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Aquaculture Department, Southeast Asian Fisheries Development Center

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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

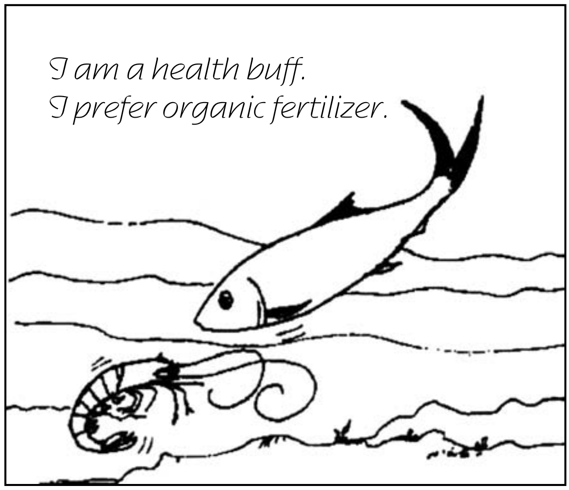
Fertilization. The SEAFDEC standard method of fertilizing brackishwater ponds consists of monoammonium phosphate (16-20-0) at 50 kg/ha plus urea (45-0-0) at 15 kg/ha applied once every two weeks. This fertilizer regimen represents average doses taken from past national surveys among fishfarmers. Monoammonium 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.

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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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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.

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.