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# AQUA FARM NEWS

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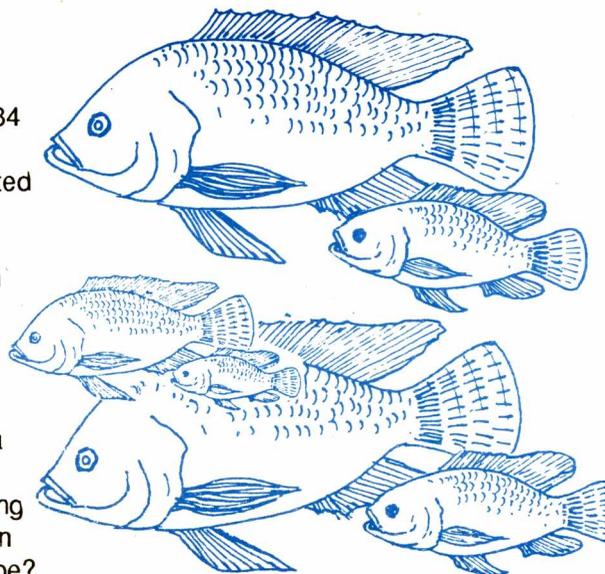
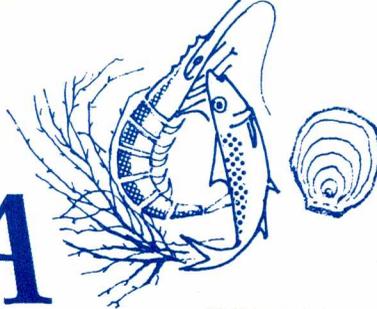
## Tilapia Culture

The brackishwater and freshwater resources in the Philippines are quite limited: less than a million hectares of swamps and estuaries, 384 river systems, and 59 lakes. Haribon Foundation notes that these resources are already heavily polluted or degraded. The question that some quarters at SEAFDEC/AQD have asked is: shall we keep on developing these resources and undertake research on fishes like tilapia? Or shall we move on to "bluer pastures" like the largely unfarmed coastal waters? What conflicts can we expect with this change?

Tilapias establish large populations in a short time and stunting (rapid changes in body form and poor growth rates) results. Uncontrolled breeding in the wild and in the farm could lead to deterioration of the tilapias' gene pools. What effects will there be?

But for the very poor, tilapias have been and will always be of immeasurable importance, notes the International Center for Living Aquatic Resources Management (ICLARM). Their introduction and spread have saved the poor people of Asia a great deal of suffering. To this day the much maligned fishes are still extremely important, low-cost, or even "free" protein sources for the poorest of the poor. In Sri Lanka, *Oreochromis mossambicus* is produced at an average of  $235 \pm 160$  kg/ha-year, accounts for 56- 99% of the total fish yield in 20 shallow reservoirs, and is the most important protein source for the people of that country.

In 1985, a workshop convened by the Philippine Council for Aquatic and Marine Research and Development and ICLARM assigned the work in different aspects of tilapia biology and culture to twelve government and non-government organizations. The reasons for studying tilapia were and still are compelling: more than half of the country's families are poor and tilapia is still one of the cheapest food items. Resources for research and extension are limited, thus, the need to cooperate. The cooperating institutions are shown on the next page. Some of the output to date are presented in this issue: **tilapia hatchery and nursery, pond culture and seafarming, and marketing.**



# ***Institutions working on tilapia***

Fishfarmers are urged to write these institutions for information and help:

- **Department of Agriculture (DA)**  
Bureau of Fisheries and Aquatic Resources (BFAR), 860 Arcadia Bldg., Elliptical Road,  
Diliman, Quezon City  
BFAR Freshwater Fish Hatchery - Extension Training Center (FFH-ETC)  
Central Luzon State University compound, Muñoz, Nueva Ecija
- **Bureau of Agricultural Economics (BAEcon)**, de los Santos Bldg., Quezon Ave., Quezon City
- **University of the Philippines (UP)**  
Marine Science Institute (MSI), UP Diliman, Diliman, Quezon City  
Institute of Biological Sciences, UP Los Baños (UPLB), Los Baños, Laguna  
Brackishwater Aquaculture Center (BAC), UP in the Visayas (UPV), Leganes, Iloilo
- **Central Luzon State University - Freshwater Aquaculture Center (CLSU-FAC)**, Muñoz, Nueva Ecija
- **Laguna Lake Development Authority (LLDA)**, Pasig, Metro Manila
- **Meralco Foundation**, Agro-Aquatic Development Center, Ortigas Avenue, Metro Manila
- **Southern Philippines Development Authority (SPDA)**, Davao City
- **International Center for Living Aquatic Resources Management (ICLARM)**  
MC PO Box 2631, Makati, Metro Manila 0718
- **Southeast Asian Fisheries Development Center - Aquaculture Department (SEAFDEC/AQD)**  
P.O. Box 256, Iloilo City 5000  
Binangonan Freshwater Substation (BFS), Tapao Point, Binangonan, Rizal

INSTITUTION	RESPONSIBILITY
DA-BFAR (BFAR) FFH-ETC	Survey of tilapia genetic resources Maintenance and dispersal, training and extension, monitoring of imported stocks
SEAFDEC/AQD	Broodstock management and selection for genetic improvement, lake fisheries, training
CLSU-FAC	Tilapia-rice culture, pond culture, broodstock management and selection for genetic improvement, cage culture in dams and reservoirs, training
UPV-BAC	Culture in brackishwater ponds and cages, broodstock management and selection for genetic improvement in estuaries, training
UP-MSI	Biochemical genetics and stock identification
LLDA	Hatchery operations and pond management, extension
Meralco Foundation	Hatchery, sex reversal, intensive cage culture, extension
UPLB	Data storage and analysis for quantitative genetics, biochemical genetics
SPDA	Verification and training
BAEcon	Economic analyses
ICLARM	Information services; started the GIFT project (Genetic Improvement of Farmed Tilapias) in 1991

Source: PCAMRD and ICLARM. 1989. *Proceedings of the Seminar-Workshop on Tilapia Genetics and Culture*; Nueva Ecija; 20-22 June 1985. Los Baños, Laguna. 62 pp.

# Classification of tilapias in aquaculture

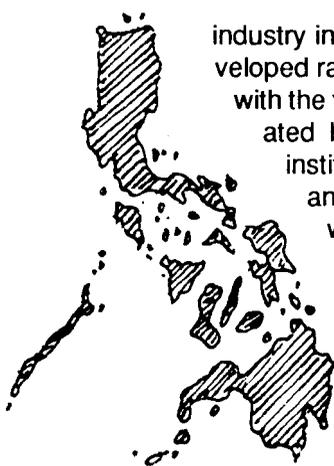
The tilapias (Family Cichlidae) used in aquaculture belong to three genera: *Tilapia*, *Sarotherodon*, and *Oreochromis*. The genera are distinguished by their reproductive behavior.

## Reproductive behavior of tilapias

<b>Substrate spawners</b> <i>Tilapia</i> : <i>T. zillii</i> , <i>T. rendalli</i> <i>T. sparmanii</i>	<b>Paternal/biparental mouth brooder</b> <i>Sarotherodon</i> : <i>S. galilaeus</i> <i>S. melanotheron</i>	<b>Maternal mouth brooder</b> <i>Oreochromis</i> : <i>O. niloticus</i> , <i>O. aureus</i> <i>O. hornorum</i> , <i>O. mossambicus</i> <i>O. spilurus</i> , <i>O. macrochir</i>
<b>Broodfish morphology</b> Little or no dimorphism between sexes; both sexes exhibit breeding colors. Long period of pair-bonding; species monogamous at least for one brood.	Little dimorphism and color differences between sexes. Monogamy at least for one brood.	Dimorphism between sexes. Males generally larger, with conspicuous breeding colors, enlarged jaws, and modified papillae.
<b>Spawning site</b> Shallow water about 50 cm deep. Substrate variable, pebbles and sand preferred. Nests solitary.	Shallow water. Substrate variable, muddy sand and pebbles. Nests in common spawning grounds.	Shallow water, depth variable 0.15-8 m. Substrate variable, mud, sand and pebbles. Nests in common spawning sites.
<b>Territorial behavior and nest building</b> Territory set up by both sexes and defended by both after pair bonding.	Territory established by both sexes of courting pair.	Male solely sets up and defends territory, and is visited by ripe females.
<b>Spawning</b> Long courtship lasting several days may precede spawning. Up to 7000-8000 yolky, olive green, 1-1.5 x 1-2 mm adhesive eggs laid on pre-cleaned substrate. Male passes over eggs to fertilize them.	Courtship lasting several hours to few days precedes spawning. Up to 1500 greenish-brown 1.5-2.0 x 2.0-3.5 mm non-adhesive eggs shed in batches in a shallow nest. Eggs show vestigial adhesive layer. After all eggs are laid and fertilized, both parents or the males only pick up eggs for mouth brooding.	Courtship lasts several hours. Up to 2000 non-adhesive 1-2 mm x 1.5-3 mm eggs shed in batches in shallow nest. After fertilization, each batch is picked up into the mouth by the female. Females may also snap up semen directly from genital papillae. This behavior prominent in species that have genital papillae modified into tassels to attract females.
<b>Brood care</b> Both parents guard, protect, aerate the brood, and help move clutch to different nest sites. Fry at first feeding are 4-6 mm and show feeble swimming ability. Fry survival relatively low.	Parents stay close to each other. Eggs and fry brooded in mouth until ready for release. Brood may not be collected once released. Fry are 7-9 mm at first feeding, and have well-developed fins. Fry survival high.	Female solely involved in brood care. After spawning, female leaves nest to rear her clutch in safety. Extended period of care during which fry seek shelter in mother's mouth. Fry brooded until free-swimming. First feeders are already good swimmers. Fry survival high.

Source: K Rana. 1988. *Reproductive biology and hatchery rearing of tilapia eggs and fry*, p. 397-406. In: JF Muir and RJ Roberts (eds.). **Recent Advances in Aquaculture**, Vol. 3.

# Farming tilapia in the Philippines



The tilapia farming industry in the Philippines developed rapidly in the eighties with the technologies generated by national R & D institutions for breeding and grow-out in freshwater ponds and cages. In 1990, the country produced 76 142 metric tons of farmed tilapia and became the world's largest grower of the fish.

Tilapias contributed 22% of the country's aquaculture production that year.

The Nile tilapia is grown in about 14 500 ha of freshwater ponds and 500 ha of cages in lakes and reservoirs. The Mozambique tilapia is cultured in over 200 000 ha of brackishwater ponds along with milkfish and shrimps.

Nile tilapia fingerlings are commercially produced in earthen ponds, or in concrete tanks and *hapas* (net enclosures). There are over a thousand small-scale hatchery operators in the country with hatchery areas ranging from 500 to 20 000 m<sup>2</sup>. The annual production of fingerlings is estimated to be 500 million.

The sex reversal technique, which produces 95-100% all-male populations, is applied at the fry stage. Artificial sex reversal is achieved by feeding sexually undifferentiated fry (about ten days old) with a synthetic male hormone (methyltestosterone) for three weeks. Genetically female fish are converted to functional males in the process. The technique is used in hatcheries in the Philippines, Thailand, Malaysia, Israel, and Taiwan. Use of sex-reversed fingerlings for grow-out in freshwater ponds and cages increases production by more than 50% compared to mixed-sex populations.

For grow-out culture, fingerlings are stocked between 50 000 and 100 000/ha in ponds of 0.2-0.5 ha and water depth of 1-1.5 m. Or, fingerlings are stocked in cages (each 20 x 10 x 5 m) at 3 000/cage or 15/m<sup>2</sup> and given commercial or home-made feeds at 3-5% of

biomass per day in 2-4 feedings. The yields of tilapia (150-200 g each) are as high as 600 kg/cage-crop and 8 tons/ha-crop after 100-120 days. Feed conversion is usually 1.7 - 2 (dry weight feeds/wet weight fish), and survival, 80-90%.

Tilapia can also be farmed in brackish and marine waters. Mozambique tilapia has long been produced as a secondary crop to milkfish, but poor management and genetic deterioration have resulted in low yields.

Trials conducted at the University of the Philippines-Visayas showed the feasibility of growing sex-reversed tilapia in ponds with salinity up to 40 ppt. The hybrid tilapia (female Nile tilapia x male Mozambique tilapia) is more salt tolerant than the pure-bred Nile tilapia and grows faster than the male parent.

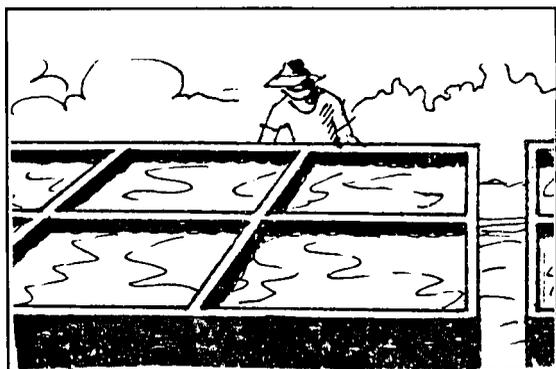
Mariculture of Mozambique and hybrid tilapias in ponds and cages is now being pilot-tested in several coastal areas of the country. Net cages (3 x 3 x 1.5m) suspended from bamboo rafts are stocked with fingerlings at 100-200/m<sup>2</sup> and fed with commercial or home-made pellets at 3-5% of biomass per day in 2-4 feedings. Fish are harvested after 3-5 months of culture when fish are 100-200 g.

The success of tilapia farming in the country may be attributed to the suitability of the fish to Philippine conditions, the locally developed technologies for production, and the presence of a vibrant market. The demand for tilapia in major markets of Metro Manila and other population centers of the country is increasing. Freshwater production of Nile tilapia in ponds and cages will further expand. Culture of salt-tolerant tilapias in brackishwater ponds and sea cages will spread.

Interest in farming tilapia is growing worldwide. Culture of the red tilapia in the United States, for instance, has become an attractive investment. In Japan, the trade of live fish used for *sashimi* includes tilapia. The potential of processing tilapia into fillets and other convenience food items has been demonstrated in Israel. This perhaps is the future for the tilapia harvest in the Philippines.

Source: RD Guerrero III. *Farming tilapia in the Philippines*. INFOFISH International 6/91.

# Tilapia hatchery and nursery



## Spawning facilities

Nile tilapia spawn in rice paddies, earthen ponds, *hapas* and concrete tanks. The use of concrete tanks for spawning and nursing tilapia is efficient but involves high capital and operational expenses. When concrete tanks are used, they should not be less than 20 tons in water capacity so that temperatures do not fluctuate too much. Tanks must be designed so that they can be easily cleaned without disturbing the females incubating eggs in the mouth. The average fry production per spawner is 80-100 per month.

In Laguna de Bay near Manila, Nile tilapia are commonly spawned and nursed in *hapas*, each 3 x 3 x 2 m, arranged in a row or two, and supported by bamboo poles. The average fry or fingerling production is 60 per spawner per month. The advantage of using *hapa* is the big savings on feeds. The breeders are given supplementary feeds only when the natural food in the lake is scarce. The disadvantage is the lack of control over water quality.

## Sex ratio and stocking density

The sex ratio commonly used for fry production in *hapas* is one male to 4-7 females. The stocking density is 5 females/m<sup>2</sup>. In concrete tanks, the sex ratio is the same but the stocking density is 4 females/m<sup>2</sup> if no aeration is provided and 6 females/m<sup>2</sup> if with aeration. In earthen ponds, the same sex ratio is used but the stocking density is 2 females/m<sup>2</sup>.

## Broodstock feeding

Poultry feed (21% crude protein) or fish pellets (27% crude protein) is used by hatchery operators in Laguna de Bay. The tilapia breeders are fed daily at 1-2% of biomass. One-half of ration is given in the morning and the other half in the afternoon.

## Water management

In earthen ponds, water is changed at least once a month to check pollution. Where water comes from underground springs, changes are done after longer periods. The pond water is 1 m deep and easily drained by gravity. In concrete tanks, the water depth ranges from 50 to 75 cm and water is changed every 10-15 days.

## Fry or fingerling harvest

One method of harvesting fry is forcibly removing them from the mouth of the female. Another method is scooping the fry as soon as they are released by the spawners. If the water is turbid, the fry are scooped when they swim on the water surface. Scissor net, *hapa* or seine are commonly used to harvest fry. A combination of these methods is used for both concrete tank and earthen pond.

In earthen ponds, the fingerlings are totally harvested after 1-2 months before they become sexually mature. In concrete tanks, harvest is done every 15 days in time with the water change. In *hapas*, the fry or fingerlings are harvested every 15 days during summer, or every 21 days during the cold months. One side of the *hapa* is raised to confine the fish to one side. The fry or fingerlings are scooped out and the breeders transferred to the other side with a net that allows the fry or fingerlings to escape.

## Nursery management

Fry are initially reared in *hapas* to protect them from predation. In nursery ponds, the pond is thoroughly cleaned and protected from the intrusion of predators. As soon as the fry in the *hapa* reach 2.5 cm in length, these can be

released into the pond. In a lake-based nursery, the fry being reared in *hapas* are sorted into two or three sizes after two weeks. Each size group is stocked in a separate net cage.

The fine-meshed *hapa* measuring 3 x 3 x 1.5 m is stocked with 300-500 fry/m<sup>2</sup> and covered. Fingerlings of 2-2.5 cm are stocked at 200-250/m<sup>2</sup>. The recommended stocking density is 40-50 fry/m<sup>2</sup> in ponds, and 1000 fry in concrete tanks.

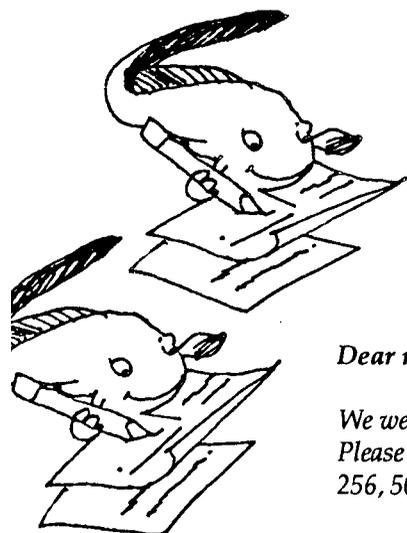
Fry reared in *hapas* are fed hard-boiled egg yolk daily for three days at a rate of one yolk per 20 000 fry per day. Then trash small shrimps are given to fry at 25 g shrimp per 10 000 fry per day. The shrimps are finely ground and mixed with water (1:2 by weight). After a week, the fry are able to feed on finely ground poultry starter mash (about 50 g per 10 000 fingerlings). Half of the feed is given in the morning and the other half in the afternoon. In lake-based nursery, no supplemental feeding is given when primary productivity and plankton density are high (as indicated by low water transparency).

Source: AMBautista. 1987. *Tilapia hatchery and nursery systems: operation and management*, p. 8-13. In: RD Guerrero III, DL Guzman, CM Lantican (eds.). **Proceedings of the 1st National Symposium on Tilapia Farming**, PCARR, BFAR and SEAFDEC/AQD. Los Baños, Laguna. PCARRD Bank Series No. 48. 68 pp.

### Summary of known nutrient requirements of Nile tilapia, *Oreochromis niloticus*

<i>Nutrient</i>	<i>Requirement (% of dry diet)</i>
Protein	35% for fry 25% for fingerlings 40% for broodstock
Essential amino acids	
Arginine	4.2
Histidine	1.7
Ileucine	3.1
Leucine	3.4
Lysine	5.1
Methionine	
+ Cystine	3.2 (Cys, 0.5)
Phenylalanine	
+ Tyrosine	5.5 (Tyr, 1.8)
Threonine	3.8
Tryptophan	1.0
Valine	2.8
Lipid	6-10%
Essential fatty acids	18:2 (n-6), 0.5%
Carbohydrate	25%
Digestible energy	2,500-4,300 Kcal/kg
Phosphorus	<0.9%

Compiled by the Feed Development Section of SEAFDEC/AQD.



*Dear readers:*

*We welcome any suggestions for topics to be featured in this newsletter. Please write the Editor, Aqua Farm News, SEAFDEC/AQD, P.O. Box 256, 5000 Iloilo City, Philippines.*

*AFN Production Staff*

# Producing 100% male tilapia

The major drawback in tilapia culture is their ability to quickly overpopulate aquatic systems. The most widely used technique to prevent uncontrolled reproduction is to produce monosex populations. All-male tilapia populations are often preferred, as they grow faster than the female.

In many juvenile fish, it is possible to fix or reverse the sex by administering androgenic or estrogenic steroids through the diet or the water. The theoretical minimum dosage and treatment duration for endocrine sex reversal varies from species to species and in some cases, strain to strain. Researchers determine the earliest time when the fish are labile to endocrine sex reversal because the residues of administered steroids can be carcinogenic and may interfere with the consumers' sexual functions. In tilapias, the labile periods vary widely: 11-69 days for *Oreochromis mossambicus*, 18-32 days for *O. aureus*, and 25-59 days for *O. niloticus*. For *O.*

*mossambicus*, the critical minimum period is 10-21 days from hatching. In other tilapias, the labile periods are short and end at a very early age when the fish are not more than 50 g. The short labile period that ends before the fish attain harvest size confers two advantages: first, the cost of hormone treatment is considerably reduced, and second, the residual steroid is so little that it is harmless to consumers.

The recommended doses of methyltestosterone (MT) to ensure all-male populations vary widely: 5-1000 mg MT/kg diet for *O. mossambicus*, 30-60 mg MT/kg diet for *O. aureus* and 5-60 mg MT/kg diet for *O. niloticus*. Apart from such wide variation in doses, success rates also vary from 47 to 98% males even at high doses (20-50 mg MT/kg diet). However, 100% male populations may be produced with the lowest dose of 5 mg MT/kg diet during the critical labile period of 10-21 days after hatching.

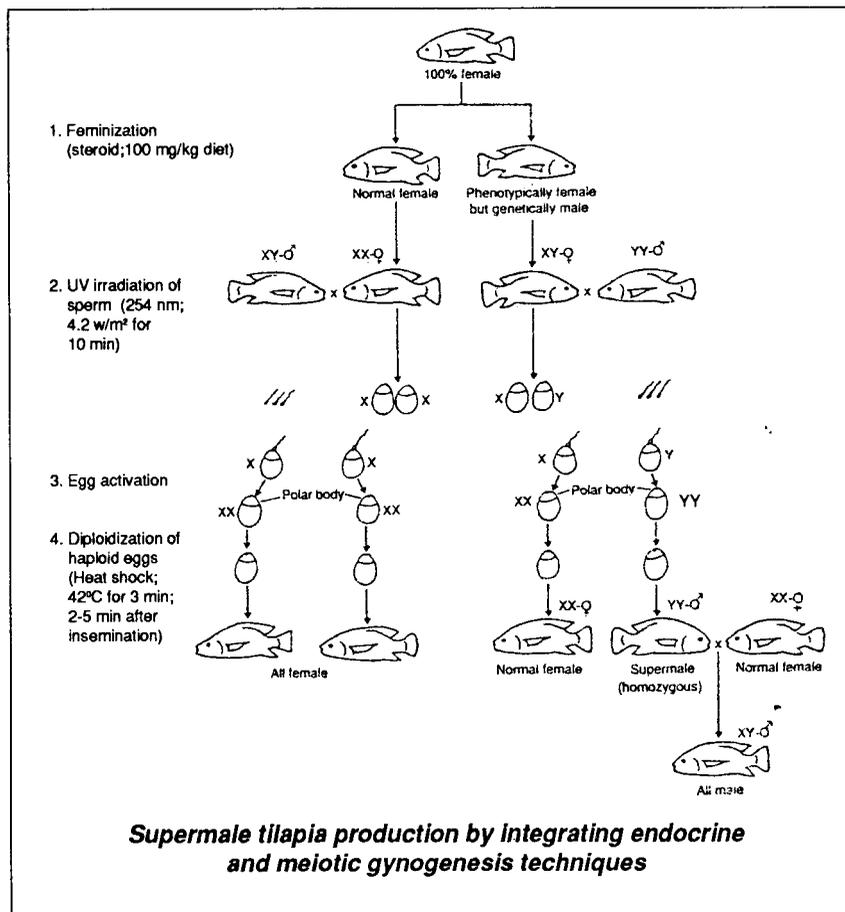
The fry of *O. mossambicus* may also be

immersed in water containing 5 mg of 17  $\alpha$ -ethynyltestosterone per liter. Dimethylsulphoxide (2.5 ppt) can be added to promote the solubility of the steroid.

Another technique is the manipulation of the chromosome set (see figure). A combination of endocrine sex reversal and gynogenetic techniques (where parental chromosomes are inactivated) can produce what are called supermales (YY).

The supermale *O. mossambicus* is viable and produces fertile sperm that can produce consistently 100% males.

Source: TJ Pandian and K Varadaray. *Techniques to produce 100% male tilapia. Naga, the ICLARM Quarterly*. July 1990.



# Pond culture of tilapia

## Pond preparation

Ponds are prepared for cropping by drying, levelling, and liming the bottom (if necessary). Fish predators and competitors are eliminated, and the ponds are fertilized to grow natural food.

For extensive fish culture, two types of natural food are grown: *lab-lab* and plankton. In the *lab-lab* method, the pond is fertilized with chicken manure at 1-2 tons/ha and diammonium phosphate (18-46-0) at 1-2 tons/ha. Water depth in the pond is maintained at 30-40 cm. In the plankton method, the pond is fertilized every two weeks with 50 kg/ha of ammonium phosphate (16-20-0) set in submerged platforms or suspended sacks. Water depth is maintained at 0.8-1 m.

## Stocking

Monosex or sex-reversed fingerlings of the hybrids of Mozambique tilapia and Nile tilapia are stocked when adequate food (*lab-lab* or plankton) is available, about 1-2 weeks after fertilization. The stocking densities are shown below. Fingerlings are acclimated to pond water salinity and temperature before release.

Culture method	Stocking (fingerlings/ha)
Extensive	
<i>Lab-lab</i>	5000 - 10 000
Plankton	10 000 - 20 000
Semi-intensive	20 000 - 40 000
Intensive	40 000 - 50 000

## Pond management

Maintenance of good water quality and adequate food is essential. Water should be kept at the desired depth and fertilization or feeding applied as recommended. In farms entirely dependent on tidal flow, pumping water is necessary during the dry season. Needless to say, polluted water should not be used.

In semi-intensive culture, a 1-m water depth is maintained. Inorganic fertilizer is applied as in the plankton method until the third month of culture. In the fourth month, fine rice bran is given as supplement at 5% of fish body weight daily.

In intensive culture, pond management and feeding are the same as in semi-intensive culture during the first three months. In the fourth month, a complete feed with at least 20% crude protein is given at 3% of biomass per day. Pond water is changed at the rate of 10-20% per week especially during the last month of culture. It is good practice to visually check water quality and condition of the fish at least once a day. Sampling of fish at least once a month enables the culturist to monitor fish growth.

## Harvest and marketing

Fish are harvested after three or four months, depending on the size desired for market. Market size ranges 100-200 g/fish.

In partial or selective harvest, bigger fish are caught by cast net or seine. In total harvest, the pond is first partially drained and most of the fish seined. Then, the pond is totally drained to recover the remaining fish. With good management, a survival rate of 80-90% can be expected.

The harvested fish should be properly handled. If the market is nearby, no ice is needed to preserve the freshness and normal color of the fish as long as they are kept cool and moist. For long-distance transport and marketing, fish should be chilled in ice water (4°C) after seining and washing in clean water, and then packed in closed styrofoam boxes with crushed ice interspersed between the layers of fish at a ratio of 1 kg ice to 4 kg fish.

Market price for tilapia varies with season and size of fish. It usually goes up on full-moon days, fiestas, and during the lean fishing months from October to March.

Source: PCAMRD. 1990. *Brackishwater pond culture of tilapia in the Philippines*. Fisheries Technology Manual Series No. 5. Los Baños, Laguna, Phil.: DOST/Phil. Council for Aquatic and Marine Research and Development.

# Seafarming of tilapia in cages

A desirable species for seafarming is one with readily available seeds, is fast growing, economical to culture, and marketable. Among the fishes that meet these requirements are the tilapias.

Suitable areas for cage farming are open waters that are protected from strong waves and currents, have stable salinities (32-36 ppt), free from pollution, and accessible. A minimum depth of one meter at neap tide is required.

Tilapia is best cultured in areas where fish supply is seasonal and market demand for fish is good. It is recommended in overfished waters and where there are no land-based livelihood opportunities for small-scale fishermen.

The Mozambique tilapia and its hybrid by Nile tilapia are recommended for seafarming. All male fingerlings should be used. Fingerlings should be gradually acclimated to the salinity of the culture site.

Cages are constructed of bamboo frames and floats, and polyethylene net enclosures. Instead of bamboo floats, empty plastic containers or styrofoam floats can be used. A cage is 3 x 3 x 1.5 m and its net mesh, 1.5 cm.

Stocking density varies from 100 to 200 fingerlings/m<sup>2</sup>. The fish are fed commercial

pellets at 3-5% of biomass per day in 2-4 feedings. If pellets are not available, a moist feed consisting of 70% fine rice bran and 30% local fish meal can be given. Feeding trays may be used to minimize waste. Depending on the size of the fish desired for market (100-200 g), tilapia in cages are cultured for 3-5 months.

The common problems in cage culture are the fouling of nets, damage caused by typhoons and predators, and poaching. Nets should be cleaned as often as necessary to ensure efficient water exchange. Double-netting of cages can prevent loss of fish. Guarding the cages at night should discourage poachers.

Tilapias are usually marketed fresh in the Philippines. The fish are harvested early in the morning and usually chilled in ice water before transport to market. For long distance travel, the fish are packed in containers with crushed ice at a ratio of 1 kg ice to 4 kg fish. Wholesale prices for tilapia depend on size, locality, and freshness.

Source: PCAMRD. 1991. *Seacage farming of tilapia in the Philippines*. Fisheries Technology Manual Series No. 9. Los Baños, Laguna, Phil.: DOST/Phil. Council for Aquatic and Marine Research and Development.



## Getting rid of tilapia's muddy smell

Tilapia often develops a strong taste or smell of mud or algae. To rid newly harvested tilapia of its off-flavor, the following steps may be taken:

- Confine the newly harvested tilapia in a holding cage for six hours to let the fish empty their stomachs.
- Transfer the fish to a large tank with clean water from the tap or well. The fish may be stocked at 200/m<sup>3</sup>. The water must be supplied with aeration.
- Check the gills of the fish after three days. If the off-flavor still persists, change the water completely.
- After another three days, check again. Better still, cook a few to determine if the foul taste or smell is still there. If so, repeat the process. It takes 7-14 days to completely remove the off-flavor taste or smell.

- Technology Dispatch, undated

# Marketing the tilapia

## ... in the USA

The red tilapia created the "white-tablecloth" tilapia market in the USA that paid an average of \$5.95/lb of skin-on fillet. It is marketed under the name cherry snapper. The grey *Oreochromis niloticus* and the silver *O. aureus* are gaining acceptance, too.

### Three grades

Tilapia is marketed under three categories of quality:

- Category A includes farmed tilapia fed good quality feeds and purged to improve flavor. Products are either fresh on ice or frozen.

- Category B includes farmed tilapia fed good quality feeds or agricultural by-products but not purged prior to marketing. They are sold live in specialty markets but at relatively low prices due to inconsistent flavor and texture.

- Category C includes wild-caught tilapia. Flavor and texture depend on water quality of the body of water from where they are harvested.

The A-quality tilapia are marketed in white-tablecloth or premium restaurants that place high value on consistency and freshness, and pay prices equal to or exceeding those of premium fish like grouper, snapper, and swordfish. Category A tilapia can also be sold as a substitute for whitefish such as haddock or cod. The entire market -- including supermarkets, fast-food chains like MacDonald's, government and school programmes -- could exceed several billion pounds annually.

The key to market expansion appears to be the know-how for producing tilapia at very low cost (under US\$0.25/lb of whole fish) and absolute quality control in purging and processing.

B-quality tilapia has a large market as an affordable alternative to other species even though there may be large variation in the day-to-day flavor of the fish. For consumers who value fish in their diet but cannot afford the high cost of premium fish, B-quality tilapia provides a very nutritious selection, and when cooked with various seasonings has proved to be very acceptable to a growing number of consumers.

It is, however, doubtful that B-quality tilapia can ever command the same large sales volume as A-quality tilapia. For the same price, most American housewives would opt for meats such as other fish or chicken rather than accept the muddy flavor. B-quality tilapia are currently being landed in Miami, reaching supermarket distributors at \$3/lb for skinless, boneless fillets in the 4-6 oz/piece size range.

C-quality tilapia are marketed primarily among the Asian communities, which have strong preference for live or freshly frozen whole tilapia. At present, the price is very good, about \$1-1.50/fish at the pond bank. Buyers, however, tend to buy A-quality tilapia whenever it is available.

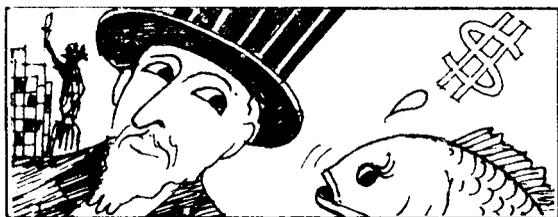
### Health benefits

The American public is constantly being re-educated to eat more fish and chicken. Some studies have shown a direct correlation between the amount of fish consumed and the lifespan of people. In Okinawa (Japan) where fish is the main source of protein, average lifespan is 83 years. For Americans, it is 76 years.

Average fish consumption in the USA is about 16 lb/person-year. A 5-lb increase in this rate, if provided by tilapia, require billion pounds of whole tilapia per year. The current annual aquaculture production in the USA is just over 500 million pounds. To reach the theoretical increase in consumption, more than ten times the current production capacity would be needed to meet demand.

### Low-cost protein

The production of low-cost high-quality fish is a universal problem. Tilapia culture can potentially bring more return for less input com-



pared to almost any other known protein crop. This is possible because of tilapia's ability to consume agricultural waste products and detritus and to filter out algae. Low-cost fish that can be produced in large quantities on less land and water could lower overall pressure on the environment. Tilapia culture could mean:

- less land for aquaculture, more forests
- less fuel consumed
- less feeds (which also demand land use)
- less water for each pound of tilapia produced than for any other protein product including protein plants

For each pound of extra beef produced in Brazil or Colombia for example, it is estimated that over 4000 ft<sup>2</sup> of rainforest must be burned to make new pasture. Thus, for each pound of beef replaced by good quality fish, 4000 ft<sup>2</sup> of cattle pasture can be replanted into forest.

More importantly, cheap but good quality fish means better nutrition, healthier populations, and good returns for fish sold domestically in each country.

Very few countries in the world produce more fish than they import. Therefore, a properly designed and managed tilapia farm can be a real asset both to earn income and to reduce imports.

Producing more tilapia will not, in our lifetime, reverse the destructive agricultural practices now prevalent. But it could slow down the trend enough to allow more time with which to solve the major problems of our children's future.

Source: M Sipe. *Tilapia marketing in the USA.*

## ... in Canada

**INFOFISH International 3/92.**

Tilapia has been test-marketed in a white-tablecloth restaurant in Ontario in an effort to determine consumer attitude toward this product, and to correlate specific product characteristics with consumer acceptance. Most respondents found fresh tilapia to be as good, or better, than the fish they most frequently eat. It appears that a restaurant market exists for tilapia, as 85% of respondents indicated that they would be likely to purchase tilapia again.

Source: D Stechey and C Okechuku. 1988. *Restaurant test marketing of tilapia in Ontario*, p. 61. In: **Proceedings of the International Aquaculture Congress and Exposition**; Vancouver, Canada, 6-9 Sept. 1988.

## PHILIPPINES 2000

### Support the Medium-Term Agricultural Development Plan

The Agriculture and Fishery sector must be modernized if it is to provide the base for industrialization and propel the economy forward ...

The Key Production Area or KPA development approach we are adopting is a blueprint for such modernization ... The KPA approach encourages farmers and fisherfolk to produce specific products only in those areas of the country where the land, water resources, and climate are suitable for those products, and where ready markets are available. It is in these areas that government will concentrate its infrastructure investments, post-harvest and marketing assistance, credit support, and research and extension services ...

In this way, farmers and fisherfolk would get the best returns on their investments and government would make efficient and cost-effective use of scarce resources.

*Department of Agriculture*

## **Legal constraints to tilapia culture in the US**

Tilapias have been imported into the United States during the last three decades. Because they are exotic, tilapias are often viewed as a threat to endemic species and are subject to state and federal laws.

The legal status of culture and transport of tilapia in the United States varies from state to state, as well as in U.S. protectorates (Puerto Rico and U.S. Virgin Islands). These regulations do not necessarily apply to research institutions. States that have regulations prohibit release of tilapia into natural or public waters. Thus, cage and pen culture of tilapia is prohibited in public waters. Many states allow tilapia to be imported for aquarium culture only.

Some states such as Maryland have general laws that prohibit or control the culture or import of any exotic fish species, and others have specific laws against certain species of tilapia. The states with specific laws are usually those where the climate favors the establishment of populations of exotics. Arizona, for example, allows the culture of species already established in the state, but does not allow importation of any other species of tilapia. Eleven states have no laws concerning tilapia, 13 states have laws that specifically prohibit the commercial culture of any species of tilapia, and 26 states allow culture of tilapia if certain conditions are met. In some states, culture of tilapia is allowed if the culturist has the appropriate permit or letter of authorization from state fish and game authorities. Other states require that the proposed culture site be inspected to insure that tilapia will not gain access to natural waters.

State regulations on the interstate transport of tilapia vary widely from state to state. Twenty-two states have no regulations, 24 states allow interstate transport if certain conditions are met, and 3 states even prohibit haulers from passing through their state with tilapia.

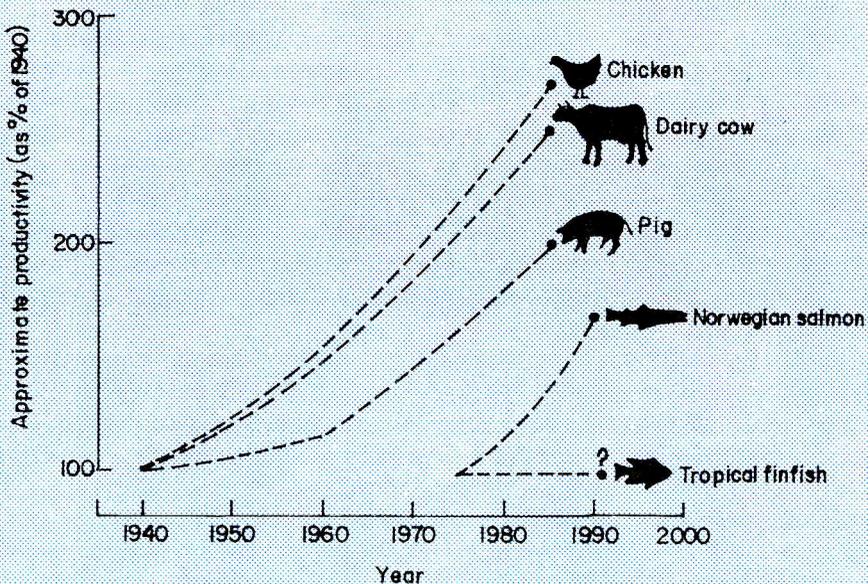
Since there are no general rules concerning the legal status of tilapia culture and transport in the United States, producers and haulers should contact state fish and game officials to determine the laws of the particular state before importing or transporting tilapia.

### **States with regulations for the culture of various species of tilapia**

<b>State</b>	<b>Species and regulations</b>
Arizona	<i>Oreochromis mossambicus</i> and <i>Tilapia zillii</i> may be cultured because they are already established, but no other species are allowed.
California	<i>T. sparmanii</i> is prohibited throughout the state. <i>T. zilli</i> may be cultured with permit in six southern counties. <i>O. mossambicus</i> and <i>O. hornorum</i> may be possessed under permit. All permits will be considered on a case-to-case basis.
Florida	<i>O. aureus</i> , <i>O. hornorum</i> , and <i>O. mossambicus</i> require permit for culture. All other species are prohibited.
Hawaii	<i>O. aureus</i> , <i>O. hornorum</i> , and <i>O. niloticus</i> are not allowed. <i>O. mossambicus</i> may be cultured under permit from the board of agriculture.
Texas	<i>O. aureus</i> and <i>O. mossambicus</i> may be cultured without permit. All other species are prohibited.

Source: JB Kingsley. 1987. *Legal constraints to tilapia culture in the United States*. **J. World Aquacult. Soc.** Vol. 18, No. 3.

# Genetics research



Genetics research initiated in the 1940s has resulted in remarkable developments in increasing the productivity of domestic mammals and birds. At least 30% of total gains in the rate and efficiency of production can be attributed to genetic improvement. The estimated benefit-to-cost ratios of such genetic improvement programs range from 5:1 to 50:1. For example, the average number of eggs laid per year by a hen steadily increased from approximately 120 in the 1940s to more than 320 by the mid-1980s; the average milk production per cow in a single lactation of 305 days increased from approximately 2,000 kg in 1945 to more than 5,000 kg by 1980. Average daily gain in the pig industry has increased from about 450 g by the start of the modern breeding programs around 1960 to about 800 g in the 1980s. After 15 years of accumulated selection and improved feeding and management, productivity in the Norwegian salmon industry has increased by 60-70%.

Aside from increased yields, these programs have greatly improved feed efficiency and reduced the duration of the production cycle. The time to produce a 1.7 kg broiler has been reduced from 14 weeks to 7 weeks and the amount of feed required has been reduced by one-half. The number of dairy cows required to produce the same amount of milk as in 1945 has been reduced from 26.6 million to 11.6 million.

Productivity of most farmed fishes in the tropics has remained almost constant, close to that of wild stocks. There are several reasons for this. Aquaculture research in general and genetic improvement research in particular have been hampered by short-term, scattered and disjointed funding. Long-term strategic research efforts have been neglected.

The few studies on genetic improvement of aquatic species have demonstrated that the potential for achieving rapid genetic gains is in general very high. This is due particularly to the large genetic variability in most economically important traits, high fecundity of most fish, and the ease with which prime aquaculture species can be bred in captivity. The "supertrout" developed by Dr. L. R. Donaldson of the University of Washington, the Hungarian "land races" of carps, and Norwegian salmon and trout are notable examples.

Source: *Naga*, the ICLARM Quarterly, April 1991.

# Tilapia genetic resources in Asia

Given the growing importance of tilapia culture in Asia and renewed interest in aquaculture in Africa, a major program to document, conserve, evaluate and utilize tilapia genetic resources is urgently needed.

Tilapias are all introduced species in Asia (see figure next page). Introductions and transfers of tilapias important to or affecting aquaculture within Asia are noted by the Food and Agriculture Organization. To summarize:

- *Oreochromis mossambicus* is a widespread nuisance and interbreeds with some cultured *O. niloticus* populations.
- *Tilapia rendalli* is not readily available for use in Asian aquaculture except in Sri Lanka, and its performance in farms rather than reservoirs is not documented.
- The identity and status of most Asian red tilapia are unclear.
- *O. aureus* genetic resources are poor throughout Asia.

## Introductions and transfers for R & D in tilapia genetics

Asian countries can not rely on the limited genetic resources for the improvement of tilapia culture. It is dangerous to introduce new exotic

fish species that could escape from fish farms and become established in natural waters, as did *O. mossambicus*. All new introductions must be quarantined to prevent the spread of disease. Existing populations are already adapted to their local environments but their culture performance may not be reliable. For *O. niloticus* whose performance is well-proven worldwide, it is advisable for countries to transfer the best cultured strains available, to assess their performance, and to use promising strains in new breeding programs.

One constraint in improving tilapia performance is the lack of sources of broodstock for new introductions. Israel, Taiwan, and Africa (e.g., Lake Manzallah, Egypt) are reliable sources of *O. aureus* and *O. niloticus*. To these may be added the Chitralada strain of *O. niloticus* from central Thailand. However, only the Israeli *O. niloticus* and *O. aureus* populations are being checked regularly for inbreeding. Some Taiwanese and Thai *O. niloticus* populations may be affected by inbreeding. Therefore, no new fish should be introduced without full documentation of their genealogy and morphometric and electrophoretic confirmation of their identity.

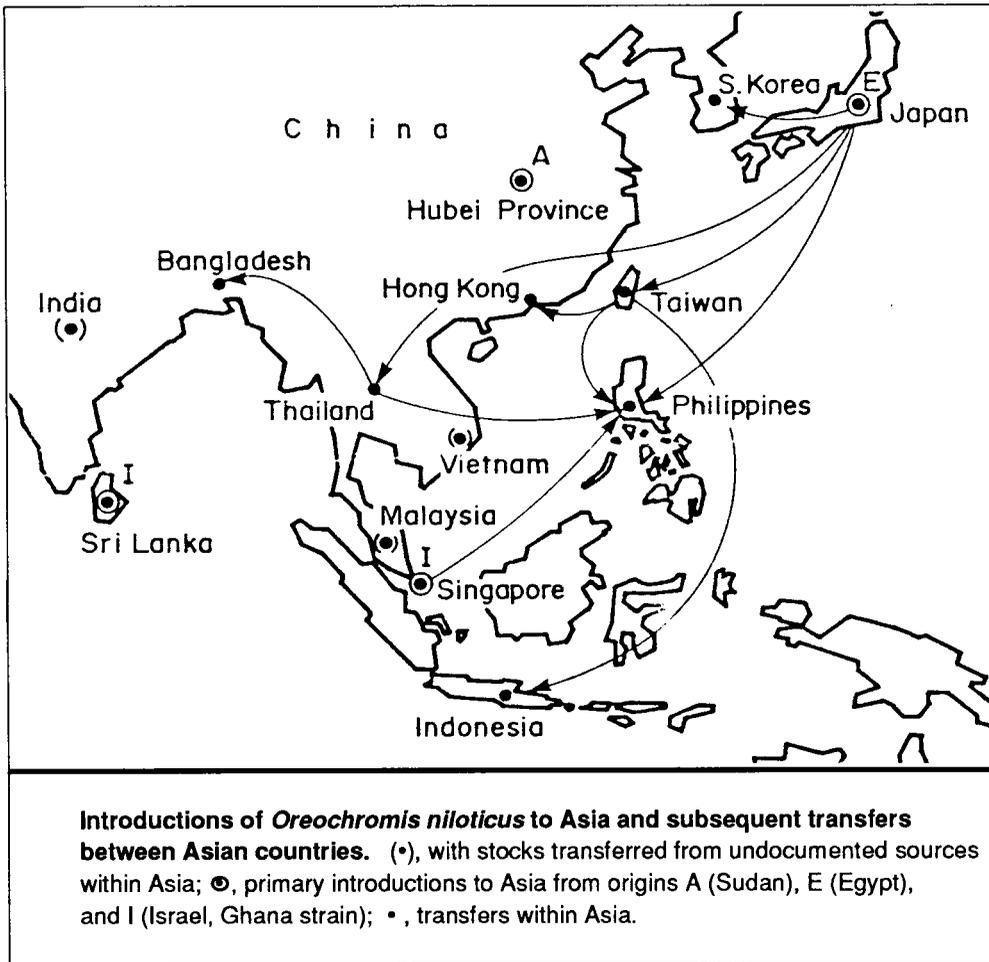
For future research and development work in the Philippines, it would be useful to introduce *O. aureus* from Israel or Africa to supplement the existing genetic resources and assess the culture prospects of this species; this species has good cold tolerance for upland aquaculture. Additional Israel or African introductions of *O. niloticus* could broaden the genetic base of this most important cultured tilapia in the tropics. It would likewise be useful to introduce the *O. niloticus* Chitralada strain from Thailand, since the Thai climate and culture systems are broadly similar to those of the Philippines. The excellent culture characteristics of this strain may be reproducible, although the founder stock introduced to Thailand (50 fish) was small. The introduction of *T. rendalli* (e.g., from Zimbabwe) would enable the initiation of research on culture of herbivorous tilapia. Further introductions of red tilapias are probably undesirable until their genetic characteristics are sufficiently documented. Commercial claims for heritability of color and culture performance



Video programs on tilapia available at SEAFDEC/AQD

**Tilapia cage farming** 7 min 12 sec  
Price: P100 US\$15

**Tilapia cage farming for lakeshore communities** 8 min 42 sec  
Price: P100 US\$15



should be treated with caution. The Ein Hamifratz hatchery in Israel is currently developing a pure red strain of *O. niloticus*, but details of its performance are not yet available.

For any future introductions and transfers, it is essential to avoid the mistakes of the past. A founder stock of at least 2000 fingerlings should be acquired and reference collections should be established in which the population never falls below 50 breeding pairs.

### Gene banks

Gene banks can help in the documentation and conservation of tilapia genetic resources. But, unlike crops for which germplasm is easily stored, the technology available for fish gene banks is restricted to the maintenance of live fish collections and cryopreservation of spermatozoa. Live fish collections are expen-

sive to maintain and require very careful management. Replication at different locations is essential. Sperm banks are potentially a useful means of conserving and distributing material, but monosex haploid gene banks have obvious limitations. They also require rigorous quality control and database management. Future documentation and conservation work on tilapia genetic resources may, therefore, involve three approaches: conservation of natural populations, live fish collections, and sperm banks.

### Future research

Further research on the estimation of genetic parameters, comparative evaluation of different tilapias for culture performance, and breeding schemes to produce genetically improved strains should be undertaken in close cooperation with farmers. The approaches used

successfully in salmonid culture, particularly in Norway, could be repeated for tilapias, provided that the required support and climate of international cooperation are forthcoming.

Sources: (1) RSV Pullin. 1989. *Tilapia genetic resources in Asia with special reference to future tilapia culture R & D in the Philippines*. In: **Proceedings of the**

**Seminar-Workshop on Tilapia Genetics and Culture**, Nueva Ecija, June 20-22, 1985. Los Baños, Laguna: PCAMRD and ICLARM, 1989. 62 p.

(2) RSV Pullin and JB Capili. *Genetic improvement of tilapias: problems and prospects*, p. 259-266. In RSV Pullin, T Bhukaswan, K Tonguthai and JL Maclean (eds.). **The Second International Symposium on Tilapia in Aquaculture**. ICLARM Conference Proceedings 15, 623 p. Department of Fisheries, Thailand, and ICLARM, Philippines.

## in the news

### TILAPIA GENE BANK COMPLETED

The country's first "gene bank" of *Nilotica* strains of tilapia has been set-up in Sucat, Paranaque by BioResearch, a pioneering R & D company in aquaculture. The 3-ha "gene farm" has more than 300 ponds and 800 ferroconcrete hybridization tanks which are stocked with Nile tilapia from Israel, Egypt, Africa, USA, Taiwan, and Singapore. The farm breeds the tilapia to upgrade or enhance its desirable characteristics. The farm also complements the 2.5-ha Gintong Biyaya Hatchery nearby.

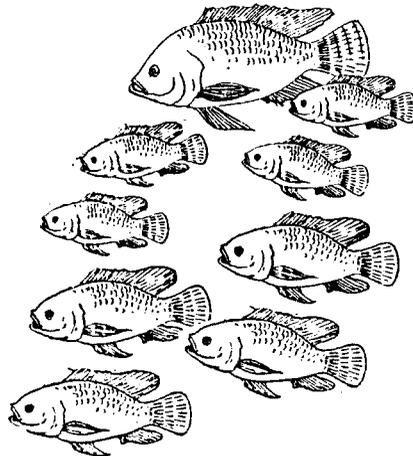
BioResearch expects to service the needs of aquaculturists who are interested in genetically superior types of tilapia. The company also offers livelihood and business opportunities for fishfarmers and others who want to raise tilapia.

Source: *The Philippine Star*, 24 Nov. 1991; *The Manila Bulletin*, 13 Aug. 1991.

### TILAPIA-BASED SNACKS

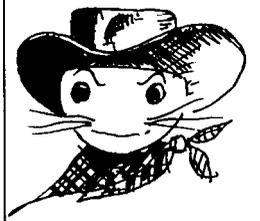
Health food enthusiasts can pack more nutrients into their family's diet by making fish-based snacks. Fish processed into noodles, crackers, cakes, and sticks provides a healthy alternative to junk food and is easy to prepare. *Oreochromis niloticus* is one such convenience food.

The Technology and Livelihood Resource Center in the Philippines conducts a course on "How to process ready-to-cook products from tilapia." Call: BTTD, TLRC 818-8328, 856-354.



# Aquaculture clinic

## WANTED



**QUERY** Can AQD help us obtain our "most-wanted" article?

**REPLY** Definitely. AQD's document delivery service is quite efficient. In addition to having ASFA on CD-ROM, AQD subscribes to the British Library Document Supply Centre (BLDSC) in the United Kingdom. BLDSC can supply photocopies of articles not found in journals or books at the AQD Library and elsewhere in the Philippines. "All you have to do is send the complete citation to us,"

AQD Library Head Ms. Marubeth Ortega said. "We check if the article can be sourced here in the Philippines, that is, university libraries and other information centers. If not, we mail the request to BLDSC. We usually deliver in four weeks, and we charge ₱1.50 per page."

The Aquatic Sciences and Fisheries Abstracts (ASFA) on CD-ROM at the AQD Library now cover 1988 to 1992. Since AQD obtained its CD-ROM last year, 85 users (40 from AQD) have availed themselves of the computer service. "One CD costs ₱97,000, so AQD subsidizes roughly ₱1,000 per user," AQD Chief Dr. Efren Flores noted. "Hence, we encourage more active sharing of resources and information especially with institutions near AQD -- the University of the Philippines in the Visayas and the Department of Agriculture Region VI. In the future, we hope to see shared subscriptions to ASFA on CD, among other things."

The AQD Library also encourages the use of two new compact discs recently obtained for trial use. WATERLIT database is compiled by the South African Water Information Centre and contains 1975-1992 records. WASTEINFO database is compiled by UK-Environment and Energy and contains 1973-1992 records. WATERLIT and WASTEINFO deal with the aquatic environment and waste-related subjects.

(Full texts of articles featured in this newsletter are all available at the AQD Library. - Ed.)

*"How I wish we have computers to help in reviewing literature. This is so inefficient."*



## Feeds for small-scale aquaculture

### *National Seminar-Workshop on Fish Nutrition and Feeds*

SEAFDEC/AQD and the Government of Japan are pleased to convene a seminar-workshop which will bring together fish nutrition researchers, practitioners, and fishfarmers to discuss and exchange information on feeds for small-scale aquaculture. The first *National Seminar-Workshop on Fish Nutrition and Feeds* will identify priorities and recommend strategies for future research on fish feeds with emphasis on the technologies appropriate for developing countries like the Philippines. The seminar-workshop will be held on 1-2 June 1994 in Tigbauan, Iloilo.

The organizers invite papers for oral or poster presentation. Contributions should deal mainly with the following topics:

- I. Advances in fish nutrition research
  - a. Nutrient requirements
  - b. Indigenous feed resources
  - b. Feed formulation and evaluation
- II. Feeds and feeding management
  - a. Farm-made feeds (preparation and equipment)
  - b. Feeding management

A limited number of fellowships are available for paper presentors.

Contact: The Secretariat, National Seminar-Workshop on Fish Nutrition and Feeds, SEAFDEC Aquaculture Department, P.O. Box 256, Iloilo City 5000, Philippines. FAX: 271-008.

*Research at SEAFDEC/AQD has demonstrated the feasibility of using indigenous and inexpensive raw materials as fish feeds. Cost-effective feeds affordable to fishfarmers would make production of important fish and shrimps economically viable.*



SEAFDEC/AQD announces its -

## 1994 Regular Short-Term Courses

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<i>Marine Fish Hatchery</i>	31 May - 20 Jul and 02 Aug - 21 Sep
<i>Seaweeds Culture</i>	07 Jun - 01 Jul
<i>Aquaculture Management</i>	07 Sep - 06 Oct
<i>Shrimp Hatchery Operation</i>	28 Sep - 16 Nov
<i>Fish Nutrition</i>	12 Oct - 22 Nov

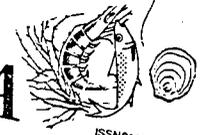
For more information, contact: TRAINING AND INFORMATION DIVISION,  
SEAFDEC/AQD, P.O. BOX 256, 5000 ILOILO CITY, PHILIPPINES.



— tackles issues, developments, and information on all phases of aquaculture. SEAFDEC/AQD R and D is highlighted.

— a production guide for fishfarmers and extension workers, this discusses the latest technology for cultured species and other noteworthy information excerpted from various sources.

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