salinity tolerance (0-45 ppt but prefers 10-15 ppt; of interest for brackishwater aquaculture; used for extensive aquaculture in some parts of Africa
Tilapia rendalii	Redbreast tilapia	Feeds on macrophytes
T. zillii	Redbelly tilapia	Grows well in full strength seawater
Red tilapia hybrids[1]	Hybrid origins	Suitable for brackishwater and seawater because of salinity tolerance of parental species; commonly used for intensive culture (cages, tanks, raceways) but also reported to be suitable for farming under low-input conditions; initial high consumer acceptance due to color; sometimes exhibit low fecundity

[1]*produced through crossbreeding of albino or mutant-reddish orange* O. mossambicus *(a normally black species) with other species, including* O. niloticus, O. aureus and O. hornorum*)*

aureus) to highly euryhaline (*O. mossambicus* and *O. hornorum*). Red tilapia hybrids are most commonly used in intensive aquaculture operations but recent reports indicate that they also have potential for culture under low-input farming.

While tilapias in general are known for their relative ease of cultivation and other attributes, their growth and other production traits are largely influenced by genetics. Popma and Lovshin (1996) reported that males of pure strains of *O. niloticus* and hybrids with *O. niloticus* as a parent, especially *O. niloticus* x *O. aureus* hybrids, are considered the fastest growers. Male *O. mossambicus* has much lower growth than other species.

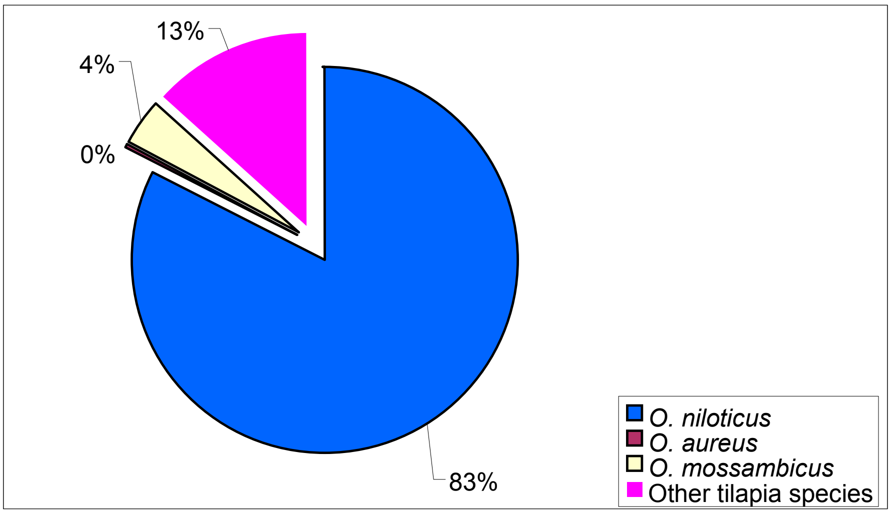
Oreochromis spp. hybridize readily in fishponds. Contamination with less desirable species, such as *O. mossambicus*, and years of inbreeding among pure strains can lead to slower growth (Popma and Lovshin 1996). The use of the recently developed improved tilapia strains (GIFT, GMT) represents a means by which the fish yields in ponds and other culture systems can be increased.

Global productions from aquaculture

The world's total tilapia aquaculture production in 2000 was 1.27 million mt and contributed about 3.6% of global total aquaculture production. The top five producing countries during 2000 are China, Egypt, Thailand, Philippines and Indonesia, each accounting for 49.7, 12.4, 7.8, 7.3 and 6.7%, respectively, of world's total aquaculture production of tilapia (FAO 2002).

Fig. 2 shows the tilapia aquaculture productions by major countries over the past 10 years. FAO (2002) statistics indicate that China has remained the number one producer both within Asia and globally; it produced 629 182 mt in 2000 which is more than 6 times the 1990 production. Egypt also made an impressive increase in tilapia production, from 24 916 mt in 1990 to 157 425 mt in 2000. On the other hand, production in Thailand only slightly increased while those in Philippines and Indonesia have almost remained stable during the period.

Fig. 1. Percent share of global tilapia aquaculture production according to species (Data source: FAO 2002)



In 2000, of the 1.27 million mt of tilapia produced from aquaculture, 85% was grown in freshwater environment, while 14.1% in brackishwater (FAO 2002).

Review on culture systems around the globe

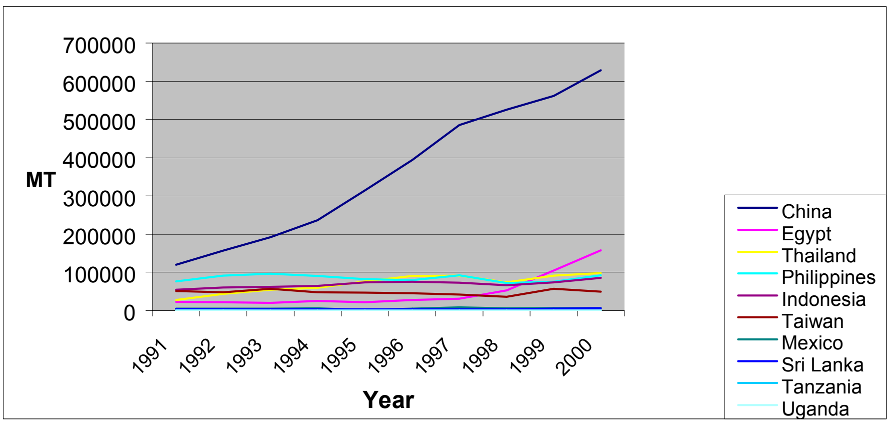
Tilapia farming ranges from a rural subsistence (extensive, low input practices, non-commercial and for household consumption) to a large-scale (capital intensive, commercial purpose and market driven) level, depending on the intensity of management employed. The following provide the details of the culture practices used globally.

Water-based systems

Cages

In Asia, the Philippines was the pioneer for cage culture in lakes and reservoirs in the region and practices semi-intensive and intensive farming (Guerrero 2002). It was reported that in 2000, the country's cages in 2000 ha of water produced a total of 33,067mt of *O. niloticus*. The average yield of 540 kg/100m^2 cage is attained with *O. niloticus* (mean weight of 175g each) after 5 months of rearing fingerlings. Unlike in Philippines where most cage farmers use Nile tilapia, farmers in China, Malaysia and Singapore prefer to grow Red tilapia hybrids in cages in former mining pools, rivers, irrigation canals and lakes/reservoirs using the semi-intensive and intensive method (Orachunwong et al 2001; Guerrero

Fig. 2. Tilapia aquaculture production by top ten producing countries (Data source: FAO 2002)



2001). In Indonesia and Thailand, cage culture of *O. niloticus* and Red tilapias in rivers, irrigation canals and lakes/ reservoirs and using the semi-intensive and intensive methods are practiced. Tilapia cage culture in Indonesia is mostly found in West Java, Jambi, South Sumatra and Kalimantan (Guerrero 2002).

Unlike in Asia, little information is available on cage culture in Africa. Jamu (2001) reported that cage culture systems which exist as pilot or fully operational especially in Southern and West Africa have not significantly contributed to actual tilapia production. However, a few have become successful in their cage culture operations and the largest is found in Northern Zimbabwe.

In America, Brazil dominates the tilapia cage culture industry and commercial cage culture operations are the major suppliers of the fish sold within and outside Brazil (Costa et. Al 2000). Five varieties of red tilapia are being cultivated with an annual estimated production of 80,000mt per year. Semi-intensive culture of Red tilapias in 6-18m^3 cages has allowed Brazilian producers to reach a productivity levels of 100 to 305 kg per m^3 per cycle (Alceste and Jory 2002, Costa et al 2000). Tilapia cage ranching in large lakes has also become prevalent in Mexico and Colombia where fisheries has been established in new reservoirs that were repeatedly stocked with tilapia fingerlings (Fitzsimmons 2000).

Land-based systems

Ponds

Most of the pond-based tilapia farmers in Bangladesh, China, Taiwan, Thailand and Vietnam use the polyculture system while in the Philippines, most farmers grow tilapias under the monoculture system. Culture methods followed in these countries vary depending on nature of farmland and farmers' capacity to invest. For example, in Bangladesh most farmers do not use commercial feeds and in Vietnam, farmers use only a small quantity of commercial feeds. On the other hand, in China, Taiwan, Thailand and the Philippines most farmers fertilize their ponds and feed the fish with formulated pellet feeds and use the semi-intensive to intensive systems.

In terms of pond yields, Dey (2001) reported that overall, the average yield of pond farming in Taiwan is very high (12 to 17mt/ha) while ponds in Bangladesh, China, the Philippines, Thailand and Vietnam produce around 1.7, 6.6., 3.0, 6.3 and 3.0mt/ha, respectively. Guerrero (2001) however claimed that in Philippines, the semi-intensive culture of *O. niloticus* in earthen ponds (0.25-1 ha, 1 meter depth) yields 4-8 mt (average size of 150-250g) per crop in 3-4 months with 80-90% survival.

Polyculture of tilapia with other native fishes in freshwater ponds is also widely integrated with agriculture and animal farming in Southeast Asia; particularly in Indonesia, Thailand, Vietnam, Cambodia and Myanmar. In Thailand, integrated livestock-fish systems have been the common practice in the Central region especially in relatively large farms since 1980s (Little 2000). About 60% of the total revenue from the integrated system is cash costs leaving 40% net income for the farmers. Similar success has been reported on polyculture of fish integrated with duck in Northeast Thailand. In Lao PDR, polyculture of *O. niloticus* in freshwater ponds is usually integrated with rice, vegetables or livestock while in Vietnam, tilapias are farmed mostly with pig or poultry.

In Israel, sex-reversed male *O. niloticus* and *O. aureus* hybrids are polycultured in earthen ponds with carp or monocultured in plastic-lined ponds at a high stocking density. Pelleted feeds and aeration are widely used and most tilapias produced are larger than 400g at harvest (Popma and Lovshin 1996). In Egypt, earthen pond aquaculture is the major type of culture system where only wastelands are allowed to be used for fish mainly because of their salt and alkali content and poor drainage. Semi-intensive aquaculture, which is done mostly in ponds, provides about 75% of the country's total aquaculture production (about 64,000 mt) and most farms are in northern or eastern part of Nile Delta (Alceste and Jory 2002).

In Africa, earthen ponds are the most important small-scale, monoculture at household level of tilapias, contributing about 38-93% of total tilapia production. Productivity varies from 0.5mt/ha/yr in extensive small-scale fishponds to 16 mt/ha/yr in commercial ponds (Jamu 2001). The species used is mostly *O. niloticus*. Apart from *O. niloticus*, other species such as *T. zillii* and *O. rendalli* are also cultured. Small-scale pond culture of tilapias are usually integrated with other agricultural enterprises such as vegetables, rice and other field crops. These systems produce twice as much income as non-integrated ponds and are reportedly more sustainable (Jamu 2001). Farming tilapias in ponds on a large scale on a semi-intensive basis also exist in some countries of Africa such as Zambia and Cote d'Ivoire.

Culture in freshwater ponds using the semi-intensive system is the practice of most commercial farmers in Brazil, Colombia, Costa Rica and Mexico. Polyculture of tilapias with shrimps is another trend in Latin America, especially in Ecuador and Peru where there were outbreaks of white spot disease in shrimps. Red tilapia hybrids which are known to be moderately (*O. niloticus* and *O. aureus*) to highly euryhaline (*O. mossambicus* and *O. hornorum*) are used for culture in brackishwater ponds traditionally used only for shrimp farming. With a crop rotation of shrimp and tilapias, tilapia production grew from 18 mt in 1990 to 15,000 mt in 2000 (Alceste et al 2001). It was reported that at an average salinity of 17ppt and a stocking density of 0.2fish/m^2, the farmers have increased the gross profitability of each production unit by over US$ 6.00 per day per hectare, in a 120 day-cycle (Fitzsimmons 2001; Alceste and Jory 2002).

Raceways and tanks

In Asia, intensive culture of tilapias in concrete tanks is practiced in Taiwan, Malaysia and Philippines. Taiwan is the pioneer in the region for the intensive culture of tilapia in concrete tanks and produces over 50,000 tons annually, most operations being small to medium level operations (Liao and Chin-Wei 2001). Red tilapias are cultured in 100-m^2 octagonal tanks with water change and aeration, and with fish weighing 100-200g and densities of 50-100/m^2.

With 3-4 times of feeding per day using commercial feeds and automatic feeders, yields of 3-4mt/tank/cycle of 3-4 months are obtained with fish weighing 600g on the average, survival of 90% or higher and feed conversions of 1.2-1.4 (Guerrero 2002). Although raceways/tank culture of tilapias is not a common practice in Africa, it is also used in some areas.

Intensive culture in raceways and round tanks with recirculating systems inside green houses or insulated buildings in order to maintain warmth has been developed in the US, Canada, Brazil and Mexico. Mexico is the biggest producer of tilapia in the Western Hemisphere (6,726 mt in 2000) and with the highly developed internal market, culture methods have become more intensive using raceway and improved technologies (Fitzsimmons, 2001). In Canada and the United States, the rearing of tilapias in raceways using aquaponics system has been shown to be technically feasible and economically possible where fresh fish and vegetables receive a premium price (Fitzsimmons 2000).

Comparative assessment of culture systems and management strategies

Culture systems

The choice of the culture system is mainly influenced by the objective of the farmer or as determined by the circumstances/conditions which include culture sites, infrastructure, environmental conditions (especially climate), socio-economic factors, technological know-how and marketing potential.

Among the culture systems, earthen pond is the most versatile for extensive, semi-intensive and intensive tilapia production. Use of earthen ponds is economically viable only when warm year-round climate, suitable land and relatively large quantities of water are available. The major drawback of pond culture is the greater risk of uncontrolled reproduction if certain measures are not taken to minimize this possibility.

Cage culture of tilapias is practiced in countries where lakes, large reservoirs, rivers, estuaries are available. Compared to ponds and raceways, the use of cages require relatively low capital investment and offers flexibility of management. Another advantage is that breeding cycle of tilapia is disrupted in cages, and therefore mixed sex population can be reared without the problems of recruitment and stunting, which are major constraints in pond culture.

Tanks and raceways can only be a good alternative to pond or cage culture if sufficient water or land is not available and economics are favorable. Unlike ponds, it is easier to manage the stocks and exert a relatively high degree of environmental control over water quality parameters. However, tank and raceway culture requires higher investment due to increased construction and production costs (complete commercial diet, aeration, recirculating system). The farming of tilapias in tanks/raceways also needs close and constant attention due to higher risk of major fish mortality caused by disease outbreak and mechanical or electrical failure.

Economics of commercial production

Overall, tilapia farming is profitable but the costs of production and profits vary considerably across countries, production environments and culture systems. Dey and Paraguas (2001) reported that cage operations in Indonesia cost an average US$ 0.43 to produce 1 kilogram of tilapia while in China, the average cost is higher (US$ 1.30). In the case of ponds, farmers in the Philippines spend an average US$0.99 to produce one kilogram of tilapia while farmers in Bangladesh spend only an average of US$ 0.16. In these culture systems, feed accounts for most of the total production costs ranging from 34% (ponds) to 87% (cages). Although production costs may vary from country to country depending on the level of management used, tilapia cage culture requires much lower capital investment and operating cost than in pond and tank culture or raceway (Orachunwong et al 2001). Among the culture systems, the cost of growing tilapias in tanks and raceways is highest. Published estimates in growing tilapias in tanks/raceways with intensive flow-through system range from US$ 2.12 to US$ 2.80/kg (Hargreaves and Behrends 1997).

Irz (2002) compared the profitability and technical efficiency of intensive monoculture of tilapia in freshwater ponds and the extensive polyculture of prawns, tilapia and milkfish in brackish water ponds in the Philippines. He found that both production systems are lucrative, with brackish water polyculture achieving the higher level of profit per farm. With a production cost of P417,075/ha (Philippine Peso 53 = 1 US dollar) the freshwater monoculture of tilapia obtained a net income of P226,778/ha or a profit margin of 35%. On the other hand, the production cost of the extensive polyculture of tilapia in brackish water was P71,246/ha produced a net income of P51,361/ha or a profit margin of 42%. In China, where both monoculture and polyculture are practiced in ponds, the latter was also found more productive than the former both in terms of production value and quantity (Dey and Paraguas 2001). Similarly in Panama, it was found that polyculture was more profitable than monoculture systems for commercial production targeting domestic market. Net returns to monoculture of tilapia were US$ 645/ha and net returns to polyculture of tilapia, grass carp and freshwater prawns were US$ 3,291/ha (Engle 1997).

In Puerto Rico, the imported feed, processing and distribution and sex-reversed fry were the greatest operating cost in commercial salt-water pond culture systems. The breakeven price was US$ 3.86/kg and the system generated internal rate of return of 18% (Watanabe et al 1997).

Constraints to tilapia farming

The shortage of fry production is still one of the factors limiting the expansion of tilapia culture. Poor broodstock productivity owing to low fecundity and asynchronous spawning cycles, remains one of the most significant outstanding constraints to commercial tilapia production and its future expansion.

Deterioration in genetic quality has come to be a major constraint in tilapia farming, even among small-scale producers. For example, in sewage-fed farms near Hanoi, Vietnam low value tilapias were produced before the recent introduction of new strains. The characteristics of 'improved' tilapia seed have generally been related to faster, more efficient production, better appearance, tolerance to certain environmental conditions, and especially, control of breeding.

Substantial benefits in terms of growth rates and improved yields under culture have been demonstrated from breeding programs for selection and sex control. The results of the successful application of these breeding programs need to be introduced to aquaculture through technically and economically sustainable dissemination programs (Mair 2002).

The lack of attention given to marketing and other business aspects has also been identified as one of the constraints to success of commercial tilapia farming. Market evaluations are seldom undertaken by aquaculturists because of time and expense and difficulties in obtaining the cooperation of wholesalers and retailers (Watanabe et al 1997). They claimed that a culture bias against freshwater fish and against fish with a silver-black appearance of most common varieties of tilapias (primarily *O. mossambicus*) has limited the market demand and commercial production of tilapias in many areas.

Conclusion

A few years ago, a greater part of tilapia production was consumed locally, with Africa and Asia as traditional countries. In recent years however, there has been a growing acceptance and consumption of tilapias in non-traditional countries such as USA, Canada, Europe, Central and South America. In US alone it was reported that importation increased to about 75,000mt (whole fish equivalent), supplying nearly 90% of the country's demand. In view of the escalating demand of this commodity, tilapia farming will continue to be an important source of animal protein, foreign exchange and employment opportunities in several countries.

Ferdouse (2001) indicated that whether the tilapias that are being produced are for export or for domestic consumption, the quality of the fish and convenience are important factors that will influence the consumer demand, particularly in urban market in Southeast Asia. She claimed that in the affluent urban markets in this region (Hong Kong, Malaysia, Singapore and Thailand), good quality fish (without any foul or muddy odour) and convenience food (e.g. fish prepared into skinless fillets) will continue to help in tilapia sales for household consumption through retail outlets such as supermarkets.

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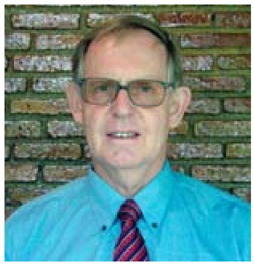
Peter Edwards writes on

Rural Aquaculture

Fish culture for the Maya in Yucatan, Mexico



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El Castillo, the largest pyramid at Chichen Itza supporting a flat-topped temple.

Towards the end of last year I was invited to give a short course on Integrated Aquaculture for Rural Development at CINVESTAV, the Center for Research and Advanced Studies of the National Polytechnic Institute in Merida, Yucatan. The objectives of the course were to review Asian practice in integrated aquaculture; and to assess its relevance for the local Mayan community. I was interested also to see if the ancient Maya had been involved in aquaculture. I took the opportunity to visit the famous chinampas or "floating gardens" in Mexico City as I was interested in exploring any possible role of aquaculture in this ancient and unique form of aquatic agronomy.

The Maya

The height of Mayan culture was over a thousand years ago from 250-900 AD, the Classic Period, when many cities with large pyramids were built in Central America. Soon after this period the Mayan civilization collapsed, with hundreds of cities becoming overgrown with forest. The decline of the Mayans had ecological roots as by the 9th century they had degraded their environment through deforestation and erosion so that it could no longer sustain an extremely high population. An unusually severe drought from 800-1050 AD is now believed to have been the final factor in their downfall. However, there was continued urban development in the northern lowlands of the Yucatan peninsula which I visited although it was conquered by Toltecs from central Mexico during the Post Classic period which continued until the arrival of the Spanish in the 16th century following which most indigenous civilizations in Mexico went into decline.

The descendants of the founders of the Mayan civilization, the present-day Maya, are relatively poor. In Yucatan most live in rural areas in traditional thatched houses with walls of vertical poles or twigs and dried soil. They farm as did their ancestors by slash-and-burn agriculture to produce maize, beans, chili peppers, squash and tomatoes. Household gardens also provide a great variety of food plants: annual root crops and vegetables and perennial fruit trees and vines.

Mayan farmers in the past also grew crops more intensively in raised fields in some areas, similar to the chinampas of central Mexico. Long and narrow rectangular ridges were raised above low-lying seasonally inundated land along rivers or in swampy depressions by heaping up rich, fertile soil. Channels between the raised fields provided irrigation water, drainage and fertile soil periodically scooped up to renew the cropped bed. According to a standard textbook on the Maya (Sharer, R.J. 1994. The Ancient Maya. Stanford University Press, Stanford, USA. 892 pp. Fifth edition), the channels between the raised fields may have been sources for harvest of fish, molluscs or other aquatic life. Sharer further wrote: "artificial channels raise the possibility that fish were raised there or in artificial ponds … or may even have been stocked" but his case for aquaculture by the ancient Maya, further supported by his statement "cultivation and stocking of this sort are employed in many areas of the world today", is essentially unsubstantiated. Sharer also wrote that there might have been artificial ponds to raise fish along the western coast of the Yucatan peninsula. Coastal fishing in coastal lagoons by ancient Maya is well documented by net, hook and line, and bow and arrow; and in inland highland streams by use of stupefying drugs.

Poor Mayan children in their dormitory at the fosterhouse.

Northern Yucatan

The Yucatan peninsula juts into the Gulf of Mexico, which borders it on the west and north, with the Caribbean Sea lying to the east. Northern Yucatan is one of the most inhospitable places for inland aquaculture that I've seen. It is covered with porous limestone rock with barely enough soil for the growth of scrub forest, although there were large trees in previous times. As it is essentially a riverless plain without surface water, the major sources of water are cenotes, circular sinkholes formed by the collapse of underground caves, which are filled with water percolating through the limestone. The ancient Maya also excavated underground bottle shaped cisterns to store rainwater.

Promotion of rural aquaculture

It is not possible to dig fish ponds in most of northern Yucatan as it has little to no soil above the limestone bedrock. Although I never expected to see concrete tanks replenished with pumped groundwater as a culture system for rural aquaculture, it may be the only option under these very difficult circumstances. CINESTAV and Marista University, Merida have developed an integrated system based on what they referred to as the "Thailand model" of integrated poultry and fish in association with derelict rainwater storage tanks. These had been built by the government but abandoned, as they were dangerous for children.

Concrete tank surmounted by a poultry shed and surrounded by land irrigated with effluent from fish culture at a fosterhouse.

There were a total of 32 concrete tanks with a volume of 40-60 m^3 in Yucatan province. Besides a visit to the prototype tank system at Marista University, two communities were visited where the concrete storage tanks were being used to raise fish to provide food for Mayan children. A foster house has been set up in each community on a farm with a converted rainwater storage tank. Poor children from neighbouring villages eat and sleep at the foster house and attend school in the same village, returning home at weekends.

Nile tilapia were stocked at 1,000-1,200 per tank, equivalent to 17-30/m^2. Thirty poultry (muscovy ducks or chickens) were raised in a poultry shed constructed over the tank so that spilled feed and droppings would provide inputs for the fish, although light penetration into the water column was restricted by the poultry shed. Water was sprayed on to the surface of the water in the tank to provide supplementary aeration and to top up the water level. The fish were netted monthly so that the tank could be cleaned. Fish were fed about one 25 kg sack of pelleted feed monthly or about 1 kg feed per day, as well as a green fodder crop, chaya. Fish grew to 300-400 g in six months with almost no mortality. Yields of 250-400 kg were reported each crop, or a final fish density of 6-7 kg/m^3. These densities of tilapia are much lower than those from continuously aerated tank or cage systems of at least 20-30 kg/m^3 but are much higher than those of 0.5-1 kg/m^3 from static water earthen ponds.

The water level in the tank was lowered to 30 cm twice a week as the fertile water was also used to irrigate vegetables. Vegetables were sold to provide money to purchase pelleted feed.

I made a visit to two of the more than 100 commercial farms that have established circular tanks made specifically to rear tilapia in Yucatan and which used mainly pelleted feed. The first used a similar but larger system than the two foster houses, but without poultry. Use of chaya was reported to reduce the need for pelleted feed by 30-40%. The second was a rural cooperative society run by Mayan farmers. While the farmers reported no technical or marketing problems, they were concerned about their large debt with a 6-8% annual interest payment. Should they experience a major problem e.g., disease, they could become seriously indebted.

View inside the poultry shed with muscovy ducks.

Chaya

The tree spinach, *Cnidoscolus chayamansa*, family Euphorbiaceae, is a fast growing shrub from the Yucatan peninsula of Mexico to Honduras and Cuba. The leaves were being harvested periodically from plants grown on the farm and fed to tilapia to reduce the cost of purchased feed. I have never seen tilapia consume green fodder so quickly. It appears to be a highly effective fish feed although there do not appear to be any experimental data. Although it is fed fresh to tilapia, it needs to be cooked before being consumed by humans to inactivate toxic hydrocyanic residues. Young shoots and tender leaves are cooked and eaten like spinach. It has a higher crude protein content than spinach (6% on a fresh and 30% on a dry matter basis) as well as being a good source of dietary minerals (Ca, K, Fe) and vitamins (ascorbic acid, beta-carotene).

As the main leafy green vegetable for the Maya today as well as in the past, it is an important dietary staple. Recently it has been introduced into the southern USA for potential use as a leafy vegetable by the Hispanic population. I was able to obtain the plant from a horticultural source in Thailand where it had been introduced from Florida. Currently it is under trials in my garden in Bangkok (but as a human vegetable rather than fish fodder).

Chaya, the tree spinach.

Chinampas

The chinampas or “floating gardens”, as the guides colourfully describe them, are a unique form of land reclamation for agriculture in shallow lakes. They may have a 2,000-year history in the Valley of Mexico where Mexico City is located today. The capital city of the Aztecs, Tenochtitlan, was surrounded by chinampas until the Spanish conquistadors destroyed it in the 16th century. It was described by the Spanish as another Venice. At the time of the Spanish conquest, it was the largest city in the world with 200,000-300,000 people. The chinampas used to produce at least 50% of the food for the capital city.

Only a fraction of the former extent of the chinampas exists today with the most famous being in the town of Xochimilco, south of Mexico City. Xochimilco is a tourist area with brightly painted flat-bottomed boats plying the canals propelled by boatmen using long poles, some with mariachi bands to entertain the tourists. Most of the produce is now flowers and ornamental plants for the markets of Mexico City.

The chinampas were reclaimed from the marshy shallows along the shores of lakes and around the island city of Tenochtitan. Long and narrow rectangular enclosures were staked out in the swampy lakebed. The stakes were joined with fences of woven branches and filled with mud and decaying vegetation with narrow canals left in between. Tall slender willow trees were planted around the perimeter, which developed a dense root system that anchored the retaining walls. As well as being fertilized periodically with mud scooped up from the bottom of the canals, which was spread on the plot before planting a new crop, the Aztecs used nightsoil transported from the city in canoes.

Fish abounded in the canals as recently as 40 years ago (Coe, M.D. 1964. The chinampas of Mexico. Scientific American 211:90-98) and were netted or speared by the chinamperos, the chinampa farmers. The axolotl, a large aquatic salamander was also prized for its tender meat. It is known that the Aztecs caught fish with bag shaped nets woven from cactus fibre and also with hooks, lines and harpoons. There does not appear to be documentary evidence for the Aztecs farming fish but the ruling class had pleasure gardens with ponds containing fish.

Chaya leaves being consumed by tilapia.

Transporting ornamental plants along a chinampa canal in Xochimilco.

Continued from page 12

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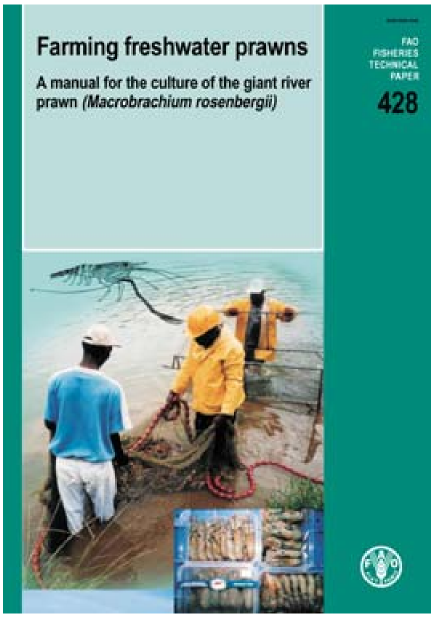
Farming freshwater prawns: A manual for the culture of the giant river prawn

By Michael New

The definitive and practical guide to the farming of giant freshwater prawn *Macrobrachium rosenbergii*. Many of the techniques described are also applicable to the culture of other species of freshwater prawns. The principle target audience is farmers and extension workers but it is also hoped that it will be useful for aquaculture lecturers and students. 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 and there are some notes on marketing freshwater prawns. The reference and bibliography section contains a list of relevant reviews, as well as other (mainly FAO) manuals on general aquaculture themes, such as water and soil management, topography, pond construction and simple economics. 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.

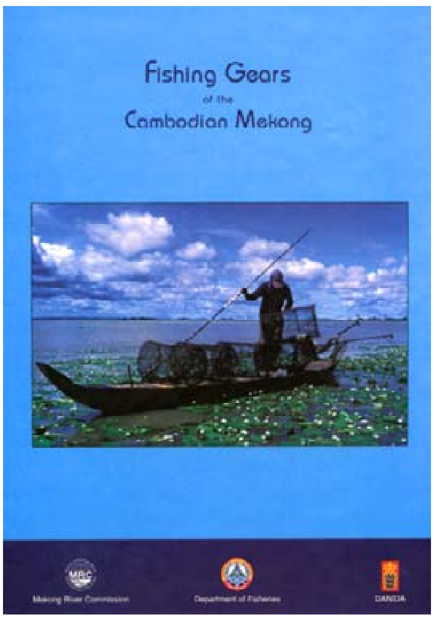
Editors note: This is simply the best technical manual I've seen. It is a must-have for anyone working on Macrobrachium. To order a hard copy contact FAO http://www.fao.org/icatalog/inter-e.htm, or you can ***download it for free*** *from the NACA website (how's that for a great deal ! Caution: its a 4.5MB PDF file): http://www.enaca.org/modules/mydownloads/visit.php?cid=74&lid=350.*



Fishing Gears of the Cambodian Mekong

L. Deep, P. Gegen and N. van Zalinge, ISSN 1726-3972.

The Mekong River Commission has released a catalogue of fishing gears used in the Mekong River system in Cambodia. This is a beautiful and informative book, richly illustrated with line drawings and photographs. For each of 150 gears a detailed description is provided including estimated cost, operation, target species, distribution and legal status. *To order, contact: Documentation Centre. MRC Secretariat, P.O. Box 1112, 364 Preah Monivong Boulevard, Phnom Penh, Cambodia, Fax: (855-23)720-972 or Email: mrcs@mrcmekong.org*

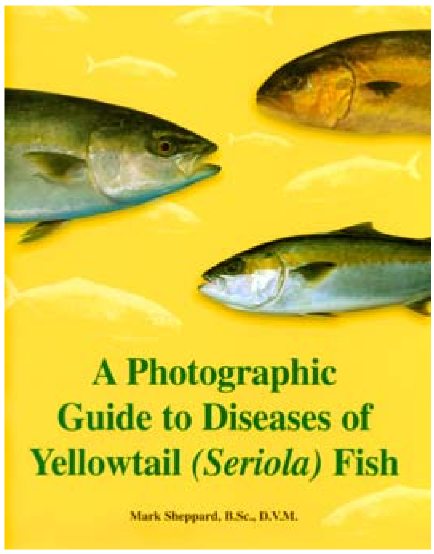


A Photographic Guide to Diseases of Yellowtail (*Seriola*) Fish

By Dr Mark Sheppard, ISBN 0-920225-14-4

As its name suggests this book is primarily a visual diagnostic guide containing sections on the main bacterial, parasitic and viral diseases of *Seriola* (yellowtail, kingfish and amberjack) and some common conditions that may be caused by environmental and nutritional factors. It has been designed as a basic 'hands-on' guide for farm staff, technicians and students and is well suited to this role. About half of the book's 60 pages are dedicated to full color photographs, which are of outstanding quality and feature useful markers to draw attention to key features. A brief (one page) description of each disease is given that includes a summary of general information and risk factors, typical signs and symptoms, primary on-site tests, sampling options for lab diagnostics and prevention and control. A very useful book for anyone working with this group of fish.

Visit http://oberon.ark.com/~svs or email svsbook@oberon.ark.com. Price: $59.95 (Canadian dollars).



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

Women in Aquaculture and their innovative contributions

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

Social awareness of gender issues confronting societal development are becoming increasingly understood around the world due to improved coverage by the media and development agencies of all kinds. Gender is now considered as a central issue to a number of developmental programs in several countries. Those countries that have been able to create the required policy support to ensure a gender-balanced approach are today reaping the benefits. However, in many other countries the gender issue still does not have adequate policy and institutional support. Attitude is recognized as one of the major factors among the many issues that hinder gender-balanced development. Changing attitudes is the most difficult challenge human society has always faced requiring generations in many cases.

A number of events have prompted me to write on this topic at this point of time. The Asian Fisheries Society (AFS), in partnership with the World Fish Centre (WFC) and various other organizations, will be organizing a seminar on Gender and Fisheries in November 2004 in Penang, Malaysia. Since 1995 AFS and WFC have been spearheading the issue of mainstreaming gender in fisheries. This article is intended to provide an update on the progress with the event and stimulate interest in the issue. Secondly, our final year Fisheries students which include three women spent a month in Andhra Pradesh, a Southern State in India, which has excelled in both freshwater and brackish water aquaculture. In fact Andhra Pradesh contributes enormously to India's freshwater sector through carp production and brackish water sector through shrimp farming. In addition, freshwater prawn farming is carried out in Andhra Pradesh and large part of the Indian prawn production (>80%) comes from this state. The farmers of Andhra Pradesh are highly enterprising and often venture into new activities. They have learnt the art of undertaking risk and reaping the benefits through dedicated efforts.

However, when the participation of women in aquaculture activity is examined, their involvement is probably low in Andhra Pradesh when compared to other states. While poor families allow women to work in field – due to economic necessity – those families that can afford it generally restrict women to household activities since allowing women to work in the field is not considered good for the status for the family. This situation is not only common to Andhra Pradesh but also probably common to most of India. However, the situation in Northeastern India is largely different from rest of the country, wherein one can witness the active participation of women in various field activities in addition to household responsibilities. In their visit to Andhra Pradesh, our three female students from the Northeastern States were surprised to see the low involvement of women in various activities including aquaculture. These students were further surprised when the training organizers asked them to take extra caution and not to move around although advice was to ensure their safety. This came as something of a cultural shock and they had to be consoled to overcome the traumatic experience. In several parts of South Asia, women are distanced from agricultural activities with increasing wealth of families. However, the situation with women in poor families is

Proudly displaying the harvested fish from her culture ponds in Cambodia.

National representatives took part in the seminar held in Phnom Penh in 1996 on Women in Fisheries in Indo-China countries, which was supported by the Government of Cambodia and PADEK.

different as they are the key determinants in influencing aquaculture development through their involvement in various field activities. As we are more concerned with empowering poor families, it is necessary to identify such poor households in the villages and assist them to derive the benefits from aquaculture.

FAO Workshop on Women in Aquaculture

The first global workshop on "Women in Aquaculture" was organized by FAO in April 1987 under the leadership of Dr. Colin Nash. The workshop acknowledged the tremendous contributions made by women in aquaculture. The workshop recommended that more information should be gathered to demonstrate the role and contribution of women in aquaculture as such information would help in formulating appropriate policies. The workshop also recognized the absence of women at policy formulation level in various countries since policies formulated by men may not meet the actual necessities of women. Apart from recognizing the need for training of women in aquaculture, provision of credit to women to carry out aquaculture activity was recognized as a major requirement. Following this first global workshop, a number of positive developments have taken place to make gender issues as central to aquaculture development in many countries.

Women in Indian Aquaculture

As the second largest aquaculture producer in the world India is yet to make appreciable progress to ensure positive benefits of aquaculture to women. As far back as in 1990, the Indian Branch of the Asian Fisheries Society organized a workshop on Women in Fisheries, which examined the role of women in fresh and brackish water aquaculture. The involvement of women in aquaculture was found to be restricted to certain activities such as the collection of wild seed. It was also shown that men often conceived aquaculture as a new activity that couldn't be entrusted to women, and those men that attended training generally retained the knowledge within themselves. Knowledge transmission to women was recognized as a critical area of activity. The workshop was followed by a number of other social developments and visible changes have gradually begun to occur. The Central Institute of Freshwater Aquaculture (CIFA) has taken up women-focused aquaculture development activities in many of the villages it supports. CIFA has shown that women not only are prompt in following the agreed work plan when an enabling environment is created, they also innovate new approaches that will be appropriate to their homesteads. The Central Institute for Brackish water Aquaculture has made similar efforts and shrimp farming has been shown to be very effective in poverty alleviation when the technical support is extended to the practicing families.

Self Help Groups (SHG)

One of the important social developments that has taken place in India in the last decade is the promotion of "Self Help Groups", which have been found to be extremely

Ten years ago women were rarely seen in aquaculture activities in India; today are a common sight in many parts of the country.

Women in Andhra Pradesh are involved in sorting out the post larvae of tiger shrimp after acclimating them to freshwater.

beneficial to empowerment of women. In many cases self help groups established as part of the rural development have now taken up aquaculture as an income generating activity. The establishment of self-help groups has also benefited in knowledge transmission related to agricultural practices including aquaculture since these groups have used agricultural activities to enhance their income. In the Eastern and Northeastern part of India there are several women's self-help groups that are actively engaged in aquaculture development. In terms of knowledge acquisition and utilization of the acquired knowledge in increasing productivity women self help groups have been found to be very effective.

Women in Cambodian Aquaculture

In Southeast Asia, the level of involvement of women in fisheries and aquaculture activities is very high compared to South Asia. When I began working in Cambodia in 1992 a number of training courses were organized to educate farmers on fish culture. Men largely attended these. When we looked into why women were not attending the training, we found that the main reasons were that the head of the family was usually male or, where it was a woman, the training venue was often too far away from home and they preferred to send male members. In response we organized special training classes for women and tried to arrange training timings to coincide with the women's needs and convenience to reach the venue. We also changed our strategy to extend the invitation to both male and female members of the family. Since many of the activities ended up being carried out by women these approaches helped to ensure the sustainability of the activities we initiated. A survey carried out to assess the participation of women in aquaculture revealed that men took a major role in pre-stocking activities such as digging ponds, pond preparation and seed procurement. We found that women played a major role in post stocking activities such as fertilization and feeding. Both men and women were involved in harvesting operations.

The innovations that women have brought to aquaculture activities in Cambodia are many. Beginning with the construction of ponds under the food for work program the ponds were built to suit the needs of fish culture with proper slopes instead of building them as wells for water storage. The awareness of men and women in using the ponds for multiple purposes resulted in the initiation of a major program by World Food Program in Cambodia on fish culture. At first many women first thought that fish were hungry when they were in fact rising to the surface to gulp air so they fed the fish unnecessarily. However, once they learned that that fish were coming to surface because of lack of oxygen in the water they began to improve their management by greening ponds through fertilization and feeding them at apt times. As they gained knowledge on the nutritional requirements of the fish they began making use of various types of waste resource available on

Dr. Meryl Williams, Director General, Worldfish Center and Dr. Mohammed Shariff, President, Asian Fisheries Society viewing the photographic competition organized by PADEK on Women in Fisheries. Both of them provided critical support essential to initiating several activities on women in Fisheries.

A farmer undertaking fish seed nursing activity in hapas in Cambodia.

the farm and surrounding area. When they found that it is better to provide cooked feed in place of raw ingredients many of the women invented effective ways to cook or process the feed ingredients to make them more suitable for the fishes.

Localized seed production and nursing activities were undertaken by the families to meet the seed requirement on a sustainable basis. Here again, women and children played a crucial role in managing the pond activities and caring for the young growing fish. High survival, good growth and excellent economic returns were common when both men and women were equally engaged in activities. Several village level hatcheries and nursing units were established in all the fish culture areas to meet the local demand for fish seed.

In 1994 a national workshop on Women in Cambodian Fisheries brought together various agencies and identified the issues that are essential to empower women through aquaculture and fisheries. Among the several recommendations that were made by the workshop participants to improve the position of women in Cambodian society, it was recommended that a regional workshop on Women in Fisheries in Indo-China countries be organized in order create opportunities for sharing of information between the countries and learn from each others experience.

Women participation in aquaculture activities of other Indo-China countries

The regional seminar on Women in Fisheries in Indo-China countries was organized in 1996 in Phnom Penh, Cambodia. Dr. Meryl Williams, then the Director General of ICLARM (now know as the World Fish Center) delivered the keynote address. The event brought out a number of issues related to aquaculture that are common to the region as a whole. In all countries aquaculture was found to be a useful opportunity not only to alleviate poverty, but also to improve nutrition and empower women.

Although the region is dominated by capture fisheries aquaculture was found to be a relatively safe (though by no means risk-free) and dependable activity for the poor. In Vietnam, women were found to be very active collaborators in various aquaculture activities with most of them contributing to post stocking activities. In a study presented in the seminar, it was shown that those involved in fish seed nursing earned the majority of their income from this activity and that most of the nursing activity was carried out by women. Similar experiences were reported from Thailand and Laos where women carry out much of the activity related to aquaculture and hence need to be given special consideration in training.

Based on the presentations and discussions held, it was recommended that training and extension programs should set numerical targets for increasing the participation of women. Participants emphasized that women should especially receive training in fish processing, marketing and aquaculture as they dominate in these sub sectors. The workshop also recommended that the roles of men and women should be mutually reinforcing and that there should be mutual respect. Participants recommended that the number of female staff working in the fisheries service sectors should be increased and that more support should be provided to assist female recruits to develop their careers.

Women in Cambodia viewing the new cooking oven developed by women for cooking fish feed.

Dr. Sununtar Setboonsarang of AIT (currently with the Asian Development Bank) making a point in the seminar held in Thailand on Women in Asian Fisheries,\ coinciding with the 5th Asian Fisheries Forum.

A farmer sharing her experience in controlling EUS disease in Bangladesh.

With the active participation of various agencies in the region, particularly by NACA, the Asian Institute of Technology and the Mekong River Commission the gender issue has received much attention in the region and most projects and training programs now incorporate gender as a major component.

Women in Asian Aquaculture

An Asian regional seminar on women in fisheries was held in Thailand coinciding with the 5th Asian Fisheries Forum in 1998. Papers relating to aquaculture were presented from several countries and prominent among them being from India and Bangladesh. While the Indian paper highlighted once again the role of self-help groups and the success of micro-credit programs in aquaculture, the papers from Bangladesh brought out a number of issues related to technology and institutions. In Bangladesh several NGOs have placed special focus on the participation of women in aquaculture activities, which has now increased substantially. Several novel approaches have been developed in Bangladesh that may be worth trying in other countries. With dedicated efforts made by NGOs over time the attitudes of the people have changed and initial stiff opposition to introducing programs to address gender issues has been broken down. In building an organization itself, gender issues have received special attention in large NGOs such as CARE, PROSHIKA, BRAC and CARITAS. This has lead to improvements in recruitment, career development support and creation of extra facilities to ensure the retention of female staff. The experience of such organizations has been that unless conscious efforts are made to integrate gender into all activities of the organization changes will not occur easily. It is also necessary for top-level management to support and champion such changes.

A farmer in Cambodia sharing her experience in fish culture with other farmers.

Moving from subsidy support to knowledge-based support

While many countries still use subsidy support as a means to help farmers in Bangladesh many NGO and even government programs are moving instead to knowledge-based developmental approaches that give both men and women equal emphasis. Due to cultural limitations it is not possible to have a mixed group of men and women in learning sessions. As a result most training sessions are organized separately for men and women with good results although in terms of cost it has been found to be expensive. However, today this family approach involving both genders is used in many other countries and the results clearly demonstrate that to ensure sustainability, it is essential to have the participation of both men and women in the training programs. This also assists in promoting rapid spread of the knowledge to others.

Innovations of women in Bangladesh aquaculture

After formation of men and women groups and educating them on fish culture possibilities with paddy in low-lying areas, several farmers started exploring this new activity. Rice farming is traditionally the domain of men in Bangladesh, however, women had a tremendous role in influencing men to give up pesticide usage and undertake fish cultivation with the rice. The percentage of farmers undertaking rice-fish culture increased tremendously, in some areas exceeding

Women farmers in a learning session in Bangladesh.

40% where it is normally around 20%. While concentrating on raising bundhs and creating canals for the fish to take shelter women engaged in breeding of common carp and nursing the young ones. Farmers developed a technique of placing water hyacinth roots attached with eggs in paddy fields directly for hatching allowing the hatchlings to thrive on the food available in the fields. This technique was found to be economically viable even with a survival rate of 3-5%. Fish culture in paddy fields in both Amon and Boro season became common in several places allowing farmers to earn good income by selling the fingerlings to other farmers or growing the fish to table size by extending the growth period to more than six months.

Cage culture is another activity that has been successfully introduced in Bangladesh and several women are engaged in this activity. Women's groups have been able to nurse the fish in cages using various types of waste materials and ensured effective cage management. Through creating access to water bodies even those women who do not have any land or pond can take part in cage culture. The increase in cage culture, particularly by women groups, has helped to increase the consumption of fish. Women generally tend to place a higher priority on family nutrition rather than selling all fish for cash.

My last article in Aquaculture Asia the "gher revolution" provided details on how prawn farming in Bangladesh has helped farming families. Although this activity has helped to increase family income several families have become vulnerable to poverty due to increasing production expenses and unpredictable market price for prawns. Education for women on how to reduce production costs using available resources resulted in farmers developing several varieties of feed production machines. This enabled farmers to almost completely eliminate one of their largest expenses, the cost of snail meat, by compounding their own feed on-farm using alternative ingredients such as oil cakes, rice bran, wheat bran and fish meal. This in turn allowed farmers to reduce their exposure to risk. In addition, diversification by placing equal focus on using the bundhs for growing vegetables and paddy during both seasons, and co-culture of fish along with prawns allowed farmers to further reduce their risk considerably.

New approaches to bring gender awareness

Another novel approach that has been tried in Bangladesh is to use the learning sessions to discuss issues beyond aquaculture, particularly on gender issues. For this purpose, key social and gender issues confronting the region were identified and special learning sessions relating to those issues were organized. For example work allocation between men and women in the family; food provision and access to education for male and female children; dowries etc were identified and learning session were planned. For some of the sessions we tried to bring both male and female groups together to discuss issues such as work allocation and plans were made to reduce the burden on women. These measures can't be said to have brought about revolutionary change but they helped to bring out the issues where they could be discussed more openly.

Husband and wife engaged in picking snail meat from shells for feeding to prawns in Bangladesh.

Female staff strength in fisheries organizations

In countries such as the Philippines, Thailand and Vietnam women are relatively well represented in fisheries organizations, in some countries exceeding 30%. However in many other countries the percentage of women may be less than 10%, particularly in South Asia. At the more senior levels a complete absence of women is common in almost all countries. Hence, it is recommended to make conscious efforts to increase not only women's participation in fisheries organizations, but also to create an environment in which they can make most effective contributions.

Once again the Asian level seminar in Thailand identified the need to provide training opportunities targeted specifically at women. The seminar also recommended to more widely trial micro-credit programs that have been found useful in India, Bangladesh and other parts of Asia.


Malawi women displaying the fish they cultured in ponds.

Global Symposium on women in Fisheries

The Global Symposium on Women in Fisheries was held in conjunction with the 6th Asian Fisheries Forum in Taiwan in 2001. The symposium provided an opportunity to share experiences on the involvement of women in fisheries from various continents. It emerged that women are involved in all activities of fisheries in all continents although the degree and type of participation is quite variable depending on local cultural conditions. In some continents fishing is the domain of men, in various other places women are the active participants. Aquaculture was found to be a rapidly emerging activity and in many places shrimp farming has proved to be very effective in poverty alleviation when farmers have adopted extensive or semi intensive culture systems. Africa, where the introduction of aquaculture had failed for several decades, is now showing progress with renewed efforts made by various organizations to develop sustainable aquaculture using native species and locally available resources. In Malawi work carried by World Fish Centre and several NGOs has shown that farmers adopt fish culture both for family food and as a source of income.

The symposium discovered for the first time on how fishers are more susceptible to HIV and AIDS because of the nature of their work, particularly in the capture fisheries sector. It may be worth investigating the nature of problems in costal shrimp farms, which are also often located in isolation and workers have to stay away from families for long time and under stress.

Moving from Women to Gender

The 7th Asian Fisheries Forum in Penang will have a special session on Gender and Fisheries. This is considered an important step since careless targeting women can further isolate them and have other negative impacts. All those working in the area with interest on gender issues should

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Women in Malawi actively engaged in making plans for aquaculture development.

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/marinefish for more information on the network or email sim@enaca.org.

Efficiencies in barramundi technology

By Dave Field

In Australia, the barramundi (Asian seabass), *Lates calcarifer*, is being increasingly cultured by Australian operators. The species is robust and the entire life cycle is manageable for commercial production. Nevertheless staff at the Darwin Aquaculture Centre (DAC) have investigated methods by which to make production more practical. From their facility in the top end of Australia, the researchers (see fig 1) have sharply increased the efficiency of the early life cycle component of barra production.

Motivation supporting industry

The drive to improve production efficiency was in part prompted by liaison with the operators of the Northern Territory's first sea cage farm, established at the Tiwi Islands near Darwin three years ago by Marine Harvest (Nutreco). DAC extended its hatchery and nursery to supply barramundi fingerlings to the farm.

Additionally, land-based barramundi farms in the NT have been growing out DAC-supplied juveniles to for several years. The Centre grows fingerlings to 100mm in length, a process currently taking 2 to 2.5 months (See fig 2).

The Marine Harvest company sources fingerlings from DAC five to six times each year, a total of 1.2. to 1.5 million 100 mm fish annually, and is the Centre's main customer. The operation has a ten-year production target of 10,000 tonnes annually, and in March 2004 there were some 800 tonnes of fish on site. The company plans to take over nursery production before the end of 2005, and to move into hatchery production within two years.

Marine Harvest product

The company produces fish with a weight of up to 3 kilos after 20 month's growout—a good feed regime using high-quality pellets and favourable

The Marine Harvest product, shown by the company's packers.

farm conditions results in high quality—in fact, the product is good enough for Marine Harvest barramundi to be become part of the recent Danish Royal Wedding feast. Marine Harvest fish were specifically requested by the master chef for the function.

While production was originally targeted towards whole fish in the 3-4 kg size range, providing customers with the widest variety of processing options—from a whole banquet fish through portions to fillets (see fig 3), recently the company has moved to add plate-sized (500g) fish to its range as a way of increasing the efficient use of the farm's infrastructure.

The company also has a relationship with a South Australian based 'smoked house' and test marketing of smoked barramundi has resulted in positive reviews.

Barramundi production and research staff: Damon Gore, Frances Murakami, Keith Newman, Chadd Mumme, Bart Penny, François Vauchez, Yann Cazenave, foreground Jerome Bosmans.

Farm environment

Established cage farm techniques as used in more temperate conditions were originally applied on the facility. Experience revealed that maintenance of the cage systems to address salt water corrosion in tropical temperatures generally adds as much as A$0.50 per kilogram to the cost of production. Plastic structures will be brought in to address this issue.

Predation complications lead to the introduction of heavily zinc-coated steel enclosure nets—the conventional mesh nets were being torn by sharks and crocodiles (See fig 4). Recently Marine Harvest's steel net supplier, Onesteel, has developed a finer mesh steel net allowing the juveniles, once they reach 150 mm, to be placed directly into the safer steel mesh environment rather than initially relying on fibre enclosures.

DAC's research

DAC scientists Glenn Schipp (see fig 5) and Jerome Bosmans (see fig 6) engaged in a study tour of Europe, also attending the Larvi 2001 Conference in Gent, Belgium. Visits to hatcheries and nurseries in France and Greece, and observations at the University of Gent, where a high-density recirculating rotifer culture system was being developed, provided background for the investigation.

With a growing demand for barramundi fingerlings in the Northern

NT Minister Kon Vatskalis (second from right) watches as fingerlings are concentrated and pumped into the tanker for shipping.

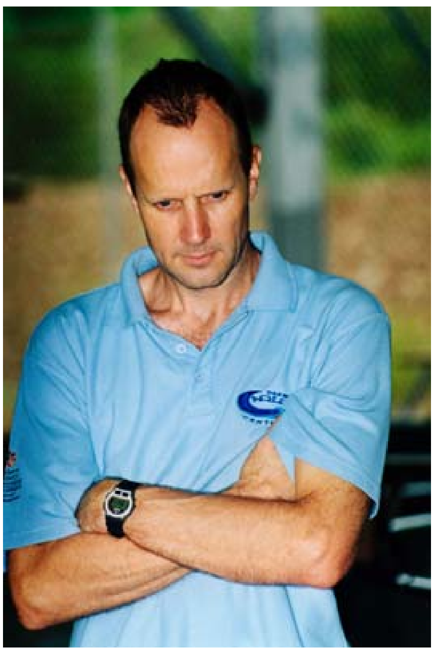
Territory of Australia, DAC elected to move into year-round production. This required development of a recirculating system.

Old and new DAC techniques

Originally DAC's barramundi farming cycle began with a semi-extensive greenwater larval production operation—a process used exclusively until November 2002. While it was successful, several problems emerged:

a) Practical water quality control over the four-week cycle in the static system wasn't possible, leading to an increased disease risk.
b) Survivals from 40 to 90 percent precluded definite production quantities.
c) The water became very cold—and it was impractical to control it—in Darwin's Dry season.
d) The low larval density (5 larvae/L) mandated the use of fairly large tanks.
e) Any given batch demonstrated a very large size variation.

In a year of research, DAC staff designed, trialed and modified an intensive recirculating larval system offering more control, operating it in parallel with the original system. The new, and much more reliable system, has been used exclusively since December 2003.



A pensive Glenn Schipp during the fingerling transfer.

A Onesteel net being installed.

Larval system

The larval system was easy to build in-house. It comprises a foam fractionator, fluidised-bed biological filter, heat/chill unit, normal sand sediment filter, degassing column, and ultra-violet disinfection, based on two 6000L tanks used in parallel (See fig 7).

Rotifers are fed automatically and continuously to the larval tanks to sustain a density of at least 20 per ml.

Chlorella paste is also fed automatically and continuously to sustain a low algal density in an intensive greenwater system, providing a clean enriched nutrient feed for the rotifers consumed by the fish larvae.

The outcome was 150,000 15-25mm fingerlings from the first month's trial from one tank. DAC's target was to inoculate 0.6 million two-day old larvae (twenty times the density of the old system) into each tank and realise at least 300,000 per tank. That target has been met consistently since December 2003.

Rotifer system—the advantages of paste

Originally a batch culturing process was used for rotifer production, working with live microalgae. In a costly, labour-intensive process, the rotifers were harvested each 3-4 days and the tanks then reinoculated. Schipp

Jerome Bosmans.

and Bosmans had observed that, while most European facilities they visited were still using rotifer batch cultures and live microalgae, some were using microalgae paste.

The paste is at an extremely high density and offers many advantages. Since 20L of paste is equivalent to 55,000L of cultured algae, rotifers can be produced at higher densities, and there's a significant cost reduction when a paste is used in conjunction with a recirculating culture system.

Live culture stocks become redundant when paste is used—closing off a demanding component in hatchery operations.

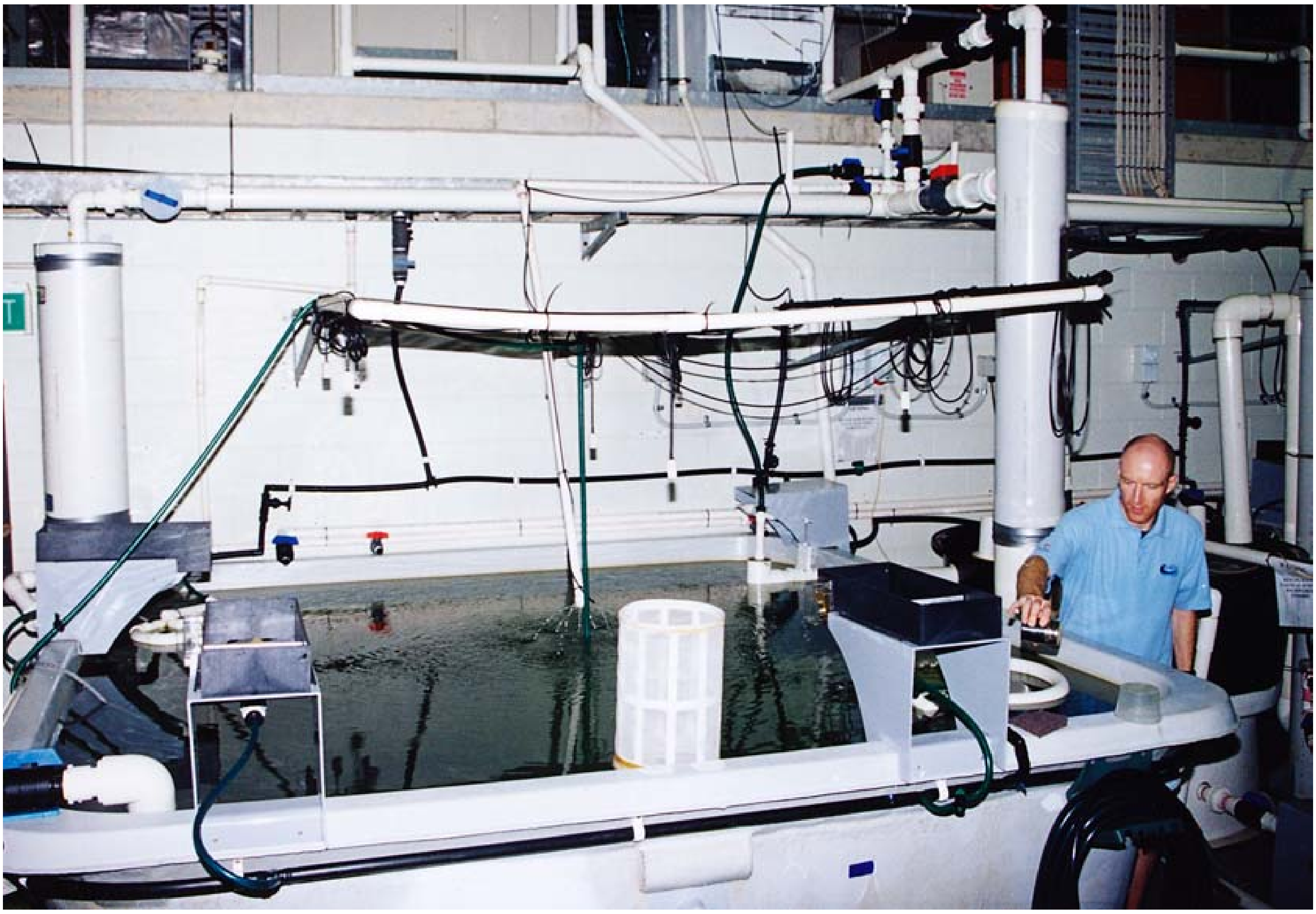
Their overseas observations helped DAC staff develop their own rotifer production process, ending the batch culture system in favour of an intensive recirculating system. The outcomes are reliability of production, a smaller space requirement, and less labour.

The paste has a number of qualities. it's enriched with Vitamin B—crucial for rotifer fecundity—and with fatty acids, providing a boost to larval stock development and to health maintenance. It's also excellent for both rotifer and larva nutrition, meaning the rotifers are always nutritionally complete.

Prior to 2002 DAC experienced regular 'crashes' of rotifer cultures. Now the same culture has been maintained continuously, and the reasons are quite clear. In a recirculating system water quality is constant and superior. In a non-recirculating system the water quality is inferior and constantly changing.

DAC currently has two rotifer production systems (See fig 8) built to in-house design, each based on one 1000L tank with a biological filter (fluidised sand bed), a floc trap, and a foam fractionator. At any one time, one tank operates, with a base rotifer density of less than 100/ml—the density is automatically-maintained. Based on a lead time of 7 days, when there's a demand for rotifers an increased quantity of algal paste is fed and the population is allowed to build. At the same time, the second system is inoculated. Expansion from 100/ml to 1,500/ml takes 4-5 days. At that stage it's possible to harvest 50-60% of the total each day and sustain the population.

Maintenance of the rotifers now occupies approximately 45-60 minutes per day. The overall outcome represents a significant reduction in costs, with increased efficiency:



Darwin Aquaculture Centre's larval culture system.

Darwin Aquaculture Centre's rotifer culture systems.

a) A prepared food source being used economically.
b) The culture system is clean and based on simple technology.
c) Bacteriological studies show the recirculating system carries a more stable bacterial population than batch systems and there's an almost total absence of harmful Vibrio bacteria—thus it's not necessary to rinse the rotifers each day, and they can be continuously pumped directly from the rotifer system to the larval system.

Looking ahead with DAC

The Centre's staff are working on a process to completely replace Artemia in the rearing of barramundi. Recent results indicate that, when the weaning diet Gemma Micro from Skretting is applied, at least 95% of Artemia consumption can be replaced without increasing the standard deformity rate of less than 1%. Fish are now growing 30 percent faster due to early weaning (by Day 18) and there's also less size variation—an advantage since barramundi need frequent grading on reaching 3-4 weeks old to minimise cannibalism.

For those seeking more technical information on these developments, DAC will be producing a scientific paper before the end of the year and will present the system at the larval workshop to be held at the Australasian Aquaculture Sydney Conference in September 2004.

For more information contact Jerome Bosmans, Senior Aquaculture Research Officer, e-mail jerome.bosmans@nt.gov.au or fax +61 (0)8 89244277.

Dave Field is a free-lance journalist, writer and editor based in Darwin Australia.

Disease-Free Barra?

Queensland's Department of Primary Industries has provided $50,000 in funds for research into the viral nervous necrosis disease. The affliction can cause high mortality rates in barramundi larvae (Asian seabass, *Lates calcarifer*). The disorder is a major problem to emerging reef finfish culture industries such as grouper culture. Studies will centre on examination of DNA samples in order to detect VNN resistance indicators, leading to virus-resistant broodstock opportunities. There'll also be the opportunity to search for other favourable genes such as those for fast growth, increased productivity and maturity. The work is a collaborative project involving Drs Kim Guyatt and Abigail Elizur of Bribie Island Aquaculture Research Station, Dr Nick Moody from Oonoonba Veterinary Laboratory, Ms Elizabeth Cox from the Northern Fisheries Centre at Cairns, and Dr Holton from the Queensland Agricultural Research Centre. *Source: FisheNews aquaculture newsletter 15/02/04), Cairns Post (3/2/2004).*

Barramundi Cod – Live Exports

Following a successful trial shipment to China late in 2003, it's likely barramundi cod will be exported live into South East Asia. The Cairns seafood export company Hong Hai Seafood sent several hundred cod weighing 500 g each to the parent company in Hong Kong. The manager said the fish were well received with prices paid at the higher end of the market. The mortality rate of the farm-produced fish was close to zero. *Source: Neil Wood in the Cairns Post (17/1/2004)*

National Standard for Seafood Safety

A new seafood safety standard is to be based on international risk management principles and will allow Australia to provide safety levels equivalent to the best in the world. The standard will be mandatory throughout the country, covering harvesting, processing, handling and storage, including aquaculture - and will also apply to imported seafood. It's expected the standard, based on the best of existing state approaches and industry initiatives, will pass into law in mid-2004 and come into operation one year later. A Draft Assessment and standard will be released for comment in December 2003. For more information, check out www.foodstandards.com.au. *Source: FishNews Aquaculture Newsletter 14/01/04). Original source: Food Australia (1/12/2003)*

New Evidence Points to Pollution as Main Cause of Much Coral Reef Destruction

Scientists agree that coral reefs are in an alarming global state of decline. However, determining the main cause or causes of this decline has proven a much more contentious issue. In the current edition of the Journal of Experimental Marine Biology and Ecology (JEMBE), Harbour Branch marine scientist Dr.Brian Lapointe and colleagues present new evidence they hope will help settle one major debate: whether pollution or overfishing is the main cause of the coral-smothering spread of seaweed on many reefs. The research suggests that pollution from such sources as sewage and agricultural runoff is the main culprit, a conclusion that has major repercussions for managers working to end the decline of reefs in South Florida and around the world. *The full news article is available from the Environmental News Network website http://www.enn.com.*

Up To 26 Times More Fish Found on Reefs Near Mangrove Forests, New Nature Study Shows

A study conducted by Nature has found the strongest link to date between the productivity of coral reef fisheries and the health of nearby mangrove forests. The study compared the numbers and amount of fish on reefs near mangrove forests to reefs far from any mangroves. One species, blue striped grunt, was found to be 26 times - or 2667 percent - more abundant on reefs near healthy mangroves, measured in total biomass. For full news article visit the WWF Newsroom at http://www.worldwildlife.org/news/headline.cfm?newsid=616. A report on "Mangrove enhance the biomass of coral reef fish communities in the Caribbean" is also available for download on http://www.worldwildlife.org/news/attachments/MumbyetalNature.pdf

Influence of Brackishwater on survival and growth of the juvenile white grouper, Epinephelus aeneus

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The natural habitat of the white grouper, *Epinephelus aeneus*, is the Mediterranean Sea, which has a salinity of approximately 35 ppt. As fish species vary in their tolerance of environmental conditions, potential production in specific conditions must be determined empirically. The growth, survival and cortisol level of 1.7 g grouper juveniles grown in diluted sea water (4 ppt) or brackish water (4 ppt) from the Tsofar well in the Arava (southeastern Negev, Israel) was compared to the growth of similar fish in sea water (43 ppt). Survival in all treatments was 100%. During the first ten days, the fish grown in brackish water grew significantly less ($p<0.01$) than the fish grown in full-strength or diluted sea water. There were no significant differences between the treatments during the second growth period or in the final weight (approximately 9 g). Total cortisol concentrations ranged 2.7-4.5 ng/l and did not significantly differ between treatments. Results indicate that the white grouper can flourish in water with salinity as low as 4 ppt and that there are no detrimental chemical factors in the brackish water from the Tsofar well. *Source: This abstract was obtained from The Israeli Journal of Aquaculture website http://www.mop-zafon.org.il/fish/ija/.*

(Malaysia) December 28, 2003, Sunday.

Aquaculture industry expected to increase use of soybeans for feed

This news article provides some information on the possibility of the replacement of fishmeal by plant protein in aquaculture feed. American Soybean Association (ASA) conducted feeding trials of the replacement feed and the results found soybean is an ideal replacement, particular for species such as carp, tilapia and catfish. ASA also indicated that soy-based meal can reduce the marine feed cost by one-third to one-half, without reducing growth and efficiency. However, it did not specify what marine species. It is particularly important for marine carnivorous finfish species (such as grouper, snapper, etc.), whether or not the plant protein replacement can be the substitution of fishmeal so that feed cost can be lower and environmental issues can be reduced. *The full news article can be obtained from GROWFish web site at http://www.growfish.com.au/content.asp?ContentId=1248.*

Aquaculture and Food Security in Iraq

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When notions of natural resources come to mind in the Arab world, most people think of oil, gas and phosphates. In an area where most climates are arid, it would be difficult to imagine aquaculture even exists in the region, let alone has expansion potential[1]. In Mesopotamia one of the sources of early human civilization, fish, crustacean, molluscs and turtles in the Euphrates and Tigris rivers with their tributaries and the coastal waters of the Arabian/Persian gulf were a major food source already 5000 years ago[2].

Water diversion has caused serious environmental damage to large areas of Iraq's wetlands. Thick reed beds teeming with life once covered 8,000 square miles (20,480 square kilometers). Now 97 percent of the main marshes are dry. Less than one-third is left of eastern marshes that reach into Iran. Rice paddies and fishing grounds are gone. Some birds are now extinct[3], and global migrations have been disrupted. When the wind blows, blinding sandstorms strip off what topsoil remains.

The marshes have suffered badly during the political upheavals of the past few decades. According to the UN Environment Program, some 7,000 square miles, or a staggering 93 percent, of the Mesopotamian Marshes drained between 1991 and 2000. This has had a serious impact on the estimated 1 billion migratory birds - flamingoes, storks, cranes - that used to stop over on flights between Asia and Africa. Tribesman no longer haul 500-pound fish to market in trucks. Vanished, too, probably, are endangered species such as the smooth-coated otter[4]. Marsh Arab villages still cling to some of those roads. They look like Arab villages anywhere, including the middle of the Sahara. The only clues to their aquatic origins lie in stately council houses, with cathedral-like spires, constructed entirely of bleached reeds.

Inland fishery

Iraq's inland fishery is based on the Tigris-Euphrates riverine system, its lakes, and seasonal floods (with a flooded area of 15 000 to 20 000 km^2) and it plays an important role in the country's economy. The Tigris and Euphrates rivers and their branches are the main sources of inland fresh water in Iraq. The inland fresh water bodies cover between 600 000 and 700 000 ha, made up of natural lakes (39%); dams and reservoirs (13.3%), rivers and their branches (3.7%) and marshes (44%). There is a potential to develop these resources through management, stocking and enhancement of extensive culture practices. Fisheries in many small water bodies and reservoirs can be enhanced through stocking and management approaches that take into account particular features of the individual fishery. Stocking and other operations, including quasi-culture methods may, where successful, increase catches significantly. The inland fisheries are based in great part on carps *Cyprinus* spp., while the most important Iraqi indigenous fishes are barbs belonging to the genus *Barbus*. The most common commercially important fishes in Iraq are:

Marine fishes

- *Tenualosa ilisha*
- *Liza oligolepis*
- *Pampus argenteus*
- *Arius thalassinus*
- *Acanthocybium solandri*

Freshwater fishes

- *Cyprinus sharpey*
- *Barbus xanthopterus*
- *Barbus grypus*
- *Liza abu*
- *Silurus triostegus*
- *Barbus luteus*
- *Asalus eorase*
- *Cyprinus carpio*

Main culture species

- *Cyprinus carpio*
- *Hypophthalmichthys molitrix*
- *Ctenopharyngodon idellus*

Aquaculture Status

The total area under aquaculture production in Iraq is estimated to be 7500 ha. The main species cultured is common carp and to a lesser extent grass and silver carp. The mean annual production for 1986-1997 was 4000 t. In 1998, production is reported to have been increased to about 7500 t. A total of 1893 fish farms are licensed for aquaculture, all operated by the private sector (companies and individuals). Ten of the farms are relatively large (100 ha each), but the average is about 4 ha. The only system of aquaculture is in earth ponds. Aquaculture in Iraq depends on freshwater resources, with no marine aquaculture practiced. Sufficient hatcheries are available, although most production is of common carp. Cage farming expanded in the early 1980's Habania Lake, but was eventually abandoned for commercial production, limiting its use for research[5].

The latest information available indicates that the total area under fish farming is estimated at 7500 ha consisting of about 1900 farms. They are mostly near sources of fresh water where the land is not suitable for agriculture. The size of these farms range between 0.5 ha and 200 ha but most are between 5 and 10 ha each. These are earthen ponds with out proper lining or insulation. Only the Babel fish farm, a government owned venture, is an integrated farm that is fully insulated and well equipped, established on a 500 ha area. All other farms are smaller, owned and operated by private companies and individuals. Productivity per unit area is low in most fish farms, ranging from 1400 to 2000 kg/ha. This is attributed mainly to the shortage of adequate fish feed. Iraq

Greening aquaculture - quest for success with Euphrates river shining like a mirror.

has had no trade in fish and fishery products due to economic sanctions imposed on the country since1991[6]. The fisheries sector in Iraq is currently of no significant value to the national economy due to absence of export and import activities at present.

Fisheries research and related activities are carried out at a number of sites by various institutions – the Fish Research Center (Zeafaraniyah, Baghdad), Marine Science Center, Basra, Agriculture Research Center IPA, Central Hatchery at Swairah, Fisheries and Marine Resources Department, College of Agriculture, Basra.

Future trends

Today, when the sky itself seems to melt into chrome-coloured lakes-rippling pools that shimmer like mirrors in the vast salt pans of southern Iraq. These days, however, those liquid sheets of light are no mirage. They are real water - unshackled for the first time in years, the Tigris and Euphrates rivers were now refilling thousands of acres of dry marsh[4].

The turmoil in Iraq since the 1960s does not provide a solid foundation for establishing a national agricultural and food system. In some parts of the country, from the Southwestern Bedouins to the Northeastern Kurds, traditional self-reliant food systems have been maintained. However, in most of the country, food security has necessitated imports both of carbohydrates and proteins. Vitamins and micronutrients have all too often been in short supply. Today's outlook for international food relief and agricultural technology does not bode well for short- or long-term community or national food security in Iraq. Interim measures have focused on importing wheat and emergency food, rather than on building self-sufficiency in food production.

While neighboring Kuwait, Bahrain and the UAE have invested in fish farming, especially in shrimp production Iraq's 2001 total fish production was 22,800 tons of which only 2000 tons come from aquaculture. Situated in what is historically known as the Fertile Crescent, Iraq is supplied with copious amounts of water from the Tigris and Euphrates. In addition to this, there are water resources in the form of lakes and ponds, especially in the northern part of the country and the Shatt Al-Arab delta area in the south. Testament to this is the amount of development that took place in Iraqi fish farming before 1990. Now, more than ever, as the country looks for ways to feed itself, aquaculture may be an area of serious growth. However, many of the farms have fallen into disrepair because of poor management and lack of investment under economic sanctions. Due to their importance to the country's present and future needs, they should be considered as a major investment opportunity. Fisheries should not by any means be considered a side or marginal activity and should be given sufficient, priority, support and protection to allow growth and development.

Research needs

Aquaculture research needs vary with development priorities and constraints at the country level, but key research targets in many countries of the region include: Sustainable intensification of production from existing freshwater pond farms, development of culture-based fisheries, including the evaluation of the potential for development and selection of species, development of viable models for integrated aquaculture-agriculture systems, including the development of low-input polyculture systems, development of management strategies to reduce the use of water in pond fish farming, development of aqua feeds from locally available ingredients (at the national or farm level) and improvement of feeding strategies, seed production and improvement of the genetic quality of brood stock, optimization of production economies and market analysis, diversification of species for marine aquaculture[6].

In order to sufficiently develop aquaculture, governmental and research agencies should improve research, the results applied inland and along the coastlines. Research in aquaculture must address improvements in technologies, contribute to reduction in the cost of production, and consider the increasing need to ensure that aquaculture is eco-friendly and that farming native and popular species on demanded as well as the possible introduction of new exotic species can be achieved without endangering the ecological balance. Sustainable aquaculture development calls for strategies to improve the quality of water used by the fish farmers, and farm management technologies, as well as environment befriendly coastal and inland water sites. If these are ensured,

Table 1: Fresh water aquaculture production (t) in Iraq[8]

Year	1997	1998	1999	2000
Production (t)	3400	7500	2183	1745

aquaculture projects can be efficiently, effectively and profitably implemented[7].

Iraq must have its own unique agricultural and food system. It cannot copy other countries. Its situation and potential are unique. There are great variations in its climate and landscape from South to North. The Kurdish diet in the North owes much to the cultures rooted in Turkey, Armenia, Azerbaijan, and the Kurdistan portion of neighboring Iran. Mountainside herding and valley orchards and gardens are typical. In the South, the diet has similarities to that of the peoples of the Persian Gulf and Central Iran. Iraq's agricultural and food system must be based on its traditional preferences and on what it can learn from other Middle Eastern countries, and from countries around the world, that have promoted small-scale farming systems.

Strategies that would help Iraqi farmers and citizens to reinvent their food system are implementing Iraq technologies such as aquaculture and the use of waste water, building up locally-based food systems rather than top-down ones, involving women and youth as a priority, and including both rural and urban systems, from rooftop gardens to hillside farms. The objective will be to create a new agricultural / food system in Iraq based on Mesopotamian history and leading edge 21st century Middle East agricultural technology. The process should aim at digesting what has been learned at the wider-level meetings and reaching preliminary decisions concerning new farming methods, restoring old farming methods, and establishing pilot farms. Another goal would be to define what is missing in terms of what is needed for education, supplies and hardware to implement the new food systems. Demonstration farms in several places throughout Iraq would be an early imperative, to provide training facilities and technical assistance to women, youth and men. Foreign assistance, primarily from Middle Eastern countries, will be needed if some of the relatively new farming methods are to be adopted. Exchange programs involving young innovative farmers are essential. Above all, the inspiration and understanding to start a new system, and not revert to the failed system of preceding generations, can only come "on-site" and not on-page, through field visits of Iraqi leaders and farmers to the practices of sustainable small-scale agriculture and self-reliant food systems.

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Entrepreneurship problems of shrimp farmers in planning, project preparation and project implementation stages

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Aquaculture makes a very strong contribution to foreign exchange earnings, food production and employment generation in India. The profitability of shrimp farming has been relatively high as the entrepreneurs have been able to realise their investment in a couple of years. However, the current state of the industry is quite volatile due to global trade and market access concerns, uncertainty over regulation of the industry and relatively low levels of cooperation between farmers. If the potential contributions of aquaculture are to be realised the issues and challenges faced by the entrepreneurs need to be determined. We conducted a random survey of 50 shrimp entrepreneurs to assess their views on the social, economic, psychological, technological, environmental and political problems facing the industry. The survey was carried out in May May 2001 in Nagapattinam and Tiruvallur districts of Tamil Nadu state of India. Nagapattinam district was selected due to the presence of the highest number of shrimp entrepreneurs having the maximum area under shrimp culture; while Tiruvallur district was chosen, because it has maximum availability of infrastructural facilities in coastal areas for development of shrimp farming.The major issues raised by the entrepreneurs are summarised below.

Entrepreneurship problems in different stages

Problems encountered during planning stage

Planning is a vital input for harnessing success in any industry. Proper planning in aquaculture is necessary for entrepreneurs to make efficient use of available resources, minimizing risk and maximizing the profits. Our discussions with entrepreurs revealed that they are facing many problems during planning stage before starting their new businesses.

Non-availability of bank loans and insurance coverage for shrimp farming was felt by almost all the farmers (96%) as the major problem during the planning stage. The lack of clear cut government policies and encouragement from officials were reported by 82 percent of the respondents as their major problem. There is a greater need for speedy formulation of the government policy on coastal regulation zone, aquaculture bills, environmental regulation, export incentives and other measures to create a conducive atmosphere for investors to come forward and take up shrimp culture.

Fear of culture failure was viewed as the major problem by 72 percent of the entrepreneurs we spoke to, as shrimp farming is a highly capital intensive and risky venture with many potential vulnerabilities. The lack of guidance and lack of economic resources under command were additional problems for 58 per cent of the entrepreneurs, and a very common among innovators and small-scale farmers. More than half of the respondents (52%) reported non-availability of a suitable site or high cost of site for starting the shrimp culture as their main problem, because the appropriate site should have good approachability, be near to a water source, have better soil and water qualities and should be free from environmental problems.

The difficulty of getting skilled manpower, lack of confidence to deal with all sectors of enterprise management and procurement of inputs like seeds and its seasonal availability from hatcheries were reported as a constraint by 42 percent each of the entrepreneurs. The skilled manpower availability can, very well, take care of the absence of entrepreneurs in the shrimp farms, as the entrepreneurs are otherwise pre-occupied with other occupations due to diversity of enterprises. Though all entrepreneurs are not facing the above discussed problems during planning stage, they have to be very effectively handled for doing the business in accordance with laid out objectives.

Problems during preparation of project

As shrimp farming is highly capital-intensive involving risk, the entrepreneurs normally approach the financial institutions and governmental agencies for obtaining bank loans and subsidies. The project has to be prepared and submitted to these organizations indicating the technical feasibility and financial viability of the proposed project.

An overwhelming majority of entrepreneurs (80%) expressed lack of support from officials of the State Fisheries Department and lack of clarity in Government policies as the major problems. It is very difficult for the Fisheries Department to help all the entrepreneurs for preparing the project report in a big district, like Nagapattinam. Entrepreneurs felt that government policies should be unambiguous on matters relating to coastal regulation zone, leasing of land for aquaculture, export promotion and subsidies. 62% of the entrepreneurs reported that lack of experience in the preparation of the project was a problem; while 52 per cent of them reported lack of information about shrimp farming techniques which might be due to the poor network of communication on matters relating to shrimp farming. These days, most of the shrimp entrepreneurs are prepared to go for a low intensity shrimp farming in a limited scale, and hence they do not prepare the project report.

Problems during implementation of the project work

It is possible to raise two shrimp crops in a year in these areas, normally one in summer and one in winter with a crop duration of around 120 to 135 days. We asked entrepreneurs about the problems they encountered beginning with the purchase of land through to harvesting and marketing of the produce by the farmers. Many of the entrepreneurs complained about poor linkages among entrepreneurs, traders, exporters, research organisations and government as their important problems. This might be due to lack of clear cut government policies leading to poor coordination between different organisations working on technology generation, transfer and development of shrimp farming in the country. The price fluctuations in seed and transportation was felt to be a major problem by 84 percent of the entrepreneurs. Many shrimp hatcheries are located near Chennai on the east coast, and the seeds from hatcheries must be transported to the distant locations like Nagapattinam which makes the seed more costly.

Getting project clearance from the Aquaculture Authority was reported to be a problem by the majority of respondents (78%). Since it is mandatory to obtain clearance from Aquaculture Authority for starting shrimp aquaculture near the coast, entrepreneurs felt that it takes lot of time to get a license cleared as their applications have to be processed and verified by various committees from district to national level. Seventy-four of the respondents perceived poor quality of seeds being supplied by hatcheries as the major problem. The hatcheries may not be able to supply uniform sized seeds to the shrimp farmers. Sometimes diseased seeds are also supplied by hatcheries.

Lack of communication among shrimp farmers was perceived as a problem by 68 percent of the respondents. This problem was very much pronounced especially during the discharge of water into the canals and creeks as well as the date of stocking, harvesting etc. Most of the respondents (58%) thought the shortage of skilled operators/labourers as a problem, which could be solved in due course of time when shrimp farming becomes more commercial and more commonly practised by medium-scale entrepreneurs. The high cost of feed and lack of quality standards was felt as a problem by fifty percent of the respondents which might be due to the high level of use of imported feed and varying cost of Indian and imported feeds. Quality standards need to be developed and enforced for the supply of balanced nutritious shrimp feed.

About 52 percent of the respondents expressed that the consultancy from the unqualified persons resulted in a great loss. As shrimp farming is a fast growing enterprise, the entry of unqualified consultants might have resulted in great loss to the entrepreneurs due to the adoption of unscientific shrimp farming technologies. The problem of lack of technical consultancy was identified by 48 percent of respondents as the entrepreneurs normally expect technical consultancies to promote modern shrimp farming methods from research and extension organizations. Forty-two percent of the respondents expressed concerns over the irregular supply of electricity, shortage of good quality feed and exploitation by feed companies as their problems. Good quality feeds should be readily accepted by shrimp with good feed conversion ratio, particle size of ingestion, stability in water, impairment of water quality and nutritional balance. The farmers complained that low quality feeds were being supplied to them by mixing some ingredients without concern for proper nutritive principles, affecting the growth rate of the shrimps, and resulting in poor yield. Around one-fifth (18%) of the respondents revealed lack of good quality feed additives as the problem, since feed additives like vitamins, probiotics, moulting accelerants and immunostimulants are thought to lead to better shrimp growth and disease resistance.

The problem of getting electricity connected was reported by 40 percent of respondents. The inordinate delay and denial of electricity connection in some districts might be due to several administrative procedures. Purchase of suitable land for shrimp culture was another problem revealed by 34 percent of the respondents as land for shrimp farming should have apprapriate soil quality, a nearby source of good quality water with optimum salinity, easy access to the farms and communication facilities. The enormous cost of the land also adds to their problems.

Implications of findings

Aquaculture as a potentially valuable and sustainable economic activity should be recognised as a high priority sector for development assistance by the Government. There is a need to ensure that all the parties involved and the local communities become aware of the problems involved and then act in unison to jointly plan and enforce measures to achieve an environmental friendly aquaculture.

Developing adequate legal and institutional measures to regulate aquaculture activities in ecologically fragile zones will help to avoid social, economic and ecological problems at the local level. Shrimp farming should be encouraged only in the areas suitable for that purpose. Entrepreneurs should give due considerations to site-specific soil and water characteristics, pond designs, effluent discharge and treatment mechanisms before starting the enterprise.

A continuous dialogue is necessary between the industries, government, financial institutions, banks and research institutions with regard to issues such as outbreak of diseases, environment and land related problems, technology and manpower training and export related issues. Strengthening links between farmers through meetings and associations will allow entrepreneurs to share experience and deliver substantial benefits.

To achieve the objectives of a productive and sustainable aquaculture, infrastructure for processing and value addition at the level of industry and support services in terms of production and investment credit, extension, input supply and training at the farm level should be strengthened. This is needed to establish strong inter-sectoral linkages between farm and industry. There is no insurance scheme *in vogue* for hi-tech export-oriented aquaculture projects. The lack of insurance is a serious issue that needs to be adressed by banks and insurance companies, jointly.

Entrepreneurs would benefit from clear cut guidelines and policies of the Government with regard to coastal zone regulation, the right type of culture to be undertaken and creation of an enabling environment with respect to issues such as credit, export concessions, easing of land, affordable and reliable electricity supplies, facilities for disease diagnosis and testing of water quality. Regulatory mechanisms to ensure that hatchery and feed companies provide good quality seed and feed may be worth considering.

Shrimp aquaculture as an enterprise has some innate advantages including the potential for high returns, high productivity, high food conversion ratio, utilization of agriculture and animal wastes and employment generation. In this background, the problems/constraints identified as above need to be addressed urgently in order to sustain the aquaculture development in the long term. Strategies for motivating and supporting the entrepreneurs who wish to take up shrimp farming need to be developed and put in place. Only then, this will result in enhancement of entrepreneurial competence.

From page 24...Women in Aquaculture

take part in this symposium. It is anticipated that the Penang meeting will move the issue from women to gender and also to look at the aspects of mainstreaming of gender in fisheries.

As this is a complex issue it is necessary that all those involved in fisheries research, teaching and development should take an active interest in ensuring gender equity in all the areas of their work. There is no reliable data available on the number of women involved in fisheries activities in government, non-government and private organizations including those self employed. Fisheries education is now becoming a specialized profession and many countries have started special programs in aquaculture. However, entry of women to these fisheries courses is limited and in some cases they are excluded because of a lack of accommodation facilities or due to other administrative reasons. In view of its importance to Asia I hope that the Penang symposium will look into a variety of issues including those related to aquaculture and come up with some practical recommendations. For more information, please contact Ms. Poh Sze at p.choo@cgiar.org

Natural Breeding in Captivity - a Possibility for Conservation of Threatened Freshwater featherback *Notopterus notopterus*

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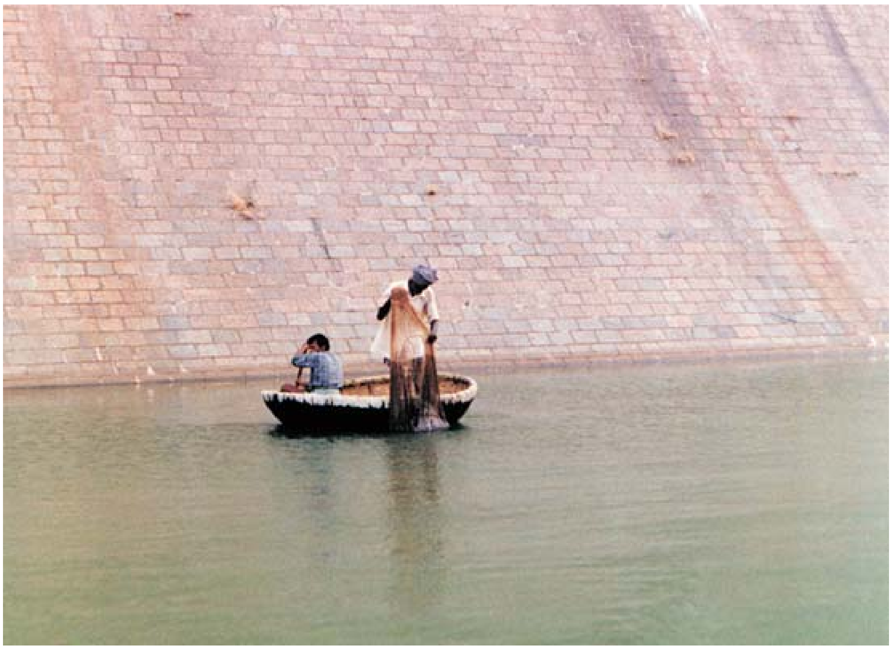
The aquatic ecosystems of India are under increasing pressure due to various human stresses such as rapid urban development, population growth, habitat destruction, over exploitation, pollution, disease and introduction of exotic species[1]. In this regard the Conservation Assessment and Management Plan (CAMP)[2] has identified 327 threatened freshwater fishes in India. These have been categorized as critically endangered (45 species), endangered (91 species), vulnerable (81 species), low risk near threatened (66 species), low risk least concern (16 species), data deficient (26 species), extinct (1 species) and extinct from the wild (1 species). The featherback, *Notopterus notopterus*, is one of the threatened species with a distribution encompassing the Cauvery, Ganga, Godaveri, Krishna and Mahanathi rivers[3]. It is an important food fish (Rs. 60-80/kg) and supports commercial fisheries throughout south India. Unfortunately populations of featherback are declining year by year due to monsoon failure and human impacts as cited above. There is now a strong need to implement conservation and management measures to maintain populations in the wild.

Male featherback broodstock, Notopterus notopterus.

Many approaches have been used in the conservation of threatened species including captive breeding, cryopreservation of gametes, habitat restoration and stock transfer in both captivity and in the wild. People involved in seed production generally prefer to use induced spawning techniques instead of natural breeding, and there is little doubt that the development of induced spawning techniques can contribute to the conservation of a species. However, before attempting artificial propagation it is necessary to study a species breeding and spawning behaviour in captivity. We have examined the breeding behaviour of the featherback under captive conditions as a first step in conservation of this species.



Collecting featherback broodstock with castnet.

Broodstock collection

Featherback were collected from Bhavanisagar dam (9.550N; 77.80E), Erode district, India between 3rd - 7th March 2001 using cast net. They were transported to CARE aquafarm and during the transport water was changed at 5h intervals. 15-20% mortality ocurred during the transport. After reaching CARE aquafarm they were given a brief dip in potassium permanganate ($KMnO_4$) and were stocked in fiberglass tanks (capacity 5000 L).

50 featherback brooders, half male and half female (length: 27 ± 3cm and weight: 350 ± 20g) were selected for stocking. The sexes can be distinguished by the shape of the genital papilla, which is cone-shaped in males and a v-shaped filamentous-like protrusion in females. The brooders were released into the breeding pond (16 x 8x 1m) on 12 March 2001 along with some aquatic plants *Hydrilla verticillata* and *Eichornia crassipes* to provide shelter and cover[4]. The fish were fed at liberty with fresh chicken intestine collected from the nearby market[5]. Periodical assessment of water quality parameters such as temperature (28 ± 2° C), dissolved oxygen (5.8 ± 0.2 mg/l) and pH (6.9 - 7.2) were recorded and the fish were left undisturbed in the pond for one year.

Temporary stocking of featherbacks at collection site.

Results of the breeding trials

20% mortality occurred during the one-year period. Juvenile featherback were first noticed in the pond about one year later on 23rd March 2002. We collected 320 juveniles, which could be differentiated into three different size groups on length and weight basis *viz*., group 1 (3.4 ± 0.3cm and 0.45 ± 0.05g), group 2 (4.5 ± 0.2 cm and 0.62 ± 0.08g) and group 3 (5.6 ± 0.3cm and 1.2 ± 0.2g). We placed the juveniles into nursery tanks (3 x 1 x 1m) and fed on boiled chicken intestine-raghi flour paste. After one week 125 individuals (length 4.5 ± 1.1and weight 0.75 ± 0.39g) were selected and introduced into culture ponds (18 x 9 x 1.5m) for growth studies.

Live featherback "gene bank" or breeding pond.

Among the different methods of conservation, seed production could be the easiest considering the cost of production and handling. While induced spawning is generally favoured our trials show that natural breeding could also be a viable, low cost alternative in a live gene bank by providing necessary facilities to maintain brood stock over a long period, ad libitum feeding, maintaining adequate water quality, providing appropriate shelter and through simulating rainy conditions.

It is clear from the survival, growth and natural spawning exhibited by the wild brooders during the study that featherback can readily adapt to captive conditions. Our findings suggest that two brooders/m^3 is a suitable stocking density for natural spawning to occur[6]. Moreover the very low mortality noticed during the rearing and culture period indicates that there is good potential for development of aquaculture of this species. Studies should now be undertaken to assess the growth, production potential and associated economics of culture of featherback. Furthermore, featherback may have a role in composite culture with major carps leading to more sustainable form of aquaculture within Tamil Nadu.

In India most fishes breed during the monsoons when seasonal temperature remains fairly uniform. Peak spawning occurs when the

Naturally spawned juvenile featherbacks collected from pond.

Different size classes of juveniles.

monsoon rains have properly set in. However, there is a general delay in fish spawning in some parts of India where the monsoon usually arrives late. The breeding cycles in most threatened freshwater fishes have yet to be studied under the prevailing natural conditions. However, mass seed production through captive natural breeding may be one solution for the conservation of threatened fish species.

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Nursery tanks for ongrowing of juveniles.

Advice on Aquatic Animal Health Care

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การวางแผนเลี้ยงกุ้งในภาวะวิกฤติราคา

(Strategy for shrimp culture during price crisis)

พรเลิศ จันทร์รัชชกูล, กรมประมง

สภาพปัญหา

(Current problems)

จากการที่ประสิทธิภาพการเลี้ยงกุ้งที่ลดต่ำลงต่อเนื่องตั้งแต่ระยะสองถึงสามปีที่ผ่านมา รวมทั้งการเข้มงวดในการตรวจสอบคุณภาพผลิตภัณฑ์ของผู้ซื้อ และผลผลิตที่เพิ่มขึ้นของประเทศต่าง ๆ ส่งผลให้เกิดภาวะวิกฤติในด้านราคากับอุตสาหกรรมการเลี้ยงกุ้งอย่างต่อเนื่องมาจนถึงในปัจจุบัน ซึ่งหากวิเคราะห์ถึงปัญหาที่พบในการเลี้ยงกุ้งกุลาดำพอสรุปได้ดังนี้

The low production capacity in the past few years, the strict product standards from buyers and the production increase in other countries have caused a price crisis for the shrimp industry in Thailand. The main problems that are affecting the production capacity of P. monodon culture are summarized below, together with some suggested measures to mitigate against price pressures:

1. ปัญหากุ้งโตช้า ในระยะ 3-4 ปีที่ผ่านมาจะพบว่าปัญหากุ้งโตช้าจะเกิดขึ้นในทุกพื้นที่ และทุกระบบการเลี้ยง ซึ่งก็ยังหาข้อสรุปที่ชัดเจนไม่ได้จนถึงปัจจุบันว่ามีสาเหตุมาจากอะไรบ้าง แต่อย่างไรก็ตามเราอาจแยกปัญหาของกุ้งโตช้าเนื่องจากสาเหตุที่น่าจะเป็นไปได้เป็นกลุ่มดังนี้

1. In the past 3 - 4 years, slow growth in shrimps, the cause or causes of which cannot be clearly identified, have occurred everywhere and in every culture system. However, there is a possibility that shrimp stunting may be caused by some of the following:

1.1 กุ้งโตช้าที่มาจากสาเหตุการติดเชื้อไวรัสเอชพีวี (Hepatopancreatic Parvo-like Virus, HPV) ทั้งนี้เนื่องจากตับและตับอ่อนจะทำหน้าที่หลักในการผลิตน้ำย่อยและสะสมอาหาร เมื่อตับถูกทำลายไปเนื่องจากไวรัสเอชพีวี ก็จะทำให้กุ้งเจริญเติบโตช้า ซึ่งเรามักจะพบว่าหากมีการนำตับและตับอ่อนของกุ้งที่มีขนาดเล็กมาก (กุ้งจิ๊กโก๋) มาตรวจดู มักจะพบไวรัสเอชพีวีเสมอ และบางครั้งก็จะพบไวรัสเอ็มบีวีเช่นเดียวกัน แต่ไวรัสเอชพีวีตรวจไม่พบในกุ้งใหญ่ที่โตปกติ ส่วนไวรัสเอ็มบีวีสามารถตรวจพบได้ในกุ้งที่มีขนาดโตปกติ ดังนั้นเมื่อเปรียบเทียบถึงผลกระทบแล้ว ไวรัสเอชพีวีน่าจะมีส่วนทำให้กุ้งโตช้ามากกว่าไวรัสเอ็มบีวี

1.1 Hepatopancreatic Parvo-like Virus or HPV may cause this slow growth by damaging the cells of hepatopancreas whose main functions is the production of enzymes for digestion and food storage. HPV is always diagnosed in the hepatopancreas of stunted shrimp while MBV is found occasionally. However, in normal shrimp, HPV will not be available while MBV may be found. This points to HPV as a more probable cause of stunting in shrimp than MBV.

1.2 กุ้งโตช้าเนื่องจากตับถูกทำลายจากสาเหตุอื่น หากตับและตับอ่อนของลูกกุ้งถูกทำลายตั้งแต่ก่อนปล่อยลงเลี้ยงในบ่อดินก็จะทำให้ลูกกุ้งนั้นไม่สามารถเจริญเติบโตได้ ซึ่งสาเหตุที่ตับถูกทำลายนอกเหนือจากการติดเชื้อไวรัสเอ็มบีวีหรือเอชพีวีดังกล่าวข้างต้นแล้ว สาเหตุอื่นๆ ที่เป็นไปได้คือ การติดเชื้อแบคทีเรีย การได้รับอาหารไม่ทั่วถึง หรืออาจมีสารพิษใน

อาหาร เป็นต้น ดังนั้นก่อนปล่อยกุ้ง เกษตรกรจึงควรทำการตรวจสอบสภาพความสมบูรณ์ของตับและตับอ่อนเสียก่อน โดยการดูผ่านกล้องจุลทรรศน์ หากพบว่าลูกกุ้งมีขนาดของตับเล็กมาก หรือไม่พบเลยเป็นจำนวนมาก (มากกว่า 20 เปอร์เซ็นต์, โดยมีการตรวจพบลูกกุ้งอย่างน้อยหนึ่งตัวมีตับผิดปกติจากการตรวจลูกกุ้งทั้งหมดสิบตัว) ก็ไม่ควรนำกุ้งดังกล่าวมาเลี้ยง ซึ่งก็น่าจะช่วยลดปัญหากุ้งโตช้าหรือกุ้งจิ๊กโก๋ได้ระดับหนึ่ง

1.2 Apart from HPV and MBV, the hepatopancreas may be damaged by other causes such as from handling during the postlarval stage before stocking in growout pond, bacterial infection, and shortage of feed or presence of toxic substances in feed. Therefore, farmers should observe the hepatopancreas of postlarvae through a microscope. Stunted shrimp can be prevented if PL are not stocked whose hepatopancreas is 20% less than normal, or if 10% of the total number of the fry have no hepatopancreas.

1.3 กุ้งโตช้าเนื่องจากวิธีการเลี้ยง พอจะแบ่งสาเหตุออกเป็นกลุ่มได้ดังนี้

1.3 Slow growth in shrimp may be caused by the following culture practices:

1.3.1 ลูกกุ้งมีขนาดเล็กเกินไป ในช่วงที่มีการปล่อยลูกกุ้งกันเป็นจำนวนมาก ขนาดของลูกกุ้งโดยเฉลี่ยจะอยู่ประมาณ 1.0 – 1.2 ซม. ซึ่งค่อนข้างเล็กมาก ดังนั้นหากการเตรียมบ่อไม่เหมาะสม มีอาหารธรรมชาติน้อย ลูกกุ้งซึ่งมีขนาดเล็กอยู่แล้วจึงไม่สามารถหาอาหารเองได้ จึงทำให้โตช้ากว่ากุ้งที่มีขนาดใหญ่กว่า แนวทางการป้องกันปัญหาดังกล่าวนี้จะมีอยู่ 2 แนวทาง คือ การเตรียมอาหารธรรมชาติให้พร้อม หรือ ปล่อยกุ้งที่มีขนาดใหญ่ขึ้น (ประมาณ 1.3 – 1.4 ซม.) ก็จะช่วยลดระยะเวลาการเลี้ยงกุ้งลง

1.3.1. Stocking of postlarvae that are less than than1.0-1.2 cm. This often happens during the period of high demand for postlarvae when the climate is good for stocking (eg. summer). If there is a shortage of natural feed in growout ponds, postlarvae that are too small to feed on artificial pellets will starve.

1.3.2 ปล่อยลูกกุ้งความหนาแน่นสูงเกินไป หากเกษตรกรปล่อยลูกกุ้งความหนาแน่นสูงก็จะมีการให้อาหารในอัตราที่สูงตามไปด้วย หากมีอาหารเหลือสะสมที่พื้นบ่อ หรือเกิดการเน่าเสียของพื้นบ่อขึ้นในบางจุด ก็จะทำให้กุ้งไม่สามารถหาอาหารกินได้ในบริเวณดังกล่าว ทำให้ลูกกุ้งที่อ่อนแอมีการเจริญเติบโตช้ากว่ากุ้งที่แข็งแรงที่อาศัยอยู่บริเวณที่สะอาด

1.3.2. Overstocking may lead to overfeeding followed by accumulation of feed waste and deterioration of the feeding area on the pond bottom. Shrimp juveniles will become stunted and weak compared with those that are stocked in ponds with a clean bottom.

1.3.3 ปัญหาการเตรียมอาหารธรรมชาติไม่ได้ หากเกษตรกรมีการใช้เคมีภัณฑ์ในการเตรียมน้ำ ซึ่งจะทำให้สิ่งมีชีวิตต่างๆ ในน้ำถูกทำลายไปจนเกือบหมดในช่วง 1-2 สัปดาห์แรก ดังนั้นการเพิ่มอาหารธรรมชาติในบ่อดังกล่าวจะทำได้ยาก จึงทำให้กุ้งมีการเจริญเติบโตช้า

1.3.3. Juveniles will stunt if the natural food (plankton) in pond is not well prepared. This usually occurs 1-2 weeks after the application of chemicals for pond water treatment, which kills almost all living organisms in the pond, including plankton parental stock. Therefore it is difficult to boost phytoplankton after fertilization during water preparation.

1.3.4 ปัญหากุ้งโตช้าในระยะปลายของการเลี้ยง เป็นปัญหาที่สัมพันธ์กับการปล่อยลูกกุ้งขนาดเล็กเกินไป ทำให้ระยะเวลาการเลี้ยงนานขึ้น ประกอบกับระบบการเลี้ยงเป็นระบบปิด ซึ่งในระยะปลายการเลี้ยงถ้าหากมีสารอินทรีย์สะสมในบ่อมากเกินไป จะทำให้เกิดปัญหาคุณภาพน้ำเสื่อมโทรม กุ้งกินอาหารน้อยลง อ่อนแอ และทยอยตายได้ การป้องกันปัญหาดังกล่าวจะต้องมีการเตรียมการตั้งแต่วิธีการเตรียมบ่อ การคัดคุณภาพลูกกุ้ง การจัดการคุณภาพน้ำ และอาหาร ซึ่งจำเป็นจะต้องมีการปรับเปลี่ยนเพื่อให้เหมาะสมกับภาวะในปัจจุบันอีกมาก

1.3.4 Shrimp may stunt at the end of culture period. This probably relates to the stocking of post larvae that are too small, which usually leads to a longer culture period. In closed systems organic wastes that accumulate on the pond bottom will cause pond water deterioration followed by less feeding, weakness and some mortality. To avoid this problem, the current practices in pond preparation, selection of postlarvae, water and feed management should be modified to suit the pond and shrimp conditions.

2. ปัญหากุ้งมีอัตรารอดตายต่ำ ในระยะ 5 – 6 ปีที่ผ่านมา จะพบว่าอัตรารอดของกุ้งในขณะจับขายจะมีแนวโน้มลดลงจากเดิมค่อนข้างมาก โดยเฉพาะการเลี้ยงกุ้งที่ใช้น้ำความเค็มต่ำ โดยพอจะแยกปัญหาได้เป็น 2 กรณี คือ

2. In the past 5-6 years, survival of shrimp has become lower, particularly in low salinity or freshwater areas. The major problems include:

2.1 อัตรารอดตายต่ำตั้งแต่ระยะ 2 เดือนแรก ทั้งนี้อาจเนื่องมาจากสาเหตุหลักๆ 2 ประการ คือ ปัญหาคุณภาพน้ำที่ใช้เลี้ยงคือความเค็มและค่าความเป็นด่างต่ำเกินไป โดยเกษตรกรยังมีความเชื่อว่ากุ้งกุลาดำสามารถเลี้ยงในน้ำจืดได้ จึงไม่ได้ให้ความสำคัญกับความเค็มของน้ำมากนัก ดังนั้นการแก้ไขคือความเค็มในขณะปล่อยกุ้งควรจะมีค่าไม่ต่ำกว่า 5 ppt. และค่าความเป็นด่างมากกว่า 80 ppt. ส่วนอีกปัญหาหนึ่งก็คือคุณภาพน้ำในบริเวณที่ปล่อยกุ้งในคอกและน้ำที่อยู่ภายในบ่อมีค่าต่างกันมาก ทำให้ลูกกุ้งไม่สามารถปรับตัวได้หากใช้เวลาในการผสมน้ำในคอกและในบ่อสั้นเกินไป เกษตรกรควรจะเตรียมน้ำภายนอกคอกให้มีความเค็มไม่น้อยกว่า 2 ppt. และใช้เวลาการปรับน้ำประมาณ 3 - 4 วันก่อนเปิดคอก นอกจากนี้ในเขตความเค็มต่ำอาจพบปัญหาตัวอ่อนของแมลงและแมลงน้ำต่างๆ เกิดขึ้นในบ่อเป็นจำนวนมาก ซึ่งจะกินลูกกุ้งในระยะที่เพิ่งปล่อยใหม่ๆ ดังนั้นก่อนการปล่อยลูกกุ้งควรตรวจสอบดูว่ามีตัวอ่อนของแมลงต่างๆ อยู่หรือไม่ โดยเฉพาะตัวอ่อนของแมลงปอ หากพบควรจะใช้อวนลากออกก่อนที่จะปล่อยลูกกุ้ง

2.1 Poor survival at early stage during the first two - months may be caused by water quality. Salinity and alkalinity of pond water during stocking may be too low. Therefore, farmers in freshwater areas should maintain pond salinity and alkalinity during stocking at levels not lower than 5 ppt and 80 ppt, respectively. Later it can be diluted. If the water quality of the nursery enclosure is different from that of the growout pond, juveniles cannot acclimatize if the period given to them to adjust to the different water condition is too short. Farmers should keep salinity in the growout pond to not less than 2 ppt and allow 3 - 4 days for water adjustment before release into growout ponds. In low salinity areas, there are a lot of water bugs and insects particularly dragonflies that feed on shrimp fry. Juvenile insects and water bugs in ponds should be dragged out by mosquito net before stocking of shrimp seed.

2.2 อัตรารอดต่ำในระยะปลายของการเลี้ยง ในบ่อที่มีการปล่อยลูกกุ้งในอัตราความหนาแน่นสูงในระบบปิดที่ไม่มีการถ่ายน้ำหรือถ่ายน้ำได้น้อย สภาพแวดล้อมภายในบ่อจะเสื่อมโทรมได้เร็วมาก ซึ่งจะสังเกตได้ว่าการกินอาหารของกุ้งและการเจริญเติบโตในช่วงหลังจากเลี้ยงกุ้งประมาณ 60 - 70 วัน จะต่ำลงเรื่อยๆ และพบกุ้งป่วยที่มีลำตัวสกปรกเกาะตามขอบบ่ออยู่เสมอๆ ซึ่งกุ้งบางส่วนก็จะทยอยตายไปเรื่อย ๆ จนทำให้ผลผลิตต่ำและเลี้ยงกุ้งไม่ได้ขนาดดังกล่าวมาแล้วข้างต้น การแก้ปัญหาในระยะปลายการเลี้ยงจะทำได้ยากมาก ดังนั้นเกษตรกรควรจะต้องมีการเตรียมการและวางแผนการเลี้ยงกุ้งให้เหมาะสมกับฤดูกาลอีกด้วย

2.2 Poor survival at the adult stage occurs in highly intensive ponds with closed systems or low water exchange systems, which causes the pond environment to rapidly deteriorate. In this case, shrimp growth and feeding requirements decrease after 60-70 days. Unhealthy shrimp with external fouling are usually observed at the shallow parts of the pond. These shrimp will gradually die and lead to poor production. It is difficult to solve this problem. Therefore farmers should have good planning and preparation for each season.

ที่กล่าวมาเป็นปัญหาหลักของอุตสาหกรรมการเลี้ยงกุ้งกุลาดำของประเทศไทย ทั้งนี้ยังไม่รวมถึงปัญหาการถูกตัดสิทธิ์จีเอสพี การถูกฟ้องเรื่องการทุ่มตลาก ปัญหาสิ่งแวดล้อมและอื่นๆ ซึ่งอาจส่งผลกระทบเพิ่มขึ้นอีกในอนาคต ดังนั้นเพื่อลดปัญหาต่างๆ ที่อาจจะเกิดขึ้นว่าควรมีการปรับเปลี่ยนกระบวนการผลิตกุ้งเพื่อให้ได้กุ้งคุณภาพเหมาะสมตรงตามความต้องการของตลาดผู้ซื้อในกลุ่มต่าง ๆ รวมทั้งวางแผนการผลิตให้ตรงตามฤดูกาลเพื่อหลีกเลี่ยงปัญหาในด้านโรคระบาดและการจัดการฟาร์มอีกด้วย ซึ่งแนวทางในการปรับเปลี่ยนและวางแผนการผลิตกุ้งจะประกอบไปด้วย

The above problems are commonly found in the Thai shrimp culture industry. However these do not include the market problems related to GSP in EU, anti-dumping charges, environmental issues and others. In order to reduce the above problems, the culture practices should be adjusted to match with the market requirements as well as to suit each season/environment. These would help avoid problems associated with shrimp health and farm management. The following are guidelines for adjustment of culture practices:

1. การกำหนดขนาดและผลผลิตของกุ้ง ในภาวะปัจจุบันราคากุ้งขนาดเล็กกว่า 50 ตัวต่อกิโลกรัม (ต่ำกว่า 20 กรัม) ค่อนข้างต่ำมาก ซึ่งจะทำให้โอกาสที่จะมีกำไรน้อยตามไปด้วย ดังนั้นแนวโน้มในการผลิตกุ้งในอนาคตจะต้องวางแผนการผลิตให้ได้กุ้งที่มีขนาดใหญ่กว่า 20 กรัม ภายในระยะเวลาการเลี้ยงไม่มากกว่า 130 วัน จะเห็นได้ว่าหากเกษตรกรมีการปล่อยกุ้งที่มีขนาดเล็กและความหนาแน่นสูงจะไม่สามารถทำได้เลย ดังนั้นจะต้องมีการวางแผนการผลิตอย่างดีเหมาะสมกับกำลังผลิตของระบบฟาร์มที่มีอยู่ โดยเน้นที่การเตรียมบ่อและอาหารธรรมชาติ การคัดคุณภาพลูกกุ้งที่ดีและปล่อยกุ้งขนาดใหญ่ขึ้น เช่น ปล่อยลูกกุ้งขนาดความยาวเฉลี่ยมากกว่า 1.2 ซม. ที่อัตราความหนาแน่น 50,000-60,000 ตัวต่อไร่ เป็นต้น โดยมีการจัดเตรียมระบบน้ำและระบบให้อากาศ ตลอดจนการจัดการพื้นบ่อที่

เหมาะสม เป็นต้น

1. Selection of shrimp size and yield of production. The price for small sized shrimp (less than 50 pieces/kg or 20 gm each) is now very low and it is difficult to make any profit. Therefore the production of shrimp larger than 20 gm within 130 days should be the trend for the future. It is not possible to use the existing culture practice that stocks small postlarvae with a high density. For this new practice, farmers should have good planning that matches with the existing farming system by focusing on good preparation of pond and natural food; selection of healthy and larger fry (over 1.2 cm); lower stocking density (31-38 PL/m2); and suitable water management, aeration and pond bottom management systems.

2. การวางแผนปล่อยกุ้งตามฤดูกาล เพื่อหลีกเลี่ยงปัญหาโรคระบาด จากข้อมูลทางภาคสนามและภาควิชาการจะแสดงให้เห็นชัดเจนว่า การระบาดของโรคที่รุนแรงในกุ้งกุลาดำจะสัมพันธ์กับเรื่องอัตราการติดเชื้อของลูกกุ้งในช่วงต่าง ๆ และฤดูกาลที่ภูมิอากาศมีการแปรปรวน โดยพบว่าโรคตัวแดงดวงขาวจะมีความรุนแรงมากในระหว่างเดือนตุลาคม - มกราคม ของทุกๆ ปี ดังนั้นการวางแผนปล่อยกุ้งลงเลี้ยงในบ่อควรจะเริ่มปล่อยประมาณเดือนกุมภาพันธ์ถึงมีนาคม และจับกุ้งขายก่อนเดือนมิถุนายน เพื่อเตรียมปล่อยกุ้งอีกครั้งหนึ่งในเดือนกรกฎาคม เพื่อให้สามารถจับกุ้งขายในรอบที่สองประมาณเดือนตุลาคมไม่เกินพฤศจิกายน ก่อนที่ฤดูหนาวจะมาถึง แต่อย่างไรก็ตามการปล่อยกุ้งลงเลี้ยงปีละสองรอบนั้นก็ยังคงมีความเสี่ยง หากไม่สามารถจับกุ้งขายภายในระยะเวลาการเลี้ยง ประมาณ 120 - 130 วันได้ เนื่องจากกุ้งโตไม่ได้ขนาด ซึ่งก็จะทำให้การเลี้ยงกุ้งในรอบสองผ่านเข้ามาในช่วงฤดูหนาว มีโอกาสเสี่ยงต่อการเกิดโรคระบาดสูง หากเกษตรกรปล่อยลูกกุ้งรอบแรกเร็วเกินไปก็ยังคงมีความเสี่ยงอีกเช่นกันโดยเฉพาะในรอบแรก เนื่องจากในระยะเดือนมีนาคมและต้นเมษายนของทุกปี อุณหภูมิจะค่อนข้างสูง มีแสงแดดจัดมาก หากเกษตรกรควบคุมปริมาณการให้อาหารไม่ดีพอ ไม่มีน้ำเปลี่ยนถ่ายในช่วงดังกล่าว ก็อาจทำให้เกิดปัญหาคุณภาพน้ำ และก่อให้เกิดโรคอื่นๆ ตามมาได้ เช่น โรคหัวเหลือง หรือโรคที่เกิดจากการติดเชื้อแบคทีเรียต่าง ๆ เป็นต้น

2. Plan for stocking at the right season. This is to avoid disease outbreaks. From scientific and field information, it is clear that the outbreak of severe diseases in P. monodon relates to the susceptibility in shrimp fry and stocking seasons. It has been observed that white spot disease outbreaks occurs most severely during the period of weather change, eg. October to January. Therefore, farmers should plan to stock shrimp fry in February or March so as to harvest before June and then start the second crop from July to October before the cold season. However, it is still risky for disease outbreak if shrimp sizes of the second crop do not reach expected marketable size within 120-130 days. The culture period has to be extended until the cold season. There is also risk for the first crop in summer when temperature and evaporation rate are too high in March and April with high sunlight intensity. If there is no proper feed management and water exchange pond water may deteriorate triggering infection of yellowhead or bacterial diseases.

ดังนั้นในฟาร์มที่มีอุปกรณ์ต่างๆ เช่น เครื่องตีน้ำ เครื่องสูบน้ำจำกัด และไม่มีบ่อพักน้ำที่เพียงพอ การปล่อยกุ้งปีละสองรอบเพื่อที่จะผลิตกุ้งขนาดใหญ่จะทำได้ยากมาก วิธีการหนึ่งที่อาจนำมาใช้เพื่อแก้ปัญหาดังกล่าวคือ ควรอนุบาลกุ้งแล้วย้ายออก กล่าวคือ หลังจากที่มีบ่อกุ้งที่จับกุ้งขายรอบแรกแล้ว ให้รีบดำเนินการเตรียมบ่อทันทีเพื่อปล่อยลูกกุ้งเตรียมไว้ก่อน หลังจากที่ทยอยจับกุ้งที่เหลือจนหมด ลูกกุ้งที่อนุบาลไว้ในบ่อแรกก็จะมีอายุประมาณ 30 - 45 วัน ก็สามารถที่จะย้ายมาปล่อยในบ่อที่ทยอยจับกุ้งรอบแรกขายไปแล้วได้ โดยย่นระยะเวลาการเลี้ยงลงได้ประมาณ 1 เดือน เป็นต้น

Therefore, it may be difficult to maintain two crops per year for production of larger shrimp in the farms that are not well equipped with aerators, water pumps and reservoirs. The solution for this is to shorten culture period in growout ponds by stocking PL in nursery pond for 30 - 45 days, in other words having larger PL.

อีกวิธีการหนึ่งที่สามารถปฏิบัติได้คือ การปล่อยกุ้งเพียงปีละ 1 รอบ ซึ่งระยะเวลาที่เหมาะสมคือ ประมาณเดือนพฤษภาคม - มิถุนายน ซึ่งเป็นช่วงที่ฝนเริ่มตกสม่ำเสมอ ความเค็มของน้ำเริ่มลดลง รวมทั้งอุณหภูมิก็ไม่สูงมาก เกษตรกรสามารถปล่อยกุ้งในความหนาแน่นที่สูงขึ้น (ประมาณ 60,000-80,000 ตัว/ไร่) เมื่อเลี้ยงกุ้งได้ประมาณ 110-120 วัน ก็แบ่งจับกุ้งขายบางส่วน (30-40 เปอร์เซ็นต์) เลี้ยงกุ้งส่วนที่เหลือต่อไปเพื่อจับกุ้งครั้งสุดท้ายประมาณเดือนตุลาคม ก็จะได้กุ้งที่มีขนาดใหญ่ขึ้นได้ และไม่เสี่ยงต่อการเกิดโรคหัวเหลืองในฤดูร้อน และดวงขาวในฤดูหนาวอีกด้วย จะเห็นว่าการวางแผนการปล่อยกุ้งในความหนาแน่นที่ต่ำลงเพื่อให้กุ้งโตเร็วนั้นจะสำเร็จได้ก็ต่อเมื่อคุณภาพของลูกกุ้งดี แข็งแรงและปลอดจากการติดเชื้อโรคต่าง ๆ ด้วย ดังนั้นการคัดเลือกคุณภาพลูกกุ้งจะมีผลต่อความสำเร็จของการเลี้ยงกุ้งอย่างมาก ซึ่งเกษตรกรควรจะให้ความสำคัญมากขึ้น เพื่อให้มีผลผลิตกุ้งที่สูงขึ้นส่งผลให้ต้นทุนต่ำลงมีกำไรมากขึ้น

Another alternative is to maintain only one crop a year by stocking at the best season in May-June when salinity and temperature become lower from rain. Higher stocking density (37-50 PL/m2) can be done in this case. After 110 -120 days the pond can be partially harvested by 30-40%; the final harvest for larger shrimp would then be in October. This will help to avoid the outbreaks of yellowhead disease in early summer and whitespot in the cold season. Increasing shrimp size by lowering stocking density can be successful when postlarvae are healthy and large enough. Therefore selection of healthy shrimp fry should be a critical factor for farmers to increase production yield and profit margin.

Aquaculture Calendar

For more events listings the NACA Events & Training page at

http://www.enaca.org/modules/extcal/

Aquaculture Europe 2004 conference on "Biotechnologies for Quality", 20-23 October 2004, Barcelona, Spain

This European and international meeting will bring together participants from as many as 40 countries to address the key issues and discuss some of the most advanced scientific results and technological tools. Aquaculture Europe 2004 will be organized through plenary thematic sessions, parallel sessions, poster sessions and a workshop. Although emphasis will be given through the plenary sessions to "Biotechnologies for Quality", other challenges for aquaculture development will also be approached during parallel sessions. On the first day of Aquaculture Europe 2004 (October 20), the EAS and the Spanish Aquaculture Society (SEA) will jointly organize the workshop "Challenges for Mediterranean Aquaculture Products". The workshop is designed to facilitate exchange of information between producers, researchers and others associated with the industry in an informal setting. The event is based at the first-class facilities of the Universitat Politècnica de Catalunya in the wonderful city of Barcelona. More details on the programme together with the "Call for Contributions Form" and other information can be found at the Aquaculture Europe website http://www.easonline.org/agenda/en/AquaEuro2004/default.asp. A paper version of the brochure can be requested through ae2004@aquaculture.cc.

Workshop on environmental issues of marine fish farming in the Mediterranean, 20 October 2004, Barcelona, Spain

There will be a 1-day workshop in connection with the Aquaculture Europe 2004 At the University of Barcelona, Spain, on 20th October, 2004 presenting results from on-going EU marine environmental research projects. The workshop will focus on new directions in monitoring, management tools and bioremediation techniques, including coverage of the following topics: Use of bio-assays to monitor release of nutrients in the Mediterranean; effects of Mediterranean fish farming on the seagrass *Posidonia oceanica*; monitoring of seagrasses around Mediterranean fish farms; predicting impacts on seagrass meadows through modeling Sensitive tools to detect organic enrichment of fish farm sediments (use of meio- and macrofauna); comparison of aquaculture monitoring methodologies; modelling cage aquaculture impacts; measurable aquaculture impacts; cage aquaculture and wild fish interactions; MERAMED recommended monitoring methods; the succession dynamics of naturally settled mixed heterotrophic and autotrophic communities and their potential for nutrient capture in differing environments; the economics of biofiltration; and the potential for a secondary harvest using co-culture in differing environments. The workshop is free of charge. If you would like to register to attend the workshop, Please inform either Marianne Holmer, holmer@biology.sdu.dk or Patrick White, pwhite@hol.gr

Training Course on Mangrove-Friendly Shrimp Aquaculture, 23 October – 11 November 2004, Philippines

The goal of the course is to provide participants with a basic understanding of the mangrove ecosystem, and technical knowledge and skills on shrimp culture so that they can grow shrimp in a sustainable and mangrove-friendly manner. At the end of the training course, the participants should be able to demonstrate the basic concepts of the mangrove ecosystem; explain the interrelationships between mangroves and shrimp culture; apply sustainable culture methods and management techniques; and prepare a feasibility study of a mangrove-friendly shrimp aquaculture project. Participants must be nominated by their respective governments; presently engaged in aquaculture extension or research work; with at least 2-3 years experience in aquaculture; under 45 years old; good command of English language; and with good physical and mental condition. For more information and a detailed propsectus visit the SEAFDEC AQD website.

Global Shrimp Outlook 2004, 9-12 November, Bangkok, Thailand

GAA presents the Global Shrimp Outlook series to help international shrimp marketers gain vital perspectives on the future of the shrimp industry. During this year's focused morning meeting sessions, industry experts and executives will report on current shrimp production and demand, and project shrimp prices for 2005 and beyond. Afternoons will remain free for business interaction and relaxing social activities. The GSOL schedule also includes panel discussions that will allow participants to actively address such issues as antidumping, antibiotic residues, product traceability and facility certification. Given the timing of the preliminary antidumping duties on imported shrimp recently established by the U.S. Department of Commerce, this Global Shrimp Outlook meeting will likely be even more strategically important than usual. Global Shrimp Outlook: 2004 is a by-invitation meeting for major international shrimp buyers, producers and related suppliers. Due to the proprietary nature of the conference content, registration is not available to members of the media. If you have not received an invitation to GSOL, please visit http://www.gaalliance.org/gsol.html online or contact the GAA office to request further information. To reach GAA, telephone +1-314-293-5500, fax +1-314-293-5525 or e-mail gaa.admin@attglobal.net.

Women in Fisheries and Aquaculture, 10-13 November 2004, Spain

The international conference AKTEA "Women in Fisheries and Aquaculture: Lessons from the past, current actions and dreams for the future" will take place in Santiago de Compostela (Galicia, Spain). Women in fisheries and aquaculture and researchers working on women issues from all parts of the world are all invited to visit our website: http://conference.fishwomen.org

International Conference on Aquaculture Production and Marketing of Shrimp and Finfish and Bangladesh Seafood Expo 2004, 28-29 November, Dhaka, Bangladesh

The conference will focus on the latest developments in aquaculture production and marketing of warm water shrimp and finfish species with special reference to freshwater prawns *Macrobrachium rosenbergii*, tiger shrimp *Penaeus monodon*, white shrimp *P. vannamei*, tilapia and marine finfish. The conference will also focus on environment friendly production techniques including organic production systems, emerging product quality/safety assurance approaches including traceability and labeling with emphasis on product presentation as well as marketing in the major markets, EU, US and Japan. For more information and registration email infish@tm.net.my or infish@po.jaring.my, or visit www.infofish.org. The organizers may also be contacted at INFOFISH, PO Box 10899, 50728 Kuala Lumpur, Malaysia

7th Asian Fisheries Forum 2004, 30 November – 4 December 2004, Malaysia

The Asian Fisheries Society endeavors to make the 7th Fisheries Forum the largest fisheries event in Asia, in terms of the number of participants and impact. Working on the theme "New Dimensions and Challenges in Asian Fisheries in the 21st Century", the status of Asian fisheries will be elevated to a new level, providing ideas and solutions to overcome the inherent and unique challenges in Asian fisheries and generating technical advancement in tandem with global development. The programme will include: How to Make a Difference: Research for Impact on Fisheries and Aquaculture; recent Advances in Biotechnology; Globalization and Its Impact on Asian Fisheries: Implications for Fisheries Management; Restoration and Management of Small-Scale Fisheries: Meeting the Challenge. A number of special symposia will also be held concurrently including on Gender in Fisheries; Advances in Shrimp Biotechnology; Restocking the Stock Enhancement of Coastal Fisheries: Potential Problems and Progress; Technology Needs and Prospects for Asian Aquaculture: Participation of the Poor; Biotechnology for Growth and Reproduction in Fish; and Aquatic Ecosystem Health. For further information, please contact: The Secretariat, 7th Asian Fisheries Society, School of Biological Sciences, Universiti Sains Malaysia,11800 Minden, Penang, Malaysia, Tel: +604-6533888 ext. 3961/ 2932/ 4005/ 4009, Fax: +604-6565125, Email: 7aff2004@usm.my, Website: http://www.usm.my/7AFF2004.

Practical Application of Food & Feed Extrusion Technology, 1-3 December 2004, Bangkok, Thailand

The three day program with be held in Bangkok, Thailand, and is aimed at providing participants with a practical knowledge of current industrial extrusion technology. The course takes participants from the basics of extrusion through to an understanding of rheology and flow in the extruder barrel. The role of different ingredients, extruder configurations, and die effects, are also covered. The content of the course covers both single and twin screw extrusion technology. The course is relevant to a range of human and pet foods, as well as to the production of aquafeeds. Offered by Food Engineering Pty Ltd in conjunction with the Food Research and Product Development Institute at Kasetsart University in Bangkok. Further information is available from the web at www.fie.com.au/extrusionasia/, or contact Gordon Young, email gyoung@fie.com.au.

International Workshop on Culture, Fisheries and Stock Enhancement of Portunid Crabs, 20-22 January 2005, Iloilo, Philippines

The workshop will include sessions on broodstock nutrition; larval culture and nutrition; nursery grow-out; fisheries and stock enhancement; genetics and taxonomy. The proceedings will be published in special edition of a peer-reviewed journal. Registration fee: $150. For more information please contact INCO_CAMS@bigfoot.com.

What's New on the Web

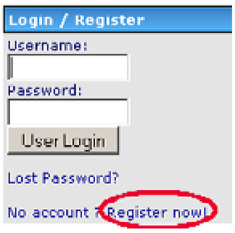
NACA website – a guide to member services

Welcome to our Online Community

The NACA website has many new services that can help you to find information, automatically track issues, publish your own news and network with your colleagues all over the world. Our goal is to establish an 'Online Community' where you can discuss issues and share information with your colleagues working in other countries. This guide shows how to use the new services to collaborate with your colleagues online.

Most of the new services require you to register as a member of the website community. Please join us (its free) and help us to become an organization without boundaries.

How to register as a member (its free)



Registration is a two-step process:

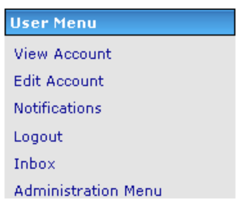
1. Submit a registration form: Click on the 'Register now!' link in the top of the left column of the NACA home page, or visit http://www.enaca.org/register.php. Please fill in the form and press the 'submit' button. You must provide a valid email address and agree to our disclaimer.
2. Activate your account: A "confirmation" email will be sent to the email address in your registration form. You must open the email and click on the link it contains to activate your account (this is a security requirement).

Now that your account has been activated you can 'login' to the website and use all the free member services.

Member services

You must register as a member of the website and login in order to use most of the interactive features.

Your personal website account



Members receive a personal website account. This is managed through the 'User Menu' that appears once you login. Your account allows you to personalize the website. You can:

- Set up 'notifications' to help you track issues of interest;
- Send personal messages to other members
- Keep track of your posts and submissions to the website
- Create a personal profile with your business or research interests and contact details, which will appear in the Member Directory.

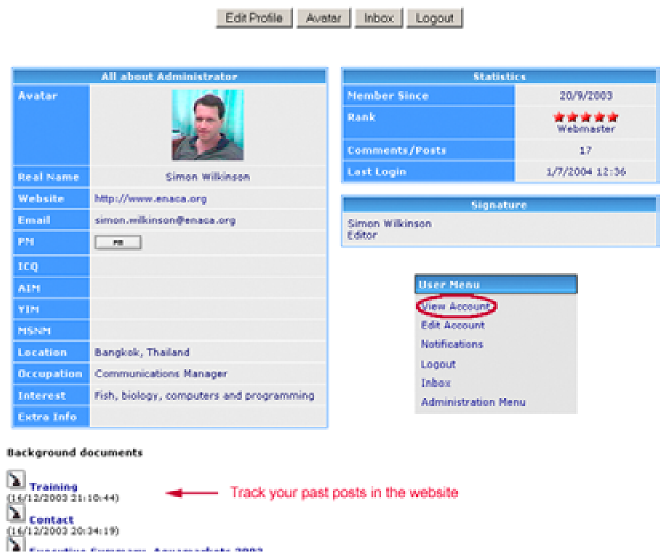
It's worth taking a few minutes to customize your account. Instructions are below.

Your personal profile – viewing and editing your account

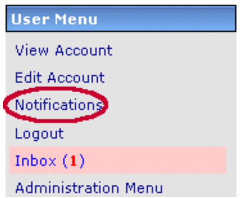
A personal profile is created when you register. Select 'View Account' in the User Menu to see your details. At first there is not much information in it (just the details you submitted in your registration form). You can add more information about yourself such as your location, occupation or research interests by pressing the 'Edit Profile' button in your profile or the 'Edit Account' link in the User Menu. Filling in your details will help people with similar interests to find you in the Member Directory.

Uploading your photograph

The 'Avatar' button can be used to upload a small picture of yourself (or anything really) that will automatically appear in your posts in the discussion forum. People like to 'see' who they are talking to ! The picture cannot be larger than 100 pixels in width or height, and must be less than 10 KB in file size.



Personal messaging



Members of the website can contact one another via a built-in personal messaging system. It's quite similar to email but only runs within the website. New messages are highlighted in your 'Inbox' link in the User Menu – click on the link to view your messages. You must be logged in to use this feature.

You can send a personal message to a member using the 'PM' button. This button appears in everyone's Personal Profile, which is available by clicking on their Username in a forum post or by searching within the Member Directory.

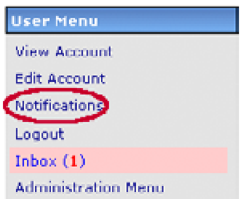
Notification system – automatic issue tracking !

Want to keep up to date on particular issues ? You can 'subscribe' to categories that interest you in different parts of the website. When new information is added you will automatically be sent an email to let you know, with a link to open the page. This makes it easy for you to track issues of interest without having to visit the website constantly. You can, for example, subscribe to the Publications page so that you will be alerted every time a new free publication becomes available. You can also subscribe to a sub-category in many places, for example 'Shrimp Publications'.

Subscribing to a category

You can subscribe to a category (or 'page') wherever you see the 'Notification Options' box at the bottom of the page. Select the option you want and press 'update now' to add this page to your notification list. You can also unsubscribe by deselecting an option.

Managing your notifications



You can manage your subscriptions through the 'Notifications' link in the User Menu. This displays a list of all your currently active notifications. You can delete them from here. By default, your notification preference has been set as 'email'. However, you can choose to be notified by Personal Message if you prefer. Change your preference by clicking on the [Change] link underneath the Notifications Options box or by editing your Personal Profile as described above.

Posting comments – have your say !

Members can post comments about nearly anything on the NACA website – for example you can comment on news stories, publications, magazine articles. We encourage you to do so – please feel free to have your say! Other members can reply so it is possible for the Community to debate a story or post reviews of a publication. Look for a "Comments ?" link or button at the bottom of each story, publication or link. This will open a submission form.

Discussion forums

The discussion forums are the heart of our Online Community. Here you can 'post' questions and seek the advice of your colleagues from all over Asia! Our members are a mix of farmers, scientists and government people - they have experience in many different fields. If you have a problem with your farm or a question about aquaculture this is a good place to ask ! Your question will also be shown on the home page where other visitors to the site can see it, so there is a good chance you will get some expert advice.

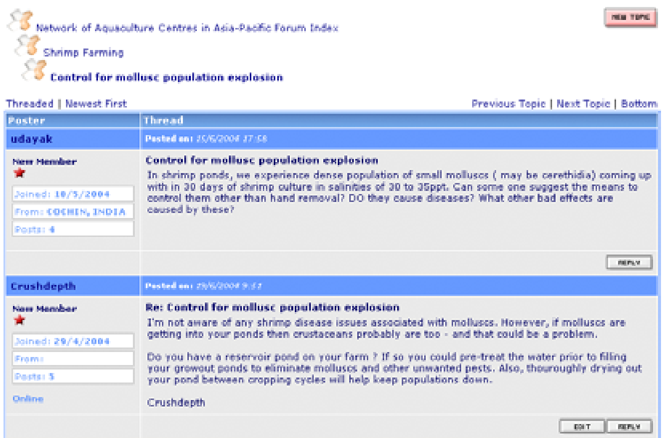
The main idea of the forums is that members can share experience and help each other solve their farming problems. Please answer other people's questions where you can - our members share their experience for mutual gain.

Please note that **you must login** to post a new message or comment. A typical 'thread' of discussion is shown below. The main controls are as follows:

Click on this button to ask a **new** question in a forum – this starts a new topic or '**thread**' of discussion. It opens a form that you can use to submit your question (also called a '**post**')

Use this button to post a reply to someone else's question or comment

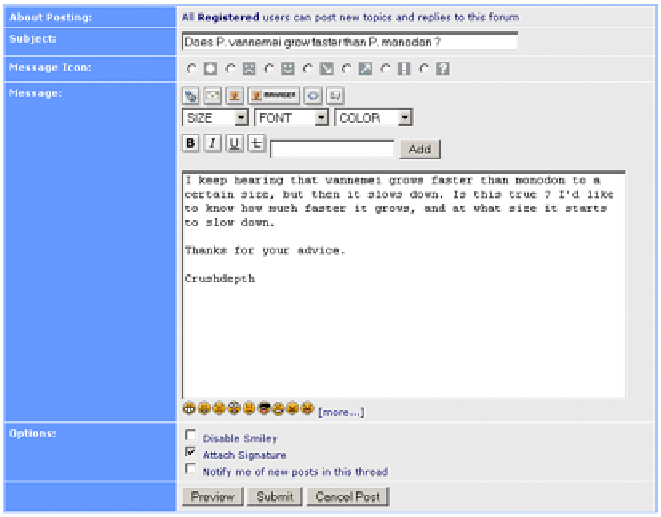
Use the edit button to change your post if you make a mistake or want to fix the formatting.



You are free to use the discussion forums in any way that you like – they are there for your use. The only restrictions are that we do not allow discussion on religion or politics and we do not permit advertisements or offensive materials. We also expect members to be polite and respectful at all times – debate is welcome but personal attacks and ‘flaming’ is not.

You may also subscribe to a discussion thread or an entire forum that interests you using the notification system as described above.

The figure below shows the submission form used to submit a post or reply in the forums. All you need to do is to type in the title and body of your post. There are also few buttons that you can use to format your text if you want to (this is not necessary).



To use the formatting controls (again we stress it is not required) you i) type the text you want formatted into the blank box next to the ‘Add’ button, ii) press the appropriate formatting buttons until the preview text appears as desired and iii) press the ‘Add’ button. The text will be inserted into the message box wrapped in some formatting codes. You might need to reposition it (and the formatting codes) into the right place in your post. If you prefer, you can type the codes in yourself – its often faster. The codes follow a simple start-finish pattern ie. [code]your text here[/code].

*Note: The ‘insert image’ button allows you to insert a picture from another website – it is dynamically ‘called’ from the other site, so you must provide the URL to reach the image.

Publishing your own content on the NACA website

Members can contribute their own news stories, publications and links for the NACA website ! Please share your local news with the network! Whenever you visit one of these sections of the site you will notice new ‘submit’ link appear in the main menu.

To submit your own news story, click on the link and a submission form will open. It is very similar to the forum submission form discussed above – the formatting controls are the same. All you have to do is type in the title and body of your story. There is a ‘preview’ button available that lets you check the appearance before you send it. When you are happy with your submission, click on the ‘submit’ button to send it in to our editors.

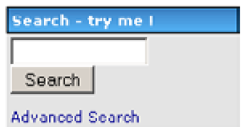
Contributions to the website are held pending approval by our Editorial team. They are normally published within two working days. Please note that contributions are subject to editorial standards – please read our Guide to Authors before making a submission.

You can download it from http://www.enaca.org/modules/mydownloads/visit.php?cid=83&lid=215

Other useful website features

These features are available to everyone and can be used without logging in.

Search tool



Looking for information on a particular issue ? The search tool is the best way to look for it – it indexes ever news item, publication, link and discussion on the site. The search results are presented by section (ie new stories, publications, links etc) for clarity. If you only want to search

Formatting controls:

Function	Button	Or you could type manually	Appearance
Bold	B	[b]this will be bold[/b]	**this will be bold**
Italics	I	[i]this will be in italics[/I]	*this will be in italics*
Underline	U	[u]this will be underlined[/u]	this will be underlined
Strike through		[d]this will be struck through[/d]	~~this will be struck through~~
‘Clickable’ email		[email]bob@enaca.org[/email]	bob@enaca.org
‘Clickable’ link		[url=http://www.enaca.org]link[/url]	link
Insert image		[image](type in the URL)[/image]	Inserts an image from URL*

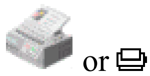
within a certain section of the site (say, publications) try the 'Advanced Search'. It works very well, try it !

Downloading publications (free full-text !)

All of our publications are available for free download. They are mostly in PDF format so you need Adobe Acrobat Reader Version 4 or higher to open them. You can download this for free from:
http://www.adobe.com/products/acrobat/readstep2.html

Printer-friendly pages

Want to keep a copy of a news story or magazine article ? Click on these 'printer-friendly page' buttons to reformat the page for your desktop printer.


or

Email to friend

You can send your friends a link to a story they might be interested in wherever you see these buttons or a 'Tell a Friend' link


or
Tell a Friend

Email newsletters

We offer several email newsletters on different subjects. These are good way to keep updated with the latest developments. You control your own subscription. To subscribe:

1. Choose a topic
2. Enter your email address and
3. Click the 'send' button.

You will then automatically receive the email newsletters as they are released. To unsubscribe, follow the same process but choose the 'unsubscribe' option in the drop down box.

News services for mobile phones & PDAs

WAP

You can access the NACA website with your WAP-enabled mobile phone. This service is currently available for the News, Publications and Links pages. Just point your WAP browser to **http://www.enaca.org/wap**

Personal Digital Assistants

We also offer a PDA-friendly news page. If you have a Palm or Pocket PC you can set it to automatically download the latest NACA news headlines whenever you synchronise your device – so you can take our news with you ! Add the following page to your Mobile Favourites folder in your PDA's browser with a 'follow links' depth of 1:

http://www.enaca.org/modules/avantgo/

Voting

Did you find a publications that you liked ? A website link that you hated ? You can 'rate' nearly every resource on the site. This helps guide other people who visit the site – they can see which items are popular and which are not. Look for links like 'Rate this file' or 'Rate this site' at the bottom of each entry. Please be objective, if everything receives a 1 or a 10, the ratings aren't very useful. And don't rate for your own resource!

Please register !

So there you have it. Interested ? Please visit **www.enaca.org** and sign up. Become a member of our online community and enjoy online networking with your colleagues in aquaculture all over the world !

Notes from the Publisher

Continued from page 3

tech monoculture systems that mass-produce high value fish. But the parallels end there. Grain to poor countries is generally a staple food of the populace. Rulers often see it as a strategic crop in that they don't want to depend on other countries for their supply. There is also romance in their farming. These political and traditional social values have largely shielded the intensive farming of grains from many of the criticisms now hurled at intensive fish farming. On the other hand, it is the traditional, not high-tech, farming of low-cost native or introduced fish in such populous developing countries as Bangladesh, China, much of India, Indonesia, Nepal, the Philippines, Thailand and Vietnam that has enabled each citizen to enjoy more than 20 kilos of fish a year. What the green revolution had achieved with grain crops, traditional aquaculture particularly of the Chinese invention, had earlier done for fish production. Traditional aquaculture by and large is green. The modern spawn, geared to mass-produce fish for export or the local upmarket, is trying hard to be. And it will be to the benefit of both poor producers and affluent consumers for it to be so. But that is another, and more complicated, story.

Got a question about aquaculture ?

Ask your colleagues from all over Asia.

Visit the forums: www.enaca.org