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Milkfish Culture

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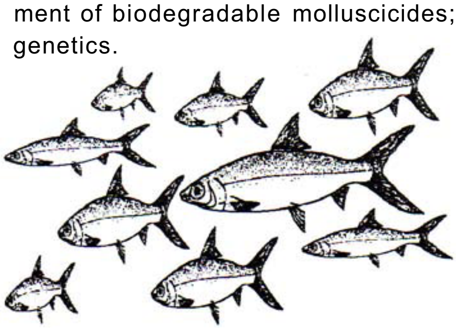
Along with tiger shrimp, milkfish research is one of the pioneering efforts of SEAFDEC Aquaculture Department. SEAFDEC/AQD began research on artificial propagation in 1975, two years after AQD was established in 1973. AQD first spawned wild milkfish in 1976 and again in 1978, after which fry were produced in the hatchery. AQD helped the Department of Agriculture put up a national breeding program but the program was privatized ten years later. Starting in 1985, AQD has been involved in technology transfer through its annual training courses in marine fish hatchery. In 1990, AQD started collaboration with the private sector by providing milkfish eggs to a shrimp hatchery operator. In 1992, AQD cooperated with four private hatcheries and in 1993, it started the adopt-a-milkfish-broodstock scheme.

AQD research in milkfish culture started in the late '70s and much of the traditional way of pond culture have been modified. AQD, however, limits itself to generating technologies that are environment-friendly, sustainable, and will give equitable benefits. AQD milkfish culture technology is essentially modified extensive or semi-intensive. Stocking rates are 12,000 fingerlings per ha and below.

AQD continues to have milkfish as its priority for research and a lot of areas still have to be covered. These include refinement of broodstock management and hatchery techniques (including eliminating fry deformities); verification and economic assessment of hatchery-nursery techniques transferred to private cooperators; improvement of brackishwater pond culture; integrated farming; development of biodegradable molluscicides; and studies in bioenergetic-nutrient cycles and genetics.



In this issue, traditional culture is discussed along with AQD's modifications. A summary of AQD's research on the natural life history of milkfish is presented as well as the issue on fry shortage. This issue also takes a look at Taiwan's broodstock-hatchery industry that farmers in the Philippines want to emulate.

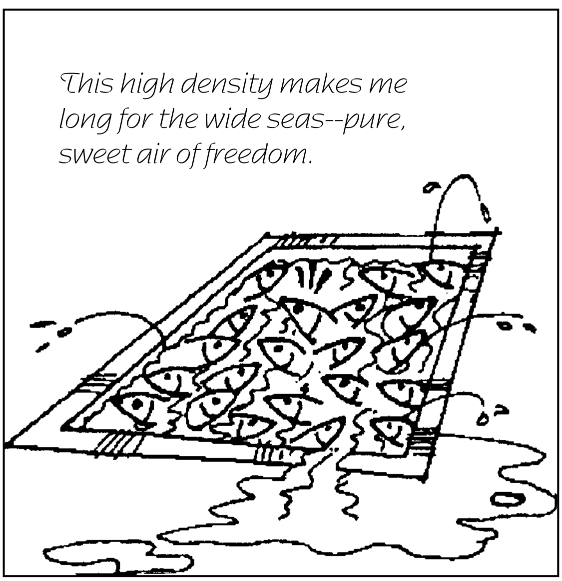
industry outlook

Milkfish culture in the Philippines

Milkfish farming is a centuries-old tradition that can be regarded as the backbone of Philippine aquaculture. Of the over 200,000 hectares of brackishwater ponds, more than half (about 114,000 ha; see p. 18, this issue) are milkfish ponds. In 1993, the Department of Agriculture estimated a total yield of about 250,000 metric tons of milkfish. In comparison, tilapia yield -- the second most important produce -- is less than half that of milkfish.

Fish and fishery products are the most important protein source in the Filipino diet. Per capita consumption is about 40 kilograms per year compared to 17 kg per yr for all other meats. But there is alarming evidence that capture fisheries can not sustain its present production because of indiscriminate fishing activities and pollution. Aquaculture, which supplies 30% of fish produce, would have to play a bigger role.

There is little prospect in expanding the brackishwater farming area without sacrificing our mangrove resources. Milkfish farms, therefore, will move towards high-density culture systems. (The term "high-density culture" refers to any or all culture systems other than traditional or extensive. Please refer to upper table next page. Note that each culture system differs significantly in production cost, productivity, and profitability.)



High-density systems entail augmenting food supply and maintaining the desired water quality. These measures increase production cost (lower table, next page). The choice of production system depends on technical and economic factors.

Until the late '80s, high-density systems were not economically attractive to farmers. In 1987, research conducted at the University of the Philippines' research center in Leganes, Iloilo successfully demonstrated the technological and economic feasibility of raising milkfish at grow-out densities of 7,000-12,000 fingerlings per hectare. (The modifications by SEAFDEC/AQD of the traditional method fall under modified extensive and semi-intensive systems; pages 9-15, this issue.) By the late '80s a number of private companies have made initial gains in raising the stocking density to 10,000-20,000 per ha with infusion of Taiwanese intensive culture methods. Since then, technology has evolved and progressed rapidly. Many commercial farms are now operating at densities of 20,000-30,000 per ha.

An important catalyst to the industry's expansion is the improved market price of milkfish which made the use of feeds economically viable to farmers and commercially attractive to feed manufacturers. Much of the industry's remarkable progress can be attributed to the growing number of experienced shrimp farmers that are shifting to intensive milkfish culture due to the widespread disease problems in cultured shrimp.

Are high-density systems sustainable? They could be, if pitfalls from the rise and fall of the tiger shrimp culture are avoided.

Excerpted from **Technical and economic considerations in high-density milkfish culture** by P.S. Cruz. Paper presented at the Annual Meeting of the Society of Aquaculture Engineers Philippines, Inc. 1995. Iloilo City. The article is part of a book to be published by Kabukiran Enterprises, Inc., Davao City. For more information, contact: P.S. Cruz, Prominence Inn, 158-C, Singcang, Bacolod City.

Important management differences between traditional and high-density culture systems

Culture system	Optimum stocking density/ha	Biomass yield/ha/ crop (kg)	Food supply	Water quality management
Traditional or extensive	2,000- 3,000	700 1,000	exclusively natural food	tidal, with a water depth 50 cm or less
Modified extensive	4,000 6,000	1,000- 2,000	mainly natural food with supplemental energy-rich feed	tidal, with a minimum water depth 80 cm
Semi-intensive	8,000- 12,000	2,000- 4,000	mainly protein-rich feed with some natural food	tidal, with supplemental pumping and a minimum water depth 100 cm
Intensive*	>20,000	4,000- 12,000	exclusively complete feed	pumping with aeration and a minimum water depth 120 cm

*Coastal farms appear to be better suited for high-density culture than inland estuarine farms. Recent experiences in coastal ponds utilizing pure seawater show that acceptable weight gains of 3-5 grams per day are attained, contrary to the common belief of poor growth under saline conditions. (The Department of Agriculture was successful in demonstrating milkfish culture in marine pens. Refer to AFN March-April 1992. - Ed.)

Typical measures for increasing pond carrying capacity through water quality management

Management measure	Approximate fixed cost per hectare	Effect on productivity
Increase efficiency of water change by increasing gate width, providing separate drain, and improving position of gate	P15,000-30,000	increase by 20-30%
Increase pond water volume by deepening the pond	P40,000-50,000*	increase by 30-50%
Increase pond water volume and capacity for water exchange with the use of a pump	P15,000-25,000**	increase by 100-300%
Increase pond water volume and capacity for water exchange with a pump, and augment DO supply with aerators	P115,000-125,000***	increase by at least 600%

* Cost for deepening from 50 cm to 70-80 cm

** Assuming no dike heightening necessary and a pump cost of P150,000-200,000 for a 10 ha area

*** Assuming two diesel powered aerators at P50,000/unit in addition to the pump.

Traditional bangus culture

The traditional *bangus* or milkfish culture refers to the straight culture of one-sized stock in earth ponds. Modifications by SEAFDEC/AQD are noted, and discussed on pages 9-15.

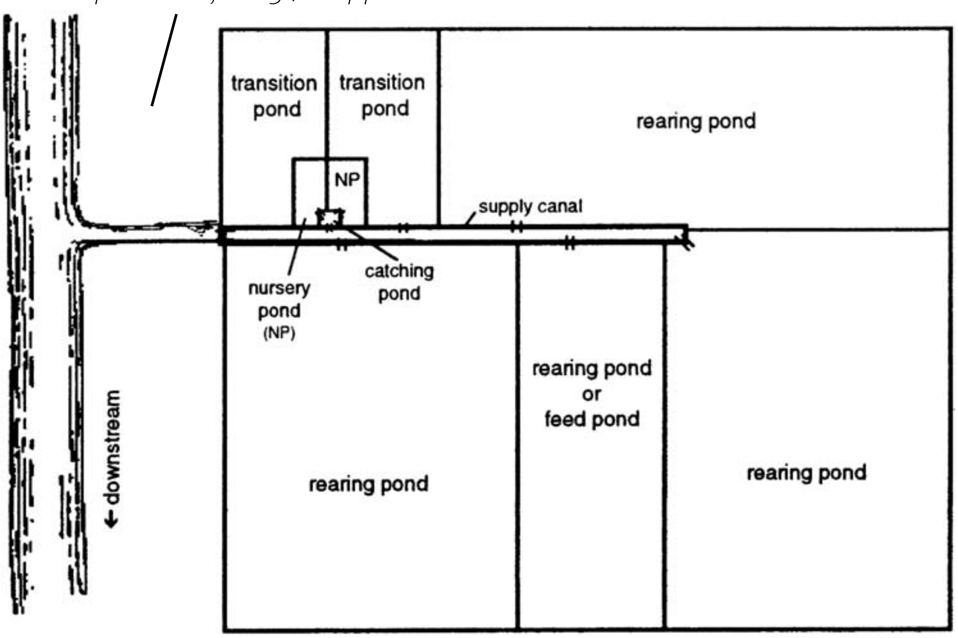
A traditional milkfish farm has several ponds classified according to their uses (refer to pond layout below):

- *Nursery ponds.* These are small ponds used exclusively for the rearing of fry to fingerlings. These occupy about 1 - 10% of the total production area. A manageable compartment ranges from 1,000-5,000 square meters.

  Nursery ponds are best located near the water source. Elevate the bottom so water can be readily drained even at low tide. Do not locate nursery ponds adjacent to perimeter dikes where fry may escape or predators and other unwanted species may enter through crab holes or leaks.
- *Transition ponds.* Fingerlings from the nurseries are kept in transition ponds until they reach post-fingerling sizes or until the rearing ponds are ready for stocking. These ponds comprise about 10-20% of the total production area. Each compartment should range from 5,000-15,000 m^2 in size.

  Transition ponds are located adjacent to nurseries for easy transfer of fry.
- *Rearing ponds.* Post-fingerlings are raised to marketable sizes in rearing ponds. These are the largest compartments, from 1-15 ha each. However, a 5-ha compartment is most manageable.
- *Catching pond.* This serves as a catchment basin for harvested fish, is constructed near the gate of the pond, and is linked to nursery ponds by another gate.
- *Feed pond (also called kitchen pond).* One of the nursery, rearing, or transition ponds may be used as feed pond to grow natural food as supplement or as fattener before the fish are harvested. The feed pond is a separate com-

A buffer zone of intact mangrove vegatation (100 meters from the sea or 20 meters from a river bank) is provided for by Philippine law.

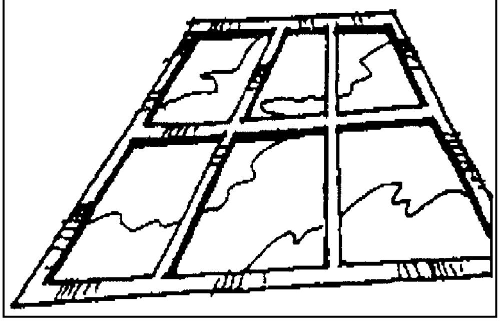


partment, located near ponds where supplementary feeding is needed.

The traditional production system is based on two to three croppings per year. The fry are kept in the nursery ponds for 4-6 weeks until they reach fingerling stage. These are then stocked in the adjoining transition pond for at least one month until the stock have grown to intermediate size (7-15 cm) and until the rearing ponds are ready. Fingerlings of about the same size are stocked in the rearing pond for 2-4 months.

Increase croppings to seven times a year.

SEAFDEC/AQD recommends the ***modular*** *method.*



The length of culture period depends upon the initial size of fingerlings and the desired size at harvest.

Pond preparation

Drain, till, and level ponds. Till the pond bottom as soon as the water is drained. For small ponds, use a shovel or rake; for large ponds, a rotavator is more efficient. Tilling brings nutrients at the bottom soil to the surface soil layers. It also eradicates weeds and burrowing fish predators.

Level all holes, mounds, and depressions. The pond bottom should slope gradually from the farthest end to the gate.

Dry the ponds. For the first cropping, allow at least 15 days for the pond bottom to dry until the soil hardens and cracks. This is done preferably at the start of the dry period in the locality.

Soil drying is important because it eliminates waste products and obnoxious gases (e.g., hydrogen sulfide) resulting from organic matter decomposition. At the same time, it allows time for other pre-stocking activities.

Repair and install screens. Make all dikes watertight. For leaks, pack new soil against the sides of the dikes. Repair broken slabs in the gates; check grooves to see if they fit; check screens for holes and clean with a soft brush.

These are the recommended mesh sizes for screens:

Pond	Mesh
nursery	fine mesh screen
transition	0.5 cm
rearing	1.5 cm

Substituting bagnets for flat screens offer a special advantage. Although the same mesh size is used, the increase in surface area allows a faster flow of water. The depth of the bag should be 2-3 meters for nursery and transition ponds and 3-4 m for rearing ponds.

Eradicate pests and predators. Pests and predators enter ponds through leaks in the dikes or through inadequately screened gates. This can also happen when fry that are stocked are not properly sorted.

Pests and predators can lower fishpond yields. Carnivorous fish species -- notably tarpon (*buan-buan*), sea bass (*apahap*) tenpounder (*bid-bid*), and gobies (*biya*) - can reduce the stock. Water snakes, lizards, frogs, and birds, like herons and kingfishers, also prey on milkfish.

Other organisms may render the environment unfavorable for fish growth. Tilapia, snails, and polychaete worms reproduce rapidly and eventually compete with milkfish for food and space. At the same time they inhibit the growth of benthic algae by destroying the bottom substrate. Because they burrow and bore, mudcrab (*alimango*), mudlobsters (*kolokoy*) and other crustaceans can destroy dikes and gates and create passageways for milkfish to escape.

Predators and pests may be mechanically removed or eliminated using chemicals.

Mechanical removal. Draining and drying ponds normally eliminate pests and predators. To induce burrowing freshwater species (mudfish and climbing perch) to come to the surface, a fresh supply of water is let in and subsequently drained after a few days. Snails that concentrate along the water line may be picked up manually or collected by means of shovels and rakes. Chironomid larvae are eliminated by a series of tidal flushings.

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Aquatin and Brestan have been banned. Use environment-friendly ways to eliminate pond snails.

SEAFDEC/AQD recommends ***piling up 15 cm of rice straw*** *on pond bottom with snails and* ***burning it.***

Predatory birds, frogs, lizards, etc. are either driven away or caught and killed. Scarelines, baits, nets, bamboo contraptions and other indigenous trapping devices are sometimes used,

Chemical methods. Use pesticides only when physical means of control fail or when days are cloudy and there is insufficient time for thorough drying. Pesticides, however, have the advantage of being pest-selective and these reach portions of the pond that cannot be totally exposed.

Organic pesticides are recommended because they are biodegradable. Although more effective, inorganic forms persist in the environment without losing their potency and thus may be lethal to milkfish. Nevertheless, large farms may find it practical to use inorganic pesticides. Read, understand, and follow instructions on the containers carefully. (The organotin pesticides Aquatin and Brestan are banned by the Philippine government. - Ed.)

Apply lime. Most newly built ponds require lime because they are likely to have acidic soils. In acidic soils, fertilization is ineffective and the ponds become unproductive. Response to fertilization is best when the soil pH is brought within the range of 6.5 to 9.0.

Other than helping correct soil acidity and preventing pH fluctuations in ponds, liming has other benefits. It hastens the breakdown of organic matter and the release of nutrients, and to some extent reduces the incidence of gill rot disease in milkfish.

Many calcium and magnesium compounds make good liming materials. The three kinds of lime commonly used are calcium carbonate ($CaCO_3$) or agricultural lime, calcium hydrate ($Ca(OH)_2$) or slaked lime, and calcium oxide (CaO) or quicklime. The amount applied depends on how acidic the soil is. The best way to determine the dosage is by soil analysis.

In the first year of production, 1,000 kilograms per hectare of slaked lime is normally applied. This is spread evenly over the pond bottom, sides and dikes. Old ponds require 500 kg/ha of agricultural lime spread over the pond bottom. To achieve maximum effectivity, the lime is worked into the soil by raking and ploughing. To prevent fixation, allow at least a week to lapse before applying phosphatic fertilizers.

Lime should be applied every other crop or twice annually.

Grow natural food. *Lab-lab* describes the complex association of minute plants and animals that form a brownish, greenish, or yellowish mat on the pond bottom and sometimes float on the pond surface as patches. Among its components are several species of blue-green algae, green algae, diatoms, rotifers, crustaceans, larvae, insects, roundworms, and detritus.

The narrow tidal range in the country favors the cultivation of *lab-lab. Lab-lab* grows well during the dry months in ponds with hard bottoms and salinities of 25-32 ppt. Ponds with a luxuriant growth of *lab-lab* can yield 1,500-2,500 kilograms per hectare per year of fish.

To grow lab-lab: Spread chicken manure evenly over the pond bottom. For a more rapid effect, mix fertilizer with water in plastic containers and allow to stand overnight. Spread evenly over the pond the next day. Use the following amounts:

Crop	New ponds (1-4 years)	Old ponds (at least 5 years)
1st crop	2,000 kg/ha	1,500 kg/ha
2nd crop	1,000 kg/ha	500 kg/ha
3rd crop	500 kg/ha	500 kg/ha
4th crop	500 kg/ha	500 kg/ha

Admit water to a depth of 5 cm. Allow the pond to dry for 3 days. Re-admit water to an average depth of 7.5-10 cm. Apply 16-20-0 at 100 kg/ha or 18-46-0 at 50 kg/ha.

Admit an additional 5 cm of water every 3 days until the pond depth reaches 20 cm. Apply 16-20-0 at 15 kg/ha every 7 days but not less than 3 days before stocking of fish. Three days before stocking, gradually drain 25% of the water from the pond and refill to the desired level. Admit water gradually to avoid disturbing the *lab-lab.* Maintain the following water level during the entire culture period:

Pond	Water depth
Nursery	20-30 cm
Transition	30-40 cm
Rearing	40-50 cm

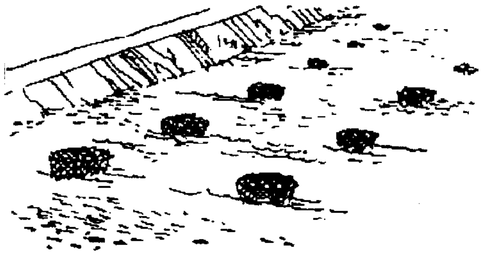
To maintain a luxuriant growth of *lab-lab* in the transition and rearing ponds, apply a side dressing of 15 kg/ha of 16-20-0 every 7-10 days during the rearing period. Stop fertilization 20 days before fish are removed from the pond

To grow lumut: Filamentous or grass-green algae or *lumut* such as *Chaetomorpha linum* (*lumut jusi*), *Cladophora* sp. and *Enteromorpha intestinales* (*bitukang manok*) may be grown in areas where *lab-lab* grows poorly. Ponds with soft bottoms, salinity of 25 ppt and a water depth of 20-60 cm are suitable. *Lumut* is poorly digested by bangus fry and fingerlings. Hence, it is better to decompose and dry it before feeding to milkfish in nursery and transition ponds.

In growing *lumut,* the same fertilization program used for *lab-lab* is applied. Growth occurs naturally but seeding may be needed when growth is sparse. Seedstock may be obtained from ponds where they survive or from special green-algae nurseries. Select fibrous or silky types and plant by staking or sowing. Luxuriant growth is not entirely desirable. Algae and the fish stock compete for living space. Ponds grown with *lumut* yield 900-1,250 kg/ha/yr of fish.

Broadcasting organic fertilizer is back-breaking.

*SEAFDEC/AQD recommends the **silo** method of fertilization.*



To grow plankton: Plankton is the collective term for microscopic organisms suspended in water. This is not as widely grown as *lab-lab* because it requires greater water depth (70-100 cm). Some fishfarmers cultivate *lab-lab* in the dry season and plankton in the wet season. The yield varies from 600-1,200 kg/ha/yr.

To grow plankton, drain the pond and then refill it after a minimum interval of 24 hours. Increase water to an average depth of 60 cm, but preferably to a depth of 75-100 cm. Apply inorganic fertilizer on a platform or sack during or after filling the pond. The rates of application are: 18-46-0 at 22 kg/ha; 16-20-0 at 50 kg/ha; or 16-20-0 at 25 kg/ha with 0-20-0 at 25 kg/ha. Stock the pond one week after fertilization. Apply fertilizer at the same dosage at two-week intervals to maintain water visibility at 20-30 cm. Stop fertilization two weeks before harvest.

Improve your return-on-investment and payback period.

*SEAFDEC/AQD recommends using **16-20-0 at 50 kg/ha + 45-0-0 at 15 kg/ha** and biweekly schedule of water replenishment.*

Stocking

In the traditional pond system, nursery ponds with abundant *lab-lab* growth are stocked with 30-50 fry/m^2 or 300,000-500,000/ha. Transition ponds are stocked with 10-15 fingerlings/m^2 or 100,000-150,000/ha. In rearing ponds, stocking rate varies from 1,500-3,000/ha for *lab-lab* ponds; 3,000-5,000/ha for plankton ponds; and 1,000-1,500/ha for *lumut* ponds.

Nurseries. The best time to stock is in the cooler part of the day, in the early morning or evening. Avoid

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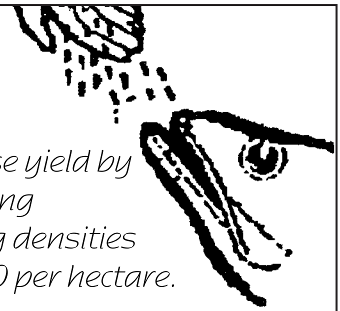
unnecessary mortality by acclimatizing the fry. Partially submerge the fry containers and tilt to one side to allow pond water to flow in. Make sure that salinity and temperature levels in the fry containers are slowly brought close to those of the pond. Allow the fish to swim out.

Sometimes, the fry are pre-stocked in small shaded acclimation ponds. The fry are fed daily with rice bran, patches of *lab-lab* or egg yolk. They are released into transition or rearing ponds by breaking some sections of the dike.



Increase yield by increasing stocking densities to 7,000 per hectare.

SEAFDEC/AQD recommends a ***high-fiber*** *or a* ***balanced amino acid diet as supplemental feed.***

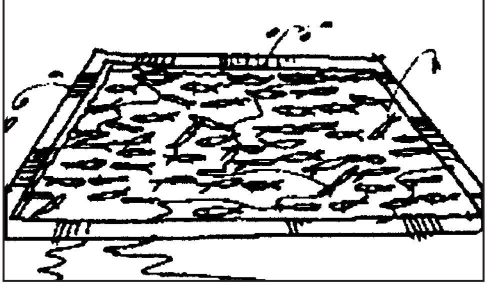
Transition and rearing ponds. Milkfish tend to swim towards a fresh supply of water and the best way to transfer fry and fingerlings is to capitalize on this behavior.

The nursery pond is partially drained at low tide. As water is allowed to enter at high tide, the fish will swim towards the inflowing water out into a confined area in the supply canal. A long drag net or seine is used to collect the fingerlings. They are scooped out into a counting net and then finally into the pond. Care is taken to ensure that a fresh supply of water passes through the confining net and the counting net.

Another method allows water previously stored in the rearing pond to flow into the confined area. The fish swim against this flow of water and enter the rearing pond through a one-way device fixed at the sluice gate.

Want to control your fingerling supply?

SEAFDEC/AQD recommends ***stunting*** *milkfish in nursery ponds at* ***20 fish per m²*** *for* ***six months.***



Pond management

Maintain good water quality throughout the rearing period. Maintain desired water levels. During sudden rains, drain water from the surface or let in water to minimize abrupt changes in temperature and salinity. Pond water becomes layered because of temperature-salinity differences in the upper and bottom water levels. This can lower dissolved oxygen.

If excessive evaporation occurs in summer resulting in increased salinity, use a pump to let in water if tidal water cannot be introduced. Too high salinities -- 36 or 40 -- are stressful to milkfish.

Replenish water or agitate the pond water when fish gasp at the surface or swim in circles. This condition usually indicates low dissolved oxygen especially when *lab-lab* dies during prolonged cloudy weather.

Have a tide table handy (calendars with tide tables are useful). Freshen the pond during the spring tide (full or new moons) or every 14 days. The spring tide lasts 4-5 days. Drain ponds preferably late in the evening or in the early morning 2-3 hours before an incoming high tide. Drain water not lower than the expected tide level.

Give supplemental feed when the *lab-lab* or *lumut* is overgrazed. Feed rice bran, bread crumbs and others at 4-10% of fish body weight. Give half of the ration in the morning and the other half in the afternoon. Artificial feeds may also be given.

Harvest

Make a harvest schedule when the milkfish reach the desired market size (250-300 g). Consider the prevailing market price, the phase of the tide and weather conditions.

Fish prices fluctuate greatly with time. To realize maximum profit, harvest when prices are high, that is, when fish are scarce in

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Modifications in bangus culture

One of SEAFDEC/AQD's achievements in aquaculture R & D is the improvement of the traditional method of bangus or milkfish culture. Although the industry is intensifying milkfish culture systems, it is likely that SEAFDEC/AQD will not support intensive milkfish culture. SEAFDEC/AQD has been, and still is, guided by three principles in developing culture technologies -- that these be environment-friendly, sustainable, and will give equitable benefits.

SEAFDEC/AQD, however, recognizes that the traditional method can still be modified to increase fish yield and profit. Below are some of the recently published or documented techniques (please refer to traditional culture on pages 4-8, this issue).

Modular method

The modular system was first practiced in large milkfish ponds in the province of Pangasinan, 300 km north of Manila. The method is basically staggered stocking and the subsequent transfer of stock to progressively bigger ponds.

In the mid-1980s, SEAFDEC/AQD pilot-tested the modular method in its ponds and later at three cooperating commercial farms. AQD had a 7-ha pond; the Negros cooperator had two sites about 5 km apart with areas of 6.91 and 2.71 ha; and the Cebu cooperators had ponds of about 7.9 ha. The ponds were sub-divided into 1:2:4 proportions. All ponds were prepared following the *lab-lab* to plankton method of growing natural food. Minor pond repairs and modifications were made to suit the modular system.

Milkfish (initial average weight, 5 grams) were stocked in the smallest pond at 3,000 fingerlings/ha. The stocking density is based on the area of the last or biggest pond. After initial stocking, the fish were transferred to the next (bigger) pond, staying at least 30 days in each pond. Vacated ponds were prepared for 15 days and stocked again. The total cycle time of about 45 days permits 6-8 croppings per year without taxing the natural food supply and a potential output of more than 2 tons in one year.

After 90 days, milkfish were harvested. For AQD, the average weight of milkfish was 225 g per fish; survival, 93%; production, 330 kg/ha per run. For the cooperators, average weight of milkfish was 200 g; survival, 93.3%; production, 309 kg/ha per run.

For all sites, the total investment per hectare averaged P18,550 of which 61-64% is capital outlay (pond development, caretaker's hut, tools, implements, nets). Working capital of about P-7,000 is used for pond preparation, stocking, caretaker's salary, and stock transfer.

The modular system gives a better return-on-investment than the straight-run method (61 % against 56%), better return on equity (122% against 112%), and shorter payback period (1.34 years against 1.64 years). The modular method also offers these advantages:

- better pond management in terms of pond preparation and predator control after every transfer of fish from one compartment to another;
- improved stock assessment;
- better production and financial planning.

Eliminating snails

Suso and *bagongon* -- also named *Cerithium tenellum* and *Telescopium telescopium* in science -- are two of the most common pests in brackishwater ponds. They crawl and graze on the pond bottom, destroying the cyanobacterial mat that serves as natural food. They can lower fish production and cause serious losses.

Snails are handpicked or removed by rake or shovel. This method is time-consuming, labor-intensive, and does not remove eggs and small snails. The application of inorganic pesticides is discouraged because they render the soil sterile and accumulate in the tissues of cultured species. The botanical toxins such as nicotine from

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tobacco dust, rotenone from *Derris* root, and saponin from teaseed cake are effective against the snails, even fertilizing the pond. However, supply of tobacco dust and *Derris* is very limited and teaseed cake is expensive.

Intense heat can kill snails. The use of calcium carbide, ignited to raise water and pond bottom temperatures and kill snails, has been reported. SEAFDEC/AQD tested the effect of burning rice straw.

How much rice straw is needed and what is its effect on the soil?

Three amounts of rice straw were tested: 1.3 kilograms (5 cm thick), 2.7 kg (10 cm thick), and 4 kg (15 cm thick). These were burned on the moist portions of the pond bottom where snails remain concentrated during pond preparation. Complete burning lasted two minutes. All the snails died when 15 cm rice straw was burned, 93% died in 10 cm, and 83% died in 5 cm. The snails found on the surface were burned, those that burrowed 0.5-1.0 cm deep were dried up. Those buried more than 1.0 cm deep secreted mucus, and when submerged in water, turned upside down, a response indicative of chemical and biological stress. Excessive release of mucus causes the digestive system to malfunction, causing death.

After burning, the pond soil has lower moisture, organic matter, and phosphorus content. Available iron and potassium increased, but pH was not affected. Flushing, liming, and fertilization should be able to improve on the "deficiency" of the soil.

Silo method

Traditional milkfish culture rely heavily on the natural food base like *lab-lab.* Fishfarmers usually broadcast organic and inorganic fertilizers to stimulate the growth of natural food. The fertilizers are spread as evenly as possible throughout the dried pond bottom.

Although effective, broadcasting is laborious and strenuous. An alternative tested by SEAFDEC/AQD is the silo method, a concept derived from agriculture. (Silo is a storage of silage for livestock feed which can make production more efficient.). For aquaculture, a similar method is used in Taiwan where chicken manure (1 -2 tons/ha) and rice bran (600-1,200 kg/ha) are placed inside perforated bags set at equal distances within the pond system. The platform method is used for inorganic fertilizers. The silo and the platform methods are based on the principle of gradual release of nutrients into the water and its distribution by water movement.

To grow *lab-lab* using the silo method, completely dry the pond bottom for 1 to 2 weeks. Sink three bamboo wicker baskets into the dried pond bottom to about one-third its height, equidistant from each other, and running diagonally from the tertiary gate to the opposite end of the pond. Equally divide a mixture of chicken manure at 2,000 kg/ha and rice bran at 450 kg/ha among the baskets. Make a basal application of mono-ammonium phosphate (16-20-0) at 50 kg/ha and urea (45-0-0) at 25 kg/ha to hasten the breakdown of organic fertilizers. Fill the ponds gradually with water, from a depth barely covering the pond bottom until 40 cm is reached in one to one-and -a-half months time. Broadcast every 15 days the subsequent doses of inorganic fertilizers at half the rate used for basal application.

In the AQD study of the silo method, there was moderate to abundant growth of *lab-lab* (apparently the floating type). Microbenthic growth near the wicker baskets was good. Water color varied in hue from green to bluish. *Lab-lab* growth was high even up to 90 days of culture. The continuous growth of *lab-lab* up to the end of the AQD study indicates that nutrients from the organic fertilizer were still available. A fertilizer residue barely 5 cm thick was left at the bottom of the wicker baskets at harvest time.

In contrast, ponds prepared using the broadcast method had natural food good for only 60 days. This method also favored excessive *lab-lab* growth as indicated by the accumulation of uneaten floating *lab-lab* along the corners and sides of the dikes. Thereafter, there was decline in *lab-lab* growth as shown by the change in water color. Water generally turned from green to brown and slightly greenish to brownish which later became clear, an indication of gradual depletion of natural food. A considerable reduction in the incremental weight of fish from day 75 to 90 was observed.

A difference in net production of 68.5 kg (at a value of $1.36 per kg) would make the silo method more profitable than the broadcast method. Furthermore, the silo method is less laborious and strenuous, cheaper and less time consuming compared to broadcasting.

Fertilizer - water replenishment scheme

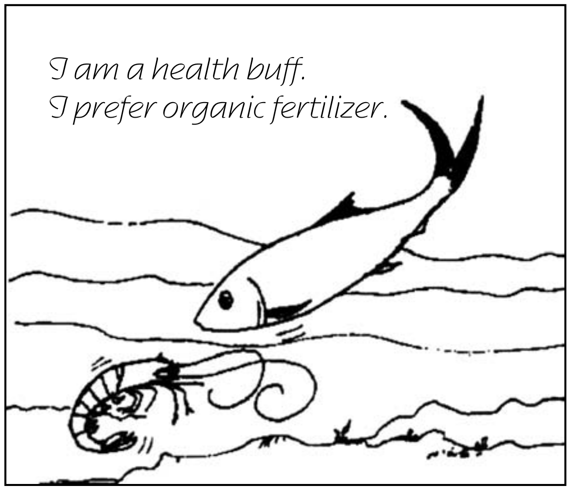
Fertilization. The SEAFDEC standard method of fertilizing brackishwater ponds consists of monoammonium phosphate (16-20-0) at 50 kg/ha plus urea (45-0-0) at 15 kg/ha applied once every two weeks. This fertilizer regimen represents average doses taken from past national surveys among fishfarmers. Monoammonium phosphate is cheap and can increase milkfish production to 1,300 kg/ha/year. The highly soluble urea can facilitate the rapid release of phosphorus in the mud and can trigger rapid growth of benthic algae. AQD also uses the organic fertilizer chicken manure to stimulate benthic algal growth. Chicken manure is also directly eaten by fish, zooplankton and bottom fauna.

What is the best fertilizer combination? AQD compared its standard practice (16-20-0 at 50 kg/ha + 45-0-0 at 15 kg/ha) to the use of chicken manure (0.5 ton/ha) and a fertilizer called MASA from processed agricultural and industrial wastes. These fertilizers were applied every two weeks to grow *lab-lab.* The ponds were stocked with milkfish fingerlings (mean weight, 14.6 g) at 40/pond, and harvested after three months.

Harvest weight of milkfish and gross production were slightly higher for AQD's standard fertilizer dosages than the other fertilizers (222 g against 133-169 g; 545 kg/ha against 330-439 kg/ha). The return-on-investment is also decidedly better (56% against 19%; MASA had negative ROI); likewise the payback period (1.64 years against 4.16 years).

Organic fertilizers in general have low N, P_2O_5, and K_2O contents and large quantities are required to supply the same amounts of nutrients found in small quantities of inorganic fertilizers. In plankton ponds (deep ponds), inorganic fertilizers can yield an average of 3.45 kg of fish per ha per day; chicken manure, 2.1 kg/ha/day. But chicken manure is cheaper and readily available in the market. Perhaps it is more useful in shallow ponds although a minimal amount of chicken manure is needed during the wet season. Photosynthesis is limited and therefore nutrients from fertilizers are not used up.

Water replenishment scheme. The length of time water is retained in the pond has a



pronounced influence upon pond fertilization. With a short retention time, nutrients may be flushed out before they are utilized by the algae. A lengthy retention may create undesirable water quality which may adversely affect the growth and survival of fish. In shallow milkfish ponds, frequent flushing may disturb the *lab-lab.* Therefore, a desirable combination of frequency of water replenishment and fertilization would be beneficial in pond culture.

Four water replenishment-fertilization schemes were tested by SEAFDEC/AQD: weekly or biweekly replenishment of water with weekly or biweekly fertilization (AQD standard dosages of 16-20-0 and 45-0-0). It appears that gross fish production was highest in biweekly fertilization if considered as a single factor. Weekly or biweekly water replenishment did not considerably improve or decrease production.

However, pond elevation in traditional milkfish farms in the Philippines is relatively high and therefore weekly water replenishment in some areas is not feasible. Furthermore, the use of a water pump is not economical in extensive milkfish culture. A weekly water replenishment would also be difficult in big ponds (5-10 ha/compartment). Therefore, a combination of water replenishment and fertilization with 16-20-0 at 50 kg/ha both done once every two weeks would be reasonable. It is also less laborious and less time-consuming for the pond caretakers.

References:

(1) RF Agbayani, DD Baliao, NM Franco, RB Ticar and NG Guanzon Jr. 1989. *An economic analysis of the modular pond system of milkfish production in the Philippines.* **Aquaculture** 83:249-259.

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(2) AT Triño, EC Bolivar, DD Gerochi. 1993. *Effect of burning rice straw on snails and soil in a brackishwater pond.* **International Journal of Tropical Agriculture** 11 (2): 93-97.
(3) DD Gerochi, MM Lijauco, DD Baliao. 1988. *Comparison of the silo and broadcast methods of applying organic fertilizer in milkfish, Chanos chanos (Forsskal), ponds.* **Aquaculture** 71:313-318.
(4) I Bombeo-Tuburan, RF Agbayani and PF Subosa. 1989. *Evaluation of organic and inorganic fertilizers in brackishwater milkfish ponds.* **Aquaculture** 76:227-235.
(5) I Bombeo-Tuburan. 1989. *Comparison of various water replenishment and fertilization schemes in brackishwater milkfish ponds.* **Journal of Applied Ichthyology** 5: 61 - 66.

Supplemental feeding

The use of a high-energy diet. The natural food produced through fertilization can normally support fish densities of 1,500-3,000/ha. More intensive methods, by stocking as high as 25,000 fish/ha, need artificial feeds (24-29% protein) and artificial aeration. Unlike Taiwanese fishfarmers, Filipinos are hesitant about intensifying culture because of the relatively low price of milkfish and high cost of production.

Energy limits the yields of milkfish from brackishwater ponds, so using cheap agricultural products as supplementary feeds can increase yields. Two batches of milkfish (average weight, 2 grams) were stocked at 6,000/ha or at 9,000/ha and given artificial feeds a month after stocking. The artificial feeds had either a low or high energy level (2,950 and 3,265 kilocalories/kg). These were formulated from copra meal and rice bran, among others, and had about 25% protein. The pond water depth was gradually increased with increasing size of the fish and was maintained between 50 and 70 cm.

Milkfish production did not vary much with energy level; more fish were produced at the higher stocking density. Ponds stocked at 6,000 fish yielded an average of 688 kg while those stocked at 9,000 fish yielded 1,042 kg. Milkfish at harvest ranged 125-143 g in all ponds.

Milkfish growth is slowest during the cold months, December-February. It appears that the best way to increase yields and profits is by increasing stocking rates and by providing supplementary feeds when natural food is scarce.

The use of fiber (from rice hull) in supplemental feeds. Supplemental feed is the largest operating cost in semi-intensive systems. Agricultural by-products and feedstuffs of plant origin are generally cheap and easily available but high in fiber. Even though milkfish do not have cellulase and therefore cannot digest fiber, fiber may be of value when it eventually finds its way to the food chain through the detrital pathway. If fiber is used, then the cost of supplemental feeds can be reduced. Generally, fibrous ingredients like rice hull (which contains 2.9% crude protein and 54% neutral detergent fiber) are used as filler to formulate low-protein, low-cost diets.

In the feeding trial, milkfish juveniles (29 g) were stocked at 7,000/ha. These were fed 25 days after stocking when natural food had become drastically reduced. The supplemental feeds are based on rice hull incorporated from 0-55 grams per 100 g diet. The feeds tested have protein-N loads of 14-26% and energy levels of 3,800-4,400 kilocal/kg feed. In contrast, milkfish ponds with chicken manure as fertilizer-feed received 18% protein and 3,600 kilocal/kg ponds.

After three months, growth and production were significantly better in ponds with supplemental feeding than in ponds receiving chicken manure. About 75-79 grams of milkfish per ha per day were produced and 93-98% were recovered in fed ponds. Only 33 g milkfish/ha/day were produced and 92% were recovered in manured ponds.

The use of rice straw compost as feed substitute. Compost is a potential organic fertilizer-feed in fish culture. It is processed from low quality agricultural by-products such as rice straw. In the feeding trial, a supplemental feed was formulated from rice bran-soybean meal-fishmeal;

this contains about 24% protein. Rice straw compost (7.4% protein, 37% organic matter, 64% ash) replaced 0, 25, 50 and 75% of the formulated feed given to milkfish. Rice straw compost (partially dissolved in water) was broadcast daily.

The supplemental feeds were tested on milkfish juveniles (0.4 g) stocked at 7,000/ha. After four months, the highest yield (725 kg/ha) was attained in fish given 100% feed-0% rice straw compost or RSC, followed by fish given 50% feed-50% RSC, and then by fish given 75%feed-25% RSC. The fish given 25% feed-75% RSC did not grow well. Hence, RSC should not compose more than 50% of supplemental feed. Average recovery rate for all fish ranged from 83.9 to 98.2%.

The use of diets with balanced amino acids. Dietary protein and ration size can influence fish growth, feed efficiency, and water quality. For this reason, the protein and amino acid requirements of milkfish have been studied (please see table this page).

Two diets (24% and 31% protein) with balanced amino acid were formulated:

Ingredients	24% protein	31% protein
Fishmeal	10.8	16.1
Soybean meal	23.8	35.7
Cassava leaf meal	13.0	13.0
Rice bran	27.9	17.4
Rice hull	15.5	8.4
Cod liver oil	2.0	2.2
Soybean oil	2.0	2.2
Breadflour	5.0	5.0
Proximate analysis (dry matter basis)		
Crude protein	24	30.5
Crude fat	11.4	11.2
Nitrogen-free extract	43.5	39.9
Crude fiber	11.2	9.1
Ash	9.9	9.3
Metabolizable energy (kcal/kg)	3,726	3,824

Summary of known nutrient requirements of the milkfish *Chanos chanos* Forsskal

Nutrient	Requirement
Protein[1]	40% for fry
	30-40% for juveniles
	44% protein:energy
Essential amino acids[2]	
Arginine	5.2%
Histidine	2.0
Ileucine	4.0
Leucine	5.1
Lysine	4.0
Methionine + cystine	2.5 (cys, 0.8)
Phenylalanine + tyrosine	4.2 (tyr, 1.0)
Threonine	4.5
Tryptophan	0.6
Valine	3.6
Lipid[1]	7-10%
Essential fatty acids[1]	1-1.5% n-3 PUFA
Carbohydrate[1]	25%
Digestible energy	2500-3500 Kcal/kg

[1] Requirement as percent of dry diet. Requirement as percent of protein.

References are given in full in **Feeds and feeding of milkfish, Nile tilapia, Asian sea bass, and tiger shrimp** published by SEAFDEC/AQD, 1994.

These were fed to milkfish (average weight, 5 g; stocked at 7,000/ha) at either 2% or 4% of body weight/day. Feeding started a month after stocking when natural food became inadequate. Milkfish were harvested after 87 days.

The results of the feeding trial indicate that milkfish growth in brackishwater ponds is not determined by protein levels if fish are fed diets with balanced amino acid profiles. Instead, milkfish growth depends on the amount of feed given. At 2% feeding rate, total production was low (839 kg/ha) compared to the 4% feeding rate (1,159 kg/ha).

SEAFDEC recommends feeding milkfish a diet containing 24% protein (with balanced amino acid profile) at 4% of body weight. This feed is able to support a biomass of over a ton/ha.

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SEAFDEC/AQD tried stunting 3-month old and 6-month old milkfish and compared these to the growth of non-stunted 2-month old fish in a straight culture system (40 fingerlings per pond; three-month duration). All the fingerlings were previously grown in the nursery ponds for 2 months. However, the (stunted) fingerlings were transferred to stunting ponds for a month (becoming 3-month old fish) orfor4 months (becoming 6-month old fish). (Farmers in the northern and southern provinces usually stunt or crowd milkfish at 15-20 per m^2 for 3 months or more.)

Stunted fish produced 383-468 kg/ha; non-stunted fish, 343 kg/ha. Average weight gain of stunted fish was 153-171 grams; non-stunted fish, 137 g. Survival for stunted fish is 90-98%; for non-stunted fish, 90%. But these differences are not significant.

The oldest stunted fingerlings (6-month old) gained the most weight during the first month; the youngest non-stunted fingerlings (2-month old) gained the least. But during the second and third months, the 3-month old fish gained the most.

Stunting does not subject the fish to weight loss but only limits the weight increase. Proper pond management can maintain a healthy population. In real practice, the stunted fish resulting from the low temperature in the months of January to February allow the farmers to get a lead start of about 70 g upon stocking in rearing ponds, and marketable size is usually attained after 2 months when the market price is still relatively high. The same is true in Taiwan where larger, overwintered fingerlings produce large-size marketable fish, giving a wide margin of profit. Stunting, therefore, can make fry available year-round without adversely affecting milkfish production.

The economics of stunting milkfish. From interviews with fishfarmers, SEAFDEC/AQD tested four stocking densities in stunting milkfish to determine its economic viability. The densities tested were: 15, 20, 25, and 30 fish/m^2; stunting period was six months.

References:

(1) NS Sumagaysay, YN Chiu-Chern, VJ Estilo and MAS Sastrillo. 1990. *Increasing milkfish (Chanos chanos) yields in brackishwater ponds through increased stocking rates and supplementary feeding.* **Asian Fisheries Science** 3: 251-256.

(2) NS Sumagaysay and YN Chiu-Chern. 1991. *Effects of fiber in supplemental feeds on milkfish (Chanos chanos Forsskal) production in brackishwater ponds.* **Asian Fisheries Science** 4:189-199.

(3) NS Sumagaysay. 1991. *Utilization of feed and rice straw compost for milkfish, Chanos chanos, production in brackishwater ponds.* **Journal of Applied Ichthyology** 7:230-237.

(4) NS Sumagaysay and IG Borlongan. 1995. *Growth and production of milkfish (Chanos chanos) in brackishwater ponds: effects of dietary protein and feeding levels.* **Aquaculture** 132: 273-283.

Stunting milkfish fingerlings

In the Philippines, fishfarmers stunt or crowd fingerlings in stunting-transition ponds before these are stocked in rearing ponds. Stunting assures the fishfarmer of a large inventory of fingerlings because fry supply from the wild is irregular and this can adversely affect grow-out operations. Farmers purchase fry during peak months (April-June) to take care of their stocking requirements during the lean months.

Do stunted fingerlings grow faster than unstunted ones? Farmers believe that they do and therefore extra croppings are possible. Farmers also prefer stunted fingerlings over newly grown ones because stunted fish usually have higher weights and would therefore require a shorter culture period.

All fingerlings attained a more or less uniform weight gain (0.05-0.066 g/day/fish). Survival, however, was lowest in fish stocked at 30/m^2 (54%) compared to the other densities (78-86%). The cost of producing stunted fish was also highest in 30/m^2 (P0.72/milkfish) compared to the other densities (0.49-0.63 centavos/ fish). The lowest cost per piece and the highest rate of return (33.5%) was at 20 fingerlings/m^2.

SEAFDEC/AQD further tested different stunting durations -- 6, 9, and 12 months -- using the best stocking density of 20/m^2. Weight gain was highest during the 6-month stunting period (0.052 g/day/fish) compared to the other times (0.031-0.037 g/day/fish). Survival was also highest (81 % compared to 52-78%). Cost per milkfish plus a 50% mark-up was lowest, too (P0.71 compared to P0.81 - 1.27).

Stunting - 20 fish/ m^2 -- is economical for the milkfish farmer when maintained up to 6 months. In areas where fry availability is irregular, fry stunting can even be maintained until 9 months.

In terms of investment, the traditional method of preparing ponds is used although nylon-screen substrates are installed like tennis nets across the pond bottom. This increases the surface area by 60% for attachment of fish food organisms.

References:

(1)I Bombeo-Tuburan. 1988. *The effect of stunting on growth, survival and net production of milkfish (Chanos chanos Forsskal).* **Aquaculture** 75:97-103.

(2) DD Baliao, BM Franco, RF Agbayani. 1987. *The economics of retarding milkfish growth for fingerling production in brackishwater ponds.* **Aquaculture** 62:195-205.

(3) RF Agbayani. 1990. *Economics of milkfish culture in the Philippines.* In: H Tanaka, KR Uwate, JV Juario, C-S Lee, and R Foscarini. **Proceedings of the Regional Workshop on Milkfish Culture Development in the South Pacific;** 21-25 November 1988; Tarawa, Kiribati. FAO/South Pacific Aquaculture Development Project and US Agency for International Development. GCP/RAS/116/JPN.

TRADITIONAL CULTURE ... FROM PAGE 8

the market. Normally, this is on full moon nights when not much fish are landed by commercial fishing. Another important rule is to regulate the quantity of fish per harvest to a level that can be absorbed by the market.

Stocks may be partially thinned. Only bigger sized fish which command a higher price are harvested. More natural food becomes available to the remaining stock. Some fishpond operators on the other hand harvest juveniles ranging from 10-20 cm and sell these as bait for tuna.

The current method of harvest — or *pasulang* — takes advantage of the tendency of the fish to swim against the current. It is the same method used in transferring stock from one pond to another. The fish that are confined in the supply canal or catching area are seined or scooped. Sometimes a stationary fish corral or *baklad* is installed in a portion of the catching area near the main gate. The confined fish are also harvested by scooping or seining.

The current method is applicable both for partial and total harvesting. About 80% of the stock can be induced to concentrate in the catching area. The rest are picked up by hand after totally draining the pond.

Chill milkfish to death as soon as these are harvested to maintain fish quality during transport to the market. Immerse fish in tanks containing crushed ice or iced water. Cover the tanks with canvas to protect the fish from the heat of the sun and to prevent ice from melting rapidly. If the travel time is long, use 450 kg of pure crushed ice per ton of fish.

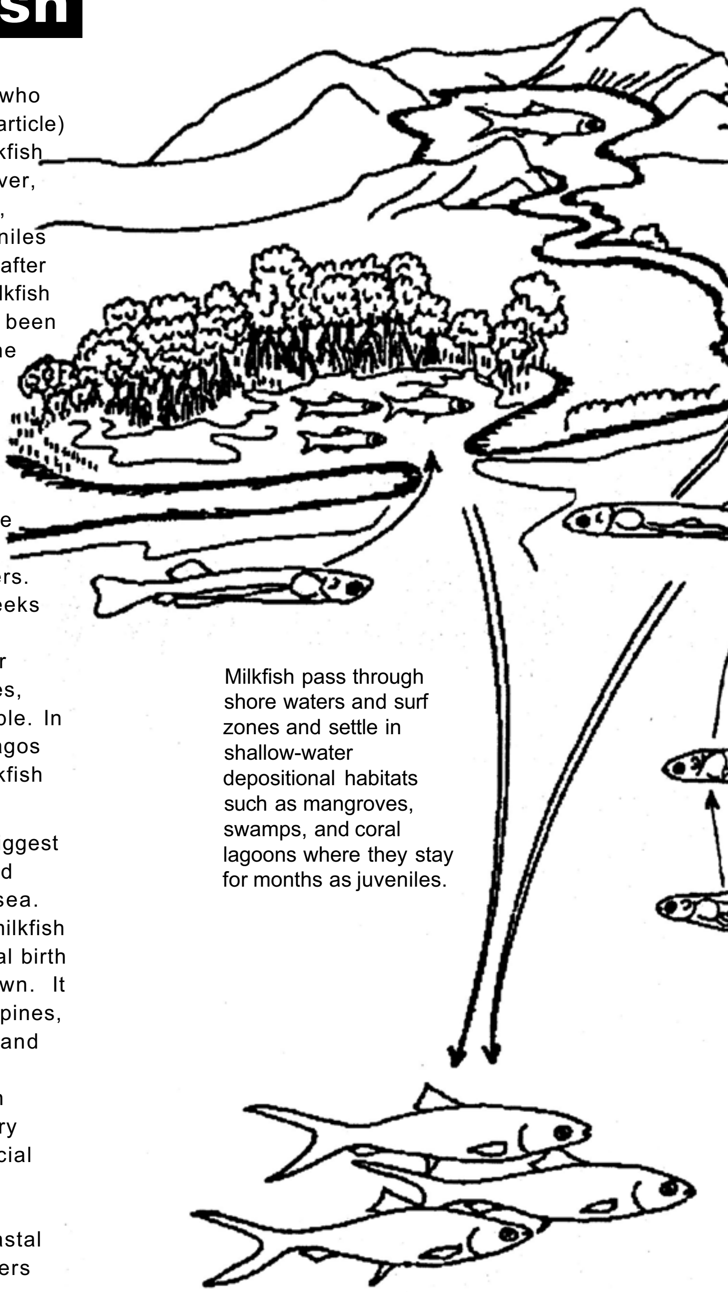
Pack the fish in round galvanized metal tubs (*bañeras*) when these are stiff and cleansed of slime, blood and mud. Plastic rectangular containers or 1 m^3 wooden boxes lined with GI sheets and styrophore slabs may also be used. Pile the fish with alternate layers of ice. Use fine crushed ice to minimize abrasive action and to chill areas evenly. A ratio of 1:1 ice to fish (weight basis) is needed for 3 hours of land travel and 1:2 for 1.5 hours of travel.

Reference: **The Philippines recommends for bangus.** 1983. PCARRD Technical Bulletin Series No. 8-A Philippine Council for Agriculture and Resources Research and Development. Los Baños, Laguna. This manual was produced with the collaboration of the Bureau of Fisheries and Aquatic Resources, SEAFDEC Aquaculture Department, and the University of the Philippines - Visayas.

The life of a fish

SEAFDEC scientist Teodora Bagarinao -- who had studied and collated information (this article) on milkfish in the wild -- notes that the milkfish life history is a series of migrations. However, little is known about the actual movements, particularly during the period after the juveniles leave the nursery grounds, and the period after the spawning of adults in nature. Since milkfish larvae are used in aquaculture, there have been attempts to link the spawning grounds to the inshore collection grounds, that is, to find the mechanism for the appearance of milkfish fry en masse in shore waters. No one has really been successful. Available evidence, Dr. Bagarinao says, indicates that milkfish larvae move by active migration and passive transport from offshore spawning grounds into shore waters. Then they enter and settle in mangrove creeks and swamps, coral lagoons, estuaries, and sometimes freshwater lakes. Shallow-water habitats appear to be obligatory for juveniles, while freshwater habitats are used if available. In the Philippines and other oceanic archipelagos where freshwater bodies are few, most milkfish probably never see freshwater.

Much remains to be studied. The biggest gaps are in milkfish ecology, physiology and behavior, including the migration habits at sea. Stock assessment has not been done for milkfish anywhere, and population dynamics, natural birth rates and mortality rates are virtually unknown. It is difficult to study wild milkfish in the Philippines, says Dr. Bagarinao, because the juveniles and adults are not fished in quantity -- probably because inshore larvae are. The effects on milkfish population genetics of the current fry fishery, the production of larvae in commercial hatcheries, and searanching of hatchery-produced larvae will need to be monitored. There must be a strong effort to protect coastal habitats so that aquaculturists and consumers may continue to benefit from milkfish.



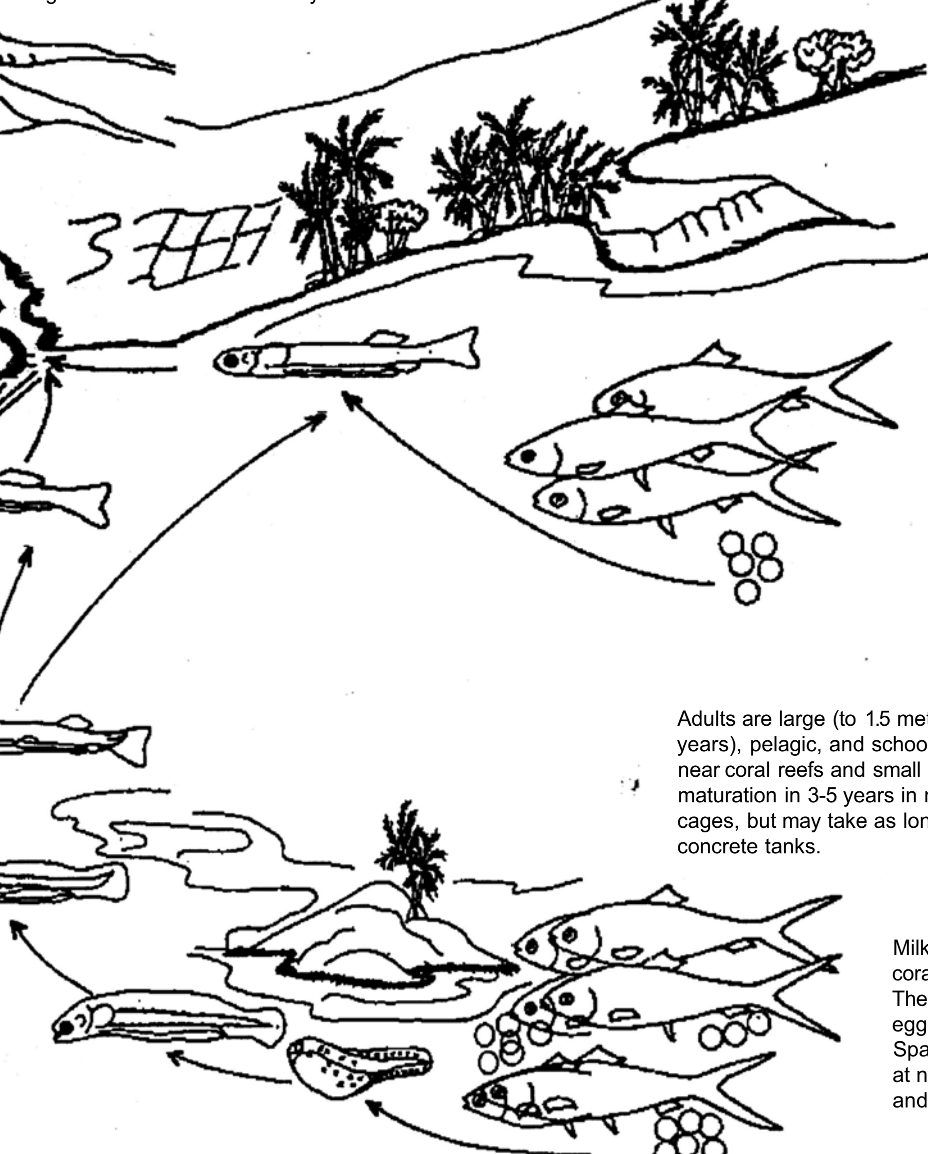
Milkfish pass through shore waters and surf zones and settle in shallow-water depositional habitats such as mangroves, swamps, and coral lagoons where they stay for months as juveniles.

Both juveniles and sub-adults go back to sea when they reach the size limit supportable by inland habitats. Little is known of milkfish at sea before they reach sexual maturity at about five years and after their spawning migrations along the coasts.

Literature citations are given in full in the book **Biology of Milkfish *Chanos chanos* Forsskal** published by SEAFDEC/AQD in 1991 and in the review paper by Dr. Bagarinao on *Systematics, distribution, genetics, and natural life history of milkfish* in the journal **Environmental Biology of Fishes** 39:23-41 (1994).

A summary of the natural life history of milkfish (similar to this one) appeared in **SEAFDEC Asian Aquaculture** Vol. XVI No. 3 September 1994.

Some juveniles enter freshwater lakes where they grow into sub-adults but they do not mature.



Milkfish eat a variety of food, most commonly: cyanobacteria, diatoms, detritus along with invertebrates such as small crustaceans and worms. Adults apparently swim through plankton masses and larval schools -- they have been found with juvenile sardines in the gut and they ingest their own eggs after spawning (in floating cages).

Adults are large (to 1.5 meter or 15 kg), long-lived (to 18 years), pelagic, and schooling. They spawn offshore near coral reefs and small islands. Adults reach sexual maturation in 3-5 years in nature and in large floating cages, but may take as long as 8-10 years in ponds and concrete tanks.

Milkfish spawn offshore near coral reefs or small islands. They produce 0.5-6.0 million eggs in 3-13 kg females. Spawning takes place usually at night, may be lunar periodic, and is strongly seasonal.

Larvae are pelagic. Larvae ≥ 10 mm total length and 2-3 weeks old (commonly called fry) move inshore by both passive advection and active migration. Milkfish fry or seed (to the aquaculturist) are larvae approaching metamorphosis and the end of pelagic interval. Those caught in the Philippines, Taiwan, Japan and elsewhere are all 10-17 mm total length, 14-29 days old (average 13-14 mm, 20 days). A fishery on inshore milkfish larvae supports the centuries-old grow-out culture industry.

Fertilized eggs are pelagic, spherical and 1.1-1.25 mm in diameter. Embryonic development is typical of bony fishes and takes 20-35 hours at temperatures of 26-32°C and salinities of 29-34 ppt. Researchers at SEAFDEC/AQD collected 1,700 milkfish eggs in 188 successful (1,898 total) plankton tows around Panay Island in 1976-1980, most abundantly near the surface but also in low numbers down to 30-50 meters deep.

industry problems

The milkfish fry shortage

In a collective effort to address the milkfish fry shortage and the resultant public outcry (see pages 23-25), an action plan tagged as Project Sabalo[1] was formulated in a Department of Agriculture-sponsored workshop last September 7-8, 1995 at SEAFDEC in Tigbauan, Iloilo.

The Department of Agriculture (DA) notes that 1 billion fry must be produced annually to meet the needs of the industry. As of September 1, 1995, data from DA regional offices showed a milkfish fry deficit of over 1.5 billion (table below).

Project Sabalo aims to evaluate existing hatcheries, assess broodstock conditions, and increase the number of broodstock. (About 10,000 milkfish broodstock are projected to be raised in the next five years. This figure is back-computed from the number of eggs a spawner can produce and the survival rate in hatcheries.) At present, there are about 2,000 sabalos distributed as follows:

Owner	Number
Private hatcheries	- 752
DA research stations	80
Open for privatization	- 367
San Miguel Corporation	26
SEAFDEC/AQD	- 1,000
Total	- 2,225

Source: DA-BFAR Aquaculture Division

About 300,000 viable eggs per spawner per year can be produced out of the present stock (assumed 50% female). With a 50% hatching rate and 10% survival rate during larval rearing, the present stock can easily produce 30 million fry per year. Project Sabalo aims to improve this figure to 1 million viable eggs per spawner per year by supporting hatchery operators (mostly those who availed of the privatized milkfish broodstock under the NBBP; see table next page for an update). Facilities must be improved especially for live food; larval rearing and handling must be improved to reduce the number of defective fry; quality feeds must be available. Technical staff must also be trained in broodstock

[1] Sabalo is the local term for milkfish spawner.

Fry requirement for milkfish ponds in the Philippines (Source: DA Regional Offices)

Regions	Fishponds in operation (hectares)	Fry requirement (per year)	Fry production from the wild (per year)	Deficit (per year)
I	11,910	629,760,000	15,000,000	614,760,000
II	1,235	12,477,742	9,000,000	3,477,742
III	20,150	137,826,000	9,000,000	128,826,000
IV	12,316	189,000,000	19,771,000	169,229,000
V	5,101	153,030	100,000	53,030
VI	30,503	439,246,800	35,288,172	403,958,628
VII	2,615	85,000,000	30,703,648	54,296,352
VIII	3,306	13,200,000	2,000,000	11,200,000
IX	10,899	54,495,267	20,000,000	34,495,267
X	3,000	27,000,000	9,000,000	18,000,000
XI	5,704	57,000,000	3,600,000	53,400,000
XII	7,556	76,000,000	6,000,000	70,000,000
ARMM	500	5,000,000	1,200,000	3,800,000
TOTAL	114,795	1,726,158,839	160,662,820	**1,565,496,019**

management and larval rearing. Budget for this will be cost-shared by DA, SEAFDEC/AQD, the Philippine Council for Aquatic and Marine Research and Development, and the private sector. The participating hatcheries are Aquasur, Davao; Pacific Farms, Pangasinan; MINARCO; Good Fry; Dobe International, Cebu; Greenwater Aquaculture Development; 3H Enterprises; and Jamandre Industries, Iloilo.

Project Sabalo does not end there. Policy and institutional changes are recommended:

- The private sector are encouraged to produce broodstock; joint ventures with the government are welcome. The government must take the initiative in areas not undertaken by the private sector.
- The government must allow the importation of broodstock as long as quarantine is observed.
- The conservation of our marine resources is an urgent need. The private sector will inform DA on pollution, dynamite fishing. DA must regulate illegal fishing. Dispersal of 300 g milkfish to reseed wild stock may have to be done.
- The private sector must organize into an accredited association to avail of incentives like tax credits and soft loans. DA will request the Department of Trade and Industry to list fry production as a pioneering industry.
- DA must make an environmental assessment of milkfish fry grounds; collect data on fry

Status of the privatization of the National Bangus Breeding Program (NBBP) stock as of August 1995. An issue of Aqua Farm News (Vol. IX, No. 2, March-April 1992) was devoted to milkfish breeding including a description of the NBBP.

Location	No. of stocks available (no. privatized)	Age (year/ month)	Average body weight (kg)	Drafted or approved MOAs	Remarks
Alaminos, Pangasinan	- (100)	12/9	4.8	Pacific Farms Inc. as of 4 Nov. 1993	production ongoing
Masinloc, Zambales	- (44)	12/9	4.5	Good Fry Hatchery as of 9 Sept. 1994	production ongoing
Puerto Princesa, Palawan	- (318?)	6/0?	3?	MINARCO (MOA in progress)	—
Bacacay, Albay	138 (200)	5/6-6/6	4.5	Greenwater Corp. as of 23 Sept. 1993; MINARCO as of 28 June 1995; 3H Corp. (MOA in progress)	production ongoing
Calape, Bohol	16 (30)	13/1	5.0	Dobe International as of 6 July 1994	production ongoing
Sangali, Zamboanga	115	8/0-8/8	4.0	-	no takers
Baliangao, Misamis Occidental	98	9/0-11/10	4.5	-	status to be confirmed
Sta. Cruz, Davao Sur	- (60)	9/11	4.5	AquaSur Dev. Corp. as of 16 June 1994	production ongoing
TOTAL	367 (752)				

The NBBP stations in Iloilo, Leyte, and Maguindanao have been terminated. (Source: DA-BFAR) production from natural fry grounds, from hatcheries, and imported fry; collect data on the extent of milkfish grow-out, stocking densities for ponds and pens. DA must also regulate illegal fishing along with appropriate government agencies.

- The government must strengthen its policy on environmental education, conduct awareness and advocacy campaigns in schools, and make funds available for these ventures.

In the workshop, SEAFDEC/AQD had an opportunity to present the results of its collaboration on milkfish larval rearing with its private cooperators (tables below). **AQD scientists notes that its technology is comparable in results, if not in scale, with Taiwanese hatcheries.** Because Taiwan has been overproducing milkfish (see pages 21-22), it has often been mentioned as a model worthy of emulation.

Milkfish hatchery operations in five of SEAFDEC/AQD's private cooperators in west central Philippines from 1991 to July 1992.

Hatchery	Commodity		*Average hatching rate, % (range)	Fry produced	Age of fry (days)	Survival rate (%)	Price (P/pc)
Iloilo I	7,886	3,221	48	1,347	21	38	0.36
			(0-75)		(16-26)	(4-86)	(0.30-0.40)
Iloilo II	6,787	732	68	1,487	23	31	0.44
			(59-74)		(22-24)	(25-34)	(0.42-0.46)
Iloilo III	1,500	-	35	32	30	2	0.40
Aklan	4,200	-	75	374	24	20	0.35
			(67-83)		(22-25)	(14-26)	
Capiz	1,956	-	47	62	24	11	-
Total/average	**22,329**	**3,953**		**3,302**		**22**	

*Based on viable or good egg count.

Costs and returns (in pesos) of milkfish hatchery operations in four of SEAFDEC/AQD's private cooperators in west central Philippines from April-July 1992.

Item	Iloilo I	Iloilo II	Iloilo III	Aklan	% production cost
Fry production (thousand pcs)	802	1,487	32	374	
1. Production cost (cost of operation only)					
a. Feeds	15,655	51,851	3,634	5,123	22
b. Power	48,400	18,138	3,091	4,437	22
c. Transportation and Communication	6,640	1,148	480	7,020	7
d. Personal Services	41,360	84,931	1,500	16,450	36
e. Materials and Miscellaneous' Expenses	10,759	6,873	3,338	4,238	13
Total	122,814	162,941	12,043	37,268	
2. Sales	301,260	699,749	12,800	133,350	
3. Net Income	178,446	536,809	757	96,082	

The milkfish industry in Taiwan

Milkfish culture has a history of over 300 years in Taiwan. For decades, the industry ranked first. From simple practices in the 16th century, the industry became highly developed with several specialized sub-businesses (see diagram and photos next page). These specializations make production more efficient, increase croppings in a year, and distribute business risks.

It was not until 1978 that the first success in the artificial propagation of milkfish was reported. In Taiwan, the first successful induced spawning occurred in 1979 and the first successful spontaneous spawning in 1983. This breakthrough assured Taiwan's fry supply which used to be imported from other countries in southeast Asia. The annual demand for fry in Taiwan is more than 100 million.

Since 1987, fry production from hatcheries was higher than that collected from the wild (see table). Milkfish fry are collected from April to October (peak season, April and July). In 1990, the hatcheries provided more than enough fry to meet the domestic demand despite poor survival rates.

Source of milkfish fry in Taiwan (x 10^6)

Year	Hatchery	Wild[1]	Imported[2]	Total
1987	100	30-40	10-30	140-170
1988	60	30-40	10-30	100-130
1989	110	10	10-30	130-150
1990	134	11	10-30	155-175
1991	90	7	7-10	104-107
1992	150	30	30	210

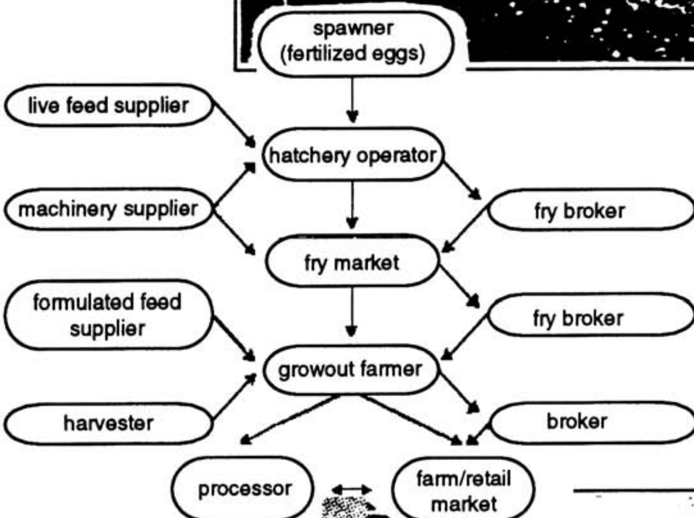
Based on survey of wholesalers and hatchery farms.
[1] Collected from coastal waters off Taiwan.
[2] Imported from southeast Asian countries.

Because broodstocks are rarely caught in the wild and are not available from commercial grow-out ponds, hatchery operators raise their own broodstocks for artificial propagation. Milkfish do not become sexually mature until after five years at least.

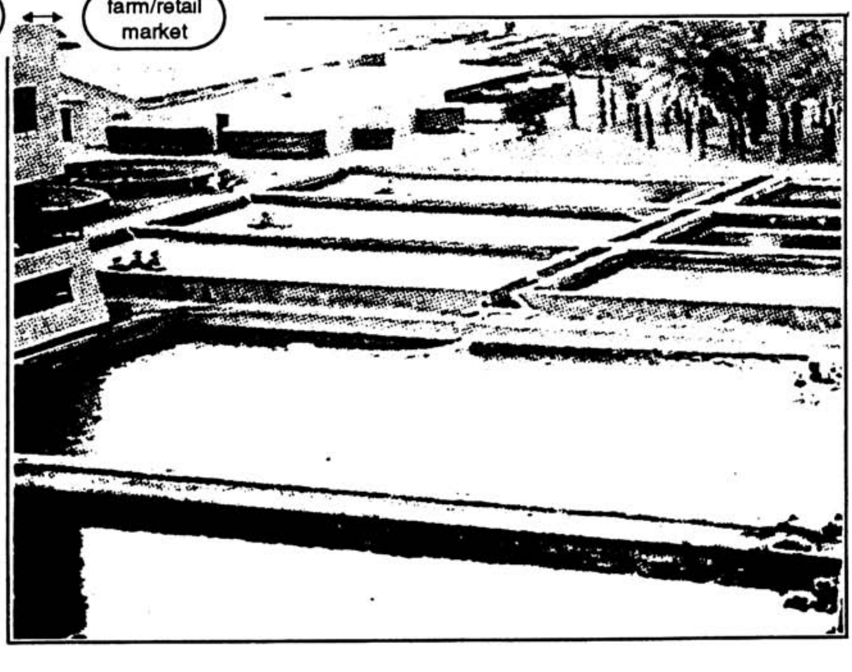
In 1990, the industry suffered economic distress due to overproduction. The price of market-sized milkfish dropped from US$2.30-3.80 per kg to US$1.50-1.70 per kg. Overproduction is partly attributed to the entry of tiger shrimp farmers who shifted to milkfish farming after the 1988 crisis in the tiger shrimp industry. Milkfish fry production also exceeds demand.

Farmers and hatchery operators need to plan and balance the demand and supply ratio. Efforts will be channeled towards developing better processed products to reduce the "boniness" factor and to attract more consumers especially the younger generation. Milkfish specialty restaurants can be established which can also serve as outlets for valued-added products.

Excerpted from I Chiu Liao. 1993. *Finfish hatcheries in Taiwan: recent advances.* In: C-S Lee, M-S Su, I - C Liao. 1993. **Finfish Hatchery in Asia; Proc. Finfish Hatchery in Asia '91.** TML Confr. Proc. 3 Tungkang Marine Laboratory, TFRI, Taiwan and Oceanic Institute, Hawaii, USA.



The diagramatic presentation of Taiwan's highly specialized and compartmentalized milkfish industry. Taiwan's research institute uses concrete ponds to spontaneously spawn milkfish (above); these are aerated to facilitate egg collection. Fishfarmers also use ponds for spontaneous spawning (below).



media monitor

Milkfish and politics

The following articles probably represent the many faces, and politics, of the milkfish industry, although these are focused on the controversial fry shortage. These articles are culled from national dailies and a local community paper -- **Philippine Daily Inquirer** *dated 6 Apr 1995, 16 Mar 1995, 16 Aug 1995, 2 Oct 1995, 18 Jan 1993;* **Malaya** *dated 14 Aug 1995; The* **Manila Chronicle** *undated;* **The Sunday Chronicle** *dated 17 Oct 1994;* **Business World** *dated 24 Aug 1995;* **The Philippine Star** *dated 23 May 1993, 16 Aug 1992;* **Today** *dated 26 Apr 1994;* **Manila Bulletin** *dated 21 Jan 1993; and* **Panay News** *dated 18 Aug 1992.*

Bangus shortage may be next if...

Edgardo Sarrosa, chair of the Chamber of Fisheries and Aquatic Resources (CFAR), received "frantic" calls from their members warning of the "virtual disappearance of fingerlings from local sources." He traced the shortage to the failure of government agencies, including SEAFDEC/AQD, to make up for the drop in the production of bangus fingerlings. Importation of bangus fry from Taiwan could help provide the stock needed by milkfish farms. But because of the high demand, unscrupulous traders and middlemen have made importation a "prohibitive and ugly" exploitation of the industry's predicament. From 25-35 centavos, prices have shot up to P0.95-1.20 per fry. Sarrosa urged the government to intervene and coordinate an orderly importation, including mechanisms to reduce fry mortality during transport.

The ecology factor

The milkfish fry shortage may be real or imagined; no one is quite sure. Importation of fry from Taiwan, a stop gap measure at best, has been liberalized by the government since 1988. The long-term solution, says SEAFDEC/AQD, lies in the concerted efforts of the government and private sector to adopt and commercialize milkfish hatchery technologies at a sustainable level.

The decline in fry collection from the wild could be attributed to several factors. First is the degradation or loss of coral reefs (the milkfish spawning grounds), mangrove areas (the nursery grounds), and sandy beaches (the fry collection grounds). Also, incidental fishing of adults and spawners -- *sabalo* or *awa* -- continues despite laws against it.

Illegal fishing...

Provincial Board Member Roberto Ferrer of Lingayen in Pangasinan says *sabalos* are being poisoned by lead, a non-biodegradable residue of potassium nitrate that is used as blasting material in illegal fishing. Lead was found in high concentrations in Silaqui Island, Bolinao, a few meters away from a private milkfish hatchery. Ferrer notes that agricultural stores are not authorized by the Fertilizer and Pesticide Authority to sell potassium nitrate (also used by mango producers to induce flowering). But yet, the chemical is openly sold.

Because of illegal fishing, Ferrer says, PCAMRD has abandoned the plan to raise *sabalo* in the gulf of Lingayen. Philippine National Police Regional Director Reynaldo Wycoco says illegal fishing is a major concern in the gulf, "but we have minimized it considerably." From January to August, 49 illegal fishers have been arrested, 15 raids conducted, 11 cases filed, and about 117 suspects identified. A five-point, land-based program to fight illegal fishing has been adopted by the police and the gulf area management commission. Alternative livelihood for the fishermen is being prepared.

... and smuggling

Frotilda Chicombing and other fishpond operators in Zamboanga City have complained that they can no longer stock their milkfish ponds because of uncontrolled smuggling of bangus fry. The export of fry to other countries is prohibited under Presidential Decree 704 which fines

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violators a measly P1,000-5,000 and gives 1-5 years imprisonment, Hatidja Manick, chief of the fisheries division of the city agriculture office, says bangus and tiger shrimp fry are smuggled to Taiwan (as tuna bait), or transported to other parts of the country without permit (as specified under the Fisheries Administrative Order #145-1). Simeon Abdullah, a fry gatherer, says he earns up to P1,200 per thousand fry by selling them to "agents" from the Visayas. Local fishpond owners offer only P700.

Manick says *sabalo,* also protected by law from fishers, are smuggled, too.

Technology, or the lack of it

Dr. Rafael Guerrero, executive director of the Philippine Council for Aquatic and Marine Research and Development, says the fry shortage problem in the country is a result of its dependence on wild fry fished in coastal waters. While the country has extensive natural breeding grounds for *sabalo,* fry supply has declined due to destructive fishing methods and environmental degradation.

In the '70s and '80s. much of the research effort and funding was devoted to the development of technologies for spawning milkfish in captivity and rearing the fry in hatcheries. In 1976, Filipino scientists were able to induce spawning using hormones; and again in 1980, another breakthrough in spontaneous spawning of milkfish in floating marine cages. But have these breakthroughs improved fry supply?

It seems not, says Guerrero. There is a need to conduct more studies to enable fishfarmers to commercialize milkfish breeding-hatchery successfully. PCAMRD will assist in these efforts.

Nelson Lopez, supervising agriculturist of DA-Bureau of Fisheries and Aquatic Resources, says DA-BFAR is now offering to the private sector the continuous research in hatchery operations because the government does not have enough funds to perfect the technology.

Another strategy the private sector is considering is the joint venture with Taiwanese firms that have successfully commercialized the production of fry in hatcheries. While some are thinking of adopting Taiwanese technology, Lopez says, it still needs modification to suit the Philippine situation. For one, the use of chemicals in fry production is prevalent in Taiwan and this has adverse effects on the environment.

The fault of the expanding industry?

Dennis Araullo, the officer-in-charge of DA-BFAR. says the fry shortage is due to the expansion of the milkfish industry. Tiger shrimp growers have shifted to raising bangus in pens or cages. The stocking density has also doubled from the traditional 3,000 fry to 6,000 fry per hectare per pond. BFAR estimates that 220.000 hectares of fishponds and 20,000 ha of pens and cages are devoted to bangus. Together, these need 1.44 billion bangus fry per cropping.

Representative Leonardo Montemayor of the peasant sector says a multipronged approach can save the P25-billion bangus industry and keep fish prices down, now ranging from P80-90 a kilo and estimated to reach P130 by yearend. But the immediate step would have to be government financing -- to the tune of P540 to 900 million - and technical assistance to fishfarmers.

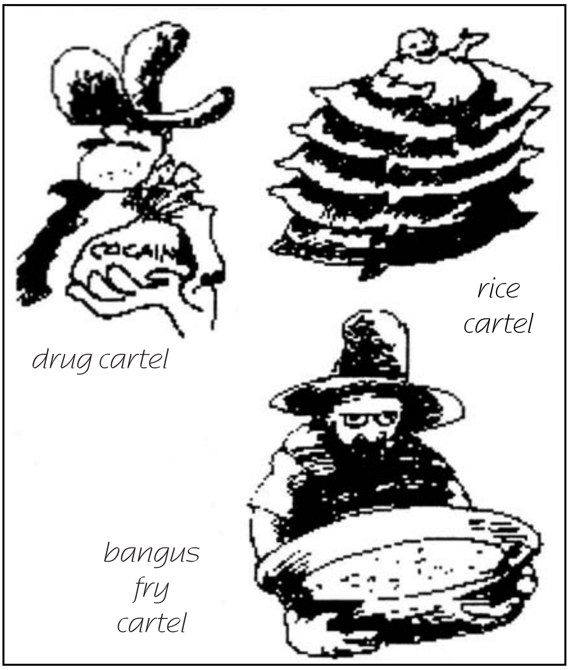
Feeds for high-density milkfish systems

B-Meg, makers of animal and aquatic feeds, launched its new feed line -- bangus feeds. This is the fourth product after its CE-90 and SD-90 shrimp feeds and tilapia feeds. Five kinds of bangus feeds are marketed: fry mash, fingerling crumble, starter pellets, grower pellets, and finisher pellets. Other companies like Vitarich and FeedPro also sell milkfish feeds.

Of pests and pesticides

"May the wind come soon, and may the wind be strong," Ma. Nelia Cap-atan used to pray. For her and other fry gatherers, the northwest monsoon winds would have brought the *bangus* fry to shore. But catch has been declining. If last year she blamed the wind, this time she sees a more complex cause for decline. "Perhaps the trawlers catch the mother fish with their huge nets. Perhaps because we've destroyed the coral reefs. Also because of the fishponds." The village she lives in lies on the bank of Loay-Lobos river (in Bohol). River banks that used to be wetlands have been transformed into fishponds by the politically influential. Cap-atan says no expert has explained things to her but she strongly feels that *bangus* and other species have fallen to the pesticide menace.

Pond preparation requires the application of pesticides to rid the ponds of pests, mostly native species of fish and shells. Brestan and Aquatin are brand names of the organochlorine endosulfan which has been found carcinogenic and subsequently banned. Aquaculturists believe the chemicals to be diluted upon release into a river or sea. Environmental Almanac 1994 disputes this, saying: "A rich broth of plankton, fish larvae, and algae reside in the ocean surface, providing food for numerous fish species and marine life. But along with this bio-broth is a concentration of toxins including pesticides. These toxins tend to concentrate at the surface where they are difficult to disperse, even with wave action." Studies indicate that these pollutants do harm to larval fish and other forms of marine life.



Cap-atan's hunch may be right. And if so, here is another graphic example of the vicious cycle of poison: the fishpond technology destroying the very fry, the supply of which is supposed to sustain aquaculture itself.

Free zones ...

Mayor Efren Esclavilla of Buenavista in Guimaras declared its coastal barangays as free zones. This means, he says, that marginal fishermen who earn their living catching bangus fry are free from the exploitation of middlemen who buy the poor folk's catch at very low prices. The town government has decided against giving fry concessions (the prevailing practice) to businessmen; this set-up obliges the fishermen to sell to the concessionaire in their area.

In Antique, the provincial government urges its municipalities to give *bangus* concessions to registered cooperatives or to give marginal fishermen the liberty to catch and the privilege to sell fry to buyers offering high prices. Antique is a major supplier of *bangus* fry, and concessionaires have amassed considerable profit while the fry catchers endure a dismal income.

... and fry monopolies?

Several town officials near Cagayan de Oro City are being assailed by small fisherfolk who charge them of cornering bangus fry sales. At the center of the controversy is an ordinance which requires public bidding (to increase local tax take) for disposing fry.

"We were deprived by the municipal government and its appointed concessionaire of the right to sell our catch," says Ben Lopez, head of a large fishermen's association. Lopez alleged that officials awarded the concession to a buyer without bidding. So, instead of getting P350-400 per thousand fry, fishermen say they are paid only P150 by the concessionaire. "We are willing to give P5 each to increase the town's income," Lopez said. Instead, the situation appears like an underground business between some officials and the concessionaire. Concessions have deprived fishers of the right to free enterprise and the use of the rich marine resources. Some 232 families rely solely on fishing, Lopez says, and they will have to be penalized if they refuse to sell fry to the concessionaire. The families appeal for the repeal of the ordinance and respect for their freedom to use the marine resources.

Some solutions

Former House Speaker Ramon Mitra says: "We should not open more fishpond areas to prevent the clearing of the remaining mangrove areas." Instead, he recommends steps to increase milkfish production:

- assure the availability of *bangus* fry and support further research to improve the acceptability and viability of hatchery-produced bangus fry; and,
- introduce semi-intensive *bangus* culture as opposed to the intensive method which has adverse effects on the environment.

SEAFDEC/AQD News SEAFDEC/AQD News

AQD scientists invited to a milkfish culture forum

AQD scientists will discuss some aspects of milkfish culture upon the invitation of U.P. Aquaculture Society, Inc. who is hosting a 3-day seminar on **High-density milkfish culture systems.** The seminar is to be held on February 19-21, 1996 at the Bacolod Convention Plaza in Bacolod City.

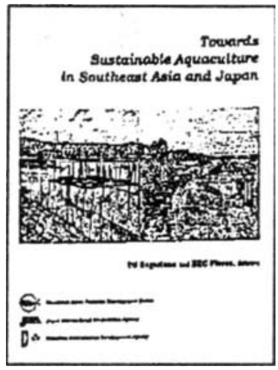
The milkfish industry is slowly moving towards intensification and there is clearly a need to understand the technical aspect of high-density systems to ensure sustainable production. AQD scientists will discuss: feeds and feeding of milkfish, prospects for hatchery-bred fry, production economics, alternative production systems, fish health management, and ecological limits of high-density systems.

AQD scientists will be joined by researchers from the Department of Agriculture and the University of the Philippines - Visayas who will take the lead in discussing pond preparation and natural food production, fingerling production, government R & D program for milkfish, marine pen culture, harvest and post-harvest, and value-added products.

Experienced milkfish farmers will also serve as discussants to share their successes and problems in the field. Their colleagues in the private sector will discuss industry directions, soil-water quality and life-support systems.

The U.P. Aquaculture Society, Inc. invites all fishfarmers, industry practitioners, government extensionists, and other interested parties to the seminar. Contact: UP AQUASOC, P.O. Box 24, Iloilo City 5000.

new publication



Towards Sustainable Aquaculture in Southeast Asia and Japan

edited by T.U. Bagarinao
and E.E.C. Flores
PUBLISHED BY SEAFDEC/AQD
1995; 254 pages

This proceedings volume documents the presentations at ADSEA '94, the third Seminar-Workshop on Aquaculture Development in Southeast Asia. ADSEA '94 included reviews of the status of aquaculture development in Southeast Asia and Japan and of the research conducted by SEAFDEC/AQD to contribute to this development. Invited scientists then talked on various topics including responsible aquaculture, mollusk and seaweed culture, integrated farming, shrimp culture, diseases and health management, and transgenic fish.

The volume also lists the priority research areas of 20 or so commodities at SEAFDEC/AQD in the next three years (1995-1997). Research programs are now directed to the generation of aquaculture technologies that are economically feasible, environment-friendly, and socially equitable.

ADSEA '94 was convened with funding support from the Japan International Cooperation Agency and the Canadian International Development Agency.

SEAFDEC/AQD News

Meeting on the Use of Chemicals in Aquaculture in Asia

20-22 May 1996
Tigbauan, Iloilo, Philippines

The meeting will synthesize all information related to the use of chemicals in aquaculture. It will review the use of antibiotics with special emphasis on their use as therapeutants; ecological effects of chemical use in aquaculture; generation of drug resistance in sediments and soils, tissues, and water; use of chemicals in aquafeeds: human health aspects in aquaculture with emphasis on food safety and food quality assurance; regulations on chemical use in aquaculture: and the use of organic manure, fertilizers, and conditioners. Information on chemical use in these countries will be discussed: China, Indonesia, Japan, Malaysia, Singapore, the Philippines. Taiwan. Thailand. Viet Nam, Cambodia, Laos, Bangladesh, India, and Pakistan.

The recommendations of the Meeting will be directly fed into the Meeting of the Working Group on Environmental Impacts on Coastal Aquaculture of GESAMP (the IMO/FAO/UNESCO-IOC/WMO/IAEA/UN/UNEP Joint Group of Experts on the Scientific Aspects of Marine Environment Protection) that will follow the Meeting at the same venue.

The meeting is organized by SEAFDEC/AQD and FAO's Inland Water Resources and Aquaculture Service with financial support from SEAFDEC. FAO, and CIDA and the cooperation of the Network of Aquaculture Centres for Asia and the Pacific, Japan International Research Center for Agricultural Sciences, Taiwan Fisheries Research Institute, and ICLARM.

Please address all correspondence to: Ms. Celia L. Pitogo/Chair. Local AQUACHEM Organizing Committee, SEAFDEC/AQD.

Training courses for 1996

TENTATIVE SKED

Aquaculture Management	26 Mar - 24 Apr
Fish Health Management	16 Apr - 28 May
Marine Fish Hatchery	3 June - 23 July
Coastal Aquaculture	31 July - 27 Sept
Freshwater Aquaculture	5 Sept -16 Oct
Shrimp Hatchery Operation	1 Oct- 20 Nov
Fish Nutrition	23 Oct - 3 Dec

For application forms and further information, please contact: TRAINING AND INFORMATION, SEAFDEC/AQD.

Second International Conference on the Culture of Penaeid Prawns & Shrimps

14-17 May 1996
Iloilo City, Philippines

The conference will review researches of the past decade, identify research gaps, and propose strategies to make the shrimp industry sustainable. Emphasis will be on genetic resources, environmental impact, emerging grow-out and culture techniques, and socio-economic and management aspects of culture operations. Shrimp physiology, nutrition, and diseases will also be discussed.

Registrations received before 15 January 1996 are discounted. Contact the Secretariat, SICCPPS, SEAFDEC/AQD.

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In citing information from AFN, please cite the institutional source which is not necessarily SEAFDEC/AQD. Mention of trade names in this publication is not an endorsement.

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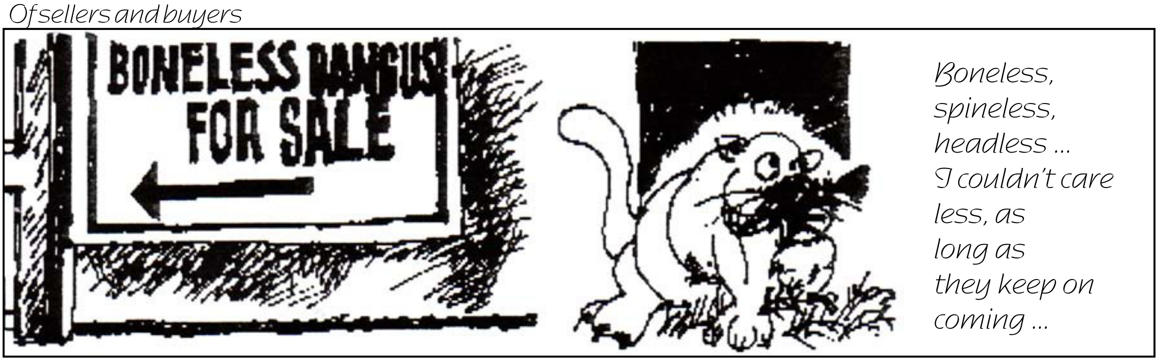

by AP Surtida